UNITED STATES COMMISSION OF FISH AND FISHERIES.

PART III.

REPORT

OF

THE COMMISSIONER

FOR

1873-4 AND 1874-5.

A—INQUIRY INTO THE DECREASE OF THE FOOD-FISHES.
B—THE PROPAGATION OF FOOD-FISHES IN THE WATERS OF THE UNITED STATES.

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Report of the United States Commissioner of Fisheries

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UNITED STATES COMMISSION OF FISH AND FISHERIES,
Washington, February 20, 1875.

GENTLEMEN: In compliance with the order of Congress, I transmit herewith my report for 1873–74 and 1874–75 as United States Commissioner of Fish and Fisheries, embracing: first, the result of inquiries into the causes of the decrease of the food-fishes of the sea-coast and lakes of the United States; and, secondly, the history of the measures taken for the propagation of food-fishes by stocking the rivers and lakes with shad, salmon, and other valuable species.

Very respectfully, your obedient servant,

SPENCER F. BAIRD,
Commissioner.

Hon. HENRY WILSON,
President of the United States Senate; and
Hon. JAS. G. BLAINE,
Speaker of the House of Representatives.

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REPORT OF COMMISSIONER.

The duties intrusted to the United States Commissioner of Fish and Fisheries, as established by joint resolution of the Senate and House of Representatives of the United States the 9th of February, 1871, are twofold: first, an investigation into the cause of the decrease of the sea-coast fishes and those of the rivers and lakes, with suggestions as to the best methods of restoring the same; second, active measures looking toward the propagation and multiplication of the useful food-fishes, either by restocking depleted waters or by introducing desirable species into new localities.

In the two reports already published will be found a history of the measures adopted to accomplish these ends during the years 1871, 1872, and the first half of 1873; and I now proceed to give the history of the labors of the commission from July 1, 1873, to July 1, 1875.*

A—INQUIRY INTO THE DECREASE OF FOOD-FISHES.

1.—INVESTIGATIONS IN 1873.

The labors of the Commission commenced at Wood's Hole, Massachusetts, in 1871, while the season of 1872 was passed at Eastport, in the Bay of Fundy. For the purpose of more completely developing the economical and natural history of the coast of Maine, the chief seat of the herring and cod fisheries, Portland was selected as a second station in that State from which to prosecute the inquiries of the Commission in 1873. Quarters were accordingly secured at Peak's Island, about three miles from the city, where a wharf, with buildings, and good anchorage near by, furnished the necessary facilities.

The law of Congress authorizing the Commission instructs the heads of all the Government departments to render it such assistance as may be in their power; and, in obedience to this requirement, the Secretary of the Navy granted the use of a stanch vessel of about 100 feet in length and nearly one hundred tons burden, then stationed at the Washington navy-yard, and not required at the time for other purposes—the steam-tug Blue Light. Commander L. A. Beardslee, of the U. S. Navy,

* The printing of the reports for the years 1873–4 and 1874–5 was ordered separately by Congress; but no provision having been made for extras, and unavoidable delays having occurred in the printing, it has been thought best to publish the two in a single volume.

was placed in charge of the vessel, and a suitable crew furnished from the navy-yard.

Various alterations were made in the vessel to better adapt her for the purposes to which she was to be applied. A pilot-house was erected on the upper deck, the old one being converted into a laboratory, and a small donkey-engine placed on the forward part of the deck to work the dredge and trawl. Leaving Washington in charge of her commander on the 28th of June, the Blue Light reported at Peak's Island for duty on the 8th of July. She proved to be everything that could be desired for her purposes; her light draught (about 7 feet) enabling her to run into the bays and harbors along the coast, and her seaworthiness to go off considerable distances to the outer banks. As on previous occasions, Professor Verrill, of Yale College, took the more immediate charge of the researches into the invertebrates, while numerous specialists were also members of the party for a greater or less length of time, among whom were Prof. Sidney J. Smith, of New Haven; Prof. J. E. Todd, of Tabor College, Iowa; Prof. E. T. Nelson, of Delaware College, Ohio; Prof. E. N. Rice, of the Wesleyan University, Middletown; Dr. P. P. Carpenter, of Montreal; Dr. J. B. Holder, of the American Museum, Central Park, New York; Mr. G. Brown Goode, curator of the museum of the University of Middletown, Conn.; Prof. Theodore Gill and Dr. E. Palmer, of Washington; Mr. J. E. Thacher, of New Haven; Mr. C. B. Fuller, of Portland; Mr. Spencer F. Biddle, of Philadelphia, and others.

The work of investigation into the general and economical history of the fishes and other marine animals was prosecuted with unremitting energy, and resulted in the acquisition of many important collections and observations. According to a rough estimate, 62 species of fishes, 130 of articulates, 145 of worms, 215 of mollusks, 34 of radiates, 50 of acalèphs, 30 of sponges, and 50 of plants, or about 750 in all, were identified; while the number of minute crustaceans, and other diminutive objects, requiring further investigation, will probably amount to nearly as many more. The present history and statistics of the mackerel, cod, herring, alewives, menhaden, &c., was well worked out as far as peculiar to the coast. The contents of the stomachs of all the fishes taken, under different circumstances, were examined and recorded, and important generalizations reached as to the relationships between the fish, their food, and the differing regions of the sea-bottom. Among other collections made by the Commission were numerous specimens of a species of flounder, *Pleuronectes glaber*, known heretofore by only a single specimen described by Storer in his great work on the "Fishes of Massachusetts."

The collection of invertebrates embraced very many extremely interesting species, some of them entirely new, and others found for the first time on this coast. Among these may be mentioned a species of *Hyalonema*, *Holtenia*, and some other very remarkable siliceous sponges which have lately attracted much attention from naturalists. Some very rare radiates were also secured, among them *Comatula*, *Cerianthus*, *Schizaster*, *Astrogonium*, &c.

The opportunity was of course embraced to study the habits and structures of the animals collected during the season and kept in aquaria; and the artist of the expedition, Mr. J. H. Emerton, made over 300 drawings of these from life mostly of species never before figured, excepting, possibly, a few from shriveled alcoholic specimens.

In addition to the biological researches, attention was paid to questions connected with the physics of the deep seas, this branch of the work being more particularly under the direction of Captain Beardslee, the commander of the steamer. These consisted of a determination of the temperature of the surface-, median-, and bottom-water, at numerous localities, and a daily record at the anchorage of the steamer off Peak's Island. Specimens of the water were also brought up from various depths and secured in well-sealed bottles for examination as to specific gravity, chemical composition, and gaseous constituents.

As on previous occasions, the occasion was made use of by some of the associates of the Commission and its visitors, to secure specimens for various public museums, principally those of colleges, among others an extensive collection was gathered by Dr. Holder for the American Museum of Natural History, Central Park, New York. After the collections have been thoroughly worked up a distribution of duplicates will be made from the stock reserved by the Commission.

Among the numerous visitors to the headquarters of the commission during its sojourn at Peak's Island, some of them members of the American Association for the Advancement of Science, attending its meeting at Portland, were Dr. J. W. Dawson, of Montreal; Messrs. Stilwell and Stanley, fish-commissioners of Maine; Mr. C. G. Atkins, of Bucksport; J. W. Milner, of Waukegan, Ill.; Professor Atwater, of Middletown, Conn.; Prof. Joseph Henry; Captain Walker, United States Navy; Mr. E. B. Elliot; Dr. T. M. Brewer, of Boston; J. W. Harper, of New York, and many others. Mr. W. C. Wyckoff, of the New York Tribune, spent much time on the island in making himself familiar with the operations of the Commission, embodying the results of his inquiries in a series of illustrated letters published by the Tribune in connection with the report of the proceedings of the American Association as one of its "lecture extras."

The Secretary of the Navy also visited the station, and spent several days in examining the operations of the Commission.

As already mentioned, the success of the operations of the season of 1873 was very greatly facilitated by the service of the Blue Light and her force. Special assistance was found in the steam-windlass for hoisting the dredges and trawls; besides saving labor, this permitted more frequent hauls in each day's excursion.

All the known forms of apparatus for deep-sea research were tried by the commission, including a full series of that used on the Porcupine and the Challenger. Among these may be mentioned the so-called accumulator, a device by which sudden strain on the dredge-rope is relieved and its breakage prevented, the use of which, however, was entirely superseded by a very simple "check-stop" invented by Captain Beardslee—an arrangement perfectly available for all uses in moderate weather and at depths less than five hundred fathoms.

Among the most interesting regions explored, were the deeper waters outside of Casco Bay, fifteen to thirty miles southeast from Cape Elizabeth. Here the bottom was of soft mud, with more or less numerous scattered bowlders. The bottom temperature varied from 36° to 40°, while that of the surface was usually between 55° and 65°, or even higher. The temperatures obtained here proved to be quite as low as in the deeper parts of the Bay of Fundy, while the fauna was correspondingly Arctic in character. For full details, however, in regard to the physical and other peculiarities, relating more particularly to the marine invertebrates, the reader is referred to Professor Verrill's report.

In a zoölogical point of view, another most interesting locality worked up during the expedition, was a small sheltered cove at the upper end of Casco Bay, about thirty miles northeast of Portland, known as being inhabited by the round clam (*Venus mercenaria*), a species not found living elsewhere on the coast of Maine. A visit to that place showed a genuine colony of various species now met with only on the south side of New England. A critical examination of the specimens at present found there and elsewhere in the vicinity of Portland, proves, in Professor Verrill's opinion—first, that in the Post-Pliocene and Champlain periods the coast was at a lower level, and the marine climate of Casco Bay colder than at present, probably about that of the present Newfoundland or Labrador coast; second, that at a subsequent period, when the coast had attained nearly or quite its present level, the marine temperature was considerably higher than at present; third, that the temperature of these waters has gradually declined, but was still somewhat higher at the period when the Indian shell-heaps were formed than at present. A similar conclusion is reached by the examination of a colony of somewhat similar character on the Gulf of St. Lawrence. Professor Verrill ascribes the survival of these earliest colonies to the fact that in the increasing coldness of the water, which exterminated certain animal forms not fitted to such temperature, the peculiar isolation and physical condition of the localities in question were such as to protect the inhabitants from the general fate of their neighbors along the coast. He thinks the causes of such changes may have been entirely local, and due to changes in the relative level of land and water in adjacent regions.

For the purpose of making observations at a greater distance from the coast than could be reached by the Blue Light, Professor Peirce, Superintendent of the Coast Survey, kindly authorized the use of the Coast

Survey steamer Bache, for research in the outer waters between Mount Desert and Cape Cod.

The steamer was under the command of Captain Howell, and for a certain period under that of Lieutenant Jaques, while the scientific labors were conducted by Dr. A. S. Packard, jr., and Mr. Caleb Cook. Several successful cruises resulted in large collections of rare and little known invertebrates, including many Arctic forms previously unknown on the American coast. An especially interesting collection was made in the vicinity of Cashe's Ledge.

In addition to the above-mentioned assistance rendered the Fish Commission by the Navy Department and the United States Coast Survey, in compliance with the law of Congress, it should be stated that, as heretofore, the Secretary of the Treasury allowed the detail of the revenue-cutter of the station, (the McCullough, Captain Treadway commanding,) whenever she could be spared, and at a later period the use of the steamer Chase, on Lake Ontario, to assist Mr. Seth Green in securing the spawn of whitefish and salmon-trout, by carrying himself and his men to the fishing-stations and bringing back the eggs, which were then transferred to Rochester for treatment in behalf of the United States and the State of New York.

Further aid was rendered by the Quartermaster-General, who, by permission of the Secretary of War, furnished two tents for the use of Dr. Slack and his party while engaged in shad-hatching on the Delaware River, to be referred to hereafter.

2.—INVESTIGATIONS IN 1874.

In selecting a station for the purpose of prosecuting marine explorations during the year 1874, a locality was sought for sufficiently remote from any previously occupied to furnish additional data in reference to the extension and the geographical distribution of the food-fishes of the coast and the objects upon which they prey; and after a consultation with Professor Verrill, the associate of the Commission in this branch of the inquiry, the village of Noank, Conn., on Fisher's Sound, was chosen. This is situated in the town of Groton, New London County, at the mouth of Mystic River, about midway between New London and Stonington, and sufficiently remote from Wood's Hole, the station of the Commission in 1871, to permit some important zoölogical differences.

The station was reached with a portion of my party on the 29th of June, Professor Verrill and his assistants arriving shortly after, when I immediately proceeded to arrange for a laboratory in the usual manner. The steam-tug Blue Light, which had been laid up during the preceding winter at Portsmouth, N. H., was again kindly furnished to the Commission by the Secretary of the Navy, with Commander L. A. Beardslee, U. S. N., as before, in charge of the vessel, and reached Noank on the 10th of July, in excellent condition. As in previous years, the station of the Commission was visited by a large number of gentlemen, many of them specialists in marine zoölogy, and others having a general interest in the objects of the Commission. During the season the Blue Light was continuously occupied on her trips, losing but little time for repairs or other purposes. The principal points visited by her, in addition to the waters adjacent to Noank, were Block Island, Gardiner's and Peconic Bay, Montauk Point, the mouth of the Connecticut, &c., a range of from thirty to forty miles from the starting-point.

Noank possesses special advantages for fishery inquiries, the inhabitants being engaged almost entirely in fishing, and a large number of smacks being owned at that place, some of which are employed in fishing off the Florida coast during the winter; but which in summer are all occupied in the vicinity, or in trips to the outer banks. Every day numerous cargoes of fish which were brought in for shipment to New York and elsewhere, furnished the means of studying the species in their varying condition of age and season. A full series was obtained for the collections of the Commission, either for photographing or modeling in plaster.

Experiments were made toward the end of July, by Mr. Fred Mather, in regard to the possibility of the artificial propagation of sea-bass (*Centropristes atrarius*), and a considerable number of eggs were successfully impregnated and placed in hatching-boxes. Unfortunately, however, it was found impossible without more extensive precautions than we were prepared to adopt to properly protect the boxes against the weather, and a severe storm at the end of July emptied the boxes and ended the experiment. The experiment, however, will be again tried, as it is believed that the process of artificial propagation is as available for the reproduction of many of the sea-fishes as for those of fresh water. Among these may be especially mentioned the sea-bass, the tautog, the striped bass, the scup, &c.

On the 22d of July, I visited the Holyoke shad-hatching station of the Commission, in charge of Mr. Milner, and found great activity prevailing, and a very successful effort in connection with the distribution of the fish.

On the 15th of August, Mr. Milner reached Noank, accompanied by Mr. Griswold, one of his assistants, for the purpose of testing the effect of the introduction of young shad into salt water, the details of which experiment will be found under the subject of "shad," and also in Mr. Milner's special report on the subject. It may, however, be here stated in general terms, that in adding salt water to the fresh in which the fish were kept, it was found that up to a certain percentage the fish were about as vigorous as in entirely fresh water, although a sudden transfer from fresh to salt water resulted in their speedy death.

With a view of ascertaining the length of time during which shad could be carried safely from one point to another, it was determined to try the experiment of forwarding a number of young fish to Europe, this answering the purpose of a test of the possibilities in the case. If the experiment met with success, the favor of the German government in presenting to the United States a quarter of a million of the salmon of the Rhine could be reciprocated. Messrs. Fred Mather and A. A. Anderson were detailed for the purpose, and visited Noank on the beginning of August to receive instructions, the steamer leaving New York on the 5th of August. Unfortunately the experiment was a failure, the fish dying a few days after the vessel left. These gentlemen returned to Noank on the 11th of September for the purpose of presenting their report. Full reference to this subject will be found under the head of the subject of "Propagation of shad for 1874," and in an appendix, and further allusion to it here is necessary only to renew the reference to the great liberality of the North German Lloyd in granting free passage to the two gentlemen mentioned above, with their freight, to Bremen and return.

The steamer Blue Light went out of commission on the 9th of September, and was laid up, under the direction of the Secretary of the Navy, at New London; after which the work of the Commission was prosecuted almost entirely by means of sail and row boats.

Many interesting discoveries were made in the way of additions of previously unrecorded species on the coast, and in extending the area of the distribution of others. A general sketch of the results, so far as the invertebrates are concerned, will be found in an article by Professor Verrill.

The labors of the Commission at Noank extended over the months of July, August, and September. Professor Verrill and his party left early in September, but the other divisions were occupied until the beginning of October. Remaining a few days to settle up the business of the Commission, I left for Washington on the 8th of October.

The working party of the Commission, for the most part, consisted of the following gentlemen: Prof. A. E. Verrill, of Yale College, in charge of the dredging operations, and of the department of marine zoölogy, with the exception of the fishes, having as special assistants Prof. S. J. Smith, Mr. S. F. Clark, Mr. Turnbull, of Yale College, and Prof. N. S. Rice, of Wesleyan University, Middletown.

The department of the fishes was under the direction of Mr. G. Brown Goode, of the Smithsonian Institution, assisted by Mr. C. W. Schuermann and T. H. Bean of Washington, and Mr. H. C. Chester.

The algologists were Prof. D. C. Eaton, of Yale College, and Dr. W. G. Farlow, of Cambridge, assisted by Messrs. Livingston and Klaburger. Prof. A. Hyatt, of the Society of Natural History, Boston, with Mr. Richard Rathburn, and Mr. Saltonstall, of Boston, were also members of the party.

Among the visitors who devote more or less of their time to natural history investigations, and who availed themselves of the material provided by the Commission, or who desired to become acquainted with its methods, may be mentioned Dr. Joseph Leidy, Prof. Henry Chapman, and Dr. Horatio Allen, of Philadelphia; Prof. D. C. Jordan, of Indianapolis; Prof. F. W. Putnam, of Salem; General A. B. Eaton, Dr. Theodore Gill, and Dr. E. Bessels, of Washington; Mr. W. C. Wyckoff, and Dr. J. B. Holder, of New York; Mr. O. S. Westcott, of Chicago; Prof. J. Hammond Trumbull, and Dr. W. O. Ayres, of Hartford; Mr. W. T. Parker, and M. W. Humphrey, of West Meriden, Conn.

The State fish commissioners, or persons specially interested in fish-culture, visiting the station during the summer, were Messrs. Alfred Read, jr., Newton Dexter, and J. Barden, of Rhode Island; Dr. M. C. Edmunds, of Vermont; Dr. W. W. Fletcher, of New Hampshire; G. C. Anderson, of New Jersey; Mr. J. W. Milner, Fred Mather, A. A. Anderson, and C. D. Griswold, of the United States Fish Commission.

The results of Professor Verrill's labors, and those of his associates in the department of marine natural history and plants, will be furnished in a special report; although it may be proper here to state that over one hundred species of invertebrates, new to the fauna of New England, were secured, most of them northern species, and many undescribed.

The principal localities over which dredgings were made were Fisher's Island Sound; Block Island Sound; off Block Island and south of Montauk Point; the eastern part of Long Island Sound; from Fisher's Island and Gardiner's Island to the mouth of the Connecticut River; the shallow waters in the harbors and estuaries near Noank; Gardiner's Bay, Long Island; Great Peconic and Little Peconic Bays and Greenport Harbor, Long Island. These latter localities showed temperatures much higher than the others, and furnished correspondingly southern types of animal life.

It was clearly shown by the investigations of the Commission that there is a very decided flow of cold currents through Fisher's Island Sound and Block Island Sound into Long Island Sound, and along the deeper parts of the latter for a great distance, especially toward the southern and deeper side. The influence of this cold current is very apparent as far west as New Haven in the deeper parts of the sound. According to Professor Verrill its flowing into Long Island Sound is due largely to the influence of the tidal currents modified by the local wind-currents. On the other hand, the much higher temperature of such inclosed localities as the Peconic Bays may be safely attributed to the direct heat of the sun over a broad expanse of shallow water, from which the cold currents are excluded.

As in previous years assistance was rendered by the Coast Survey in carrying on operations at distances remote from the coast, and which the Blue Light was not suited to reach. A part of the month of September was occupied by the steamer Bache, under command of Captain Platt, in dredging operations off the coast of Maine. The scientific work was in charge of Dr. A. S. Packard, assisted by Mr. C. Cook and Mr. Robert Rathburn. Dredgings at about forty stations were made off the coasts of Maine and New Hampshire, at various depths, down to

125 fathoms. The results of this investigation will also be found in Professor Verrill's report.

The attention of Professor Verrill and his party, especially of Prof. W. N. Rice, was directed to investigations as to the best method of preserving the invertebrates for museum purposes, and to improved methods for killing in an expanded state such species as usually contract when placed in alcohol. In regard to the preservation of *Actiniæ* very satisfactory results were obtained by slowly adding a saturated solution of picric acid to a small quantity of sea-water in which they had been allowed to expand. When fairly dead they were transferred to a pure saturated solution of the acid and allowed to remain from one to three hours, according to size. They were then placed in alcohol of about 60 to 70 per cent. for permanent preservation. The alcohol should be renewed after a day or two, and this repeated until the water is all absorbed from the specimen.

It was found that hydroids and most kinds of jelly-fishes can be easily and beautifully preserved in the same way, but of these the specimens may usually be placed alive directly in the acid of full strength. The success with osmic acid was not so marked, the specimens contracting more, and finally becoming so darkly stained as to render them useless. Various trials were made with different kinds of drugs for the purpose of killing marine animals in an expanded state, but no better method was discovered than that of allowing them to suffocate in stale sea-water

B—THE PROPAGATION OF FOOD-FISHES.

3.—EXTENT OF THE WORK.

The work of propagation and distribution of food-fishes has been enlarged year by year. Applications have been received from all of the States and from four Territories. This has necessitated a continual expansion of the plans for each season's work.

The work of the United States Fish Commission in multiplying useful food-fishes was commenced in 1872, and has been prosecuted with satisfactory results up to the present time.

The species to which special attention has been directed are the shad (*Alosa sapidissima*,) fresh-water herring or alewive, (*Pomolobus pseudoharengus*,) striped bass or rock-fish (*Roccus lineatus*,) California salmon (*Salmo quinnat*,) the salmon of Maine (*Salmo salar*,) land-locked salmon (*Salmo sebago*,) white-fish (*Coregonus albus*,) and the carp (*Cyprinus carpio* and var.,) each of these having special relations to certain portions of the country, and promising in their anticipated aggregate an extremely important addition to the food-resources of the United States.

The States which have so far been the direct recipients of spawn and young fish of more or less of these species are Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Delaware, Maryland, the District of Columbia, Virginia, West Virginia, North Carolina, South Carolina, Georgia, Louisiana, Mississippi, Missouri, Texas, Tennessee, Kentucky, Ohio, Illinois, Indiana, Michigan, Wisconsin, Minnesota, Iowa, Utah, Nebraska, Colorado, and California; while other States, as Alabama and Arkansas, which have not been the actual scene of the operations of the Commission, have been indirectly benefited by the introduction of fish into their waters at points outside of the State limits, thrty-three States and two Territories in all. The extension of the work to other States and its amplification in all is only a question of time.

The operations of the Commission have, it is believed, given entire satisfaction to the people at large, as shown by the general popularity of the measures adopted, the great interest excited in the subject throughout the country, and the appointment of State fish commissions in nineteen States, in most instances for the purpose of directly co-operating with the United States Commission in its efforts to secure from the waters their fullest yield of animal food. This has rightly been considered an object of the greatest importance in view of the rapidly-increasing population of the United States and the almost corresponding diminution in the average yield of vegetable food by the farming-lands, and it is not considered exaggeration to say that the water can be made to yield a larger percentage of nutriment, acre for acre, than the land.

A further evidence of the importance of this effort is shown by the fact that China, with its enormous population, greater to the square mile than that of any other part of the world, derives the largest portion of its animal food from the interior waters of the empire, the methods of fish-cultivation there being conducted in a very efficient manner, and every cubic yard of pond and stream thoroughly utilized.

It is well to bear in mind that the work prosecuted by the United States Commission is in no case that which would be carried on by State commissions or by private enterprise. The States of Iowa, Minnesota, Ohio, or Pennsylvania would not find their advantage in going to any great expense in the way of stocking their streams in view of the fact that the fish, when mature, would, on their return, enter the mouth of the Mississippi and traverse all the intermediate States before arriving within their borders, with the certainty that a large portion of the catch would be secured by citizens of other States. On the other hand, the young and immature fish, requiring the cold upper sources of the streams as their home, will not find in the great waters of the more Southern States the proper conditions for their preservation and growth. Furthermore, the primary outlay for securing the eggs of such species as the California salmon, &c., is greater than single States can meet, while the cost of obtaining a supply for the entire country at a single establishment is much less proportionately than the aggregate cost of separate effort.

The plan as regards the propagation of shad is to establish hatching-camps in March on the southernmost streams on the Atlantic slope, there to hatch all the eggs that can be procured, and, placing a portion of the young fish in the stream where they are procured, to transmit the remainder to other waters now entirely unprovided. This operation would be continued by removing the camps northward as the season advanced until the Connecticut River is reached, toward the end of June, and from which the States along the Great Lakes, the Upper Mississippi, and the Pacific coast would be supplied.

The California salmon is a species which can withstand the warmest regions of the United States, and is extremely hardy and prólific, and its multiplication is considered extremely important. Some idea of the scale on which the work of the commission connected with this species has been conducted can be formed from the fact that the eggs collected during the season of 1875 at the United States establishment on the Upper Sacramento numbered about 11,000,000, with a bulk of 80 bushels, and weighing, with the packing in which they were transported to eastern establishments, nearly 10 tons.

In further illustration of the results that may be looked for from a judicious and systematic prosecution of the work of propagating the food-fishes, we may refer to the Potomac River, in which from six to ten million pounds of shad and herring are taken during the spring months alone. There is no reason why any stream in the United States having direct communication with the Gulf of Mexico, or either ocean, may not be made to abound in an equal degree with these and other fishes, and in view of the aggregate of the animal food to be derived from a number of such streams, the importance of this work can hardly be overestimated.*

Another fish to which it is proposed to devote the efforts of the Commission is the European carp, a species eminently calculated for the warmer waters of the country, especially the mill-ponds and sluggish rivers and ditches of the South. This fish has been domesticated for thousands of years, and is one of the species which furnish the principal food of the Chinese. Living on vegetable matter instead of animal, it can be multiplied at very little expense in restricted waters.

It is not alone to the introduction of suitable fishes into water previously uninhabited by them that the efforts of the Commission are directed, but also toward restoring a full supply to streams where they were formerly abundant. At one time all the rivers on the Atlantic

* Large, however, as is the present yield of "herring" and shad in the Potomac River it is but a mere fraction of that which prevailed less than fifty years ago. Martin's Gazetteer of Virginia and the District of Columbia, published in 1835, states that the number of fisheries on the Potomac in the previous year was 150, and that in six weeks' time 22,500,000 shad and 750,000,000 herring were taken in this river. Allowing an average of three pounds for each of the shad and three-fourths of a pound to the herring, we have the enormous aggregate of 630,000,000 pounds of food taken in a single river in six weeks' time alone, not including the immense quantity of striped bass or rock-fish, sturgeon, and other fish that doubtless belonged to the catch. These statistics, large as they appear, are corroborated by the older fishermen of the Potomac.—S. F. B.

coast abounded in shad and furnished an enormous aggregate of food, sufficient for several months' supply to the inhabitants, and allowing a surplus for shipment, either fresh or salted. Now, however, this condition has become a matter of tradition in regard to nearly every stream south of the Potomac, and nothing but artificial propagation will restore the stock. When, however, we bear in mind that the eggs of a single pair of shad, artificially treated, can be made to produce more young fish than those of two hundred pairs of natural spawners, the importance of the measures adopted by the Commission will be readily appreciated.

4.—THE SHAD.

The hatching and distribution of shad began rather late in 1874, as the appropriation for the purpose was not available early enough for work in southern rivers. In the last week of June Mr. Milner proceeded with a force of men to the hatching-station of the New York commissioners, at Coeymans Landing on the Hudson River, from which point the distribution to western waters was at once begun. Four hundred thousand shad were placed in the tributaries of the Mississippi, in the Brazos and Colorado Rivers of Texas, and the tributaries of the great lakes. On the 3d of July the traveling parties moved to South Hadley Falls, Mass., on the Connecticut River. From this station over two millions of shad were transferred to the tributaries of the Mississippi, of the great lakes, Lake Champlain, and rivers of New England. Five hundred and sixty-five thousand fry were carried above the dam and placed in the Connecticut River, for the most part above Bellows Falls, Vermont. In all, three million and thirty-one thousand young shad were planted in waters of the United States between June 25 and August 15 of 1874.

Those in charge of the transfers were very successful in transporting these fishes and in placing them, in a healthy condition, in the waters for which they were destined.

The generous action of Germany in the gift to the United States, in 1873, of 250,000 salmon-eggs prompted an attempt to transport some young shad to Germany, and the North German Lloyd Steamship Company kindly offering free passage for both men and fish to Bremen and back, the experiment was entered upon early in August. On the 5th of August Mr. Fred Mather and Mr. A. A. Anderson left by the steamer Donau, captain Neinaber, with 100,000 shad-embryos, a large and convenient compartment was assigned for them, and the cans were so arranged that the movement of the ship need not affect the shad, while an abundance of Croton water was taken on board for their use. Unfortunately, after six days the fish showed signs of distress and in ten days they were all dead.

A detailed account of the trip will be found in Mr. Mather's report. Excepting in this instance every shipment was a complete success.

Shad-hatching in 1875 was commenced April 1. The first efforts were on the Neuse River, North Carolina. A camp was established by Mr. Milner at Kinston, in the vicinity of three fisheries, which was continued until May 10. The river was exceedingly high during the whole time. Continued fishing was not begun until April 14, when the water had lowered sufficiently for seine-hauling. The catch was very light, and no spawners were found.

On the 12th of May a camp was made near Fish-Haul, on the Pamunky River, Virginia, and some fifty thousand eggs impregnated, but the ova not thriving well the station was continued only ten days, with results of no consequence.

On the 27th of April a reconnaissance of the fisheries of the Potomac was made in the steam-tug Triana, United States Navy, Captain Cook, kindly placed at my disposal by the Secretary of the Navy. Mr. Milner directed the trip, the commissioners of Virginia and Maryland being members of the party. The results secured by this reconnaissance were an intimate knowledge of the fisheries, the selection of favorable hatching-stations, and the securing of a collection of the fishes of the river, while the good will of the fishery proprietors was sought for the purpose of facilitating the obtaining of eggs at the fisheries. A full report of the expedition will be found in the appendix.

Stations were established on the Potomac at Free-Stone Point, Va., at the Virginia end of Long Bridge, and, later, at Moxley Point, Md., and at Ferry Landing, Va. The work lasted from May 15 to June 5, and about 4,885,000 shad were released in the Potomac River. The season at the fisheries was a poor one. The protracted cold weather of the spring retarded the ripening of the ova, and the eggs did not thrive well in the cold waters after they were taken from the fish. In an ordinary season a much larger number of young shad would have been placed in the water as the result of such effort. Still this is to be considered as very fair success if compared with the hatching of 1873, which yielded only 1,370,400 shad for the Potomac, and 70,000 shipped to waters of Virginia and West Virginia.

The season having closed in the region just referred to, traveling parties proceeded to the Hudson River, arriving on the 11th of June, when the work of distribution began. Shipments were made from here to four important tributaries of the Mississippi, and to the Colorado River of Texas, of about 425,000 young shad.

On the 1st of July operations commenced at South Hadley Falls, Mass. The first shipment was started on the 7th of July, between which date and the 31st, transfers were made to waters in the Mississippi Valley, Lake Champlain, to the Atlantic Slope rivers, and the rivers of the Gulf States. As a general summary of the work at this station, it may be stated that the waters of New England other than the Connecticut River received 320,000 shad; there were carried westward and southward, 590,000; carried above the Holyoke Dam to the Upper Connecticut, 1,205,000; batched and put in below the dam, 4,500,000; sent to Germany, 400,000. Total, about 7,000,000.

From Point Pleasant, Pa., shipments were made of about 200,000 shad, on July 8, to the headwaters of the Roanoke, in Virginia, and to the Pearl River, of Mississippi and Louisiana.

The entire number of shad hatched out during the season was over 12,500,000. The accompanying tables give the facts pertaining to their distribution. Preference was given this year to the Mississippi waters and the rivers of the Atlantic and Gulf slopes. The only shipments to the tributaries of the lakes were to those of Lake Champlain.

In reviewing the labors of the season, it may be remarked that no success was had in southern waters, the stock of fishes being greatly reduced and the hauls small, and consequently ripe male and female fish are rarely obtained at the same time. The Potomac, although the season's catch was very much diminished, afforded a larger quantity of eggs, but it would appear to be at a disadvantage when compared with the Hudson or the Connecticut for obtaining spawn.

The head of the present migration of the shad in the Connecticut is the Holyoke Dam. For a half mile below the dam, the water is shoal and runs among projecting rocks. Just below the Holyoke Bridge is a deep and wide area of the river, into which the shad congregate to spawn. This is the seining-ground, and offers probably the best facilities for obtaining shad-ova of any locality in the United States.

In the Hudson the upper spawning-ground is near Coeymans Landing, where a long projecting point shelters a large bayou or arm of the river. About twenty miles above this is the Troy dam, which, until the fishway was erected, was an effectual obstruction to the fishes, but for some reason few shad go above Coeymans. So well recognized is this habit, that the occasional shad found above the Coeyman's spawning-ground are termed gipsies. This station of the New York commission is established at the spawning-grounds, where plenty of ripe fish are to be obtained during the season.

The Potomac has no extensive seining-ground above the end of Long Bridge. Small seines, pound-nets, and skim-nets are used to the very foot of the falls, but no hauls are made sufficiently large to warrant a hatching-station with the probability of taking ripe males and females at each haul above the Jackson City fishery. In fact, the spawning-ground does not concentrate at any one point, but is found along the river at nearly all the shad-seining grounds. This compels a multiplication of stations, and the past season eggs were obtained from Free Stone Point, Ferry Landing, and the end of Long Bridge, Virginia, and from Moxley Point, Maryland, and in fact it would be worth while to test any fishery where there was sufficient shelter for the hatching-boxes from the effect of wind and sea. The Ferry Landing fishery afforded the largest number of eggs in 1875, although the time occupied was shorter than at some of the other localities.

Hoping to favorably solve the problem as to the possibility of carrying young shad alive across the Atlantic Ocean, in which a failure was experienced in 1874, a shipment was determined upon during 1875, and the preliminary experiments were first begun at Washington under the care of Mr. Fred Mather, who made the attempt the previous year. Among the apparatus devised by this gentleman was a cylinder of tin hung upon gimbals, as would be necessary at sea. Within the cylinder was a screen a few inches from the bottom. A current of water flowed through a rubber hose into an inlet in the bottom of the cylinder, and, rising through the screen, overflowed at the top. No success, however, was obtained with this contrivance, and Mr. Mather proceeded to Point Pleasant, Pa., to renew his experiments at the shad-hatching station near that point.

A new device, however, was finally hit upon, the suggestion of Mr. Charles Bell, Mr. Mather's assistant. Instead of a cylinder, a funnel-shaped vessel was made, the bottom above the inlet being guarded by a wire screen only 2 inches in diameter. The eggs were put into the funnel, and the flow of the water up through the small end lifted them toward the surface repeatedly as they fell back toward the bottom. Mr. Mather reported his experiments with this arrangement as entirely satisfactory, and recommended it for the Atlantic trip, as will be seen from his report in the appendix.

At Coeymans Landing experiments for a similar purpose were begun about June 15, by Mr. Welsher, who, before they were completed, associated with him Mr. Monroe A. Green. In these the eggs were taken soon after impregnation and put into a series of flannel screens, which were adjusted in a case in the same manner as a case of drawers. In the upper screen was a quantity of ice, the water from which dripped upon the screens below. By this process the eggs were successfully retarded about seven days, and then hatched out as vigorous fishes. Mr. Welsher having announced the success of his experiment in advance of Mr. Mather's completing his, he was called upon to take charge of the trip across the ocean.

About four hundred thousand eggs were taken and impregnated by Mr. Monroe A. Green, on the night of the 16th of July. These were all selected eggs, the lighter ones from each fish having been flowed out of the impregnating pans and only the heavier superior ones retained. The screens were filled, and the cases with a large quantity of broken ice placed in contact with them, packed in turners' shavings. The shipment started from New York on the steamer Mosel, Captain Neinaber, the 17th of July. The purpose was to carry the eggs in the cases for six or seven days, and then remove them to tin vessels devised by Mr. Green, when they were expected to hatch and the embryos to remain until deposited in the Weser. This hatching-apparatus was a tin funnel, quite similar in form to Messrs. Bell and Mather's; but, instead of the flow of water and movement of the eggs by a stream of water, air was forced in from below; the bubbles, forcing the water upward in a current diverging along the outward sloping sides of the funnel, raised the eggs with a cloud of minute bubbles of air. Nine of these funnels were provided with rubber hose leading to an air-reservoir filled by an air force-pump. Unfortunately, however, on opening the cases after getting under way, the eggs were found to have suffered from railroad jolting, and they all rapidly died before any were hatched or even the eye-specks had begun to show.

At the end of the season at South Hadley Falls, Mass., Mr. Milner arrived at Noank, bringing with him about 45,000 shad, when experiments were carefully made in attempting to accustom shad to small proportions of sea-water. For this purpose, earthen jars with a capacity of about four gallons were used. The object in view was to ascertain the effect of a very gradual increase of sea-water. The jars received a continually-increasing proportion of sea water, until, in two of the tests, it became all sea-water. In the other two experiments, it was allowed to reach a certain proportion and so remain. Other jars were assigned for tests of the effect of different temperatures upon the fish. It was found that shad placed directly in sea-water die very rapidly, but that sea-water introduced gradually and in small proportions has not a sensibly injurious effect. The decision, however, was against its use, unless with extreme caution and in very small quantities, when it is absolutely necessary for purifying stale water. Later in the season, Mr. Chas. D. Griswold experimented with partially-grown shad taken at Holyoke, Mass. The results showed far less advantage in the transportation of the older shad; the numbers that could be carried were but a minute fraction of the large numbers of embryos usually transported, while in most instances they did not survive as long as the younger fish.

5.—CALIFORNIA SALMON.

Mr. Livingston Stone arrived at the McCloud River station and began operations August 6, 1873. A pen, or corral, was built in the river, but it was found to be too small, the fish not retaining their vigor, while a large proportion of those confined in the inclosure died. The seine was again resorted to, and sufficient salmon taken to make up the prescribed quota of 2,000,000 eggs. The hatching establishment was moved to the bank of the river, and the water raised by a bucket-wheel turned by the current.

The eggs were packed in moss in boxes two feet square by one foot deep, each containing 75,000 eggs. Two boxes were put into a crate, with a space on all sides, which was packed with hay and broken ice. When ready for shipment, there were about 2,000,000 in good condition. The first lot, 300,000, was shipped September 20, 1873; a second lot, 500,000, on the 30th; a third lot, 330,000, October 7th, and a fourth lot, 250,000, on the 14th. A fifth lot, 20,000, was placed directly into the McCloud River on the 19th of October, and 500,000 were left to hatch. The total was 1,900,000 salmon-eggs.

The consignees who received the eggs and arranged for their care in the hatching-houses where they were carried forward until the young fish were placed in the waters, with the number of eggs to each, were as follows: J. H. Slack, Bloomsbury, N. J., 550,000; James Duffy, Marietta, Pa., 170,000; Seth Green, Rochester, N. Y., 200,000; R. G. Pike, Middletown, Conn., 150,000; Livingston Stone, Charlestown, N. H., 50,000; E. A. Brackett, Winchester, Mass., 50,000; Charles G. Atkins, Bucksport, Me., 50,000; George H. Jerome, Niles, Mich., 120,000; A. P. Rockwood, Salt Lake City, Utah, 40,000; Dr. W. A. Newell, San Francisco, Cal., 20,000. The 500,000 for the Sacramento waters were hatched at the station. Some of the cases of eggs arrived in excellent condition, while many were found to have heated and fermented, with but a small proportion of the eggs in a healthy condition. The number of fishes reported by the State commissioners as resulting from the 1,900,000 eggs was 1,522,930, the distribution of which is given in detail in the appended table.

Mr. Stone began operations at the McCloud station on the 5th of July, 1874. Modifications in the apparatus used were effected which resulted in a great improvement of the condition of the eggs. The trays in the hatching-boxes were quite deep, and the eggs put into them in twelve layers; the water rising from below in the Williamson troughs buoyed the eggs so that the lower layers did not suffer from the weight of those above them. By this means space was economized and a very large number of eggs cared for. The corral, or pen, of the previous year was also improved upon. A substantial timber-grating was built across the stream somewhat in the style of that used by Professor Rasch in the fiords of Norway. Below the fence large corrals, or pens, were erected, into which the salmon were gathered and retained until their spawn was needed. The grating was an entire bar to the salmon, no opening being left to permit their passing above it; and the experiment satisfied Mr. Stone that salmon which ascend the river to spawn never return to the sea. The number which had passed above the grating before it was finished, he estimated at hundreds of thousands, while thousands crowded against its lower side when completed, vainly attempting to pass. As to their return, he failed to discover a single live salmon, though thousands of dead ones lodged against the upper side of the grating.

The work of developing the eggs to the point of hardiness requisite for their safe shipment, was continued until the 25th of September, when the first shipment was made. On the 18th of October, the sixth and last shipment was made. The whole number transmitted eastward was 4,155,000, which with 850,000 hatched at the station for California waters, make a total of 5,005,000. There were reported from these 2,908,710 fishes distributed, and 25,000 eggs remaining to be heard from. November 30, the last of the fishes was placed in the waters of the McCloud and the camp closed for the season. The details of the distribution will be found in the accompanying table.

The California salmon, believed to be the same as the *quinnat* salmon of the Columbia River (*Salmo quinnat*, Rich,) is one of the largest of this family. Its average weight in the Sacramento River is 20 pounds, while in overgrown individuals it is as high as 100 pounds. Its flavor when fresh and properly cooked is scarcely inferior to that of the Atlantic coast salmon (*Salmo salar*,) and in the markets of California and as far eastward as New York it is sought as a luxury, and commands a high price. Prepared in cans it finds a wide market throughout the United States and in Australia.* It is by far the most prolific fish on the Pacific coast. Of an anadromous habit, it swarms up the Columbia, the Sacramento, and San Joaquin Rivers in vast shoals from March to August, and thus becomes valuable not merely as an occasional article of table luxury, but as a large commercial resource. Statistics published in the weekly Astorian, Astoria, Oreg., for the season of 1875 on the Columbia River, give 13,000,000 pounds as the aggregate put up at the different canning establishments, which sold at the average wholesale rate of eleven cents per pound, making a total money value of $1,430,000. Besides the sale of the fish as food the manufacture of oil from the heads has been begun, and this season a single fishing locality produced 9,000 gallons.

Statistics procured from the books of the Central Pacific Railroad Company show that 4,079,025 pounds of salmon were shipped from points on the Sacramento and San Joaquin Rivers between November 1, 1874, and August 1, 1875. (See report of California commissioners, p. 11.)

The species has proven itself thus far to be the best adapted of the family to the methods of artificial propagation. When properly packed and kept at a sufficiently low temperature the eggs endure transportation with inconsiderable loss. Once in the hatching-troughs the loss is very small before hatching, while the young are possessed of great tenacity of life, and grow to be several months old with less loss than has been experienced with any other species; indeed, they are commended by all the fish-culturists who have had to do with them for their hardiness, activity, and good-feeding tendencies. In the mature stage they are capable of adapting themselves to a variety of conditions. They pass up the Sacramento when its waters are turbid from the great quantities of sediment washed into them by the rains and the extensive

* An item published in several of the newspapers of the United States has a tendency to excite prejudice against canned salmon as food. It appeared under the heading "Poisoned by eating canned salmon," and stated that part of a can had been partaken of by several persons who experienced no unpleasant results, but that after two days the remainder of the contents of the can which had been set aside and exposed to the air, being again eaten of by the same persons, purging and strong symptoms of poisoning resulted. The fact that such large quantities of the article are consumed throughout the country with but a single instance of any ill effects suggests the possibility of something else than the salmon as a cause for the sickness—the accidental mixture, perhaps, of some deleterious article with the salmon before it was served.

hydraulic mining operations along the banks of the river and its tributaries; they go up through the warm valley of the San Joaquin River, lying in the second hottest summer area of the United States, in large shoals, ascending the numerous side tributaries to their spawning-grounds. The hottest temperature area for the months of June, July, and August, as shown by the temperature charts for the United States, lately compiled for the Smithsonian Institution, is the region of the Gila and mouth of the Colorado Rivers in Arizona Territory. The mean for these months is 88° Fahrenheit. The valley of the San Joaquin, portions of Arizona, and the lower valley of the Rio Grande River have a mean of 84°. No other portion of the United States has so high a summer mean. During the months of August and September, 1875, temperature observations were made at the railroad bridges of the Central Pacific Railroad.* The maximum, minimum, and mean temperatures for the months of August and September were as follows:

		Maximum.	Minimum.	Mean.
		°	°	°
Upper crossing	Air	107	82	98.7
	Water at surface	84	74	79.7
	Water at bottom	83	73	78.7
Lower crossing	Air	98	73	86.9
	Water at surface	82	72	76.3
	Water at bottom	81	71	76.2

As referred to by Mr. Milner in a communication to the commissioners of fisheries at their meeting in New York, February 10, 1875, the Sacramento salmon, and especially the colony entering the San Joaquin River, spawn in latitudes farther south than any anadromous species of the genus *Salmo*.†

In the report of the commissioners of fisheries of the State of California, for the years 1874 and 1875, the following statement is made with reference to the Sacramento salmon: "Large numbers pass up the San Joaquin River for the purpose of spawning in July and August, swimming for one hundred and fifty miles through the hottest valley in the State, where the temperature of the air at noon is rarely less than 80° Fah., and often as high as 105°, and where the average temperature of the river at the bottom is 79° and at the surface 80°. The salmon of the San Joaquin appear to be of the same variety as those in the Sacramento, but average smaller in size." Leaving the bed of the San Joaquin, they ascend the tributaries, the Merced, the Stanislaus, and others, and find their spawning-grounds in the snow-fed sources of these

*A series of observations were made on the temperature of the San Joaquin River, California, through the kindness of Mr. B. B. Redding, of Sacramento, commissioner for fisheries of California.

†The trouts, *Salmo fontinalis*, Mitch., in the Appalachian range, and *Salmo pleuriticus*, Cope, of the headwaters of the Rio Grande River, extend their range to about the same latitude, 37° N., as the San Joaquin salmon.

streams. The mean temperature for the Sacramento for July, said to be of ten years' observations, is given at 74°.66.*

The temperature for the McCloud River was observed between the 6th of July and the 12th of November, 1874, at 6 a. m., 3 p. m., and 6 p. m. by Mr. Livingston Stone, the maxima, minima, and means of which will be found in the following table:

Temperature, air and water, at McCloud River hatching-station.

		Air or water.	Maximum.	Minimum.	Mean.
			°	°	°
July	24 days; 67 observations	Air	106	48	76.4
	26 days; 73 observations	Water	62	54	57
August	31 days; 87 observations	Air	97	43	70.7
	31 days; 86 observations	Water	60	52	55.9
September	27 days; 78 observations	Air	100	37.5	67.8
	27 days; 77 observations	Water	58	49	51.1
October	31 days; 88 observations	Air	96	35	56.56
	31 days; 91 observations	Water	55	42	49.8
November	12 days; 30 observations	Air	58	35	48.4
	12 days; 28 observations	Water	50	42	46.89

Observations of the temperatures of the Columbia River have been kindly furnished by the firm of the Oregon Packing Company, J. W. & N. Cook, proprietors. These were made in the months of May, June, July, and August, 1875, at 7 a. m. and 12 m. The results are shown in the following table:

	Water.	Maximum.	Minimum.	Mean.
		°	°	°
May, 22 days; 44 observations	Water	56	50	46.2
June, 26 days; 52 observations	Water	61	55	58.3
July, 27 days; 54 observations	Water	70	60	66.2
August, 12 days; 24 observations	Water	70	65	66.8

By this series of temperatures, which exhibits the maxima, minima, and means of the waters where the fish have their natural home, we are enabled to judge as to the degree of warmth they may be expected to endure when transported to new waters. The testimony as to the warmth of the San Joaquin water is the most important, reaching, as it does, a maximum of 84°, and showing a mean of nearly 80° during the two months the salmon are ascending in large numbers. But the high temperature is not the only seeming trouble they encounter. According to the observer at the San Joaquin bridge, the water was very turbid at the time it was so warm, yet the salmon, passing up in large numbers, appeared in the clear waters of the tributaries higher up in a healthy, vigorous condition.

Taking into consideration the temperature, the turbidity, the volume, the velocity, and the characters of the sources, as well as the other physical conditions of the rivers inhabited by the California salmon, it seems probable that a very large number of the rivers of the Eastern

*Proceeding of the Agassiz Institute, Sacramento, California. Annual address and report on physics, &c., of Sacramento River, by Thomas M. Logan, M. D., president, October 20, 1873.

United States are equally adapted for the production and growth of this species.

On the Atlantic slope, there are few if any rivers as turbid as the Sacramento; few which have not spring sources in the Appalachian range, and among their tributaries many rapids, pools, and eddies, in rocky and gravelly places, suitable for spawning-grounds. Of the rivers of the Gulf States, the Chattahoochee and the Alabama have their sources in the southern slopes of the Blue Ridge, among cool, spring-fed brooks. They rise among hills and rocks in a country full of large springs. The Brazos and Colorado Rivers, of Texas, have their sources among the springs of the southern hills and spurs of the Rocky Mountains, and the Guadalupe and San Antonio Rivers are fed by large springs. Most of the Texas streams are turbid, but not more so than the Sacramento or San Joaquin.

The suggestion that the salmon are not likely to find suitably cold waters after descending to the sea, the following facts show to be groundless.

The temperatures of the bottom of the Gulf of Mexico have been recorded* through a series of lines extending from the longitude of the mouth of the Mississippi to the Tortugas and Key West, Fla., and temperatures found equally as cold as those off the coast of Massachusetts and New England. As low as 34° Fahrenheit has been observed at a depth of 896 fathoms; at depths of 421, 610, and 790 fathoms, 35° and 36° were observed, while 40°, 41°, and 42° were common at from 400 to over 1,800 fathoms, and 50° to 60° between less than 100 to 400 fathoms and more.

The only peculiarity especially notable in the streams to which the California salmon belong is that they are snow-fed during most of the year. As, however, the Maine salmon, a species much more sensitive to heat than that of California, inhabits rivers not snow-fed, and moreover is kept in the Bucksport breeding-pond throughout the entire summer at a temperature of 70°, we have a sufficient guarantee that the California fish will not be affected in its transfer; indeed, the whole question is one relating to the rapidity of development of the eggs, rather than to the conditions surrounding the fish; the warmer the water the more rapid and premature the birth of the embryo.

Thus far we have left entirely out of consideration the great system of waters contributing to the Mississippi River. The main stream extends from latitude 47° 50′ to 29°, and the northernmost tributary of the Missouri as far north as 50°. Its greatest length is 2,616 miles,† from its highest source to the Gulf. From the source of the Madison Fork, the formerly-supposed head of the Missouri, (within the National Yellowstone Park,) to the Gulf, it has a length of 4,194 miles.†

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* Coast Survey reports.

† See measurements in tables on page 91 of the Physics and Hydraulics of the Mississippi River. United States Engineer Bureau.

The Mississippi River, with its tributaries and subtributaries, as laid down on the larger maps of the United States, exhibits over 120,000 miles of combined lengths,* which we know falls much within the extent of waters available for food-fishes; and, were the system of the Chinese adopted, all waters would be considered down to the brooks, ponds, and even ditches.

From this an idea may be formed of the vast work to be done in making the waters of the United States afford their proper quota of the food-resources of the future.

The physical conditions of the Mississippi River in contrast with the rivers of the Atlantic coast which contain or have contained the Atlantic salmon (*Salmo salar*) are very marked. Such streams as the Saint John of New Brunswick, the Penobscot, the Kennebec, and the Androscoggin of Maine, the Merrimac of New Hampshire, and the Connecticut of Western New England are, for their greater lengths, clear and with rocky bottoms, with considerable fall, and with sources, in the longest, not more than 500 miles from the sea.

The Lower Mississippi is a turbid, alluvial stream, with a fall of less than 5 inches to the mile for eighteen hundred miles from the Gulf. The nearest source, having an elevation of 3,000 feet, is near the head of the Red River, about 1,500 miles from the delta. Fort Atkinson, Kansas, on the Arkansas River, has an elevation of 2,331 feet, 1,750 miles from the mouth of the Mississippi River.

The remoteness of the elevated cold sources of the Mississippi seems to be its most unfavorable feature when viewed as to the adaptation of salmon to its waters. The California salmon traverse the Sacramento Valley to the headwaters of the Little Sacramento and the McCloud Rivers, about four hundred miles, to the headwaters of the San Joaquin, about two hundred and fifty miles. To Fort Boise, on the Snake River, where the *Salmo quinnat* are said to have been taken from the mouth of the Columbia River, is about seven hundred miles. There is no hindrance to their ascent to the vicinity of the Shoshone Falls, one hundred and fifty miles above Fort Boise, which would increase the distance from the Pacific Ocean to about eight hundred and fifty miles. The great Shoshone Falls of the Snake River, over two hundred feet high, are of course an effectual barrier to their progress up the stream.

In the report of the commissioners of Iowa,† a correspondent writing from Elko, Nev., says: "This stream is one of the many that form the headwaters of the Columbia River, and to this point, eighteen hundred miles from its mouth, the salt-water salmon come in myriads to spawn."

* A rough approximation made by running a chartometer on the Land-Office map, and correcting the error by comparison of lengths of seventeen rivers given in the work just referred to.

† First Report of the State Fish Commissioners of Iowa for the years 1874 and 1875. Des Moines: R. P. Clarkson, State Printer, 1876, p. 17

The large King salmon, or chowichee,* and the Red salmon, hoikoh,† are, according to Mr. Dall, taken as far up the Yukon River as Fort Yukon, fourteen hundred miles from the sea.

The shad of China, samlai (*Alosa reevesii*, Rich.,) according to Mr. Salter, extend their migrations up the Yang-tse-kiang for over a thousand miles; and, according to Dr. MacGowan, to a distance of three thousand miles from its mouth.

A specimen of a shad (*Alosa sapidissima*) was received at the National Museum from Mr. R. O. Sweeney, which was taken in the Mississippi River at Saint Paul, Minn.

From these facts we may infer that the instinct of location is probably sufficient to attract a colony of fishes as far inland as the headwaters of the longest river, whenever their home has been once established there.

The vigorous strength and the energy exhibited by the California salmon during its migrations up the Sacramento and Columbia Rivers, afford the evidence that its capacity for a long migration from the sea to its spawning-grounds, is unsurpassed by any species of fish known.

Wherever the California salmon, in the process of artificial propagation, has come under the hands of the fish-culturist, it is acknowledged, as previously mentioned, to exceed all other species, which are propagated, in hardiness, in tenacity of life, and in freedom from tendency to disease. Although it will not compare with the catfishes (*Siluridæ*) or the eels (*Anguillidæ*,) or even the suckers (*Catastomidæ*,) in retaining life out of water, yet, unlike these, it does not owe its tenacity of life to a low, sluggish action of the vital forces, that retain life when the respiration has become almost entirely impeded, but rather to the possession of an excess of vitality, and which exhibits itself in all stages from the egg to the mature fish. Mr. Charles Nordhoff, in an article on The Columbia River and Puget Sound, in Harper's New Monthly Magazine,‡ in describing the processes at the canneries, says: "A salmon bleeds like a bull." Professor Agassiz thought he found evidence in the structure of the salmon family that indicated "the highest rank in the class of fishes,"§ and refers with enthusiasm "to their admirable structure" and great vigor.‖ In addition, we have the testimony of Seth Green and other fish-culturists, that the eggs and young fishes are hardy and enduring, the latter great feeders and very rapid growers. In the ponds of different fish-culturists in the country, it is common to see a school of several thousand California salmon a year old or more, which are said to have suffered no loss whatever in

* *Oncorhynchus orientalis*, Pall. (English) King salmon; (Russian) Chowichee; Native K'hah. Alaska and its Resources. By William H. Dall, director of the scientific corps of the late Western Union Telegraph Expedition. Boston: Lee & Shepard, 1870, p. 579.

† *Oncorhynchus proteus*, Pall. (English) salmon; (Russian) hoikoh. Op. cit.

‡ No. 285, February, 1874, p. 341.

§ Lake Superior. Boston: 1850, p. 25.

‖ Op. cit., pp. 327, 328.

numbers since they were placed in the pond. In the report of the commissioners of fisheries of the State of New York for the year 1874–'75, it is said of the California salmon: "These fish will endure a much higher temperature of water, spawn at a different season, are less exacting in the circumstances necessary to their well-being." In view of these facts, as to their habits, endurance, and general vigor and energy, have we not a right to hope for ultimate success in stocking the Mississippi and other eastern rivers with this valuable species?

The stocking of a large number of rivers of the United States with this food-fish to as great an extent as the Sacramento River or even the San Joaquin, is an enterprise well worthy great effort and much pecuniary outlay, and its successful achievement will prove a blessing to the poorer classes of the country as well as another evidence of the value of science in its application to the economic industries. If, however, our anticipations are only partially realized in a moderate proportion to what we now have in the California and Oregon rivers, the labor and cost of the experiment will not have been in vain, and coming generations will have cause to thank the liberality and statesmanship of our present law-givers.

6.—ATLANTIC SALMON.

During the seasons of 1873–'74 and 1874–'75 the collection of eggs of Penobscot salmon has been conducted at Bucksport, by Mr. C. G. Atkins, in the same manner as described in the report for 1872–'73.

The fixtures and apparatus employed have undergone considerable enlargement and amendment, but the essential features of the system remain the same as at first adopted. The salmon are caught in early summer in pounds in the Penobscot River, carried alive to a small fresh-water pond, and kept there until the breeding-season, when they are caught again and manipulated.

During the first season the salmon had the range of a pond of 60 acres, and a large number escaped recapture at the spawning-season. They have since been confined in an inclosure of about 10 acres, and each year the inclosing barrier has been made more secure. In 1873 and 1874 it was a strong net, and in spite of all exertions a number of salmon each year escaped. In 1875 a fence composed of wooden racks was substituted for the net, and proved an effectual means of confining the salmon.

The means of catching the fish in the fall have been improved by the introduction of additional pounds, nets, and other apparatus, so that the waste of eggs by the fish laying them before they can be caught and manipulated is reduced to a very small amount.

In the hatching-house since the first season the troughs have been reduced to a uniform length of about 23 feet, and fitted with covers.

The use of tin boxes for packing eggs for transportation has been mostly abandoned on account of its expense. Wooden trays, 3 inches deep and from 1 to 2 feet in length and breadth, are now employed, and make at once the most compact, convenient, and economical package with which I am acquainted. The eggs are placed in these trays in layers, alternating with layers of moss, from which they are separated by pieces of thin fabric. When filled and put together in stacks, the trays are encased in sawdust, which protects from freezing during long winter journeys. In packages of 50,000 to 100,000 they occupy about one cubic foot for 5,000 or 10,000 eggs.

The number of breeding-salmon bought and manipulated, their size, the number of eggs obtained and distributed, and the number of young salmon set free are exhibited by the following table:

Year.	Salmon bought.		Salmon recaptured at spawning season.					Eggs.		Young salmon set free.
	Number.	Average weight.	Males.	Females.	Total.	Average weight.	Average length.	Number taken.	Number distributed.	
		Pounds.				*Pounds.*	*Inches.*			
1873–'74	650	13.28	143	279	422	12.28	32.24	2,453,638	2,292,675	2,065,445
1874–'75	601	14.03	178	343	521	12.73	32.19	3,008,356	2,744,877	1,686,668
Total.....	1,251	....	321	622	943	....	....	5,461,994	5,037,552	3,752,113

The ratio of impregnation has been about 95 per cent.

Complete success has attended the incubation of the eggs, except in the season of 1874–'75, when the eggs were all, or nearly all, affected by a deficiency of strength in the outer shell. An average success was had with those eggs that remained that season in the hatching-house at Bucksport to hatch for the State of Maine; but of those that were packed for transportation large numbers were lost *en route*, or so greatly injured that they died before hatching, or soon after. Mr. Atkins attributed this phenomenon to causes existing in the state of the water of the pond and hatching-house, which remained, through prevalence of warm, dry weather, in a low, foul state through the greater part of the spawning season. In 1873–'74 the water was renewed by copious rains, and the eggs throughout incubation were in perfect health.

In 1872 and 1873, and again in 1875, all the fish handled at the spawning season were marked with metal tags and dismissed to the river. The mode of tagging in 1872 was by affixing a stamped aluminum tag to a rubber band passing around the tail. This was a defective mode, and no results were obtained from it. In 1873 the aluminum tags were attached directly by a platinum wire to the rear margin of the first dorsal fin. A reward was offered in the following spring for the return of the marked salmon, and about twenty of them were sent in, nearly all caught in the river, and more than half of them above Bangor, 25 miles further up the river than Bucksport, where they were set at liberty, showing that instinct did not impel these liberated fish to return at once to their marine feeding-grounds. They were all poorer than when set free in the fall. In 1874 the marking was omitted, but the offered reward was renewed in the spring of 1875, and resulted in the return of seven or eight of the marked salmon of 1873, now in prime order, weighing from 16½ to 24¼ pounds. Unfortunately the aluminum tag had fallen off, and we could not trace the individual salmon, but the wire remained to attest the date of their liberation and return. The salmon set free in autumn of 1873 in poor condition returned in good condition in 1875, and not before. Probably a much larger number of these salmon were caught that were never reported, for the wire was fine and not easily seen; indeed, two marked salmon were placed in the pond without discovering the mark till the spawning season.

The experiment has been renewed in 1875, with a change in the material, platinum being substituted for aluminum in the tag.

7.—THE WHITE-FISH.

The white-fish (*Coregonus albus*, Les.,) of the Great Lakes is a fine table-fish, and as it is produced in considerable numbers in favorable waters, some attention has been given to its propagation. In 1872, arrangements were made with Mr. N. W. Clark, of Clarkston, Mich., to hatch a half million of eggs of this fish. About the middle of February, 216,000 were shipped to San Francisco, Cal., but being left to the care of the express messenger, beyond Omaha, Nebr., they suffered from the changes of temperature incident to a car with a fire in it, and arrived in very bad condition. On March 10, another shipment of 116,000 was made, which arrived in good order. In 1873, 25,000 more were transmitted and hatched, and the young fish placed in the waters of Clear Lake, from which partly grown ones were afterward taken. In 1874 an additional 20,000 were sent by Mr. N. W. Clark, late of Northville, Mich., which were hatched at Berkeley, Cal., and put into Tulare Lake. On March 8, 1875, there were shipped to San Francisco, Cal., 100,000, and March 23, 100,000 were sent to the Lakes in the Indian Reservation at Keshena, Wis. The States bordering on the Lakes and Canada have now begun the propagation of this species, by which means they intend to keep up the stock of the Great Lakes.

8.—THE CARP OF EUROPE.

After considerable inquiry and investigation we are disposed to believe that there are varieties of the European carp of superior value, because of their table qualities, and that the idea entertained by many that the carp is a very inferior food-fish has arisen from the testimony of those who have been so unfortunate as to have eaten only those of inferior quality.

Admitting its value as a table-fish, or even that it is of average excellence, it should be considered a desirable acquisition to the waters of the United States, for it has other characteristics which render it valuable, and which are not known to be possessed by any American species, among which are its fecundity and adaptibility to the most varied waters, from deep cool lakes and rapid streams to the merest puddles and ditches,* and to latitudes from St. Petersburg, Russia, to Italy.†

Its diet is also varied; unlike the great proportion of American food-fishes it can be sustained on vegetable matter, being expecially fond of water-cresses and similar succulent plants; it also devours worms and insect-larvæ voraciously. Heckel speaks of its fondness for sheep-dung, and of its becoming fat upon it. It has proved to be admirably well adapted to the processes of artificial culture, and throughout Europe the species has been kept in a semi-domesticated condition from time immemorial in a very large number of hatching-ponds. It becomes very tame after a time, and may be taught to eat from the hand, to come to the side of the pond the culturist desires, and to follow him along its edge.

Heckel and Kner ‡ speaking of it, remark that its capability of rapid propagation, its tough constitution, and excellent table qualities have induced its abundant cultivation from a very early time. It is believed to have been introduced into Europe from temperate Asia, and has spread from the Danube over the whole of Middle and part of Southern Europe. It is said to attain to an average of from five to ten pounds and even more, according to the waters inhabited, while Dr. Rudolph Hessel states that in Lower Hungary he had seen specimens weighing thirty and forty pounds. The species is of rapid growth, and, under favorable circumstances, may be made to attain a weight of three or four pounds in three years. §

In its domesticated condition the carp has developed very many varieties, some of which are improvements in quality over the original type, while the contrary is true of others. These different forms falling into their hands, naturalists have been led to name them as different species, and later students in studying the carp in its numerous forms

* In Couch's British Fishes a quotation is made from Sir Roger North, as follows:

"Carp are sometimes fed, during the colder season, in a cellar. The fish is wrapped up in a quantity of wet moss, laid on a piece of net, and then laid into a purse, but in such manner, however, as to admit of the fish breathing; the net is then plunged into water and hung to the ceiling of the cellar. The dipping must be first repeated every three or four hours, but afterward it need be plunged into the water only once in six or seven hours. Bread soaked in milk is sometimes given him in small quantities; in a short time the fish will bear more and grow fat by this treatment. Many have been kept alive, breathing nothing but air, in this way several successive days."

A History of the Fishes of the British Islands, by Jonathan Couch, F. L. S., vol. iv, containing seventy-three colored plates, from drawings by the author. (London: Groombridge & Sons, 5 Paternoster Row. 1845. Carp, p. 4.)

† In winter they are said to bury themselves in the mud in large bodies, and to remain in a somewhat torpid condition and without food, but losing little or nothing in flesh, until the following spring.

‡ Die Süsswasserfische der östreichischen Monarchie mit Rücksicht auf die angrängenden Länder bearbeitet von Jakob Heckel * * und Dr. Rudolph Kner * * * Leipzig, Verlag von Wilhelm Engelmann, 1858, p. 57.

§ Aigner, quoted by Heckel and Kner.

have been obliged to gather long lists of synonyms, each applying to one or more of the varieties. Günther's list of synonyms embraces thirty-one binomial names, and several common names. Beginning with the Κυπρῖνος of Aristotle, his volume includes new ones to nearly the date of its publication.* He finds the names applied to the normal type, to "varieties of the integuments," to "varieties of form," to "monstrosities," to the "eastern [Asiatic] specimens," and to a "variety with the fins much prolonged." His material for study included European specimens from different parts of England, Holland, Hungary, Switzerland, and Russia, and Asiatic specimens from China, Formosa, Japan, and Java, all which varieties he refers to the one species, *Cyprinus carpio* L.

Another species, the Crucian carp (*Carassius vulgaris* (Nilss.) Nord.) is found in temperate Asia and Europe. This, too, has been domesticated and has developed varieties principally in the particular of form. An extensive list of names pertains to this species, also. The testimony of writers agrees rather uniformly that the Crucian carp is inferior in flavor to the common carp; still, it is cultivated in portions of Europe. Its present distribution appears to extend farther north than the common carp, as it is taken in Norway and Siberia. A variety is also found as far south as Sicily.

To add to the confusion into which the existence of so many variable forms has placed the question of species, it is known that two or more hybrids exist between the *Cyprinus carpio* and other species. The best known one is that which was identified by Heckel as *Cyprinus Kollarii*, now believed to be a cross between *Cyprinus carpio* and *Cyprinus carassius* L.; it is said to be found wherever the two species are kept under domestication. This hybrid is considered to be inferior to the common carp. Another one is the cross between *C. carpio* L. and *Carassius auratus* (L.) Bleeker, which is thought superior to the latter, though much cannot be said in its favor. In a letter received from Dr. O. Finsch, still another hybrid is referred to between *C. carpio* L. and *Cyprinus brama* L.

Among all these variations of form and external characters, differing as they do in proportions of body, in the size of the scales, in the partial or complete absence of scales, in the form of the fins, and in the combinations of the characters of two species in a hybrid, there is also a variation in their edible qualities, in their prolificness, some forms being entirely sterile, and popularly believed to be neuter in gender, and also in their hardiness and adaptability to more or less unfavorable waters.

In referring to the sterile carps, Siebold remarks that many are found in which ovaries or spermaries are never fully developed. In some they are so little developed that the generative organs are found only with the

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* Catalogue of the Fishes in the British Museum, by Albert Günther, M. A., M. D., Ph. D., F. R. S., F. Z. S., etc., etc. Volume seventh, London: Printed by order of the trustees, 1868.

greatest difficulty, and they are considered by many as asexual. The sterile carp is mentioned by Aristotle. They are generally well known and can be distinguished by those accustomed to handle them. In France the sterile form is the Carp Bréhaigne and Carpeau. De Latourette states that the sterile carp has shorter and thicker lips, and that the belly in the vicinity of the anus is thin and shrunken.* The better varieties seem to be the Spiegel-karpfen, mirror carp (*Cyprinus specularis* Lacep), (*Cyprinus rex-cyprinorum* (Bloch), Cuv.,) and the naked carp (*Cyprinus nudus* Bloch) or (*Cyprinus alepidotus* Ag.) and the sterile ones. It is claimed by certain English writers that by a process of spaying or castration, which can be performed on the carp, the flavor is much improved.

The artificial propagation of the carp has been carried on successfully in Europe for a number of years. Their annual deposit of eggs, however, is so large in numbers that artificial impregnation is seldom necessary, though affording a larger percentage of increase over the natural. The spawning season in Middle Europe is May and June, though, according to Siebold, some spawn as late as August. The eggs are very adhesive, and in a state of nature are found sticking to the leaves of plants and the small twigs of brush which have fallen into or which grow under the water. The eggs are thought to develop best when only one or two inches from the surface.† The fish emerges from the egg after about twenty days, leaving the shell still attached to the plant or twig. The artificial method is to express the eggs on light frames of netting, or on baskets made by wattling a wooden frame with boughs, the milt being scattered over them as they lie adherent to the nets and the leaves. The netting frames are placed vertically in a floating box, which, in a running stream, is afforded the necessary water circulation. The basket, when covered with the impregnated eggs, is treated in like manner. The boughs of the juniper (*Juniperus*) are said to be the best for making the baskets. The pairs of ripe fish may be put into the basket and left to themselves, a piece of netting being tied over the top to prevent their escape. After the eggs have been deposited the fishes should be removed.

Among the localities in Europe where, it is stated, they are bred, the following are referred to, with, in some cases, the name of the proprietor or superintendent of the ponds:

"The naked carp (*C. nudus* Bloch) is chiefly raised in North Germany; the mirror carp (*C. rex cyprinorum* (Bloch) Cuv.) in South Germany; the scaled genuine carp in North Germany (Mecklenburg, Holstein, &c.), in Bohemia and Silesia;" *fide* Dr. O. Finsch. Casel, mirror carp, Mr. Lewin Fischhof; Geirsdorf, Silesia scaled carp; Wittengen, Hanover, Mr. Link; Hameln, Fishermeister Schieber; Liebbinchen, Brandenburg;

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*See Die Süsswasserfische von Mittel-Europa bearbeitet Von C. Th. E. v. Siebold. Leipzig, Verlag von Wilhelm Engelmann, 1863.

†Report 1872–'73, p. 568.

Drobriluyk, Brandenburgh, Traugott Mende; Wittengen, Bohemia, Prince Schwarzenburg; Biddahausen, near Brunswick, naked carp, Prince of Schonnburg-Lippe; Wiesbaden, common carp, mirror carp, and gold-orfe, nassauische Fisherei, Actiengesellschaft; Nürnburg, mirror carp; Gunzenhausen, mirror carp; Lusatia, estate of Cottbus Peitz; Upper Silesia, Baron Rothschild; Brickaberg, naked carp; Heesen, Mr. Bodeman; Hochst,* near Frankfort, mirror carp, scaled carp, and gold-orfe; Oldenburg, hybrid, *C. Kollarii* Heck., Mr. Wagner.

This list might be multiplied many times.

The present distribution of the carp (*Cyprinus carpio* L.) in Europe may be given as throughout the middle latitudes of Europe, extending northward to Northern Germany and southward into Italy. The *C. carassius* L. has a more northern range into Siberia and Norway, while the variety *C. humilis* is found in Sicily.

The special advantage to be gained by the possession of the carp is in its general adaptability to all waters, and that it thrives under conditions unfavorable to many species. According to Heckel and Kner, it prefers water not too rapid and a boggy bottom.

As a fish for propagation in ponds and other sluggish waters both south and north, it is believed the carp will excel all others. In Northern Silesia, according to Mr. Von dem Borne,† on the estate of Baron von Rothschild, puddles two or three feet deep in the villages are used for raising two-year-old carps for stocking distant waters. From this resource, a single estate realized what would amount to about $55 per American acre of pond-surface.

The following is a recapitulation of the good qualities of the carp:

1. Fecundity and adaptability to the processes of artificial propagation.
2. Living largely on a vegetable diet.
3. Hardiness in all stages of growth.
4. Adaptability to conditions unfavorable to any equally palatable American fish and to very varied climates.
5. Rapid growth.
6. Harmlessness in its relations to other fishes.
7. Ability to populate waters to their greatest extent.
8. Good table qualities.

The food-fish indigenous to the United States, which has been the most widely distributed in the smaller ponds and lakes, is the large-mouthed black bass (*Micropterus nigricans* (Cuv.) Lacep.) This fish is very carnivorous, preying upon almost all species in the same waters. Even the pickerel is said to decrease rapidly when in contact with it. The necessity for fish-food is always a bar to a great increase of numbers among fishes, especially in small bodies of water. Species which feed

* Carp in ponds at Baltimore, Md., obtained here by United States Commission Fisheries.

† Circular No. 1, 1876, of the Deutsche Fisherei-Verein, see translation in appendix.

upon invertebrate and vegetable forms fill out the possible quota of the waters with their own kind, while the carnivorous species require that a large, generally the larger, proportion of the inferior species upon which they feed inhabit the waters with them. An instance of the ability of the carp to stock waters to their utmost occurred at Heidelberg, Germany, where male pikes (*Esox lucius* L.) were introduced for the purpose of reducing their numbers.

9.—AQUARIUM CAR.

During the winter of 1872–'73, Mr. Livingston Stone was employed in an investigation of the fisheries of the Sacramento River and some of the inland lakes of California. In the spring of 1873, he came East to prepare for a return to California with an aquarium-car loaded with fishes for both the inland waters and sea-coast of California—an enterprise partly under the auspices of the State commissioners of California. This car, originally built for the transportation of fruit, was furnished by the Central Pacific Railroad Company. It was fitted up with the necessary tanks, ice-chests, and beds for attendants; the supply-reservoir was arranged so as to receive water from the spouts of the railroad tanks.

The stock of fishes and invertebrates taken on board consisted of 60 black bass (*Micropterus salmoides*); 11 wall-eyed pike (*Stizostedium Americanus*); 190 yellow perch (*Perca flavescens*); 12 bullheads (*Amiurus catus*); 110 cat-fish from Raritan River, *Amiurus albidus ?*); 20 tautogs (*Tautoga Americana*); 41,500 eels (*Anguilla bostoniensis*); 1,000 trout (*Salmo fontinalis*); 20,000 shad (*Alosa sapidissima*); 162 lobsters (*Homarus vulgaris*); and one barrel of oysters from Massachusetts Bay (*Ostrea virginica.*) The start was made from Charlestown, N. H., June 3, and everything resulted favorably until the 8th of June, when, by the giving way of the trestle-work of a bridge at the Elkhorn River, Nebr., the aquarium-car was precipitated into the river, the car was partially up-ended, and the tanks thrown into confusion. As the lids were floated off from the tanks, it is probable that most of the fishes escaped into the river. Many of the species, however, were well adapted to the waters of the river, but of course not the tautogs, lobsters, or oysters.

In the year following, Mr. Stone left Charlestown, N. H., on June 4, 1874, under the auspices of the commissioner of fisheries of California. He arrived at the Sacramento on the 12th of June, and at San Francisco the same day. A tabulated list of the results of this expedition will be found in the appendix.

Record of distribution of young shad made from June 25, 1874, to August 15, 1874, by United States Commission of Fish and Fisheries, under direction of James W. Milner.

Date of transfer.	Place whence taken.	Period of journey.	Number of fish. Originally taken.	Number of fish. Actually planted.	Introduction of fish. Place.	Introduction of fish. Stream.	Introduction of fish. Tributary of—	Transfer in charge of—
		Hours.						
June 25	Coeymans, N. Y.	27	Loss scarcely perceptible.	60,000	Eagleville, Ohio	Grand River	Lake Erie	Chase and Mather.
June 26	do	28	do	60,000	Fremont, Ohio	Sandusky River	do	H. W. Welsher.
June 31	do	34	do	75,000	Logansport, Ind	Eel River	Wabash River	Mather and Vealey.
July 3	do	132	23,000	20,000	Hempstead, Tex	Brazos River		Milner, Mason, and Clark.
July 4	do	149	47,000	40,000	Austin, Tex	Colorado River		Do.
July 9	do	44	Loss imperceptible	70,000	Rockford, Ill	Rock River	Mississippi River	Welsher and Chase.
July 9	do	32½	do	75,000	Bellefontaine, Ohio	Miami River	Ohio River	Mather and Vealey.
July 15	South Hadley Falls, Mass.	5	do	215,000	Bellows Falls, Vt	Connecticut River		Do.
July 27	do	5¾	do	140,000	do	do		Chase and Brooks.
Aug. 1	do	5	do	120,000	do	do		Mather and Vealey.
Aug. 8	do	1	do	60,000	Smith's Ferry, Mass	do		H. J. Brooks.
Aug. 20	do	5¼	do	30,000	Bellows Falls, Vt	do		Do.
July 18	do	24½	do	65,000	Monroeville, Ohio	Huron River	Lake Erie	H. W. Welsher.
July 18	do	23	do	65,000	Elyria, Ohio	Black River	do	Oren M. Chase.
July 22	do	36	do	80,000	Indianapolis, Ind	White River	Ohio River	Mason and Clark.
July 22	do	5	do	110,000	Putnam, Conn	Thames River		Mather and Vealey.
	do	8	do	20,000	Noank, Conn			Do.
July 25	do	15	do	100,000	Waterville, Me	Kennebec River		Mason and Clark.
July 28	do	23	do	100,000	Mattawamkeag, Me	Penobscot River		Welsher and Griswold.
Aug. 14	do	25	do	100,000	do	do		H. J. Brooks.
July 28	do	10	do	150,000	Vergennes, Vt	Otter Creek	Lake Champlain	Chase and Brooks.
	do	6	do	36,000	———, R. I.	Blackstone River		Ellis.
July 30	do	33	do	80,000	Elkhart, Ind	Saint Joseph River	Lake Michigan	Frank N. Clark.
	do	51	do	60,000	Ottumwa, Iowa	Des Moines River	Mississippi River	Mather and Vealey.
	do	60	do	40,000	Des Moines, Iowa	do	do	Do.
July 31	do	38¼	85,000	80,000	Columbus, Ind	Wabash River	Ohio River	H. J. Brooks.
Aug. 1	do	27	Loss imperceptible	80,000	Detroit, Mich	Detroit River	Lake Erie	Chase and Griswold.
Aug. 3	do	7½	do	100,000	New Milford, Conn	Housatonic River		Frank N. Clark.
Aug. 5	do	60	do	100,000	Saint Paul, Minn	Mississippi River		Chase and Vealey.
Aug. 6	do	31½	do	80,000	Corunna, Mich	Shiawassee River	Lake Huron	Frank N. Clark.
Aug. 10	do	2	do	80,000	Westfield, Mass	Westfield River	Connecticut River	Charles D. Griswold.
Aug. 13	do	2¼	do	210,000	do	do	do	Frederick A. Smith.
Aug. 11	do	11	do	120,000	Winooski, Vt	Winooski River	Lake Champlain	Brooks and Griswold.
Aug. 12	do	12¼	do	80,000	Georgia, Vt	Lamoille River	do	Do.
	do	12	do	80,000	Swanton, Vt	Missisquoi River	do	Do.
Aug. 15	do	8½	do	50,000	Noank, Conn			Charles D. Griswold.
				3,031,000				

Record of hatching and distribution of shad (Alosa sapidissima) made from May 15, 1875, to July 31, 1875, by United States Commission of Fish and Fisheries, under direction of James W. Milner.

State.	Date of transfer.	Obtained from—	Place whence taken.	Number of fish actually planted.	Introduction of fish. Place.	Stream.	Tributary of—	Transfer in charge of—
Connecticut	July 9	U. S. Commission	South Hadley Falls, Mass	100,000	Canterbury, Conn	Quinnobaug River	Thames River	H. E. Quinn.
Georgia	July 22		......do	60,000	Rome, Ga	Coosa River	Alabama River	Clark and Quinn.
Illinois	July 31	U. S. Commission	......do	60,000	Rockford, Ill	Rock River	Mississippi River	Chase and Ingalls.
Indiana	June 13	N. Y. commission	Coeymans Landing, N. Y	100,000	Indianapolis, Ind	White River	Wabash River	F. N. Clark.
Iowa	June 27		......do	90,000	Des Moines, Iowa	Des Moines River	Mississippi River	Clark and Quinn.
Louisiana	July 29	U. S. Commission	South Hadley Falls, Mass	60,000	Tickfaw, La	Notalbany River	Lake Pontchartrain	Mather and Bell.
Maine	July 12	....do	......do	100,000	Mattawamkeag, Me	Mattawamkeag River.	Penobscot River	Quinn and Griswold.
Maryland	May 26 to June 27.	....do	Moxley Point, Md	1,182,500	Moxley Point, Md	Potomac River		J. Mason.
Massachusetts	July 8, 13, and 16.	....do	South Hadley Falls, Mass	725,000	Smith's Ferry, Mass	Connecticut River		Mason and Quinn.
Do	July 7 to 31	....do	......do	4,500,000	South Hadley Falls, Mass.	....do		Charles C. Smith.
Mississippi	July 16	N. J. commission	Point Pleasant, Pa	100,000	Jackson, Miss	Pearl River		Anderson and Schwartz.
Ohio	June 15	N. Y. commission	Coeymans Landing, N. Y	75,000	Columbus, Ohio	Scioto River	Ohio River	Mason and Ingalls.
Do	June 23	....do	......do	100,000	Bayard, Ohio	Muskingum River	....do	Clark.
Rhode Island	July 23	U. S. Commission	South Hadley Falls, Mass	8,300		Warren River		J. Mason and others.
Do	July 23	....do	......do	13,800		Pawcatuck River		Do.
Do	July 23	....do	......do	22,300		Pawtuxet River		Do.
Do	July 23	....do	......do	5,600		Barrington River		Do.
South Carolina	July 10	....do	......do	80,000	Gaffney's Station, S. C	Broad River	Santee River	Clark and Quinn.
Tennessee	July 10	....do	......do	80,000	Nashville, Tenn	Cumberland River	Ohio River	Chase and Boehme.
Do	July 16	....do	......do	80,000	....do	....do	....do	Do.
Do	July 16	....do	......do	100,000	Knoxville, Tenn	Tennessee River	....do	Mason and Ingalls.
Texas	July 4	N. Y. commission	Coeymans Landing, N. Y	60,000	Austin, Tex	Colorado River		Mason and Marks.
Vermont	July 28	U. S. Commission	South Hadley Falls, Mass	70,000	Georgia, Vt	Lamoille River	Lake Champlain	O. M. Chase.
Do	July 7 and 17.	....do	......do	480,000	South Vernon, Vt	Connecticut River		Griswold and Quinn.
Virginia	May 15 to 25.	....do	Free Stone Point, Va	1,156,750	Free Stone Point, Va	Potomac River		J. Mason.
Do	May 18 to June 5.	....do	Washington, D. C	1,072,800	Jackson City, Va	... do		H. W. Welsher.
Do	May 2 to 29.	....do	Ferry Landing, Va	1,473,500	Ferry Landing, Va	....do		Do.
Do	July 8	N. J. commission	Point Pleasant, Pa	100,000	Stanton River Station, Va.	Stanton River	Roanoke River	Anderson and Bell.
				12,055,550				

Table of California salmon transported to new waters in the United States in 1874-'75.

States.	Where finally hatched.	Waters stocked.	Tributaries in which fish were placed.	Locality.	Date of transfer.	Number of fish.	Remarks.
California	McCloud River Station, United States.	Sacramento River	McCloud River		October and Nov., 1874	850,000	Report of Commissioner of Fisheries, California, 1874-'75, p. 16.
Colorado	Georgetown, Colo		Green Lake	Georgetown, Colo	—, —, 1874	22,900	Livingston Stone's tables (MSS.)
	do		Clear Lake	do	—, —, 1874	(*)	
Connecticut	North Branford, Conn	Connecticut River	Cocnochogue River	Durham, Conn	Dec. 30, 1874	50,000	Conn. Rep. Com. Fish., 1875, p. 16.
	do	Thames River	Shetucket River		Dec. 26, 1874	50,000	Do.
	do	Long Island Sound	Farm River	New Haven, Conn	Jan. 20, 1875	20,000	Do.
	Trout Association, Westport, Conn.	Housatonic River	Butter Creek	New Milford, Conn	Dec. 18, 1874	50,000	Do.
	do	Connecticut River	Farmington River	Pine Meadow, Conn	Dec. 21, 1874	50,000	Do.
	do	do	do	do	Dec. 23, 1874	20,000	Do.
	New York State hatching-house.	Long Island Sound	Quinnepiac River	———, Conn	Dec. 18, 1874	5,000	N.Y.Rep.Com. Fish., 1875, (MSS.)
Illinois	Michigan State hatching-house.	Mississippi River	Fox River	Elgin, Ill	Dec. 19, 1874	20,000	Letter of C.H. Jerome, Apr. 16,'76.
	Northville, Mich	do	Rock River	Rockford, Ill	Dec. 22, 1874	15,000	Letter of W. D. E. Andrus, Dec. 23, 1874.
Indiana	Michigan State hatch'g-house	Wabash River	White River	Indianapolis, Ind	Dec. 16, 1874	16,000	Letter of C.H. Jerome, Apr. 16,'76.
	do	Ohio River	Tanner's Creek	Guilford, Ind	Dec. 24, 1874	16,000	Do.
Iowa	Anamosa, Iowa	Mississippi River	Upper Iowa River	Fredericksburgh, Iowa	Dec. 15, 1874	300	B. F. Shaw's tables (MSS.)
	do	do	do	Decorah, Iowa	Mar. 10, 1875	8,000	Do.
	do	do	Tributary	Waukon, Iowa	Jan. 4, 1875	700	Do.
	do	do	Bloody Run	McGregor, Iowa	Dec. 15, 1874	5,700	Do.
	do	do	Turkey River, Volga River.	Greeley, Iowa	Jan. 6, 1875	600	Do.
	do	do	Turkey River	Clermont, Iowa	Jan. 27, 1875	(†)	Do.
	do	do	do	Maynard, Iowa	Jan. 27, 1875	(†)	Do.
	do	do	Turkey River, Volga River.	Fayette, Iowa	Jan. 6, 1875	14,000	Do.
	do	do	Tributary	Clinton Junction, Iowa	Dec. 27, 1874	(‡)	Do.
	do	do	Little Maquoketa River.	Farley, Iowa	Dec. 15, 1874	2,500	Do.
	do	do	do	Epworth, Iowa	Dec. 15, 1874	3,500	Do.
	do	do	Maquoketa River	Monticello, Iowa	Dec. 8, 1874	7,000	Do.
	do	do	do	Maquoketa, Iowa	Dec. 11, 1874	7,000	Do.
	do	do	do	Charlotte, Iowa	Dec. 27, 1874	‡5,000	Do.
	do	do	do	Worthington, Iowa	Jan. 4, 1875	2,000	Do.
	do	do	do	Delhi, Iowa	Jan. 6, 1875	400	Do.
	do	do	do	Hopkinton, Iowa	Jan. 6, 1875	400	Do.
	do	do	Maquoketa River	Manchester, Iowa	Feb. 1, 1875	200	Do.
	do	do	Maquoketa River, Spring Creek.	Delaware, Iowa	Jan. 6, 1875	4,600	Do.
	do	do	Wapsipinecon River	Anamosa, Iowa	Dec. 28, 1874 Jan. 18, 1875 Apr. 7, 1875	16,000	Do-

	do	do	do	Oxford, Iowa	Jan. 18, 1875	§21,000	Do.
	do	do	do	Independence, Iowa	Jan. 27, 1875	(†)	Do.
	do	do	Wapsipinecon River	Dixon, Iowa	Dec. 28, 1874	‖5,000	Do.
	do	do	Big Rock Creek	Big Rock, Iowa	Dec. 28, 1874	(‖)	Do.
	do	do	do	Walker, Iowa	Jan. 27, 1875	(†)	Do.
	do	do	Iowa River, Cedar River.	Cedar Rapids, Iowa	Dec. 12, 1874	12,000	Do.
	do	do	do	Waterloo, Iowa	Dec. 5, 1874	3,500	Do.
	do	do	do	Tipton, Iowa	Dec. 18, 1874 Feb. 13, 1875	8,100	Do.
	do	do	do	Marion, Iowa	Dec. 12, 1874	3,000	Do.
	do	do	do	Wilton, Iowa	Jan. 18, 1875	(§)	Do.
	do	do	do	Springville, Iowa	Jan. 27, 1875	†21,000	Do.
	do	do	Iowa River	Iowa Falls, Iowa	Dec. 18, 1874	10,000	Do.
	do	do	do	Iowa City, Iowa	Jan. 18, 1875	(§)	Do.
	do	do		Storm Spring, Iowa	Mar. 6, 1875	4,000	Do.
	do	do	Des Moines River	Des Moines, Iowa	Dec. 2, 1874 Jan. 12, 1875	10,400	Do.
	do	do	do	Ottumwa, Iowa	Jan. 11, 1875	11,000	Do.
	do	do	do	Fort Dodge, Iowa	Dec. 18, 1874	15,000	Do.
	do	dd	Des Moines River, Boon River.	Webster City, Iowa	Feb. 1, 1875	9,800	Do.
	do	do	Des Moines River, Twin Lakes.	Pomeroy, Iowa	Feb. 1, 1875	10,000	Do.
	do	do	Des Moines River, Storm Lake.	Storm Lake, Iowa	Feb. 1, 1875	10,000	Do.
	do	do	Brown's Creek		Jan. 12, 1875	500	Do.
	do	do	Des Moines River, Coon River.		Jan. 12, 1875	500	Do.
	do	Missouri River	Nishnabottomy River	Atlantic, Iowa	Jan. 5, 1875	6,000	Do.
	do	do	Little Sioux River	Cherokee, Iowa	Feb. 1, 1875	10,000	Do.
	do	do	Floyd River	Lamar's, Iowa	Feb. 1, 1875	5,000	Do.
	do	do	do	Sioux City, Iowa	Feb. 1, 1875	5,000	Do.
Louisiana	Pokagon, Mich	Lake Pontchartrain	Tangipahoa River		Jan. 1, 1875	15,000	Letter of J. E. Leet, Jan. 2, 1875.
Maine	Bucksport, Me	Penobscot River	Craig's Pond	Bucksport, Me	1875	30,000	Maine Report Commissioners of Fisheries, 1875, p. 6.
Maryland	Green Springs, Md	Susquehanna River	Octorora Creek	Liberty Grove, Md	Dec. 5, 1874	10,000	Maryland Report of Commissioners, Jan. 1, 1876, p. 81.
	do	do	Deer Creek	Pennsylvania line	Dec. 15, 1874	6,000	Do.
	do	Gunpowder River	Gunpowder River	Freeland, &c., Md	Nov. 30, 1874	10,000	Do.
	do	Patapsco River	North Patapsco River.	Tank Station, Western Maryland Railroad.	Nov. 30, 1874	6,000	Do.
	do	do	Patapsco River	Hood's Mills, Md	Dec. 5, 1874	6,000	Do.
	do	Patuxent River	Branches	Howard County, Md	Dec. 9, 1874	8,000	Do.
	do	do		Near source	Dec. 15, 1874	10,000	Do.

* The 22,900 was divided between Green Lake and Clear Lake.
† All distributions marked with the † are included in the 21,000 marked to Springville; the number was not deposited at that point, but divided among the other places as well.
‡ The 5,000 marked to Charlotte was divided with Clinton Junction.
§ The 21,000 marked to Oxford was divided with the other places having the (§.)
‖ The 5,000 marked to Dixon was divided with Big Rock.

Table of California salmon transported to new waters in the United States in 1874-'75—Continued.

States.	Where finally hatched.	Waters stocked.	Tributaries in which fish were placed.	Locality.	Date of transfer.	Number of fish.	Remarks.
Maryland	Green Springs, Md	Monocacy River	Pipe Creek	Wakefield, Md	Nov. 25, 1874	1,500	Maryland Report of Commissioners, Jan. 1, 1876, p. 81.
	do	do	do	Union Bridge, Md	Nov. 25, 1874	1,000	Do.
	do	do	Owens Creek	Slabtown, Md	Nov. 25, 1874	1,500	Do.
	do	do	do	Mechanicstown, Md	Dec. 2, 1874	6,000	Do.
	do	do	Bush Creek	Monrovia, Md	Dec. 5, 1875	4,000	Do.
	do	Potomac River	Antietam Creek	Hagerstown, Md	Nov. 25, 1874	3,000	Do.
	do	do	Conococheague River	do	Dec. 2, 1874	10,000	Do.
	do	do	Evitts Creek	Tannery, Md	Dec. 2, 1874	5,000	Do.
	do	do	Wills Creek	Jennings Run, Md	Dec. 2, 1874	5,000	Do.
	do	do	Savage Creek	Frankville, Md	Dec. 3, 1874	15,000	Do.
	do	do	North Fork	Fort Pendleton, Md	Dec. 9, 1874	15,000	Do.
	do	Rivers		Eastern Shore, Md	Dec. 1, 1874	6,000	Do.
Massachusetts	Winchester, Mass	Mystic River			1874 and 1875	7,000	Stone's tables, MSS.
Michigan	Pokagon, Mich	Lake Huron	Au Sable River	Grayling, Mich	Dec. 23, 1874	50,000	Letter of G. H. Jerome, Apr. 16, '76.
	do	Lake Erie	River Raisin		Mar 22, 1875	10,000	Do.
	do	Lake Michigan	Saint Joseph River (Dowagiac River).		Dec. 17, 1874	10,000	Do.
	do	do	do		Dec. 24, 1874	10,000	Do.
	do	do	do		Jan. 15, 1875	7,000	Do.
	do	do	do	Pokagon, Mich	Jan. 16, 1875	7,000	Do.
	do	do	Kalamazoo River		Dec. 26, 1874	40,000	Do.
	do	do	Kalamazoo River (Baptist College Pond).	Kalamazoo, Mich	July 3, 1875	100	Do.
	do	do	Manistee River (Hersey River).		Dec. 18, 1874	50,000	Do.
	do		Metcalf Lake		Dec. 23, 1874	8,000	Do.
	do		Crystal Springs Creek.		Jan. 16, 1875	6,000	Do.
	do		Goguac Lake		Jan. 16, 1875	2,500	Do.
	do		Private ponds of J. C. Hyde.		Feb. 27, 1875	5 0	Do.
	do		Orion Lake		Mar. 29, 1875	10,000	Do.
	do	Lake Superior	Carp River		Dec. 30, 1874	60,0[illegible]0	Do.
Minnesota	Hon. E. Rice, Saint Paul, Minn.; Watkins & Bogart, Red Wing, Minn.; and Stillwater Trout-Brook Company.	Red River		Breckinridge, Minn	May, 1875	500	Minnesota Report Commissioners of Fisheries, 1875, pp. 9, 10.
	do	Lake Superior	Saint Louis River, Twin Lakes.	Pine County, Minn	May, 1875	500	Do.
	do	Mississippi River	Saint Louis River, Big Lake.	do	May, 1875	500	Do.

	......do......................	......do............	Saint Croix River...	Chisago County, Minn.	May, 1875	5,000	Do.
	......do......................	......do............	Saint Croix River, several lakes.	......do..............	May, 1875	12,800	Do.
	......do......................	......do............	Saint Croix River, White Bear Lake.	Ramsey County, Minn	May, 1875	300	Do.
	......do......................	......do............	Saint Croix River, Bass Lake.	......do..............	May, 1875	100	Do.
	......do......................	......do............	Saint Croix River, Lake Como.	......do..............	May, 1875	100	Do.
	......do......................	......do............	Saint Croix River, Lake Johanna.	......do..............	May, 1875	100	Do.
	......do......................	......do............	Cannon River	Owatonna, Minn	May, 1875	1,000	Do.
	......do......................	......do............	Minnesota River, Cedar Lake.	Rice County, Minn ...	May, 1875	1,000	Do.
	......do......................	......do............	Minnesota River, Minnesota Lake.	Faribault County, Minn.	May, 1875	1,000	Do.
	......do......................	......do............	Farmington River..	Dakota County, Minn.	May, 1875	1,000	Do.
	......do......................	......do............	Iowa River, Cedar River, Lake Albert Lea.	Freeborn County, Minn.	May, 1875	1,000	Do.
	......do......................	......do............	Iowa River, Cedar River.	Mower County, Minn	May, 1875	300	Do.
	......do......................	......do............	Lake Minnetonka...	Hennepin Cou'y, Minn	May, 1875	500	Do.
New Jersey	Bloomsbury, N. J..........	Delaware River....	Tributaries	....	1874, 1875....	160,000	New Jersey Report of Commissioners of Fisheries, 1875, p. 19.
	......do......................	Passaic River.......	......do............	....	1874, 1875....	2,000	Do.
	......do......................	Raritan River.......	......do............	....	1874, 1875....	3,000	Do.
New York	State hatching-house	Lake Ontario	Oswego River.......	Skaneateles Lake.....	Dec. 9, 1874	21,000	Seth Green's tables, (MSS.)
	......do......................	......do............	......do............	......do..............	Mar. 2, 1875	3,000	Do.
	......do......................	......do............	Oswego River, Fish Creek.	....	Dec. 10, 1874	20,000	Do.
	......do......................	......do............	Oswego River.......	Fulton, N. Y..........	Dec. 11, 1874	2,000	Do.
	......do......................	......do............	Oswego River, Oneida Lake.	....	Dec. 18, 1874	20,000	Do.
	......do......................	......do............	Genesee River, Caledonia Creek.	Caledonia, N. Y.......	Dec. 15, 1874 Dec. 22, 1874 Jan. 26, 1875 Mar. 2, 1875	27,010	Do.
	......do......................	......do............	Genesee River, Conesus Lake.	Livingston Co., N. Y..	Jan. 2, 1875	10,000	Do.
	......do......................	......do............	Genesee River, Allen Creek.	....	Dec. 15, 1874 Mar. 15, 1875	50,000	Do.
	......do......................	......do............	Oak Orchard Creek.	Orleans County, N. Y.	Dec. 17, 1874	30,000	Do.
	......do......................	......do............	Sandy Creek.........	......do..............	Dec. 25, 1874	10,000	Do.
	......do......................	......do............	Salmon River, Beaver Creek.	Sand Bank, N. Y......	Dec. 30, 1874	10,000	Do.
	......do......................	Hudson River	Fortville, Peatwig, and Ingelsby C'ks.	Fort Edward, N. Y....	Dec. 21, 1874	45,000	Do.
	......do......................	......do............	Mohawk River	....	Dec. 30, 1874 Jan. 11, 1875	47,000	Do.
	......do......................	......do............	Mohawk River, Sequoit Creek.	Oneida County, N. Y..	Jan. 9, 1875	8,000	Do.

Table of California salmon transported to new waters in the United States in 1874-'75—Continued.

States.	Where finally hatched.	Waters stocked.	Tributaries in which fish were placed.	Locality.	Date of transfer.	Number of fish.	Remarks.
New York	State hatching-house	Alleghany River	Chautauqua Lake	Chautauqua Co., N. Y.	Feb. 24, 1875	1,000	Seth Green's tables, (MSS.)
Ohio	New York State hatching-house.	Lake Erie	Grand River	Eagleville, Ohio	Dec. 9, 1874	10,000	Do.
	Northville, Mich	do	Huron River	Monroeville, Ohio	1874	10,000	Letter of ——
Pennsylvania	Marietta, Pa., and Bloomsbury, N. J.	Susquehanna River	Swatara Creek		Dec. 22, 1874	30,000	Pennsylvania Report Commissioners, 1874, p. 14.
	do	do	Yellow Breeches		Dec. 26, 1874	30,000	Do.
	do	do	Pine Creek		Jan. 5, 1875	15,000	Do.
	Bloomsbury, N. J	do	Connadaquinnat Riv		Dec. 6, 1874	6,000	Do.
	Marietta, Pa	do	Buffalo Creek		Jan. 5, 1875	10,000	Do.
	do	Delaware River	Bushkill Creek	Easton, Pa	Dec. 21, 1874	60,000	Do.
	do	do	Tributaries		1875	111,000	Stone's tables, (MSS.)
	do		Aquatong Lake		1875	30,000	Do.
Rhode Island	Ponaganset, R. I	Blackstone River			1874, 1875	12,000	Do.
	do	Pawtuxent River				35,000	Do.
	do	Pawcatuck River				20,000	Do.
	do	do	Artificial ponds			1,000	Do.
Texas	Niles, Mich	Brazos River		Hempstead, Tex	Dec. 11, 1874	2,000	Letter of G. H. Jerome, April 16, 1876.
	do	Colorado River		Austin, Tex	Dec. 12, 1874	12,000	Do.
Utah	Jordan, Utah	Salt Lake	Jordan River	Jordan, Utah	Sept. 29, 1874	195,900	Letter of A. P. Rockwood.
Virginia	do	James River			Nov., 1874	5,000	Letter of W. B. Robertson, December 23, 1874.
	Bloomsbury, N. J	Roanoke River		Salem, Va	Dec. 22, 1874	5,000	Letter ——
	do	Rappahannock River				Unknown	
	do	New River			Dec. 22, 1874	10,000	Report J. H. Slack, (in present volume.)
	do	Potomac River	Cedar Creek	Winchester, Va	Jan., 1874	30,000	Maryland Report Commissioners Fisheries, Jan. 1, 1876, p. 81.
	do	do	South Fork	Romney, Va	Dec. 9, 1874	15,000	Do.
Wisconsin River	Boscobel, Wis	Mississippi River	Green Lake		Dec., 1874	10,000	Stone's tables, (MSS.)
	do	do	Tributaries			22,000	Do.
Canada*	do	Lake Ontario		Newcastle, Ontario	1874, 1875		
New Zealand*							
Total						3,077,310	
Distribution outside of United States not reported						50,000	
Grand total						3,127,310	

* A shipment of 25,000 eggs to the government hatching-house of Canada; and a shipment of 25,000 was made by Mr. W. A. Newell to New Zealand.

Table of Penobscot salmon (Salmo salar) transported to new waters in the United States in 1874 and 1875.

States.	Where finally hatched.	By whom hatched.	Waters stocked.	Tributaries in which fish were placed.	Locality.	Number of fish.	Date.
California			Sacramento River		Redding, Cal	305	1874
Connecticut	Westport, Conn	E. M. Lees	Connecticut River, Conn	Farmington River	New Hartford, Conn	65,000	1875
Illinois	Pokagon, Mich	G. H. Jerome	Calumet River		Kensington, Ill	25,000	1874
	Elgin, Ill	W. A. Pratt	Illinois River	Fox River	Elgin, Ill	19,000	1875
Iowa	Anamosa, Iowa	B. F. Shaw	Mississippi River	Dubuque Creek	Dubuque	3,000	1875
	do	do	do	Cedar River	Cedar Rapids	4,000	1875
	do	do	do		Waverly	25,000	1875
	do	do	do	Turkey River	West Union	15,000	1875
	do	do	do	Iowa River	Marshall	5,000	1875
	do	do	do	Maquoketa River	Manchester	2,000	1875
	do	do	do		Worthington	2,000	1875
	do	do	do	Bear Creek	Bear Creek	4,000	1875
	do	do	Missouri River		Council Bluffs	10,000	1875
Maine	Bucksport, Me	C. G. Atkins	Penobscot River	Mattawamkeag River	Eaton and Danforth	45,000	1874
	do	do	do	Salmon Stream		25,000	1874
	do	do	do	Tributary of Baskahegan		5,000	1874
	do	do	do	Passadumkeag River		10,000	1874
	do	do	do	Seboois Stream	Whitney Ridge	25,000	1874
	do	do	do	do	Howland	25,000	1874
	do	do	do	Piscataquis River	Milo	15,000	1874
	do	do	do	Pleasant River	Brownville	15,000	1874
	Sebec Lake	H. L. Leonard	do	Piscataquis River	Dover	25,000	1874
	do	do	do	Sebec Lake	Ship Pond Stream	20,000	1874
	Dobsis Stream	G. L. F. Ball	Saint Croix River	Schoodic Lakes	Dobsis Stream	10,000	1874
	Pembroke, Me	J. N. Whitman	Penmaquan River			8,613	1874
	Bucksport, Me	C. G. Atkins	Penobscot River	Seboois River	Howland	30,000	1875
	do	do	do	Madaceunk Stream		15,000	1875
	do	do	do	Salmon Stream		5,000	1875
	do	do	do	Mattawamkeag River	Bancroft	20,000	1875
	do	do	do		Danforth	45,000	1875
	do	do	do		Kingman	94,000	1875
Maryland	Green Spring, Md	Alex. Kent	Unknown	Unknown		Unknown	1875
Massachusetts	Westbrook, Conn	E. M. Lees	Red Brook	Quobaug	Palmer, Mass	30,000	1874
Michigan	Pokagon, Mich	George H. Jerome	Lake Huron	Au Sable River	Wildwood	8,000	1874
	do	do	do		South Lawn	7,000	1874
	do	do	Manistee River	Pine River		40,000	1874
	do	do	Boardman River	Salmon Creek		40,000	1874
	do	do	Muskegon River	Higgins Lake	Roscommon County, Mich	7,000	1874
	do	do	Saint Mary's River			25,000	1874
	do	do	Saint Joseph's River	Dowagiac River		5,000	1875
Minnesota	Red Wing, Minn	Watkins & Bogart	Unknown	Unknown		18,600	1875
New Hampshire	Concord, N. H	W. W. Fletcher	Connecticut River	Headwaters	Sundry places	50,000	1874
	Charlestown, N. H	L. Stone	do	Connecticut River	Charlestown	15,000	1874
	Winchester, Mass	E. A. Brackett	do	Headwaters and tributaries	Sundry places	97,000	1874

Table of Penobscot salmon (Salmo salar) transported to new waters in the United States—Continued.

States.	Where finally hatched.	By whom hatched.	Waters stocked.	Tributaries in which fish were placed.	Locality.	Number of fish.	Date.
New Hampshire.	Winchester, Mass	E. A. Brackett	Merrimac River	Pemigewassett River	Near Plymouth, N. H	30,000	1875
	do	do	do	Contoocook River		30,000	1875
New Jersey	Bloomsbury, N. J	J. H. Slack	Delaware River			12,000	1874
	do	do	do	Musconetcong River		65,000	1874
	do	do	Raritan River			31,000	1874
	do	do	Hackensack River			10,000	1874
	do	do	Passaic River			50,000	1874
	do	Mrs. Slack	do	Whippaug River	Morristown, N. J	1,000	1875
	do	do	do	Rockaway River	Dover, N. J	1,000	1875
	do	do	Raritan River	South Branch	South Branch	3,000	1875
	do	do	Delaware River	Pauliaskill, Pohatcong, Musconetcong.		74,000	1875
New York	Caledonia, N. Y	Seth Green	Lake Ontario	Allen's Creek		10,000	1875
	do	do	Hudson River	Mohawk River	Rome, N. Y	20,000	1875
	Charlestown, N. H	Stone & Hooper	do	Saranac River	West Plattsburgh, N. Y	36,500	1875
	do	do	do	Salmon River	Peru, N. Y	10,000	1875
	do	do	do	Chazy River	Ellenburgh, N. Y	48,500	1875
	Marietta, Pa	J. P. Creveling	Delaware River	Bushkill Creek	Northampton County	55,000	1874
	do	do	Susquehanna River	Swatara Creek	Dauphin County	30,000	1874
	do	do	do	Chiques Salunga Creek		25,000	1874
	do	do	do	Donegal Creek		12,000	1874
Rhode Island	Poneganset, R. I	J. H. Barden	Blackstone River	Slatersville Branch	14 places	4,000	1874
	do	do	Pawcatuck River		18 places	15,000	1874
	do	do	Pawtuxet River		28 places	40,000	1874
	do	do	Blackstone River	Slatersville Branch	10 places	15,000	1875
Vermont	Westport, Conn	E. M. Reeves	Connecticut River	Passumpsic tributaries	Wheelock, Vt	10,000	1874
	do	do	do		Concord, Vt	5,000	1874
	do	do	do		Barnet, Vt	30,000	1874
	do	do	do		McIndoe's Falls, Vt	25,000	1874
	do	do	do	Wells River		25,000	1874
	do	do	do		Newbury, Vt	25,000	1874
	do	do	do	Saxton River	Rockingham, Vt	5,000	1874
	Charlestown, N. H	L. Stone	do	White River	Royalton, Vt	15,000	1874
	do	do	do	Lamoille River	Georgia, Vt	70,000	1874
	do	do	do	Dog River	Northfield, Vt	12,000	1874
	do	Stone & Hooper	Lake Champlain	Lewis Creek	Ferrisburgh, Vt	24,000	1875
	do	do	Hudson River	Battenkill Creek	Manchester, Vt	47,500	
Wisconsin	Waterville, Wis	H. F. Dousmann	Rock River	Madison Lake		7,500	1874
	do	do	Illinois River	Geneva Lake		,500	1874
	Boscobel, Wis	A. Palmer	do	Elkhart, Cedar Rock, and Devil's Lakes.		Unknown.	1875
Total						2,294,565	

CONTENTS.

APPENDIX A.

SEA FISHERIES

AND

THE FISHES AND INVERTEBRATES USED AS FOOD.

I.—HISTORICAL OBSERVATIONS ON THE CONDITION OF THE FISHERIES AMONG THE ANCIENT GREEKS AND ROMANS, AND ON THEIR MODE OF SALTING AND PICKLING FISH.

By J. K. Smidth.*

If it is interesting to follow the great and rapid progress which pisciculture has made and is still making in our times, it is, on the other hand, of no small importance to go back through the ages and inquire into the position which this sister of agriculture held in antiquity, especially among those two great nations, the Greeks and Romans concerning which we have the most accurate and ample information in the writings of their poets, historians, and scientists. Although this rich and almost perfect literature is known, at least in part, to many persons through the study of the classical texts themselves, and by means of more or less faithful translations of the same, but few, perhaps, are aware of the fact that a large portion of these writings treats of the life of the seas. They describe its inhabitants and their mode of living, and inform us that in those times fish were used as an article of food, or put to medicinal and other uses. It would be a great mistake to suppose that we would find a few obscure names only, as having discussed this subject; on the contrary, they begin with Homer, and are found throughout the entire wide range of classic literature.

If any one should ask for the reason of this ardent attachment of the ancient writers for the sea and everything connected with it, the best answer will be found in Buffon's Natural History of Fish, where this famous natural historian says: "Fruitfulness, beauty, and long life are essential characteristics of the inhabitants of the ocean." This is the reason why Greek mythology, which, so far as regards the ultimate cause of its imagery, was much better informed than we usually suppose, and which produced ideals of undying beauty, placed the cradle of the goddess of love and beauty in the ocean, and represents her as springing from the foaming waves surrounded by her sacred fish, glittering with gold and azure. This allegory, as beautiful as it is instructive, is by no means astonishing, for we find that the ancient Greeks had observed the

* Nogle historiske Bemærkninger om Fiskeriernes Tilstand paa Grækernes og Romernes Tid samt om de dengang brugte Tilberedelsesmaader af saltet og marineret Fisk. Af J. K. Smidth. < Tidsskrift for Fiskeri. Udgivet af H. V. Fiedler, og Arthur Feddersen.—6te Aargang. Kjøbenhavn. Jacob Erslevs Boghandel. 1871. pp. 34-62.

habits of fish more closely than those of any other animals. They were not only familiar with them, but they preferred them as food even to the choicest poultry. The modern Greeks inherited from them this love of the sea and its inhabitants, and still preserve it; while the Romans, weighed down beneath the most cruel despotism, the most fearful immorality, and the most insane luxury that ever disgraced a noble nation, still clung to their love for the inhabitants of the deep. It is by no means improbable that they inherited it from those ancient nations of the East, among whom these characteristic traits may still be observed.*

The nearness of the coast, and the nature of the sea which surrounded their country as it did on almost every side, naturally inspired them with a love for ocean life; and it may well be said, "that this circumstance is more closely connected with the progress of civilization than is usually supposed. We find that it vanishes completely first in those unfortunate portions of Europe and Asia where barbaric hordes of wild huntsmen, issuing forth from their northern forests, succeeded by their numbers and fierceness in changing the customs and ideas of the conquered nations."

These words of Buffon form the theme and starting-point for the following observations, which are partly taken from ancient Greek and Roman authors themselves; partly from more recent writers, such as Paul Jovius [Giovio], Aldrovandi, Petrus Artedi, Gesner, Buffon, Sabin Berthelot, and partly from the very able writings of Noël de la Morinière, of Rouen, on this subject.

The archetypes of our modern fishing implements, the net and the line, have been known and used throughout the whole world from times immemorial. In Homer we find the fisheries in a flourishing condition, and he frequently takes his similes from the art which, in all probability not only the twin-sister of agriculture, but together with hunting, constituted the first mode of securing subsistence in the earliest days of the human race. In the Odyssey, *e. g.*, Penelope's sighing lovers are compared to the fish gasping on the shore, where the fisherman's net has been emptied. Hesiod places on the shield of Hercules a fisherman on his lookout, ready to cast his net over some of the finny tribe which are pursued by a dolphin.

The ancients knew as well as we that certain natural advantages, wisely managed, would open up new and remunerative lines of business. Hence, the Greeks developed their fisheries to such a degree as to enlist a large amount of physical and mental exertion, and they gradually became one of the most remunerative of occupations. Large salt-

* During my stay in Paris, I had a long and interesting conversation with the Chinese minister, and was astonished to hear how far advanced the Chinese are in pisciculture, especially as regards the breeding and raising of fish. They also seem to have a great many fishing implements which are unknown to us. He finally assured me that M. Coste (the great French pisciculturist) himself might learn a good deal by traveling to China, an opinion which was strongly corroborated by his secretary, a Belgian.

ing-houses were established in favorable places, round which soon rose a constantly increasing number of fishermen's huts. These again attracted artisans and merchants, so that the village soon grew to a city, of which the fisheries might be called the nucleus. Of such cities there was a large number, Byzantium and Sinope being illustrious examples. It is well known that the wealth from fish gave to the sea near the former city the name of the Golden Horn. "Proud and beautiful Venice" is of later date, but of similar origin.* Many private individuals rapidly accumulated large fortunes by dealing in salt-fish, and the ancient writers of comedies frequently make such a trader (Keriphilos by name) the object of their raillery. This man, it seems, had been honored with the Athenian citizenship, but his son, by a life of dissipation, soon spent the fortune which his thrifty father had amassed.

We are acquainted with about four hundred different names of fishes, which have been described by Greek authors. "This abundance of words," says Buffon, "this wealth of exhaustive and accurate terms, presupposes the same abundance of ideas and knowledge. Is it not evident that nations, who had fixed the names of many more objects than we, must naturally have known a great many more?"

From what Aristophanes and other dramatic writers tell us of the mode of living among the ancient Greeks we know that in their time fresh and salt fish formed a very important article of trade. Athenæus quotes about two hundred passages of authors, whose works are now lost, in which different ways of preparing and preserving fish are mentioned. Xenocrates, Æschylus, and Sophocles did not consider it beneath their dignity to speak of very tempting bills of fare; and Archestratus, who assisted Epicurus in seeking the qualification of the senses, seems to have described a great many such in his poem, "Dipnologia," a most amusing and excellent cook-book, whose loss is still deplored by modern gourmands. In the city of Athens the government, in its paternal care, even went so far as to make a law obliging fishermen as soon as they brought their fish to the market to sound a gong, so that everybody might buy fresh fish. We are also told that fishmongers, in order to sell their stock more rapidly, were not allowed to sit down, but required to stand during the time fixed for selling.†

That fish formed a favorite article of food in those times, is clear from the fact that great importance was attached to their fisheries. But other considerations also tended to increase their interest in the success of the fisheries. Fleets, as is well known, played an important part in all of the wars of those ages. It was often a matter of considerable difficulty

* Regarding the remarkable fish-colony, Commachio, compare the work by M. Coste, "Voyage d'exploration sur le littoral de la France et de l'Italie." Paris, 1861.

† This law seems to have been known in Vienna in the fifteenth century. At any rate, there has been found in the archives of that city an ancient decree ordering the fishermen to sell their fish standing and bare-headed, exposed to the scorching rays of sun and to storm and rain, thus forcing them to sell their fish speedily and at a reasonable price.

to find sailors sufficient to man them, and especially experienced sailors. It was, therefore, a matter of great importance to the governments of Athens, Sparta, and other states, that the fisheries should be encouraged, especially the sea-fisheries, which, in our days also, are considered the best nurseries of sailors for the navy.

We must also take into account the fact that the greatest wealth of Greece grew out of her colonies. To maintain an intimate connection with these was of the utmost importance; and for this end, also, the fisheries were especially useful, since along the coasts of these colonies all those fish were caught which move in schools. These fish formed an important article of trade, not alone for the colonies, but also for the mother-country, so that the former were necessarily dependent upon the latter. The article for which there was the greatest and most widely-spread demand, was salt-fish. All historians of that period agree in laying stress on the great importance which this article held in commerce, even before the time of Alexander, and during the last centuries of the independence of Greece.

But after wealth increased, and luxury and effeminacy took the place of the original simplicity of life and manners, the fisheries developed an inexhaustible supply of new articles of food, and the Black Sea (*Pontus Euxinus*) and the Sea of Azof (*Palus Mœotis*) became what the banks of Newfoundland were to the maritime states of Europe during the first centuries after their discovery. Besides fresh fish, dried and salt fish, oil, glue, and a number of other articles, prepared in an ingenious manner from the roe and the intestines of fish and of other animals living in the water, as also a large number of peculiar kinds of medicine, prepared from them, became the objects of large and extended mercantile enterprises; and all these were often sent, at an enormous expense, to the most distant portions of the then known world. Hence it was that the fisheries constantly increased in importance, so that thousands of slaves became educated as sailors and fishermen.

But the fisheries of Greece could not save her from decay. There arose in Italy a new nation whose fixed purpose was to subdue the world, which it ultimately accomplished. Rome, nursed by a wolf, never renounced its wolf-nature. First, it ravished its neighbor's daughters in order to secure wives; then their sons, in order to secure slaves; and, finally, it carried its eagles over the beautiful land of the Greeks. But Rome was practical, and its rule proved an advantage to the fisheries. The most important question was how to raise sailors for the fleet. The number of fishermen was not sufficient, and the crews of the Roman galleys consisted more of rowers than of sailors; but the latter were in great demand, as they were more familiar with the element where battles were to be fought.

Not only politics, but religion also, proved advantageous to the fisheries, for the Licinian law decreed that on certain days of the year salt-fish only could be eaten. The fishermen had also their special festival, which was celebrated with great pomp on the 3d day of June.

The Romans, like the Greeks, carried on their fisheries partly along the coasts and partly in the open sea. A large number of fishermen's societies had been organized, which fitted out large vessels and sent them on long cruises all over the Mediterranean, and even beyond the Pillars of Hercules, up and down the coasts of North Africa, Spain, and Portugal. They well knew how to make use of favorable weather, and were familiar with the best hours for fishing by day and by night; as, for example, just before the rising of the sun and the moon, and just after their setting.

The most ordinary fishing-implements were the harpoon, the line, and different kinds of nets and seines. It will thus be seen that fishermen in our time are not so very far in advance of their ancient brethren, although of course these implements have been somewhat improved during the progress of ages.

Noël de la Morinière gives the following account of the method of fishing with lines: "The lines were generally made of horsehair, single, double, and plaited. The hair of horses was preferred to that of mares, and black hair was not esteemed as highly as white. According to Ælianus, the hair was colored in different ways. The fishing-pole was chosen with reference to the supposed weight of the fish to be caught and the resistance it could offer. The hooks, which were of copper or iron, covered with tin, were single, or composed of several branches, and of different thickness. If fish were to be caught having sharp teeth, and hence able to injure the line, it was surrounded just above the hook with a covering of horn or some other hard substance, *e. g.*, copper. For catching sharks, or similar fish, iron chains were employed. Many details concerning these implements are found in the works of the ancient writers." (Histoire générale des Pêches, p. 188.)

Special care was taken in the selection of bait for line-fishing. The most common bait was small fish, larvæ, worms, or insects; sometimes, also, the lungs and liver of hogs and goats, shell-fish, and polyps; and even at times the entrails of animals which had been saturated with an extract of myrtle and other odoriferous plants. Oppianus, and, after him, Cassianus Bassus, as well as other writers in the time of the emperors, have described a large number of different kinds of bait. They were prepared to suit the tastes of the different fish. Thus the "aurata" was caught with almonds and the sword-fish with mullets. Oppian says that the "lycostome" (a sort of herring) was the best bait for catching the "sargus." As soon as a certain quantity had been thrown into the water they came in large swarms to eat it, and the fishermen then seized the opportunity to inclose them in their nets, and thus frequently caught large numbers.*

* This use of bait in net-fishing reminds us of the sardine fisheries on the coast of Brittany, as carried on in our own time. But here the roe of the cod-fish is used as a bait for the sardines. To give an idea of the enormous quantity of roe used for sardine-fishing, I will only mention that 30,000 kegs of roe are exported annually from

The Romans also used artificial baits; and the art of making flies of feathers and other materials has, perhaps, never been carried further in our time even in England itself. Fishing by torch-light was a favorite amusement, and several ancient authors describe this mode.

There were peculiar methods of net-fishing, which we have only imitated or somewhat developed. Hemp, flax, and Spanish reeds were used for the manufacture of these nets, which were afterward tanned several times in order to make them stronger. The fishermen set them both along the coast and in the open sea. Drag-nets, which were first used by the Greeks, served for inclosing the large schools of migratory fish, and the stationary nets stopped them in their course. These latter were very large, and were made of a kind of plaited work of Spanish broom. Permanent nets of this kind were soon used at the mouth of the Bosphorus, on the coasts of Italy, Sicily, and Sardinia, especially in the Ligurian Sea, the Bay of Naples, the straits of Bonifacio and of Messina, at the entrance of the Adriatic, the straits of Cadiz, and along the coasts of France and Spain. Strabo makes especial mention of the large stationary nets on the coast of the island of Elba.

The four hundred names of fish spoken of by Greek authors are given in alphabetical order in the work of Aldrovandi, who, also, gives alphabetical lists of fish in Latin, Italian, French, German, and English. Similar lists are found in Gesner, Artedi, and other authors. Those who desire further information on this subject are referred to the works of those ichthyologists. But to enable the reader to form some idea of the numbers and kind of fish known in those times, the following list is given, in which those groups and families are mentioned which were most numerous in the Greek and Latin seas. Each of these groups, therefore, comprises a considerable number of important species, to enumerate which would lead us too far from our special theme. In this list Lütken's system has been followed:

FIRST ORDER.

a. The perch group.—Red mullets (*Mullus*); breams (*Sparus*); sciænoids (*Sciæna umbra*); and white mullets (*Mugil*); besides quite a number of labroids (*e. g.*, the parrot-fish, *Scarus*, and other similar fish.)

b. The toad-fish group.—1, gurnards (*Trigla*); 2, frog-fishes, *e. g.*, the angler (*Lophius piscatorius*); 3, gobies (*Gobius*); 4, blennies (*Blennius*); the sea-wolf (*Anarrhicas lupus*); 5, codfishes (*Gadus*), and especially the "*Asellus*;" 6, flounders (*Pleuronectes*); and among these the turbot (*Pleuronectes rhombus*), plaice (*Pleuronectes limanda*), sole (*Pleuronectes solea*,) &c.

Norway to France. Each of these kegs contains about 140 kilograms, making a total of about 4,500,000 kilograms, or about 9,000,000 of pounds, valued at about 3,000,000 francs. Several owners of large fisheries have assured me that the buying of this roe deprives them of half the profits of their sardine-fisheries.

c. *The mackerel group.*—The mackerel (*Scomber scombus*); the tunny (*Scomber thynnus*); the scad (*Caranx trachurus*), and the swordfish (*Xiphias*).

d. *The pipe-fish group.*—The sea-horse (*hippocampus*).

SECOND ORDER.

a. *The carp group.*—The common carp (*Cyprinus carpio*); the tench (*Cyprinus tinca*), and the loach (*Cobitis*).

b. *The eel group.*—The common kinds of eel and the sea-eel (*Anguilla, Conger*).

c. *The salmon group.*—Nearly all kinds.

d. *The herring group.*—Especially the anchovy (*Engraulis encrasicholus*).

THIRD ORDER.

a. *Sharks* (*squalus*).—The dog-fish (*Scyllium canicula*); the blue shark (*Galeus vulgaris*); and others.

b. *Rays* (*raja*).—The saw-fish (*Pristis*); the cramp-fish (*Torpedo*).

FOURTH ORDER.

Lampreys (*Petromyzon*).—The river lamprey (*Petromyzon fluvialis*), and the sea-lamprey (*Petromyzon marinus*).

Besides these fish, whales, dolphins, lobsters, crabs, oysters, various kinds of shell-fish and other sea-animals, that came within the scope of the fisheries, are mentioned, and ought therefore to be noticed in this place. In the following pages some of the most important fish, as well as the mode of fishing for them, &c., will be mentioned; then the salting of fish; and finally we will see what Pliny says about the artificial fish-ponds, which will naturally lead us to speak of lobsters, oysters, shell-fish, &c.

THE MULLET.

The mullet (*mullus*) was a great favorite with the Romans. Horace says, "You praise, O fool, a mullet of three pounds, which you are obliged to cut into several pieces;" and Martial praises the mullet, saying, "The mullet of four pounds, which you had bought, was the chief attraction of your feast," (*cœnæ pompa caputque fuit*).*

Noël de la Morinière tells us in the following words to what length the Romans carried their passion for mullets:

"The mullet was one of those fish that were most sought for in degenerate Rome, and it was made the subject of the most refined sensual enjoyment with the emperors and the aristocracy, who had become thoroughly depraved by the extravagant use that was made of the world's plunder. It is difficult for us to realize the enormous value which the Romans placed upon this fish, for as it never reaches

* Martial, Epigrams, x, 31.

any great size, they did not hesitate to pay its weight in gold if it was unusually large. Seneca and Suetonius have given us, in their writings, descriptions of the extravagant taste in the preparation of the mullet for the table of the rich. We read there how each guest, with the most refined cruelty, looked upon the mullet destined for his own dish, die before him, in order to enjoy the rapid change of brilliant hues which the fish then exhibited. The wildest fancies that the most extravagant luxury could imagine were realized in preparing it for the table. The freedmen who were intrusted with the preparation of the mullet enjoyed the greatest privileges, and a good cook was often better paid than a good general. Mullets were served on dishes lavishly adorned with precious stones, and the most costly spices were used in cooking them. During the reign of Heliogabalus, extravagance reached such a height that this emperor, who had become tired of mullets, although at that time they were growing scarce, ordered (according to Lampridius) a dish to be prepared consisting of nothing else but the mouth-fibers of mullets. It may well be imagined what an enormous quantity was required to satisfy this morbid taste.

"Mullets from the straits of Gades (the straits of Gibraltar or the straits of the Pillars of Hercules) enjoyed the greatest reputation.

> Dat rhombos Sinuessa, Dicarchea littora pagros,
> Herculeæ mullum rupes . . . .

"Scarcely less famous were those from the sea around Sicily and Corsica. According to Seneca, (epist. 95,) the Emperor Tiberius sold at auction a mullet, weighing four pounds, to Apicius and Octavius jointly, for the sum of 4,000 sesterces, ($156.) This fish, which can easily be recognized, is very frequently represented on the fresco paintings which have been dug out from the ruins of Herculaneum and Portici."

Though not exposed to the same cruelties as the mullet, there was another fish which almost equaled it in costliness:—

THE SCARUS.

The scarus, a fish of the labroid family, was, according to Pliny, (Hist. Nat., ix, 17; xxx, 10,) originally found only in the Ægean Sea. But in the time of the emperors, when the simplicity of former days degenerated into extravagance and luxury, the wrasse was brought from Greece to adorn the tables of the wealthy Romans. One of the freedmen of the Emperor Claudius, Elipertius Optatus, who commanded a Roman fleet in the Ionian Sea, brought a large quantity of these fish to the coast of Italy, where they were put into the water near Ostia, at the mouth of the Tiber. For five years all fishermen who caught such fish in their nets were ordered to throw them into the sea again; and the consequence was, that that portion of the sea, and even the Tiber itself, as far as the gates of Rome, swarmed with them. This attempt to transplant fish proved so entirely successful, that these transplanted scari soon gained the reputation of excelling in richness of flavor those of the Greek seas. In the time of Pliny, the scarus was, without doubt, considered one of the greatest dainties. Originally, the sturgeon held this place, then the basse (*lupus*) and asellus, and at last the scarus "came, saw, and conquered."

Ovid, in his book "Halieutikon," relates a remarkable trait in the nature of this fish: when it has been caught in a net it does not swim any further, as this would cause it to become fastened with its gills in the meshes, but it swims backward, wagging its tail. As soon as another scarus outside the net notices this movement, it comes to its assistance, by seizing the tail of the captive, and thus draws it out of the net. The relation of this remarkable phenomenon shows the accuracy of the observations of the ancients. Pliny tells us that the mullet and the scarus when they find themselves pursued, act like partridges and little children, hiding their heads at the bottom of the sea, and imagining that the pursuer cannot see them, because they cannot see him.

According to Suetonius, the "shield of Minerva," the famous monster dish which Vitellius brought into fashion, was garnished with scari The part of this fish most esteemed was the liver.

THE MURÆNA.

The muræna is described in the following manner by Pau. Jovius, whose words are given in a literal translation to show at the same time how natural history was written in the sixteenth century: "Murænas are found in great numbers in all parts of the sea, but those from the coasts of Sicily are the largest and best. These are the kind which Columella calls 'flutes.' They swim near the surface, and it therefore sometimes happens that when the warm rays of the sun dry their skin, thereby depriving them of their flexibility, they can no longer dip beneath the water and can easily be caught with the hand. They are speckled, and are said to have star-like figures on their sides, arranged in the shape of the dipper, which, however, disappears immediately after death. They possess great cunning, for when they find themselves caught they swallow the hook, bite through the line with their teeth, and thus make their escape. I am of opinion that the ancient Romans prized the muræna more on account of its long life than of its delicious flavor; for the large numbers required for daily use could easily be kept in ponds prepared for this purpose, while most other fish soon died, either through grief at having lost their liberty or through the neglect of the pond-keepers. We know from Pliny that C. Hirrius, at a banquet given to Cæsar as Dictator, could place on the tables 6,000 murænas from his own ponds. Murænas could easily be tamed, and taught to take their food out of a person's hand. Crœsus, surnamed the wealthy, was so much attached to a muræna which he had raised himself, that when it died he shed tears, and had it buried. We also read an account of an answer, which

Crœsus gave to L. Domitius, who laughingly expressed his astonishment that any one could weep over a dead muræna; it might, perhaps, be thought strange, he said, that he, Crœsus, shed tears over a dead muræna, but it was far more strange that he, Domitius, did not shed any tears over his three dead wives. (Domitius had three wives, whom he is reported to have poisoned in order to obtain their property.)

Certain ladies showed great affection for murænas; thus Antonia, the daughter of Drusus, adorned a tame muræna with gold rings and bracelets.

Murænas eat human flesh, and the cruelty of Vedius Pollio in this respect seems well established. He placed those of his slaves who had been condemned to death in his fish-pond, in such a manner that they could not be eaten at once, but were gradually torn to pieces by the teeth of the murænas. It is said that the muræna breathes through its tail, and therefore dies sooner when struck on the tail than when struck on the head.

D. Ambrosius and several other ancient writers assert that snakes mate with murænas, and that the latter entice the snakes to the seaside by a certain peculiar whistling sound. Athenæus does not believe this, and in corroboration of his opinion quotes from a work on popular superstitions, written by Andreas. Murænas spawn all the year round, and of this kind, the *Murus*, the largest and strongest is of a uniform color, very much resembling that of the larch; so at least, Aristotle affirms: Pliny calls this kind *Myrinus*. There is also a river Muræna, which is much smaller and has only one point; and which according to Dorianus is the same that Athenæus calls *gallaria*, and I think that Athenæus must have meant by this smaller kind what we call lamprey and not the sea-fish. Iresius assures us that the flesh of the muræna is not less nourishing than that of the eel, but on account of a certain hardness and moisture it is very indigestible. It is, however, much prized on account of its delicious entrails, with which, as Lampridius tells us in his history, Heliogabalus, while far from any sea, regaled his court and the whole rural population.

THE COD FAMILY.

Of the cod family, our northern codfish was certainly not known to the ancients. The kind best known and most highly prized was the *Asellus*, which, in all probability, is our *Gadus merluccius*. At all events, Jovius tells us that the fish which the Ligurians call *asellus* was named by the Romans *squamus*, or *merluza*. Pliny informs us how highly this fish was prized. There were two kinds. The larger one is named, by Jovius, *banchus*, and reaches a length of two feet. The smaller kind he calls *callarius*. Pliny says that they have a small stone in their head, and praises their delicate flavor. Galenus maintains that its flavor strongly resembles that of the codfish. Aristotle relates that during the great heat of summer they hide themselves, and he is unable to tell how often they spawn. The *asellus* was also called *Bacchus* on account of the wine color of its mouth, and this circumstance caused Ovid to exclaim "that a fish with so many excellent qualities did not deserve so ugly a name as *asellus* (*i. e.*, little ass.)"

As an article of commerce the *asellus* was, for the most part, salted, and in that shape sent all over the Roman empire.

The Romans did not confine themselves to these common fisheries, but also ventured to attack the more dangerous animals of the sea; and even *whales*, which came into the Mediterranean, often became a prey to the fisherman.

According to Oppianus, this fishery, although only of casual occurrence, resembled very much our mode of catching whales before our fishermen began to use explosive projectiles. There were attached to the line, which the whale would drag under water while escaping, two large leather bags filled with air, precisely like those which the Greenlanders and the inhabitants of Kamschatka use. The description of Oppianus is remarkable, as it contains many interesting details, and seems to be entirely trustworthy. He says: "The moment the monster is attacked, it dives down to the depths of the sea, and the fishermen anxiously wait for its return. Their light boats plow the foaming waves, and rapidly fly toward the battle-ground, where a combat is soon to take place, on whose fortunate termination the keenest interest is centered. The fishermen encourage each other by shouts, every one strains his powers to the utmost, and the sea presents a scene of animated confusion. As soon as the whale shows himself again, it is attacked with double-hooked spears. Its blood begins to flow, and colors the sea for a great distance; but like a staunch vessel, braving the thunder and the lightning, the whale resists the furious attacks, sometimes with a single movement of its tail sweeping away the boats which surround it, and mocking all the exertions of its assailants. But the decisive moment approaches; though mortally wounded, its tail still throws a deluge of water over its enemies. But nothing can now restrain the zeal of the pursuers. The monster is overcome, and silent and motionless it floats on the water like a conquered man-of-war after a sanguinary battle. The victors then drag their prize ashore amid tumultuous shouts of joy."

THE SWORD-FISH.

The ancient Romans possessed many sword-fisheries throughout the whole extent of the Mediterranean, from Byzantium to Gibraltar, but they were of the greatest importance on the coasts of the Tyrrhenian sea and in the great and shallow bay which forms the southern boundary of France. The name of the promontory Xiphonion (called so after the Latin name of this fish, *i. e.*, *xiphias*) shows how valuable the sword-fish was to the inhabitants of those coasts.

De la Morinière says: "One of the most common modes of fishing was to employ, as the Greeks do, boats built in the shape of a sword-fish, with a long projecting point representing the sword of the fish's upper jaw, and painted with a dark color like that peculiar to this fish. The sword-fish, imagining he sees a comrade, confidingly approaches these boats, when the fishermen, profiting by the mistake, plunge their spears into its side. The animal, although surprised, nevertheless vigorously defends itself, and by plunging its sword into the sides of the treacherous boat often exposes it to imminent danger. This moment is seized by the fishermen to cleave its head, and if possible to chop off its upper jaw. After thus overcoming its resistance, they tie their victim to the boat, and so drag it ashore.

Oppianus has preserved an amusing characteristic of this fish, which seems to contradict the statement made concerning its courage. He says that if accidentally, or in the too eager pursuit of mackerel or tunnies, it finds itself in a stationary net, it retreats, suspecting some snare, although it could easily tear the net. This timidity, however, proves disastrous, for, at last remaining quite still, the fishermen come, drag it ashore in their nets, and kill it.

SALTING.

This branch of industry was carried on in the earliest times by the Phenicians on the western coast of Spain, and was afterward continued by the Greeks; but it was reserved for the Roman empire to raise it to the highest degree of perfection. It was applied to many different kinds of fish. By the term "salt-fish," we must not understand exclusively fish laid in brine, but also those that were pickled with spices and odoriferous herbs. According to Noël de la Morinière's learned researches, fish were preserved both in a raw and in a cooked state, and in the latter case they were prepared with precious herbs only. He adds, that it would really seem difficult to suppose that the Roman Sybarites, who had the most costly fowl and fish brought from Persia, Colchis, and India, at such great cost, could find in salted tunnies, and mormyri anything to gratify their spoiled palates.

The art of preserving fish in different ways made rapid progress. Care was taken not only to preserve such kinds as would retain a delicate flavor, but, also, to bring new articles into the market, that thus a brisk intercourse might be kept up between the cities of Italy and the colonies on the coasts of the Mediterranean. In those days the mullet was frequently salted, at which people in these times, at least with us, would sneer; and its roe formed a favorite dish with all classes. From a passage in Athenæus, where he quotes Archestratus, we learn that the sword-fish was then salted in exactly the same manner as is now done on the coast of Sicily. "When you come to Byzantium," he says, "take a piece of salt sword-fish, and choose a slice of the back nearest to the tail." Large fish were cut into pieces and underwent different processes, both simple and complicated, according to which they were differently named.

It would detain us too long to give a complete list of those fish which, when salted, were held in great esteem. The following are some for which there was the greatest demand: the sea-eel, from Sinope; the tunny, from Byzantium; the mackerel, from Spain; the tunny, from Cadiz; the sword-fish, from Sicily; the mullet, from Exone; the scarus, from Ephesus; the "*pagrus*," from Italy; the eel, from Strymon; the mormyrus, from the Nile, &c. The names of all these fish of acknowledged excellence served as recommendations for those cities or countries which had gained fame by their manner of preparing them.

But most of these fish have lost in our days the reputation which they formerly enjoyed. The mormyrus of the Nile, *e. g.*, which Athenæus described, and with which the learned Geoffroy St. Hilaire has made us acquainted, is now scarcely known beyond the works of natural historians. The same holds good of the tunny, which is now preserved in oil, instead of being salted or dried as was the custom among the ancients. The Romans had learned from the Greeks a mode of preserving it, which, with some modifications, is used even in our time among the Italians and Spaniards; it is called "escabeche." The fish are first fried in oil with bay leaves, salt, and spices, and then boiling vinegar is poured over them. This method was especially employed with several kinds of mackerel, but likewise with other fish, such as the "pagrus," the dorado, and even the larger kinds of perch.

The inhabitants of the Greek Archipelago were the first to preserve the tunny. This fish was salted on the islands of Eubœa, Samos, and on the coast of Icaria, which acquired the surname, "the coast rich in fish." The ancient names, Cetaria domitiana, (near Orbitello and Santo Stephano,) and Terra cetaria, (stretching from Segarte to the promontory now called Santo Vito,) designate places where the Romans had large stationary nets, and they show the importance of these fisheries.

Tarentum, in the Tyrrhenian Sea, had gained a great reputation for its salt fish, especially for its delicious tunny, which was exported to remote districts. No less famous was the tunny from Sicily, especially that kind salted in Cephalo.

The ancient Cetobriga, a Phœnician colony on the southern coast of Lusitania, near the mouth of the Guadiana, maintained its former great importance under the Romans on account of its stationary nets, and the immense quantities of tunnies which were salted on that coast. Resendius, (Antiquitates Lusitaniæ, 210,) assures us that even in his time, the ruins of the salting establishments of Cetobriga could be seen. The new town, Neocetobriga, which rose not far from the old one, and which the Portuguese have called Setubal, (Saint Ybes,) continued to carry on the trade in salt tunny, which had once enriched the Greek town. Castro, the historian, fully corroborates the statements of Resendius. He says the name of the town is derived from "briga," which in the old

Lusitanian language means "castle" or "fortified town," and from "cete," *i. e.*, "great fish" (tunny).

Malaga also owes its wealth and its name to the tunny fisheries, for, in the Punic language, "Malach" means both "to salt," and the "salting place." Several other Spanish towns contended for the fame of bringing the best articles into market. Gades (Cadiz) gained the prize. The favorite parts for salting were the gristly portions of the head; but many portions of the body were also used for this purpose. According to Galenus this fish was preferred in the salted state, because it then seemed less hard and easier to be digested.

One of the most important fisheries in those times was a tunny-fishery, which, during the Grecian period, brought great wealth to the Carian and the Milesian colonies on the Black Sea. When these fish in their periodical migrations came out of the sea of Azof, (*Palus Mœotis,*) they followed the coast of Asia, and many were caught in nets near Trapezon. Thence they went in company with other kinds of mackerel to Sinope, whose inhabitants, according to Strabo, grew immensely wealthy through this fishery. Amastris, Tejum, and Heraclea, located on the same coast, likewise reaped a rich harvest. If we may believe the author of "Storia philosophica e politica delle colonie degli antichi nel mar Negro," the best harbors were Sinope and Galidon, on the river Halys, near whose mouth great salting establishments were located.

Notwithstanding the enormous quantities of tunny caught on the coast of Thrace, the salt-fish from Sardinia were the most famous, and those of the best quality were called sardinians.

The fish known in France by the name of "*auriol,*" (in Spanish "*cavalla,*") is another kind of mackerel, great numbers of which were salted by the Greeks. Athenæus praises it in the most eloquent manner, and its fame increased still more after the Romans had conquered Spain, and had learned how to extract from its entrails the far-famed "*garum sociorum,*" a fish sauce which was greatly prized. Although several ancient authors have written the most glowing encomiums on this secret preparation, (for it seems to have enjoyed then as great a reputation as the English fish-sauce in our times,) it is impossible to discover what this 'garum sociorum' really was. Pliny, the encyclopedist of the ancients, says that this fluid matter was an extract from the entrails of certain fish that had undergone the process of fermentation. "The Greeks," he says, "in former times, prepared 'garum' from the fish called by that name; the best 'garum' comes now from Carthage, in Spain, (Carthagena,) and is called 'garum sociorum.' You can scarcely buy two boxes (each containing about ten pounds) for a thousand pieces of money. No fluid, except scented waters, sells for so high a price, and it is in great demand by all classes of society. The fishermen of Mauritania, Betica, and Carteja, prepare it from mackerel, fresh from the ocean, which alone are fit for this purpose. The 'garum' from Klazomene, Pompeii, and Liptes is also highly praised; and the prepared fish from Antipoles, Thurium, and Dalmatia are no less to be recommended." (Pliny, Hist. Nat., XXXI, 8.) Paul Jovius tells us that the best "garum" was obtained in Africa. This "garum sociorum" was chiefly prepared by a certain society of mackerel fishermen, (hence the term "sociorum,") which in those times seems to have played a part similar to that of the "Maatjes Haringen," herring-society, in the Netherlands.

Besides this prime article of "garum," other kinds formed an extensive item of trade among the Romans. Athenæus tells us, among other things, of one kind prepared from the entrails of the "*lykostome*," a fish which is closely related to the anchovy, and which is probably the same as that still to be obtained at Antibes, although Martial only speaks of "garum" prepared from tunnies. (Mart. Epigr. XII, 103.) A similar preparation, called "Incia," was frequently used in the time of Heliogabalus, for preserving fish.

The epicure, Apicius, offered a great prize to any one who would invent a new sauce or paste of the livers of mullets. But the name of the man who secured the prize has been lost to posterity; for, as Pliny remarks, "it is easier said than done."

We will only mention, in conclusion, that the Greeks preserved the sea-eel in salt and marjoram. They were the greatest masters in pickling the dorado and in preserving the scarus in brine. But the Romans far excelled them in the use of costly spices, and in pickled and preserved fish, which still further increased the enormous prices paid for the rarest fish brought at large expense from foreign countries.

LOBSTERS.

Of lobsters, Paul Jovius speaks thus in the fortieth chapter of his book: "Among the shell-fish, the lobster enjoys the greatest reputation. Theodorus thinks this is the animal which Aristotle calls the crab. But Oppianus understands by the term 'crab,' what is commonly known as the 'lion,' and Theodorus calls this kind '*Commarus*.' For in the passage where he describes so vividly the combat between the muræna and the crab, he gives to the latter an indented pincer-like claw, with which it bites the neck of the lamprey." It is certain, however, that both the lobster and the crab were known to the ancients, besides some other kinds, such as the craw-fish, and those which Oppianus and the rest of the Greeks called "*Karidæ*." Paul Jovius does not show any great knowledge of natural history, when he says that the lobster is red, and yet certainly quite as much as the French Academy of Sciences in the good city of Paris more than three hundred years later, since, not very many years ago, one could read in the great dictionary of that academy under the word "écrevisse" the following remarkable definition: "animal rouge qui marche en reculant," *i. e.*, "a red animal which walks backwards!" "The flesh of this animal was generally found to be very hard, but its eggs were eaten prepared in different ways and were considered a great delicacy. They were also put to various medicinal uses; thus they were recommended for hectic and feverish persons; and Galenus's teacher, Ærkhirion, advises those who have been bitten by a mad dog, to roast alive one of that kind of crawfish, which in Greek is called "*Karkinos*," and to turn towards the constellation Canis, when the sun passes through the sign of Leo," &c.

FISH, OYSTER, AND SNAIL PONDS.

As to these ponds, we give the information found in Pliny, Paul Jovius, and the Frenchman Coste in his extremely interesting work, Voyage d'exploration sur le littoral de la France et de l'Italie, &c., in that portion of the book where he speaks of the raising of oysters in Lake Fusaro, p. 97.

From the passage quoted from Pliny, we see that the Romans had fish-ponds for various kind of fish, but that the muræna, on account of its peculiar tenacity of life, was best suited for being thus kept. Several such ponds are mentioned as belonging to noted persons. Spawning-ponds, however, such as are now found in great numbers on the coast of France, where the fish are raised and fattened till they are fit to be sent away, seem to have been unknown. It would appear that persons were satisfied with putting those fish in ponds that were caught in the sea, to have them on hand, as it were, to fill an order at any time; although many circumstances seem to favor the opinion that, at least as far as the murænas were concerned, many of these fish were bred and raised in these very ponds. Though there are not sufficient grounds to prove that the Romans had a regular system of breeding and raising fish, we know enough to conclude that the raising of oysters had reached such a degree of perfection as to command our highest admiration.

Pliny tells us that the first inventor of oyster-ponds was a certain Sergius Orata, who in the time of L. Crassus lived near Bajæ. What led him to this invention was not gluttony, but a spirit of speculation. He had made a good deal of money by his bathing establishment, and by redecorating old country-houses so as to make them look like new ones, when he conceived the project of speculating in oysters. At that time the existence of oysters on the English coasts was not known, and Brundusium, which had almost the exclusive privilege of supplying the whole of Italy with the article, was so far from Rome, quite in the southeastern part of the peninsula, that the oysters reached the capital in a very poor condition, often completely spoiled. It is well known that oysters and fish are of a better quality in some localities than in others. Thus the best lupus or basse* is found in the river Tiber between the two bridges; the best turbots in Ravenna; the best murænas in Sicily, &c. Orata found in Lake Lucrinus a place specially favorable for his undertaking. This

* Lupus of the ancients, or *Labrax lupus* of naturalists.

lake, which had a clear bottom and pure water, was connected both with the salt water of the ocean and with fresh river-water, and in the hands of Orata it soon became a gigantic oyster-pond, which could at all times supply Rome with oysters of such an excellent flavor as soon to gain the very highest reputation among all the dainty eaters in Italy; for they ordered these oysters to be sent to them in wooden boxes filled with water, even to places at a great distance from the sea. Athenæus tells us that a noble sycophant, by the name of Apicius, sent fresh oysters carefully packed in jars to the Emperor Trajan, while he was waging war against the Parthians in the interior of Asia.

The fullest information on this subject we gain from two ancient monuments of the time of Nero, of which a short description is given in the above-mentioned work by M. Coste. These remains consist of two supulchral-urns of glass, one of which was discovered near Popularia, the other near Rome. They resemble in shape our refrigerators of terra-cotta, viz, a round vessel with a long, narrow neck. The outside of these urns is covered with a sort of engraving, which, notwithstanding its rudeness, shows us very distinctly an ancient oyster-pond. To convince us still further, we find on one of them the following inscriptions over the engraving: "Anima felix vivas," and "Stagnum Pallatium," (the first containing a wish that the soul may live happy, the second being the name of a country-seat which the Emperor Nero possessed on Lake Lucrinus;) and immediately in the center of the engraving we read the word "ostriaria," *i. e.*, oyster-pond. On the other urn we read the following inscription, "Stagnum Neronis Ostriaria; Stagnum Silva Bajæ," which leads the thought to Bajæ's famous coast, where also Nero had a villa. The most remarkable thing about these engravings is that a great number of poles are seen rammed in the ground—placed in circles—for this can only have been done with the same object for which this is done in our days near Lake Fusaro, viz, to give to the young oyster an object to which it may cling.

It is evident from this that the ancients not only kept a stock of oysters in their ponds, but also let them breed there, and in various ingenious ways made their extraordinary fruitfulness a source of income. We have here authoritative proof of a regularly organized system of oyster-culture, which brought untold wealth to its inventor, Sergius Orata, this "magister luxuriorum," as Cicero calls him. His example was followed, and soon many other oyster-ponds were established. Licinius Murena was the first who had ponds for fish, especially for the muræna, which he named after himself, and soon most of the rich and noble Roman families possessed their own fish-ponds, such as Philippus, Hortensius, and Lucullus. The last mentioned, as Pliny tells us, had a channel dug through a mountain, near Naples, at a greater expense than it would have cost to build a magnificent country seat, and in this manner brought the sea-water into his gardens. Pompey, from this circumstance, called him a "Xerxes in the toga."

Shortly before the outbreak of the civil war with Pompey, Fulvius

Hirpinus was the first in the Tarquinian district to establish snail-ponds. He arranged them in separate divisions: one for the white snails from Reatine, one for the Illyrian snails distinguished by their great size, one for the African snails, which are very fruitful, and another for the Solitanian snails, which are the finest of all. He even invented a special kind of food for them, prepared of thick must, flour, and other ingredients, and by means of this artificial diet they grew to an enormous size.

Galenus says that, as a general thing, oysters, especially if eaten raw, produce witty thoughts. Pliny attributes to them a purging property, and advises people to use the burnt shells as a remedy for dysentery.

In addition to the above, a large number of mussels and garden-snails were eaten, such as the blue mussel, "purpuræ," "buccina," "aures," "digiti," "ungues," "patellæ;" and Horace says, "effeminate Tarentum boasts of her large scallops." The ancients knew how to prepare even sea-urchins and star-fish as dainty dishes.

The above may serve to give some idea of the state of the fisheries among the ancient Greeks and Romans, as well as the different branches of trade and industry connected therewith; and we certainly feel constrained to admit that they had attained to an astonishing degree of perfection. The fall of the empire also brought about the decline of the fisheries. Rude hordes of barbarians overran the empire in overwhelming numbers, and destroyed a refined, and, in many cases, effeminate, but at the same time beautiful, product of the oldest civilization.

I close these remarks with the following words of the excellent Noël de la Morinière: "The conquest of so many countries which were forced to accept laws made for them by the barbarians, sundered all commercial ties, after having destroyed the industry and art which gave them life. We therefore see the most important fishery of the Mediterranean, the tunny-fishery, after being entirely destroyed, revived again after long ages.

"In the history of the later emperors, we hear no longer of those costly fish which the luxury of the wealthy procure from distant countries, and which gave luster and the greatest enjoyment to their banquets. The fish-ponds which once swallowed princely fortunes, stand empty and deserted. The time of extravagance has passed, and strange and morbid fancies have lost their sway. People can procure only with great trouble the most common fish, in order to fulfill the ritual of their religion. Fishing is carried on only by the poor inhabitants of the coasts, whose abject poverty is their best protection against the plundering invaders, or who only manage to carry on their miserable trade, undisturbed, by retiring to lonely nooks, such as the lagoons near Venice, or the swamps of Narbonne, thus interposing large and almost impenetrable morasses between themselves and their avaricious pursuers."

Public interest is now directed toward the North, and here we also find fisheries springing up anew, which soon grew to an astonishing extent and won for themselves a new and grand commerce; so that Sergius Orata would still not be entirely out of place among us.

II.—STATISTICS OF THE MOST IMPORTANT FISHERIES OF THE NORTH ATLANTIC.

By Carl Dambeck.*

The following statistics show the yield of the fisheries of the most important States on the North Atlantic Ocean:

1.—Norway.

During the twenty years from 1850 to 1870, the average annual amount of herring caught was 1,452,000,000 pounds, (avoirdupois,) representing a value of upward of $2,200,000. The total export of herring in 1870 was valued at $3,850,000. During the last few years the herring have mostly gone to the province of Nordland. In the bay of Malanger a comparatively large number of great herring were caught in 1871. From August to November, 270,600,000 pounds were caught; and in 1872, as many as 1,210,000,000 pounds. The herring fisheries south of the Stadt promontory have decreased. The cod-fisheries in Söndmöre were very considerable in 1871. Up to the 19th of March four millions of cod were caught, representing a value of $330,000. The yield of the spring cod-fisheries in 1873 was nineteen and a half millions of fish, 110,000,000 pounds of liver, or at least 55,000,000 pounds of oil, and 39,600,000 pounds of roe, or two millions of fish more than the year before, or a half million more than the average annual yield of the last fourteen years. The total values have probably been the largest ever realized in the spring fisheries, and amounted to $1,870,000; while in 1872 it was only $1,386,000; and, on an average, $1,375,000 annually during the period from 1859 to 1872. The mackerel fisheries, of course, did not yield so abundantly. In 1870 a million of mackerel, valued at $14,300, were exported to England from Christiansand; and in 1871, 1,813,860 were exported from the same place, valued at $63,202.70; while 100,000 were sold in the city and neighborhood. The salmon fishery in 1871 was likewise very productive. During the first half of the year, 177,685 pounds, valued at $29,729.70, were exported. The yield of the Norwegian fisheries were larger in 1870 than in any previous year. The fish exported were valued at $10,833,909.90, or $1,268,300 more than in 1869, and $2,865,500 more than in 1866.

2.—Sweden.

According to the report of the superintendent of fisheries, Mr. von Yhlen, the value of the fisheries in 1869 was only $894,947.90, while in

*Das Ausland, Stuttgart, 1874, No. 18. Translated by H. Jacobson, p. 368.

1870 it amounted to $917,079.90; for during the last years the herring has again appeared on the coast of Bohuslän. Large quantities were also caught in 1870 near Marstrand and Malmö, so that in Carlshamn alone 19,146,600 pounds were salted, while in 1872 there were only 11,000,000 pounds. The mackerel fishery on the coast of Bohuslän, which only continues one month, yielded in 1871 an income of from $8,400 to $11,200 in the district of Strömstadt alone. The salmon fisheries on the south coast near Carlscrona, adjacent to the Kullen promontory, and those in the rivers Dal and Klara, were likewise very productive. The export of fish from Gottenburg was very large in 1872. No less than 135,905 pounds of salmon packed in ice, 349,882 pounds of dried cod, and 5,500 pounds of anchovies were shipped.

3.—Denmark.

The Danish fisheries are not so extensive, because the abundance of fish is not so great, and because the extent of coast is less. In 1869 the fisheries in the Ljimfjord yielded the following: the 2,459 persons employed caught fish valued at $104,975, yielding a net income of $79,312, and giving about $32.50 to each fisherman. This was less than in 1868, when the total yield of fish was valued at $112,370. The number of herring caught in the autumn of 1870, on the coasts of the island of Funen, was so large that they did not all find a market. In the Great Belt it was very small in 1872, twenty-eight boats from the town of Korsör catching about a million, and valued at $6,445. In 1871 a large number of cod were caught on the western and eastern coasts of Jutland, of which about 353,100 pounds, valued at $3,332.50, were exported.

4.—Germany.

The German fisheries are not so remunerative, since the extent of coast is small, and much of it consists of inland seas. The total net annual income is valued at $1,500,000. Two fishing societies were organized in 1868, at Hamburg and Bremen, on the North Sea. The Hamburg North-Sea fishing society has worked with a capital of $120,000, and their receipts during the first half of 1869 amounted to $23,380.64, and during the same period in 1870 to only $19,713.26, or $3,667.38 less. In consequence of the poor fishing season and the foundering of a vessel, the society sustained a loss of $4,281.46, and was obliged to close its office in 1871. The Bremen society met with similar disastrous experiences, and has also been dissolved. Great Britain exported to Germany, in 1871, 962,533,000 of herring, valued at $3,436,837.50, which outlay ought to have been avoided. If, however, this importation of foreign fish is to be prevented, the fisheries must be carried on much more energetically than they have yet been. In Emden, a new herring-fishing society has been formed, which had every reason to be satisfied with its success in 1872, for in twenty-one trips they realized $39,780. And if it should combine fishing in deep water with fishing on the ocean, the probability is that it will be more successful than its predecessors. The fishermen operating from the mouth of the Elbe up to the boundary of Jutland, catch, for the most part, bream, herring, and sturgeon. The sturgeon fishing has been particularly good during the last few years. In 1871, however, it was not so good in the river Eider. In 1873, so many plaice were caught that whole wagon-loads were sold for a trifle. The number of cod and ray caught was likewise very large, while the herring-fisheries on the east coast of Schleswig-Holstein were very poor. On the Mecklenburg coast, especially near Warnemünde, the herring-fishery has been carried on for some years by societies. Warnemünde possesses four herring-nets. Of the three societies fishing east of that town, one netted $750 in 1871, while another realized only half of that sum. The fishermen on the coast of Pommerania are very poor, for the fisheries yield but little. The fisheries on the coast of Eastern Prussia are richer, salmon and bream being caught in considerable quantites. In September of 1860 about 3,500 salmon were caught at the village of Russ, near Memel, the average weight of each being 33 pounds, while some ranged in weight from 82½ pounds to 102 pounds.

5.—Great Britain and Ireland.

Great Britain, undoubtedly, has larger fisheries than any other country in Europe. Cod are caught near Newfoundland; herring, pilchard, and sprats, off the British coasts; salmon, mackerel, plaice, and other fish are caught in Scotland and Ireland. McCullogh estimates the annual income of the British fisheries at $20,000,000; others, at $60,000,000. The increase of the cod-fisheries will be seen from the following figures: In 1790, it was 72,160,000 pounds; in 1814, 137,038,880 pounds, valued at $12,458,080; in 1825, only 107,030,000 pounds; and in 1835, only 78,320,000 pounds, valued at $1,780,000; while in 1848, it was again 110,000,000 pounds. The success of the mackerel fisheries in 1821 was entirely unexpected. The value of fish caught by sixteen boats, near Lowestoft, on June 30, was $26,260; and the total value of fish caught on the coast of Suffolk amounted to about $70,000. In 1827, no less than 10,521 persons were engaged in the pilchard fisheries on the coasts of Cornwall and Devonshire, and the capital employed in these fisheries was $2,206,075. There are cases on record where 10,000 barrels were landed in a single day at one port, each barrel containing 2,500 fish. During the winter of 1829–'30, the sprat fisheries were so successful that loads of from 1,000 to 1,500 bushels—costing from 12 to 16 cents a bushel—were brought to Maidstone to be used as manure for the hop-fields. The herring fisheries are still more abundant, and were especially rich in 1871 on the south coast. In Lowestoft alone, more than 50,000,000 of fish were brought ashore in seven days. They sold, of course, at a very small price. On the Scotch coast, the fisheries were not so successful. The herring-fisheries in Stornoway proved a failure, and the result of the fisheries on the east coast was not much better. Notwithstanding this, Great Britain exported to Germany, in 1871, 962,533,000 pounds, valued at $3,272,750. In 1872, the fisheries proved very successful. The Fraserburg herring-fleet of six hundred boats caught in a single night upward of 10,000,000 of herring, valued at from $75,000 to $80,000. This is the largest haul on record in those parts. In no country of the world, in proportion to its size, are the salmon fisheries as valuable as in Great Britain. They are most extensive in Scotland, where from 10,000 to 12,000 salmon are caught annually. In 1820, 21,817 were caught; and from 5,000 to 6,000 are caught every summer in the Tweed alone. The Scotch salmon fisheries were particularly successful in 1870, many large and beautiful fish being taken.

6.—France.

As this country is very rich in natural products, and as the extent of its coast is small, the fisheries are not carried on to any great extent. But notwithstanding this, they yield a large income, the annual sum being estimated at no less than $8,200,000. Herring, pilchard, and sardines are chiefly caught on the coasts and in the North Sea. Sardines and tunnies are caught in the Mediterranean, and cod near Newfoundland. In 1848, 110,000,000 pounds of cod were taken. The herring and pilchard fisheries are even more productive. Single boats from Dunkirk, Calais, Dieppe, and Boulogne, have caught as many as 28,000 in a single night. On the coasts of Provence and Languedoc, from 220,000 to 330,000 pounds of tunnies are frequently caught at a single haul. The finest sardiens are found near Antibes, Fréjus, and St. Tropez, and they are brought to the fair at Beaucaire in enormous quantities.

7.—North America.

The following statistics will show sufficiently the importance of the North American fisheries. The fisheries near Newfoundland have yielded the following: Excluding those fish caught by the English and French, the Americans, in 1829, caught 195,030,000 pounds of cod. St. Johns, in 1842, exported cod-fish and oil valued at $4,476,315. The Americans caught, in 1848, 165,000,000 pounds of cod. St. Johns also exported, in 1842, salmon valued at $68,390, and herring estimated at $35,595. Montreal exported in 1841 fish valued at from $350,000 to $400,000, and from Gaspé there were shipped from 14,300,000 pounds to 16,500,000 pounds. The New Brunswick fisheries annually yield from $200,000 to $300,000, and those of the United States in 1847 yielded $17,069,262. The most important fisheries in the country last named, are the cod and mackerel. Boston, alone, in 1849, exported about 231,856 barrels of mackerel. The cod-fisheries of Greenland were also very successful in 187 .

III.—ON THE FISHERIES OF NORWAY.*

CHRISTIANIA, *November*, 1873.

To Dr. SPENCER BAIRD,
President of the United States Commission
Fish and Fisheries, Washington, D. C.:

Of the Norwegian salt-water fisheries, the haddock-fisheries are the most important, and next to them the herring-fisheries.

The largest haddock-fisheries are those of the Loffoden, (Islands,) in the district of Nordland, carried on from the beginning of the year till some time in April.

About the time that the fisheries cease near the Loffoden, another important haddock-fishery commences, in East and West Finmarken, which continues till about the 24th of June.

A third periodical haddock-fishery, which promises to become of considerable importance, is carried on on the coast of the Romsdal district, and partly, also, further north, in the districts of Fosen and Namsdal, about the same time that the Loffoden fisheries are in progress.

Of the herring-fisheries, that of the spring herring, which is conducted in the districts of Stavanger, Southern and Northern Bergenhus, and Romsdal, during February and March, has, so far, been the most important. During late years this fishery has been somewhat irregular. While it has partly abandoned the usual fishing-places, especially in the districts of Stavenger and Southern Bergenhus, it has been confined, to some extent, to places where fishing was formerly not very good. On the whole, however, it has diminished considerably, and during the last four years the number of fish caught has not been half of what it formerly was.

At the time that the spring-herring fisheries began to diminish another large herring fishery was opened up in the northern part of the country, especially in the district of Nordland, and partly, also, in that of Tromsö. The fisheries have generally continued from the middle of October till some time after the beginning of the year. The number of fish caught has been constantly on the increase, and last year it reached 700,000 "tönder," (2,156,000 bushels,) or as much as in former times was considered the result of a good spring-herring season. The species of herring called great herring (stor sild,) has become an excellent article of trade.

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* Translation of a printed letter addressed to the United States Fish Commissioner by the authorities of the Norwegian commission, in response to an application for documents relative to the fisheries of Norway and Sweden.

Besides the periodical herring-fisheries mentioned, there may be reckoned scattered fisheries along the coast of the Bergen and Trondhjem districts, all during the summer and autumn. Summer herring and fat herring are caught here, and they constitute an article of food much sought after.

Further information regarding the kinds, results, and methods of our fisheries, is contained in a work on the Norwegian fisheries, published in 1864, by O. N. Löberg, in the official statistics of fisheries; as, also, in the annual reports of the various superintendents of fisheries.

These works will show that besides the fisheries referred to, other regular fisheries are carried on during the year, each of which, considered separately, is not as important as those already mentioned; but which, nevertheless, taken as a whole, play no inconsiderable part in the economy of the country.

Scientific investigations concerning our fisheries have, as far as the herring fisheries are concerned, been made by Mr. Axel Boeck. The results of his investigations are published in a work entitled "On Herring and Herring Fisheries," only the first part of which, however, has been printed. What connection there may be between the decrease of the spring-herring fisheries and the development of the great herring fisheries, is yet an unsolved problem.

Similar investigations regarding the haddock fisheries on the Lofloden, have been made by Mr. G. O. Sars, who has published several reports on the investigations which have led to very valuable discoveries as regards the development and the manner of living of the haddock.

There is no uniform law prescribed for our salt-water fisheries, but there is a number of separate laws for the separate fisheries, or for the various districts.

Attempts, however, have been made to secure some uniformity of principle in these different laws, so that no greater discrepencies exist between them than are necessarily found between different fisheries and different localities. The old laws and regulations undertook to exert an influence on the fisheries as well as on the preparing of the fish, by various restrictions and prohibitions. The new fishing laws, on the contrary, have been limited principally to regulations concerning the maintenance of good order during the fishing season, especially by appointing officers for this purpose; so that the fishermen are allowed, to a great extent, to carry on their fishing operations in any way most acceptable to themselves.

A sea-police has been organized by the law of May 23, 1857, for the haddock fisheries on the Loflod Islands. This police exercises its functions by means of small vessels called "skates," (sköiter,) manned by five or six men, and generally under the command of a naval officer. As to the details of this organization we refer to a resolution of the government sanctioned by the king, October 27, 1858, and contained in the official journal (*Departement tidende*)for 1858, p. 781, sqq. The expenses of this police amount annually to about 7,000 Norwegian "specie dalers," ($7,966).

A similar sea-police has been organized for the spring-herring fisheries by the law of September 24, 1851, modified by the amendments of August 28, 1854, March 21, 1860, June 22, 1863, and March 27, 1869. The annual expenses of this police, which formerly amounted to 10,000 Norwegian "specie dalers," ($11,380,) have been reduced, during the last few years, to 4,000 "specie dalers, ($4,552.)

It has also been found necessary to strengthen the local police for the great-herring fisheries. There has not, however, been the same amount of inspection for these as for the Loffoden and spring-herring fisheries.

Legislation with regard to the great-herring fisheries is comprised in the laws of April 25, 1863, as amended May 22, 1869, April 20, 1872, and April 5, 1873. These laws apply generally to all herring fisheries, except the spring-herring fisheries, since these are the only ones with regard to which the law of September 24, 1851, with its amendments, is in force.

The Finmarken haddock fisheries are regulated by the law of September 13, 1830, some of whose provisions, however, were annulled by the law of May 18, 1860.

The law of 1830 is based on old and limited principles of fishing; and the question has been raised, since most of its provisions are considered antiquated, whether it would not be better to introduce regulations for the Finmarken fisheries similar to those in force at the Loffoden fisheries.

As will be seen, however, from the report of the committee appointed for this purpose, made August 12, 1868, (published as "Storthing," Parliamentary document No. 79, session 1868–'69,) the committee thought it advisable, in deference to public opinion in the district, not to make any changes for the time being.

The above-mentioned law of May 18, 1860, contains some general provisions for all the salt-water fisheries in the districts of Nordland and Finmarken, in as far as these fisheries have not become the subject of special legislation.

In addition to the laws already mentioned a law of February 20, 1869, is in force, making some changes in the regulations concerning fines.

We must consider the law of July 26, 1781, concerning the preparing of so-called "round-fish," (rund-fish,) in the districts of Romsdal and Söndmöre, as nearly antiquated; also the law of December 21, 1792, concerning the haddock fisheries in the district of Fosen; the law of August 21, 1821, concerning the fisheries near Skudesnæs, and the law of the same date regarding the spring-haddock fisheries in the Borgenfjord (bay) of the Söndmöre district.

With special reference to those salt-water bays and inlets which indeed may be considered as inclosed basins, and whose abundance of fish is supposed to be chiefly dependent on local increase, the law of

June 5, 1869, prohibits the use of any implements which, by catching or destroying the young fish, would prove detrimental to the fisheries.

As to lobster-fishing, there is a law of June 29, 1848, still in force, which, however, is destined, at no distant period, to undergo considerable alterations.

As regards the administration of justice at the fisheries it may be well to notice the following; it is a general rule that any differences arising among the fishermen are not referred to any other judicial authorities than those to which they naturally belong, and are treated in no other manner than other matters in law, except that, as far as local circumstances make it necessary, the local police is strengthened, and the local judge is himself either present at the fishing-stations, or sends a substitute.

There are special regulations for maintaining order and for administering justice at two of the more important fisheries, viz, the spring-herring fishery in the districts of Stavanger, Southern and Northern Bergenhus and Romsdal, and the spring-haddock fishery on the Loffoden Islands in the northern district.

A special sea-police has been organized for each fishery, as authorized by the laws which regulate these interests, consisting of from three to four officers and a number of subordinates, all under the command of a naval officer. This police, which, as far as the naval officers are concerned, belongs to the department of the interior and is commanded by the officer who superintends the whole fishery, is under the immediate control of the respective local civil authorities. The higher local authorities are empowered to appoint for each of the two fisheries above mentioned one or, if necessary, several special judges, who, instead of the ordinary judges, administer justice during the fishing season in all matters relating to fishing in the fishing-districts.

This superintendence during the fishing-season consists in the exercise of the usual police functions, and in seeing that the special fishing-laws, the general commercial laws, and the liquor laws are properly observed. In case of violations which can be punished by fines, the superintendent imposes the fine. If this fine is paid, the matter is considered adjusted; if not, it is referred to the judge. The superintending authorities, *i. e.*, the nearest officer present, with two men chosen by him, must also arbitrate in cases of conflict between fishermen. (Law of September, 1851, section 9, and law of May 23, 1857, section 33.)

The special judge must decide in cases where the fine imposed by the superintending authorities is not paid, as well as in other cases of violation of the law which are punishable by heavier penalties than fines. If, however, the case after having been heard by the judge cannot be determined in accordance with existing regulations without the ordinary authorities, (the government of the district,) it is then referred to them to be disposed of in the usual manner. The special judge also arbitrates in private differences arising in fishing or in the fishing trade. He has also the power, in cases not strictly belonging to the fishing superintendence, to select two men, who, in conjunction with the judge, have power to make a decisiom.

The period of office of the special judge is limited to the fishing season, and those cases which he cannot finish for want of time are referred for further action to the ordinary judge of the district. The judge also exercises this authority in cases belonging to his jurisdiction, which otherwise belong to the bailiff, such as the carrying out of judgments, arrest, confiscation, &c.

The superintending authorities have, as has been already intimated, some small sailing-vessels at their disposal, on which the naval officers live during the fishing-season; and they sail round to the different fishing-places, while the judge is generally stationed on shore, where he hears and acts upon the cases presented for decision.

As to the right of fishing in salt water, the following statements may be made:

1. All kinds of fishing can be freely carried on in salt water by every Norwegian citizen, whenever he may please to do so, in the sea or along the coast. The state does not reserve to itself any rights in this respect, except the necessary police-regulations for maintaining order. (Regarding the privileges of landowners of the coast see 2.)

2. Free fishing in salt water is not confined to the sea, but also comprises fishing on the coast, except that as far as the coast itself is used in fishing, *e. g.*, for drawing fish on land or for fixing implements, this rule is somewhat modified; and in some places a different law has grown up in course of time, as regards fishing for salmon and oysters.

Fishing from land is the exclusive right of the landowner, and he alone has authority to place stationary fishing implements. Any one, however, may make use of the land to draw his fish ashore, but with this condition, that the landowner can claim a certain bonus, which, for herring fishing, is fixed at 3, and in some cases at 6 per cent. (See law of May 23, 1863, and law of September 24, 1851, § 36.)

The right to fish for salmon on the shore belongs, in many places, exclusively to the landowner, even if fishing is not carried on with stationary fishing implements. Oyster fishing belongs as a rule to the landowner. It may well happen that in some places a more exclusive right of the landowner with regard to that portion of the sea adjoining his property has grown up in course of time.

3. Besides the use of the coast for drawing fish ashore, which is guaranteed to every fisherman, some fisheries, carried on in the open sea with boats, such as the haddock fisheries, require that the fisherman shall have some place on shore for his boats, for his implements, and for drying and preparing the fish. The old fishing laws contained various regulations obliging the land-owners to allow the fisherman a certain space on the coast, in return for a bonus fixed by law; and even

now similar regulations are made in the Finmarken fishing law of September 13, 1830, sections 28–30.

Like regulations contained in the old laws regarding the most important haddock-fisheries, viz, those of Loffoden, were annulled by the law of May 23, 1857. By this law, this matter is left to a mutual arrangement between the fisherman and the landowner, and the latter is in no way obliged to grant the fisherman any space on his land along the coast.

It is but natural that among the fishermen themselves certain customs and usages in fishing have arisen, which are strictly observed. Of such usages, however, which are always taken into consideration by the judges in deciding a case, we are unable to give any further information

Of Löberg's book "On the Fisheries of Norway," and of G. O. Sar's last report, the Department of the Interior possesses no more copies. We inclose the following:

1. Statistics of Fisheries for 1870 and 1871.
2. Reports on the Spring-Herring Fisheries for 1868–'69, 1869–'70, 1870–'71, 1871–'72, and 1872–'73.
3. Reports on the Loffoden Fisheries for 1869, 1870, 1871, 1872, and 1873.
4. On Herring and Herring-Fisheries, especially the Norwegian Spring-Herring Fisheries, by Axel Boech, Part I.
5. Reports of G. O. Sars, 1864–1869.
6. Department Journal, (Departementstidende,) 1858, No. 49.
7. Amendment of the Law regarding Spring-Herring Fisheries, March 27, 1869.
8. Amendments to the Law regarding Herring-Fisheries, May 22, 1869, April 20, 1872, and April 5, 1873.
9. "Storthings," (Parliamentary,) Document, No. 79, session 1868–69.
10. Law regarding Changes in the Regulations for treating Judicial cases arising under the Fisheries, February 20, 1869.
11. Law regarding the Limitations in the Use of Fishing-Implements in Salt-water Inlets, June 5, 1869.

The other laws mentioned in this letter will be found in the Review of Fishing Laws prepared by Mr. Thomas Boeck.

IV.—STATISTICAL DATA REGARDING THE SWEDISH FISHERIES.

By Hjalmar Widegren.

[Nordisk Tidskrift for Fiskeri, published at Copenhagen. New series, Part I, November, 1873. Translated by H. Jacobson.]

Sweden, extending from north to south through more than 12° of latitude, is washed by the sea on about two-thirds of its circumference, which forms, in many places, large inlets. The country itself is traversed by numerous streams, and possesses a very large number of lakes, so that nearly one-tenth of its whole area is covered with water. The natural conditions of the eastern and western coasts, as well as those of the water-courses and lakes of northern and southern Sweden, are different, so that, taken as a whole, the country possesses a very great variety of fish.

In such a country the fisheries must of course form a considerable source of income; and, it is well known, that next to agriculture, forest-culture and mining, the fisheries are the most important source of revenue, giving employment and subsistance to a large portion of the population.

The most important fisheries in Sweden are—

1. *The lake-fisheries and the coast-fisheries in the numerous narrow inlets.*

2. *The salmon-fisheries in the streams and inlets.*

3. *The herring-fisheries in the Baltic and along the coasts.*

4. *The fisheries in the Kattegat and the North Sea.*

1. *The lake and coast fisheries* in the south of Sweden are chiefly productive of *perch*, *pike*, *bream*, and fish of the carp species; as also the *burbot* and the *eel;* while in the north of Sweden, they yield mainly fish of the genus *Coregonus*, but also some of those just mentioned. The lake and coast-fisheries are carried on partly as a means of living by the fishermen residing near the lakes and coasts; and partly as a means by which those farmers, peasants, mechanics, and soldiers, who either own the right of fishing in certain places, or have temporarily secured it, may earn some little money. Although statistics regarding the Swedish fisheries have been collected for some years, it is not yet fully known how many persons are annually engaged in them; nor has the value of the implements used, and of the fish caught been ascertained. From what is known in this respect as to some of the provinces, it appears that this branch of the Swedish fisheries is of considerable financial value, in proof of which, we may mention, that in Nerike, one of the

smaller provinces of the kingdom, 489 persons are employed in them, and that the value of the implements is $9,430.

In the other provinces, with the exception of Skåne and Blekinge, the lake and coast fisheries are carried on by a much larger number of persons. The money value of gwiniad, *Coregonus albula*, and char caught in lake Wettern, amounts annually to $27,775. On the Calmar coast, the fisheries are carried on by 182 persons as their exclusive source of income, while 689 having some other employment in addition, are also engaged in them. The value of the implements used is $29,385. The fish caught in the lakes and on the coast are either sold fresh in the neighborhood, or are used in the households of the fishermen. As these people keep no account of their labors, it has been found impossible to obtain any exact data regarding the money value of these fisheries. In order to reach some approximate result, the number of men employed and the value of the implements used have been ascertained; and from these figures a tolerably correct estimate may be made regarding their great value.

2. *The salmon fisheries.*—These are carried on in the streams of the northern provinces, from the end of May till the beginning of September; and in the western streams, (Wiska, Atra, Nissa, Laga, and Quistrum,) from the beginning of April till the middle of July; and on the coasts of Blekinge and Skåne, (in the south of Sweden,) during the winter months as long as the ice does not interfere. The streams richest in salmon, are the Torneå, Luleå, Umeå, Ljusne, and Angerman, in the province of Norrland. Next come the western streams, mentioned above, whose salmon are more highly valued than those from the east coast, and which are fully as good as the Scotch salmon. The most extensive salmon fisheries in Sweden are those of Elfkartlby, in Gestrikland, and of Mörrum, in Blekinge; the former yielding an average annual income of $11,110; and the latter, of $8,300.

At present, the salmon is mostly sold fresh in the country, or, packed in ice, is exported from Gottenburg and Stockholm to England and Germany, and especially to Berlin. The larger portion of the salmon caught on the south coast of Sweden, during winter, is smoked and sent to Germany and Denmark. According to the most recent statistics, the annual yield of salmon from twenty-seven Swedish streams is valued at $170,035. The salmon-fisheries on the coast of Skåne and Blekinge yield an average annual income of $33,330.

3. *The herring-fisheries in the Baltic and along the Coasts.*—These fisheries, which are by far the most important in Sweden, are carried along the whole coast from Kullen on the sound, to the farthest point of the Gulf of Bothnia, exclusively with open boats, each manned by two or three persons. The fishermen use both stationary and floating nets; and the best fishing is at different seasons along the northern and southern coasts. On the southern coast, the herring-fishery is carried on by a population living together in large fishing villages, and depend-

ing entirely for subsistence on this fishery. On the coast of the inner Baltic, along the northern line of the Gulf of Bothnia, and on the island of Gotland, the herring-fishery is partly carried on by persons living in the interior, who, during the fishing-season come to the coast, and partly by fishermen living permanently on the coast or on the small islands near it. The Baltic herring are partly sold fresh, or smoked in the towns on the coast, partly salted, packed in casks, and sent all over the country, and of late years even exported to Germany.

As salt herring constitutes the daily food of the Swedish peasants and the lower classes in general, the amount secured in the country is not sufficient, so that a considerable quantity must be imported from Norway.

Along the coast of Sweden, from Kalmar to Malön near Haparanda, the herring fishery is carried on with 3,275 boats, and the annual yield is about 66,500 tons of salt herring. In Blekinge there were salted in 1868, 47,732 tons of herring; and in the Melmö and Christianstad districts, where the herring fishery is carried on with 685 boats, there were salted during the same year 13,600 tons. The greater portion of the herring caught in the two districts last mentioned are sold fresh to the inhabitants. On the island of Gotland, 1,911 persons, with 606 boats, are engaged in the herring-fishery, and the yield in 1869 amounted to 30,070 tons.

It may be safely asssumed that on an average the total annual yield of herring on the Swedish coasts of the Baltic amounts to 150,000 tons, representing, according to last years' prices, a capital of $833,330. Besides the herring fishery carried on in the Baltic, the *Clupea harengus* and *Clupea sprattus* are caught during the autumn and winter in the Kattegat near the coast of the province of Bohuslän. The *Clupea sprattus* is partly used fresh and partly salted or pickled, as anchovies, of which latter very large quantities have been exported during late years. The amount of herring caught near the coast of Bohuslän was, in 1871, valued at $24,680.

4. *The fisheries in the Kattegat and North Sea.*—These fisheries are partly carried on near the coast with smaller boats and partly out on the Kattegat and along the western coast of Norway with larger vessels, of from 20 to 40 tons, and manned by twelve or fourteen persons.

The implement used is the so-called "storbackan," a line with hooks which is laid out on the fishing-banks to the depth of 100 fathoms. Muscles or pieces of fresh fish are used as bait. With this implement they catch cod, ling, flounders, halibut, and other fish. Some of these are sold fresh, but most of them having been salted either by Norwegian or Bohuslän traders, are exported. Codliver oil is prepared from the liver, and the roe is salted and exported to France to be used as bait in fishing for sardines. In 1871 Bohuslän carried on the fishery in the Kattegat and the North Sea with 126 boats, manned by 1,226 persons. The amount of fish caught by them during the same year was valued at $177,930. During that year 5,257 cwt. of salt-cod were exported from Gottenburg to England. The fisheries on the coast of Bohuslän, including mackerel-fisheries, employed 351 boats, manned by 1,378 persons. The income from this fishery in 1871 amounted to $97,790.

The lobster-fishery in Bohuslän was valüed in 1871 at $22,180, and the oyster-fishery at $4,610.

The editor of the Scandinavian Piscicultural Journal adds to the above article the following items of information: In Sweden, the following officers are appointed to manage the fisheries:

A superintendent of the lake, river, and Baltic fisheries, with two assistants, and one teacher of pisciculture. This superintendent is, at present, *Dr. Hjalmer Widegren*, and his assistants are *Dr. C. Byström* and *Mr. V. Wehlburg;* while the teacher's place is filled by Baron *C. G. Cederström.* Besides these government officials there are special superintendents over certain sections of water in some of the provinces, whose chief duty it is to see to the proper observance of the fishing-laws. Some of these superintendents receive a small addition to the salary paid them by the provinces, from the central government, while others are paid entirely by the provinces, by fishing-companies, or by large-landed proprietors. The superintendence of the open sea fisheries (Kattegat and North Sea) is intrusted to an official, who is responsible to the Bohuslän authorities. The present incumbent is Mr. G. von Yhlen.

The duties of the first-mentioned superintendent,* as defined by a letter from his majesty, the king, dated February 12, 1864, and by a royal proclamation, dated November, 1867, are as follows: 1, to inspect the fisheries in the different parts of the country; 2, to propose suitable fishing-laws wherever needed, and to assist the local authorites in upholding these laws; 3, to collect and compile statistics of the fisheries; 4, to superintend the government Normal Institution of Pisciculture, and all similar establishments throughout the country; and, 5, to give the necessary instructions to the other superintendents.

* Dr. Widegren.

V.—ACCOUNT OF THE FISHERIES AND SEAL-HUNTING IN THE WHITE SEA, THE ARCTIC OCEAN, AND THE CASPIAN SEA.

BY ALEXANDER SCHULTZ.

The similarity in many respects between the fish and fisheries of the great lakes and the northeastern coast of the United States and those of certain portions of Russia has induced me to print the very interesting and important memoir of Mr. Schultz,* prepared to accompany the Russian display of fishery-products, implements, &c., at the Vienna Exposition. In regard to the conversion of the sturgeon, so abundant in the United States, and until lately considered a refuse fish, into a valuable article of trade, the memoir will be found replete with valuable information. It also details novel modes of capturing and utilizing the cod, the herring, the salmon, the seals, and the smaller cetaceans, (porpoises, &c.,) many of them perfectly available in the United States, and worthy of introduction.—[S. F. BAIRD.]

In the district of Archangel, large fishing-villages are found on the coasts of the White Sea, especially near the mouths of rivers and streams, such as the Dwina, the Onega, the Souma, the Kem, the Kovda, the Niva, the Oumba, and the Varzoukha. A still larger portion of the population of the cities of Archangel, Onega, and Kem, as well as of the town of Souma, devote themselves exclusively to fishing and trading in fish. The coast of the Arctic Ocean which extends east of the White Sea has a very sparse population. Only here and there, at a great distance from each other, are seen the wretched huts of fishermen, inhabited only in the summer, and the felt tents of Samoyed families, who also live by fishing. The inhabitants of the town of Mezene, and those of the village of Poustozersk, at the mouth of the Petshora, are engaged either in fishing or hunting the seal or the walruss.

Not more than 3,000 fishermen live in the vast region of the Lower Petshora, extending three hundred versts (about one hundred and ninety-eight miles) along the shores of the sea, and four hundred versts (about two hundred and sixty-eight miles) up the river. The Lapland coast, with the exception of the Kola Peninsula, is entirely uninhabited as far as the Norwegian frontier. Only nomadic Laplanders show themselves

*Ministère des domaines. Comité spécial, chargé de la collection des produits des industries rurales et forestières pour l'exposition universelle de Vienne.—Notice sur le pêcheries et la chasse aux phoques dans la Mer Blanche, l'Océan Glacial et la Mer Caspienne. Par Alexandre Schultz, conseillor d'état actuel et président de l'administration des pêcheries d'Astrakhan.—St. Pétersbourg, 1873. 8vo, 80 pp., 2 l.

here and there. This country, called the Mourman coast, possesses a great number of large and small inlets, which form excellent anchoring-places. Five thousand fishermen assemble there for the season, from April till the middle of August. The majority of these come from the coast-villages of the White Sea, located in the districts of Onega and Kem, and they are known by the name of "Pomortsie"—inhabitants of the sea-coast.

The average annual value of the fisheries in the White Sea, the Arctic Ocean, and the rivers flowing into them is a million "roubles," (about $700,000 gold.) Of this sum, the cod-fisheries on the Mourman coast yield at least 400,000 "roubles," (about $280,000 gold,) and the herring-fisheries in the White Sea 250,000 "roubles," (about $175,000 gold.) The phocæ-hunt yields annually about 80,000 "pouds" (2,880,000 pounds) of oil, valued at 120,000 "roubles," (about $84,000 gold.)

The manner of fishing and of preparing the fish when caught is much less perfect on the coasts of the White Sea and the Arctic Ocean than that of the Astrachan fishermen. The fish are, in general, salted in an imperfect and slovenly manner. The monks of the convent of Solovetsk alone distinguish themselves by their manner of salting herring; and an exception must also be made with regard to the salting of the salmon of the Dwina and the Onega. The reason of this is, not that the fishermen do not know the approved method of preparing fish, but that they shun the trouble and expense, and content themselves with the old saying, "We go on doing as our fathers and grandfathers have done before us."

A—THE FISHERIES IN THE WHITE SEA AND THE PETSHORA.

In the White Sea and the rivers falling into it, such as the Petshora, the following kinds of fish are found, of which I will first give the Russian names: "Okoune," (*Perca fluviatilis*,) perch; "yorsche," (*Acerina vulgaris*;) "revtsa," (*Cottus quadricornis*;) "kertcha," (*Cottus scorpio*;) "zoubatka," (*Anarhichas lupus*,) wolf-fish; "karass," (*Cyprinus carassius*,) carp; "vyoune," (*Tinca vulgaris*,) tench; "pestousch," (*Gobio fluviatilis*;) "yélets," (*Leuciscus grislagine*;) in the Tsilma and Peza Rivers: "yaz," (*Leuciscus idus*,) nerfling; "soroga," (*Leuciscus rutilus*;) "lestche," (*Abramis brama*;) "oukleïka," (*Aspius alburnus*;) "stchouka," (*Esox lucius*,) pike; "siomga," (*Salmo salar*,) salmon; "couinja," (*Salmo trutta*,) sea-trout; "koriouchka," (*Osmerus eperlanus*,) smelt; "kharyouss," (*Thymallus vexillifer*, Agassiz,) grayling; "sig," (*Coregonus oxyrhynchus*, Lin.,) long-snouted white-fish; "nelma," (*Coregonus leucichthys*, Pall.;) "seld," (*Clupea harengus*,) herring; "treska," (*Gadus morrhua*,) cod; "pertoua," (*Gadus callarias*;) "navaga," (*Gadus navaga*;) "saïda," (*Gadus saïda*;) "nalim," (*Lota vulgaris*,) burbot; "kambala," (*Pleuronectes platessa*,) flounder; "kambala," (*Pleuronectes flesus*;) "sterliad," (*Acipenser ruthenus*,) sterlet; "minoga," (*Petromyzon fluviatilis*,) lamprey; "pétchorskoï sig," (*Coregonus polkur*, Pall.,) "peliad," (*Coregonus peled*, Pall.,) "tchir," (*Coregonus nasutus*, Pall.,) "omoul," (*Coregonus omul*,) and "sàoureï," (*Coregonus vimba*,) species of white-fish.

Of all these kinds of fish, those forming the largest article of commerce are the herring, the salmon, and the cod; then follow the "navaga," the "sterliad," and the "minoga." The fish are exported to the districts of Vologda, Viatka, Yaroslaw, Moscow, Olonets, St. Petersburg, and to the several districts of the province of Archangel.

1.—THE HERRING.

The species *Clupea harengus* is found in the White Sea only, and is divided into a large and a small kind. The former is caught especially on the southwest shore in the bay of Kandalakcha, near the convent of Solovetsk, and near the village of Pongamà, and more rarely near the city of Kem and on the northwest shore of the bay of Kandalakcha. The small herring usually attains the length of from 6 to 7½ inches; and a thousand weigh about two "pouds" and a half, (90 pounds.) These herring come up in large numbers from the depth of the sea in the beginning of November, and make for the bays, especially the bay of Soroka, where the inhabitants of the coast villages always catch them in great abundance.

Herrings leave the deep sea only during the spawning season, in order to reach the more shallow bays, and the fishermen call them by different names, according to the time when they make their appearance. The herring of St. George (appearing about the time of that saint's day) has perfectly matured roe, and spawns in April. Two hundred and fifty of these fish weigh only one "poud," (36 pounds.) It requires, on the other hand, only from 80 to 120 herring of St. John to make the same weight, and these have most of the time roe and milt. The autumn herring are the fattest, but have neither roe nor milt.

Organization of the herring-fisheries.—It is a rule very generally observed that the interests of a whole community shall not be injured by the preponderating influence of private individuals, and that the personal rights of every fisherman shall be protected. To insure this, various measures are taken, varying according to local conditions. For instance, in the villages of Kandalakcha, Kovda, and Kniajnoï, the herring-fishery is organized in the following manner: the places near these villages where the fisheries are most productive being known, the entire community goes there, and the result of the common labor is divided among the fishermen in proportion to the number of male inhabitants of each village.

This proportion is calculated in the following manner: At first, the number of fishermen is determined, and then the number of inhabitants obliged to furnish one fisherman. In counting one fisherman to three inhabitants, a family composed of three members must furnish one; a family of six members, two; and so on. Families having only two members associate themselves with others numbering four members, and thus furnish two fishermen in common. Every one of these must furnish the salt and the necessary fishing-implements. When the fisheries have come to an end, all the fish which have been caught are sold in a lump, and the proceeds are divided among all the persons who have taken a part in the fishing. Families which, though taking a part in the common fisheries, wish to fish in other places, are authorized to do so with their own means; but, if the places where they desire to fish are particularly rich, the community has the right to take possession of them as common property.

On the northern coast of the White Sea, there is a large fishing-village called Kauzomene, where, in the autumn, herring-fisheries are carried on on a large scale near the mouth of the river. It is the custom in this village that the inhabitant of the village who first arrives at the mouth of the river has the right to cast his nets first; but after having drawn them in, he must yield his place to the one who comes second, and so on. The herring caught there spawn in May and disappear entirely during the latter half of July.

Toward the end of the autumn and the beginning of the winter, great herring-fisheries are going on in the bay of Soroka, where the inhabitants of the coast are joined by considerable numbers of Kareles, who come from their villages, far away from the bay. Here every person fishes for himself, every family enjoying its own gains. The fishing here is always very productive, and it is not a rare case to find 100,000 herring in the net and 70,000 in the sweep-net.

Implements for the herring-fisheries.—The two wings of the net, when spread out, have a total length of from 16 to 35 "sagenes," (112 to 245 feet;) their depth is from 2½ to 4 "sagenes," (17½ to 28 feet;) the meshes of the wings are from 1 to 1¾ of an inch square, and those of the purse or bag ¾ of an inch. The bag is 4 "sagenes" (28 feet) long, and can contain 300 "pouds" (10,800 pounds) of fish. These nets are used on the south coast of the White Sea, particularly in the bay of Soroka, where usually 750 of them are employed at a time. The fisheries commence in the middle of November and last till the end of February. Holes are made in the ice in order to get the nets into the water, and they are kept there by means of small sticks tied to the wings of the net by long cords, and laid across the holes made in the ice.

For the autumn herring-fisheries, nets are used whose wings are generally 8 "sagenes" (56 feet) long, and every fisherman has such a net in his boat. The boats always go out two by two. A cord with a running-knot tied to the prows of the two boats prevents their separating. Every boat is manned by three fishermen, one of whom rows while the second guides the helm, and the third continually sounds the sea by means of a long pole, to ascertain the presence of a school of herring. The moment the fishing ought to commence, the cord uniting the two boats is pulled out; and the fishermen in each rowing rapidly, they soon separate. During this time, one of the nets is cast, and the boats keep in the same place till the whole net is in the water; then the oars are again put in motion, dragging the net a certain distance, when the two boats again unite. The wings are then drawn into the boats, the bag is detached from them, tied up like a purse, and left in the water till the second net has likewise been cast and drawn. After having brought this double operation to an end, the herring are taken out of the bag by means of hand-nets and crayfish-nets and put in the boats or laid on the shore.

The largest nets, the so-called "cissauges," which are always hauled on shore, are from 50 to 100 "sagenes" (350 to 700 feet) long, and have a bag measuring 7 "sagenes," (49 feet.)

The total length of this implement is 8 "sagenes," (56 feet,) and a cylindrical net is attached to its bag serving as a leap, 3 "arsheens" (7 feet) in length, and stretched over three small wooden rings. The meshes of the cylindrical net and those of the bag measure only half an inch, while those of the wings measure 1¼ inches. With nets of this kind, small herring scarcely two inches long are caught under the ice; of these small herring, 2,500 weigh one "poud," (36 pounds.) This kind of fishing is chiefly carried on near the mouths of the Dwina, and cart-loads of these fish are taken to Archangel, the price of one cart-load being generally 5 "roubles," ($3.50 gold.)

The sweep-nets have mostly ten hoops; the first or foremost one, being the largest, about 2½ "arsheens" (5 feet 10 inches) in diameter, while the last or hindmost, being the smallest, measures only ½ "arsheen," (1 foot 2 inches.) The hoops are placed at a distance of 1½ "arsheens" (3 feet 6 inches) from each other. The meshes are one inch square. Two little necks, shaped like funnels, called "gorges" by the fishermen, are attached to the inside of the nets; and, through these openings, the fish enter the net, where they become imprisoned. Each wing of the net measures 10 "sagenes" (70 feet) in length. These sweep-nets are placed at a depth varying from 1 to 3 "sagenes," (7 to 21 feet,) chiefly during the months of January and February.

Preparing the herring.—The herring caught in the spring, summer, and autumn, in the bay of Kandalakcha, at Pogama, at Solovetsk, and other places, are always salted. The monks of Solovetsk know how to do this admirably. They do not take out the entrails, but after having washed the herring properly, they barrel them in layers with the greatest precision, and put a thick covering of salt on every layer, after which the barrels are placed in the ice-vaults.

In most of the villages, on the contrary, the herring are thrown promiscuously into pine barrels, which are so badly made that they scarcely retain the brine; then a quantity of salt is added, and the whole is well shaken. Sometimes the large herring of St. John are dressed, and then placed in layers in the barrels, slightly salted. The barrels are then left to stand a week and a half till the fish are completely impregnated with the salt, and then finally closed. The barrels generally used are 16 inches high and 9½ inches in diameter. Every barrel contains usually from 70 to 100 herring of St. John, or from 200 to 250 of St. George, and its weight varies between 34 and 42 pounds. To every barrel the fishermen take 4 pounds of salt in the spring, and 6 pounds in the autumn. The largest barrels, containing from 150 to 400 herring, are one "arsheen", (2 feet 4 inches) high, and half an "arsheen" (1 foot 2 inches) in diameter. At Archangel, the price of such a barrel varies from 30 to 50 "kopecks," (21 to 35 cents.) For salting, Spanish or Archangel salt is used.

The herring are smoked in some villages of the district of Kem, at Saroka, at Jisma, and at Saukhoï Navoloki, where there are 80 smoke-houses. The village of Ouna, in the district of Onega, has 4 smoke-houses. They are simple sheds covered by a slanting roof, with small apertures to let the smoke pass out. Parallel to the walls, fifteen or more poles are placed at a distance of 1½ "arsheens" (3 feet 6 inches) from each other, supporting other poles, which are placed across the former. On these poles small laths are placed, pointed at the end, and on which the herring are spitted, after having been washed and salted. After eight or nine days, the herring are thoroughly smoked. The whole process usually takes twelve days. The smoked herring cost 90 "kopecks" (63 cents) a thousand, and sometimes even 1 "rouble" 25 "kopecks," (about 87 cents.) Not less than ten millions of herring are smoked every year.

2.—THE SALMON.

They distinguish three kinds of salmon according to the time when they show themselves in the rivers. The first makes its appearance immediately after the breaking of the ice, toward the end of May or the beginning of June. Its roe is almost matured. The salmon of this kind is of medium size, and weighs about seven pounds. The second kind appears toward the end of June and during July; it is small, and weighs only three pounds. At this time, male fish are found with the milt almost matured. The third kind begins to ascend the rivers in August, and stays there till the water is covered with a slight coating of ice. Among them are found males as well as females; but milt and roe are so little developed that this salmon cannot spawn that same autumn. This kind is the largest and fattest; some caught in the Dwina and Onega weighing twenty pounds. The first two kinds named enter the rivers to spawn during the autumn of the same year. After having spawned, they spend the winter in the rivers, returning to the sea in the spring. In the Petshora, the Mezene, the Dwina, the Onega, and the Varzoukha, the salmon is caught in enormous quantities.

Implements for salmon-fishing.—The bars, which extend over the entire breadth of the river or over a portion of the stream, consist of stakes firmly driven in the ground, to which poles are attached supporting a sort of trellis made of boughs. These parks are arranged in zigzag shape, the outer angles having openings, where leaps or wooden boxes are placed. These bars are not used in the Petshora, the Mezene, the Kouloï, and the Dwina, but in all the other rivers falling into the White Sea.

As soon as the rising of the river has subsided, people begin to build these bars, always leaving an opening of 3 "sagenes" (21 feet) to let the fish and the boats pass. The bar of the river Ponoï consists of two parallel rows of stakes on which transverse beams rest, surmounted by long thick poles weighted down by stones. The stakes are driven in at a distance of 2 "sagenes" (14 feet) from each other. In the intervening spaces, horizontal and vertical poles are fixed, furnished with a trellis of thin branches, and here the apparatus for catching the fish is placed, consisting of a large box whose opening is turned toward the mouth of the river. This apparatus is called "taïnik" in Russian. A funnel, 10 inches broad and 1½ "sagenes" (10½ feet) long, leads to this box, open at the top and crossed by planks, on which the fisherman stands ready to take out the captured salmon with a small net.

In the Onega, near the village of Podporojyé, the bar has only one row of wooden stakes, on which thick poles are placed, weighted down by heavy stones. In the intervening spaces, poles driven in at a distance of 2 "arsheens" (4 feet 8 inches) from each other, support the trellis. As rafts of timber and planks float down the river, bars have been built 2 "sagenes" (14 feet) in front of the chief bar, in order to preserve them against accidents. These last-mentioned bars are a sort of ramparts formed by beams floating on the water and attached to trestles placed there for the purpose. In the Onega, no boxes, but sweep-nets, are placed on the bars. While the fishermen take up and examine the sweep-nets, they are replaced by a net stretched on a wooden frame, so as to prevent the fish from passing.

Near the town of Onega, they use, besides the sweep-nets, a bog-net called "kourma." This is placed opposite the opening of the sweep-net, and is intended to catch those salmon which may attempt to escape the moment the leap is taken up.

At the bar of the river Kitcha, another sweep-net is used, which has the shape of a truncated pyramid, and consists of a certain number of poles fastened in a wooden frame. The foremost part of this pyramid is open and is turned toward the opening in the bar. A funnel-shaped net, called "gorge," is attached to the frame, having the shape of a quadrangular, truncated pyramid. This apparatus is placed on a support by means of a winch, and one of the fishermen slips inside to take the salmon. The sweep-nets of the bar of the river Souma are called "merschi," and consist of several wooden frames resembling the apparatus which has just been described.

Skillful divers are kept at all the bars, who immediately repair any damage done under the water. These bars are constructed and put in position by special manufacturers, who inspect them during the fishing-season, and take them to pieces at the end of the autumn.

In June and July, they fish for the salmon with seines 6 "sagenes" long, (42 feet,) whose bag is 4 "sagenes" (28 feet) long and 3 "sagenes" (21 feet) wide. The meshes of the bag are an inch square, and those of the wings of the seine from 1½ to 2¼ inches. These seines are also used as stationary nets. The following is the method of fishing: One of the fishermen remains on shore and holds the cord attached to the shortest wing. The others gradually lower the net into the sea, standing at a distance of several "sagenes" from each other. One-half of the net is in a straight line from the shore, while the other half forms a large semicircle, whose extremity approaches the portion under water in the shape of a hook, in such a manner that there is a passage of 4 "sagenes" (28 feet) between the halves, which leads into the hook above mentioned. As soon as one of the fishermen, who is on the outlook in one of the boats, notices that a certain number of salmon have entered the net, he detaches from the pole the cord keeping back that end of the wing of the net which forms the hook, and takes off the nippers holding the bolt-ropes to the poles, so that the longer wing of the net becomes free and can be hauled on shore by means of a winch. The salmon which have been caught in the hook are in this manner forced to enter the bag, which the fishermen afterward draw on shore.

In the Petshora River, seines are used measuring from 250 to 400 "sagenes" (1,750 to 2,800 feet) in length.

They first place a net on the shore in a perpendicular position and fastened to poles, and then a second net is cast so as to form with the first the letter T. At the ends, there are curtains of crescent or polygonal shape, whose concave portion is turned toward what is called the "wall," viz, the perpendicular net on the shore. The entrance is between two nets which join the stationary nets in a slanting direction. The bottom of the apparatus where the fish are caught is likewise formed by a net.

When the salmon approach the shore, they meet the "wall" and follow it till they enter into the apparatus itself, from which they cannot escape.

Other stationery nets, simple parts of nets, have only a single "wall," and are placed on the shore in a perpendicular position. At the mouth of the Petshora, one of these "walls" extends as far as five and even seven "versts" from the shore, (two and two-thirds miles to four miles.)

Every net is from 40 to 50 "sagenes" (280 to 350 feet) long, with meshes 3½ inches square, sixteen of which make the height of the net. A certain number of these nets are tied together, the head bolt-ropes being fastened to poles driven in at a distance of 15 "sagenes" (105 feet) from each other. The nets are examined at the time the tide is out, and the salmon caught in the meshes are taken out. These nets are set during the month of July, and taken up in September. They also use the drag-net, which consist of two or three parallel nets, the inner part of which has small meshes, while the two outer have large ones, or a single large-meshed net.

The floating seines used in the Dwina are from 150 to 200 "sagenes" (1,050 to 1,400 feet) long, seldom as long as 300 "sagenes," (2,100 feet.) Those of the Petshora are ususually 200 "sagenes" (1,400 feet) long, and those of the other rivers from 80 to 100 "sagenes," (560 to 700 feet.) The depth of the seine is from 28 to 32 meshes, each measuring from 2 to 2½ square inches. Two boats, at some distance from each other, go down the stream dragging the net; they finally approach each other, and the net is gradually drawn into one of the boats. This fishing is carried on from the middle of July till the rivers are frozen.

Fishing is also carried on in these streams with floating nets in the shape of a bag, measuring 2½ "sagenes" in length, (17½ feet.)

In the dark autumn nights, the salmon, the pike, and the "lavaretus" are caught with fish-gigs by torch-light. The fish-gig has the shape of a fork with three or four prongs, each terminating in a barbed pike. A fire is made on a chafing-dish on the prow of the boat, so that the fish at the bottom of the river can easily be seen and speared. They also use fish-gigs composed of a whole bunch of prongs.

Preparing the salmon.—Salmon is mostly placed in the market salted, rarely smoked. The salting is done in the following manner: The head of the fish is cut off, the belly is opened, and the entrails are taken out; then it is washed clean and filled with salt; salt is also put under the gills, and the scales are usually rubbed with it. They calculate, generally, 17½ pounds of salt to 100 pounds of fish. The quantity of salt to be used depends also on the season of the year and on the quality of the fish. The best salmon comes from the Onega and the Dwina. That of the Petshora is larger and fatter, but it is salted so little that it becomes worthless.

3.—THE "NAVAGA" (GADUS NAVAGA) AND OTHER SALT-WATER FISH.

The "navaga" appears in large numbers at the mouths of rivers and near the sea-shore toward the end of the autumn. This fish, which is very voracious, spawns in the autumn. It has an excellent flavor, and is sent frozen, in enormous quantities, into the interior of Russia as far as Astrachan, where fish is so plentiful.

In the villages located on the rivers falling into the White Sea, flounders (*Pleuronectes flesus*) and plaice (*Pleuronectes platessa*) are, when caught, stuck on small poles, and are thus smoked; while at Mezene, they are salted. In the bay of Kandalakcha, a small kind of cod-fish is caught, which the fishermen salt exclusively for their own use.

Implements for catching these fish.—A line of twisted horse-hair is attached to a stick or to a piece of lath, from which hangs a piece of lead pierced by a strong wire. To the two ends of this wire, and sometimes also in the middle, thin little horse-hair strings are tied, furnished with small fish-hooks. The fisherman makes a hole in the ice, and places the apparatus in the water, using small fish as baits. He draws it out soon to plunge it in again, for this fishing is very productive, a practiced fisherman often taking not less than 2,000 "navagas" in one short winter's day.

To fishing-tackle measuring 40 "sagenes" (280 feet) in length, copper or wire hooks are attached by means of horse-hair strings 10 inches in length. The hooks are placed at a distance of three-fourths of an "arsheen" (1 foot 9 inches) from each other, and are baited with small pieces of herring, or *lavaretus*, (*Coregonus polkur.*) This apparatus is placed in the spring near the shore.

4.—RIVER AND LAKE FISH.

Among the river-fish, the sterlet (*Acipenser ruthenus*) holds the first rank. During the second decade of the present century, the sterlet first commenced to show themselves in the Dwina; then, in 1848 and 1849, in the Soukhona in large numbers. These precious fish seem to have come to the Dwina from the Kama through the canals. This fishery is, however, so far, not very considerable. As regards fresh-water fish, great quantities of "nalim," (*Lota vulgaris;*) of "koriouchka," (*Osmerus eperlanus;*) of *Coregonus* and of "minoga," (*Petromyzon fluviatilis,*) are caught, these last mentioned chiefly in the Onega, while the "omoul" (*Coregonus omul*) and the "nelma," (*Coregonus leucichthys,*) the Siberian salmon, are caught more frequently in the Petshora. Every year, about 100 "pouds" (3,600 pounds) of "minoga" (*Petromyzon fluviatilis*) are exported from the town of Onega. Next to the salmon, the "omoul" (*Coregonus omul*) finds the best market. They are salted in casks containing 12 "pouds" (832 pounds) each, reckoning about a pound and a half of salt to each "poud;" (36 pounds.)

The above-mentioned fish are either caught with lines, or with stationary nets having meshes from 1½ to 2 inches square. In the lakes, seines from 60 to 100 "sagenes" (420 to 700 feet) in length are used for catching scaly fish. Unfortunately, the spawn is also taken, especially in the lake of Koubino. For this purpose, hoop-nets are used with a bag measuring 4 "sagenes" (28 feet) in length. The meshes of the bag are so narrow that a fly could not pass through. Nine of these meshes measure only 2¼ inches, while seven meshes of the wing of the seine measure 2½ inches. The roe of the "okoune," (*Perca fluviatilis,*) and of the "yerschi," (*Acerina vulgaris,*) is dried in ovens specially constructed for this purpose, and is used as a seasoning during Lent.

B—FISHERIES IN THE ARCTIC OCEAN.

1.—FISHERIES ON THE MOURMAN COAST.

The Mourman coast, in Russian Lapland, begins at the Cape of Saints, the point of demarkation between the White Sea and the Arctic Ocean, and extends as far as the Norwegian river Worghema. On this coast-line of eight hundred "versts," (about four hundred and sixty-one miles,) there are fine bays offering the fisherman good and safe anchorage. There are forty-one of these inlets into which rivers fall. At these points, the fishermen have built huts and sheds and scaffolding of various kinds, so that the shores of those bays which are frequented most look somewhat like large villages, busy with the excitement of fishing-life. The fishermen meet there in the spring and remain till the middle of August. Other anchoring-places, where the coast is almost barren, are frequented only in June and July by those fishermen who come from the populous anchoring-places, or by others who come from Archangel on large boats, manned by their masters, in order to catch a large number of fish in a short time.

Species of fish found on the Mourman coast.—The fisheries of the Mourman coast comprise especially the different varieties of "treska," (*Gadus morrhua;*) the "kambala," (*Pleuronectes flesus;*) and the "kambala," (*Pleuronectes platessa;*) a good many salmon also are caught near the mouths of the rivers.

Of the cod, the *Gadus morrhua* is caught most frequently. It spawns in February and in March, and is caught with baited hooks. For bait, the fishermen mostly use *Mallotus arcticus**, or *Ammodytes lancea*, or, in case of necessity, *Arenicola piscatorum*, a sort of thick worm dug out from the sand of the beach. The *Mallotus arcticus* and the *Ammodytes lancea* resemble the *Osmerus eperlanus*, and are, like it, easily distinguished by a peculiar odor resembling that of the cucumber. Among the varieties of the cod, there are the *Gadus æglefinus*, and the *Gadus virens*, the latter called "saïda" by the Russians.

The *Hippoglossus maximus*, Cuv., which the Russians call "paltouss," usually weighs 2 "pouds," (72 pounds;) but near the North Cape some are caught weighing 15 "pouds," (540 pounds.) The small kinds of plaice (*Pleuronectes platessa*, L.) and the *Pleuronectes limanda* have but little value as articles of commerce, as likewise the *Brosmius vulgaris*, a sort of cod; the *Sebastes norvegicus*, Cuv., called by the Russians "morskoï okoune;" and the *Anarrhichas lupus*, L.

The two kinds of sharks (*Scymnus borealis* and *Selache maxima*) are caught only for the sake of their liver, which is used in the manufacture of cod-liver oil.

Fishing-implements.—The "palangre" consists of a chief line as thick as a man's finger, and from 33 to 42 "sagenes" (231 to 294 feet) long, to which small lines of the thickness of a quill are attached at the distance of 1¾ "arsheens" (4 feet 1 inch) from each other. These lines have baited hooks. A succession of lines tied one to the other forms what is called in Russian a "yarous," extending from 6 to 10 kilometers in the sea. This "yarous," or train, is kept by three anchors a little above the bottom of the sea. Every anchor is attached by a cord to a

*A fish similar to the capelin of the North Atlantic coast.

buoy, the location of which is indicated to the fishermen by a bunch of sea-weeds placed vertically on a pole.

The fishermen of the Mourman coast use only English hooks, which they buy from Norwegian merchants from the towns of Wardoe, Wadsoe, Hammerfest, and Tromsoe. They cost 8 "roubles" ($5.60 gold) a thousand. Every fishing-boat, called "schniaka," uses not less than 5,000 hooks a year. These boats are open, and have only one mast, with a large sail and six oars. They are from 28 to 40 feet long, their breadth is from 6 to 9 feet, and their draught is 4½ feet. Their capacity is from 150 to 250 "pouds," (5,400 to 9,000 pounds.) The price of one of these boats, completely rigged, is 60 "roubles," ($42 gold.) The fishermen will go thirty "versts" (upward of seventeen miles) out to sea in these boats.

Before setting out for the cod-fisheries, the fishermen provide themselves with a quantity of bait for their hooks, to be used on the following day. They begin to bait the hooks some hours before going to sea, and continue doing this till they reach the fishing-place. There a train, "yarous," is laid, and every six hours the captured fish are taken out. Returning from the fishing-expedition, the nets are hung up to dry on scaffolds erected for the purpose, after which boys of from nine to thirteen years put the "palangres" again in order; *i. e.*, disengage the hooks and the entangled lines.

Strong threads each 1 "arsheen" (2 feet 4 inches) long, with steel hooks, are suspended from the two ends of a slightly-curved iron rod. The hooks are baited. A cord 2 "arsheens" (4 feet 8 inches) long, with a piece of lead at the end, is attached to a ring at the middle of the rod. Then the whole is tied to a cord 280 feet in length. This implement is chiefly used by the Laplanders and by poor fishermen, who have no means for buying nets.

A large iron hook is moved easily by means of an iron ring with a pole, to which an iron chain of 4 "arsheens" (80 inches) is attached. This chain is connected with a cable 200 to 300 "sagenes" (1,400 to 2,100 feet) long, to which a weight of 10 "pouds" (360 pounds) is attached. Roasted phoca-fat is used for bait. In order to attract the sharks, large pieces of fat are placed in the deep sea in perforated boxes. The voracious shark rushes with avidity at the choice morsel of fat which is baited on the hook, and he is caught. To bring the captured shark to the surface of the water, a winch kept on the boat for the purpose is employed. When brought up, he is killed; the belly is opened, the liver is taken out, and he is then again thrown into the water. But in order that the body may not sink to the bottom and become the prey of other sharks, it is inflated with air by means of a long tube passed into the inside of the fish. In summer, the shark is caught at a depth varying between 100 and 300 "sagenes," (700 and 2,100 feet;) sometimes at 100 "versts," (about 57½ miles;) while in the autumn he is caught near the coast. It often happens that during the few hours of an autumn day four fishermen catch sharks enough to yield as much as 100 "pouds" (3,600 pounds) of liver. The inhabitants of Kola catch the shark under the ice.

The small species of cod called *Gadus virens* is chiefly caught in July and August, when it rises to the surface of the sea in enormous schools. These small fish are caught like a large "carrelet," (a sort of square net fixed on a pole,) or globe, which hangs down in the shape of a bag, surrounded by a bolt-rope of the thickness of a finger. Every side of the net is from 15 to 17 "sagenes" (105 to 119 feet) long, and the meshes are an inch square. To the four ends long cords are attached, by means of which the fishermen keep the globe up and extended.

For this operation, four boats are required, each manned by three fishermen. As soon as a school of cod approaches, the fishermen cast the net into the water, first by the side of the school, and then they manage to get it underneath. To effect this, the cords attached to the four corners must be stretched evenly by the four boats. As soon as the net is placed horizontally beneath the school, the fish are frightened by yelling, striking the water with the oars, and by throwing stones into the sea, so that the fish; desiring to sink to the bottom of the sea, become entangled in the net which is below them. When this has been done, the four boats lift up the net by a regular movement. This fishery is very productive, each boat often receiving as its share about 200 "pouds" (7,200 pounds) of cod.

The small fish mentioned above, which resemble the *Osmerus eperlanus*, and are used as a bait for cod-fishing, are caught with hoop-nets 30 "sagenes" (210 feet) long. The meshes of the bags of these nets are so narrow that 44 of them make 7 square inches. When they have caught with the hoop-net 6 "pouds" (216 pounds) of these fish, it is considered sufficient to bait about 3,000 hooks on the following day.

Preparing the various products of the fisheries.—Among the various kinds of cod, the *Gadus morrhua* and the *Gadus virens* are salted or dried, according to the season, while the *Gadus æglefinus* is almost always salted. The *Hippoglossus maximus* and the *Anarrhicas lupus* are only salted without cutting off the head, as is done with the different kinds of cod.

The way to prepare the cod is as follows: The head of the fish is cut off; then it is split open along the back, so that the vertebral column adheres to one-half. Then the belly is opened, and the liver and entrails are taken out; after which it is washed, and brought to the huts to be salted or suspended on poles to dry.

In the huts, the halves of the fish are laid out in rows, the side of the skin turned back, and every row is covered with a thick layer of salt.

They generally reckon from 17 to 20 "pouds" (612 to 780 pounds) of salt to 100 "pouds" (3,000 pounds) of cod-fish; and from 7 to 9 "pouds" (252 to 324 pounds) of salt to 100 "pouds" (3,600 pounds) of "pilchouï," or *Gadus æglifinus*. The same quantity of *Hippoglossus maximus* requires 25 "pouds" (900 pounds) of salt. On the Mourman coast, Spanish and English salt are used, which can be imported duty-free. Wealthy fishermen usually buy their stock of salt in Norway, and sell some of it again to the poorer fishermen.

The cod salted in the spring are taken to Archangel in large sail-boats, and are much sought after as being freshly salted. The cod salted in the summer are carried in large boats, called in Russian "ladyà," which come from Archangel for this purpose. During the time of lading, and as long as the boats are at anchor near the fishing-places, the fishermen continue to salt, on board their boats, the fish taken during this time.

The cod is dried from the beginning of the fishing till the middle of May. The Russian fishermen do not take out the vertebral column as the Norwegians do. They split the back of the fish and open the belly, so that the two halves are connected only by the tail. The cod dried in this manner is by the Russians called "rochkirka," and by the Norwegians "roskaer." In Norway, they also prepare "rondfish," which the Russians call "rountovka." For this purpose, the head of the fish is cut off, and the belly is opened, but without flattening the opened fish. They are then tied two and two by the tails and hung on poles to dry. The Russians do not prepare what the Norwegians call "klipfish," that is, codfish salted and then dried.

As soon as the drying is done, the fish are taken from the poles, and heaped up like wood, placing on the top of each heap boards weighted down by stones, in order to flatten those fish which, while drying, may have become warped.

The dried cod is shipped from Archangel to St. Petersburg and to the districts of Olonets and Vologda. About 30,000 "pouds" (1,080,000 pounds) of dried cod arrive every year at St. Petersburg, and scarcely 5,600 "pouds" (201,600 pounds) of salted cod. The chief market for salt cod is the district of Archangel, especially the rural districts.

The heads of the cod-fish are generally thrown away, but sometimes the largest are gathered and spread on rocks to dry. They are taken to Archangel, where 50 "kopecks" (35 cents) are paid for a "poud," (36 pounds.) The chief buyers of this vile food are the peasants of the district of Pinéga, who live in the most wretched manner.

The tongues of the cod-fish are salted separately, 15 pounds of salt being used to 100 pounds of tongues. These salted tongues are sold at Archangel at 4 "kopecks" (2⅘ cents) a kilogram. From April till the middle of August, every boat can gather, if the fishing is good, about 1,600 kilograms of cod-fish tongues.

The swimming-bladder of the cod also forms an article of trade in the shape of fish-glue, after having been carefully washed, laid out, and dried. Packed in parcels of from 6 to 10 pounds, this fish-glue usually sells at Archangel for only 18 "kopecks" (12½ cents) a kilogram.

The liver of the cod-fish is gathered in tubs, and exposed to the heat of the sun. After ten days, a coating of oil of amber-color is found swimming at the top, which is skimmed and sold in casks containing from 8 to 10 "pouds," (288 to 360 pounds.) Three "pouds" (108 pounds) of liver usually yield 1 "poud" (36 pounds) of oil. The cod-liver oil sells at 2 "roubles" ($1.40 gold) a "poud," (36 pounds.) The residue is cooked, and produces a dark-brown oil, which costs less than the first-mentioned kind. One "poud" (36 pounds) of this oil is usually obtained from 2 "pouds" (72 pounds) of the residue. The dark and burned matter remaining at the bottom of the kettles is sold to the Norwegians, who pay 1½ "roubles" ($1.05 gold) or a bottle of rum for a barrel, and use it as grease.

Organization of the fisheries.—The financial condition of the fishermen, as regards both their mutual relations and their relations to their masters, varies according as the fisheries on the Mourman coast are carried on by fishermen who have established themselves there permanently, or by those who only stay there during the summer-months.

Among the permanent inhabitants of the Mourman coast are the inhabitants of the little town of Kola, and the Laplanders who live in the neighborhood. Those fishermen who have their own boats and fishing-implements buy on credit from the rich merchants of Kola all that is required for their households, and pay in kind, *i. e.*, by fish. The price of the fish is fixed by the merchant himself, to whom the fishermen are bound to deliver the fish caught during the spring-fisheries, which season is generally considered as continuing till the 29th of June. If their debts have been paid before this time, the merchant pays the fishermen up to the 29th of June in cash, the price determined beforehand for each fish delivered. After that time, the fishermen are at liberty to sell their fish to whom they please, and can fix their own price. The principal buyers at this time are the fishermen who sail for Norway to exchange fish, or those who come from there. In the autumn, the men lay in fish for their own winter-provision; but as soon as the frosts commence, they again deliver the frozen fish to the merchants, who send them to St. Petersburg. In the middle of December, the fishing stops entirely, to recommence three months later.

The poor inhabitants of the town of Kola, and most of the Laplanders, work as day-laborers with the merchants, and receive a certain share of the fish delivered to the merchants. The merchants furnish them fishing-implements and provisions, but they must generally pay for the boats from their own funds. The merchants divide the proceeds of the fisheries with their laborers, and buy their share of fish from them at a price fixed beforehand.

The organization of the fisheries of the "pomortsi," who only fish for some months on the Mourman coast, is entirely different. They form fishing-associations, each member receiving a certain portion of the whole number of fish caught, while the largest portion goes to the head of the association, who defrays all the expenses.

Formerly, the inhabitants of Archangel and Kholmogori likewise fished on the Mourman coast; but at present the fisheries are almost exclusively carried on by the fishermen of the district of Kème and Onéga. Those fishermen who have the means to build small houses, depots, and sheds on the coast, as well as large and small boats, and to provide fishing-implements and the necessary provisions, become independent master-fishermen, and form associations, of which they become the leaders, and which are usually composed of four fishermen. The laborers hire themselves out, and receive in return part of the fish which have been caught.

The head of the association engages his laborers in the autumn or the beginning of the winter; gives them money to buy provisions for themselves and their families; and defrays all their expenses. Every head of an association has an anchoring-place in some bay on the Mourman coast. Thither he sends his laborers. These set out on their long and difficult journey about the middle of March. According to an ancient custom, the master (head of association) gives them a feast on the eve of their departure, and presents each with a piece of cloth sufficient for a pair of gloves. The pilot of the boat, and those laborers who have to draw the net, receive two pairs of gloves.

They reach the village of Kandalachka with tolerable ease, for the roads lead through well-known villages, where they are well received and conveyed on sleighs. But from Kandalachka to Kola and the village of Raznavoloki, a distance of nine hundred "versts," (about five hundred and eighteen miles,) they are obliged to perform the journey on foot, dragging their clothes and provisions after them on little sleds. From Raznavoloki to the fishing-places, they travel in sleighs drawn by reindeer, at the expense of the master; and from Kola on boats, with wooden runners. They hoist the large sail, and the wind drives them rapidly to the open sea. Having arrived at the place of their destination, they immediately set to work. They have to remove the masses of snow under which the huts and sheds are almost buried, to repair the boats, to get the fishing-implements into working-order; and, after all this has been done, they go to sea.

The money-value of the fishing is divided in the following manner: The master first takes two-thirds, and the laborers divide the other third, so that every laborer receives one-twelfth. If every one of them receives 100 "roubles" ($70 gold) as his share, the total sum realized by the fishing has been 1,200 "roubles," ($840 gold.) The pilot, who has to lead the expedition, must keep order among the laborers, and watch over the interests of the master, for which he receives a certain *pro rata* of the eight-twelfths which come to the master, and, moreover, a certain fee, which is fixed beforehand, and which varies from 10 to 50 "roubles," ($7 to $35.) In this manner, the master's portion amounts to 20 forty-eighths, while the combined portions of the four laborers amount to 19 forty-eighths, of the whole sum. At first sight, it might be thought that the masters make a considerable profit, and that the laborers are working at a disadvantage. This, however, is not the case; for the sum which the laborers receive is the actual pay for their labor, while the master must deduct from his portion a large amount for the boats, fishing-implements, salt, &c. These expenses are seldom less than 250 "roubles," ($175 gold,) so that, as a general rule, the laborers work on favorable conditions.

The trade with Norway.—The bartering-trade with Norway has been going on since the second half of the last century, and is increasing from year to year. The Russian vessels, laden with rye-flour, wheat-flour, millet, and oat-meal, are obliged to put into one of the four Norwegian ports of Wardoe, Wadsoe, Hammerfest, and Tromsoe, to declare their cargoes and to pay the duty; rye-flour, oat-meal, and building-materials alone being free of duty. The Russian government, upon its part, authorizes the citizens and peasants inhabiting the coast of the White Sea to export rye-flour and oat-meal to Norway, while the merchants of the first guild have the right to trade in other articles. The Norwegian authorities are very strict in their watch over the coast. As soon as the Russian sailors have been authorized to commence their bartering-trade, they sail for the different bays of the coast, where they have least competition to fear, and there exchange their cargoes of rye-flour and oat-meal for fish.

The Norwegian government allows the inhabitants of Finnmarken, during six weeks, viz, from the 1st of July to the 15th of August, (new style,) this bartering-trade with the Russian fishermen, who are also allowed to sell their goods for cash only to merchants. But when a Russian vessel has been in Norwegian waters for six weeks, it can also sell rye-flour to the inhabitants for cash, on condition that the regular terms of the bartering-trade are not exceeded, and not less than three bags to one buyer. The Russian fishermen find it much to their advantage to barter their cargoes for fish. They usually receive, for one "poud" (36 pounds) of rye-flour, from three to five "pouds" (108 to 180 pounds) of cod-fish, or four to eight "pouds" (144 to 288 pounds) of saïda, (a small kind of cod-fish.) The Russian fishermen usually exchange a portion of their rye-flour and their oat-meal for fish, and the other portion for walrus-skins.

From 400 to 500 Russian ships, manned by more than 2,000 men, devote themselves every year to this bartering-trade. It may be safely asserted that they export annually from Norway about 700,000 "pouds" (25,200,000 pounds) of fish. In 1860, the export amounted to a million of "pouds," (36,000,000 pounds,) because the cod-fisheries, and especially that of the "saïda," had been particularly rich.

The average prices at Archangel during the years from 1852 to 1860 were as follows: Salt cod, 60 to 75 "kopecks" (42 to 52 cents) per "poud," (36 pounds;) dried cod, 1 "rouble" to 1½ "roubles," (70 cents to $1.05 gold;) salted "saïda," 20 to 30 "kopecks," (14 to 21 cents gold;)

dried "saïda," 1 "rouble" to 1 "rouble" 20 "kopecks," (70 cents to 84 cents gold;) cod-liver oil, 2 "roubles" to 2 "roubles" 20 "kopecks," ($1.40 to $1.54;) dried cod-fish heads, 10 "kopecks," (7 cents.)

2.—FISHERIES AT NOVAYA-ZEMLYA.

Between the years 1830 and 1840, Novaya-Zemlya was visited by considerable numbers of "pomortsi," inhabitants of Mezene, and fishermen from the Gulf of the Petshora, and every year large sailing-vessels brought thence rich cargoes of salmon or trout, of seals and walruses. After that, the product of the fisheries and of the chase diminished; the animals left their usual places of abode and removed to others less accessible. The fishermen consequently ceased going to Novaya-Zemlya, so that in 1850 and 1860 only five vessels sailed for that group of islands.

The northern island of Novaya-Zemlya is most frequented by fishermen, while those who have strong and well-equipped vessels venture as far north as Matoschkine. The arrangements are made so as to arrive toward the end of June at Novaya-Zemlya, where the fishermen commence their work by hunting the seals and the walrus, and afterward devote themselves to fishing for the common trout, the variety called *Salmo alpinus*, which the Russians call "golets." This little fish, which only weighs four pounds, enters the rivers in large numbers during the spawning-season, when it is caught by means of small bars and leaps. They are fished for in the sea with seines and stationary nets. Every boat usually contains three seines and six stationary nets. The "golets" fishery is always productive; for during its stay in these latitudes, every boat catches about 300 "pouds" (10,800 pounds) of this fish. A "poud" (36 pounds) of salted "golets" costs 3 "roubles," ($2.10.) In 1830, and during the three following years this fishery was so extraordinarily abundant that the fishermen were obliged to throw a large number of "golets" into the sea, because they had not salt enough. In 1852, the fisheries were also productive; the stationary nets contained on an average 20 "pouds" (720 pounds) of this fish, and one fisherman caught 480 "pouds" (17,280 pounds) in a single day.

The "golets" fishery ceases in the middle of August, and the fishermen sail for the "Iron Gate," the narrow channel which separates the northern island of Novaya-Zemlya from the island of Vaïgatch, where they hunt the walrus.

The fishermen always try to be at home again in September; most of them dread the idea of spending the winter in Novaya-Zemlya, on account of its severe and unhealthy climate. Some men, however, from the Gulf of the Petshora, always spend the winter there.

The species sought.—Seven different kinds of animals living in the sea are hunted on the northern coast of Russia for their fat and their skin. These are the "nerpa," (*Phoca anneallta* and *Phoca vitulina*, L.;) the "zayats," (*Phoca barbata*, Nils.;) the "lysoune," (*Phoca grœnlandica*, Müll.;) the "tevyak," (*Cystophora cristata*, Nils.;) the "morje," (*Tricheeus* *rosmarus;*) and the "belouga," (*Delphinapterus leucas*, Pall.;) *i. e.*, five kinds of seals, the walrus, and the white orca.

The walrus is caught on the coasts of Novaya-Zemlya and the islands of Vaïgatch and Kalgouyew; the "tevyak" on the Mourman coast, very rarely in the White Sea; the orca is caught in the White Sea by means of nets; the small seals and the "zayats" are shot with guns from the coast, or are killed with boat-hooks when they assemble in flocks on the ice with the "lysounes."

b. Seal-hunting.—On the eastern coast of the White Sea, the "Winter Coast," as it is called, and in the bays of the Dwina and the Mezene, and on the coast of Kanine, they chiefly hunt the species of phoca called *Phoca groenlandica.* This phoca is larger than the kind found in the Caspian Sea, and usually yields six "pouds" (216 pounds) of fat. It is killed on the ice.

These animals live in the high regions of the Polar Seas from May till September, and only a few occassionally show themselves in the White Sea; but, later, they make their appearance in the gulfs and bays of the Arctic Ocean, where the females give birth to their young, and feed them. These animals pair in the beginning of February, on the ice in the White Sea, and especially in the Gulf of the Dwina.

At this time the hunting commences on the "Winter Coast" and lasts till the end of March.

The huntsmen carefully observe from the eoast the movment of the floating ice. High wooden towers are erected for this purpose all along the shore, whence the observers watch the horizon with telescopes and when the have discovered an encampment of phocæ, they decide whether it is possible to get to them, and whether it is worth while to give them chase. Small hunting-sheds are also built along the coast, each of which can accomdate as many as twenty huntsmen. As soon as the phocæ show themselves at a short distance from the shore, the huntsmen venture on the floating ice, drawing a small boat after them, and they kill the young phocæ by blow with their boat-hooks, and the old ones by gun-shots. In order to approach the phocæ as near as possible, the hunters make use of the following ruse: They make themselves, as it were, invisible by muffling up in long and large and white shirts, and by advancing slowly and noiselessly on the snow. When the chase is over, the dead animals are at once skinned and dragged on shore. They usually kill only those which they can take with them for the wind easily drives the ice far away, and the booty would be lost to the huntsmen, who themselves are often exposed to the greatest dangers.

This chase takes place on the "Winter Coast," extending over a space of four hundred "versts," (two hundred and thirty miles;) and numerous huntsmen meet there from the districts of Archangel, Pinega, and Mezene. The principal place of meeting, and at which generally two thousand huntsmen assemble, is called Kedy, and is located twelve "versts" (about seven miles) from Cape Voronov. The huntsmen have built at this place about one hundred huts, where there is constant excitement from February till the end of March, while during the rest of the year these huts are deserted.

About the middle of March, the young phocæ are large enough to leave the ice and swim toward the open sea, whither the old ones do not follow them. They assemble in the Gulf of Mezene, where they rest on the ice and pair. The pieces of ice in the gulf are sheltered from the wind, and are not carried about by the waves, although they melt a little, especially during the rainy periods.

Numerous societies of huntsmen assemble in the beginning of April at the mouth of the river Kouloï, in order to follow for several weeks the chase of the phocæ on the ice. They use sailing-vessels 22 feet long, with an iron-plated bottom. Every vessel is manned by seven huntsmen, is completely equipped, and furnished with provisions and fuel.

The huntsmen all leave the shore at the same time; and, having reached the floating ice, they draw their vessels on the ice, and there establish a vast encampment. The younger and more active huntsmen are sent out to reconnoiter. Provided with snow-shoes, they hasten in all directions to search for the phocæ. As soon as they observe a flock, they advise the other huntsmen of the fact, and these all run toward the spot, drawing their boats after them. Having arrived within gunshot distance, the most expert are placed in the front rank and commence the chase; for every shot must kill, and not merely wound, lest the cries of the wounded phocæ frighten the whole flock and make them speed away. The animals which are killed are then placed in the boats, and the huntsmen return to the shore—sometimes on the ice, sometimes on the open sea—to deposit there the result of the chase, and bring new provisions to the comrades who had been left there.

The huntsmen usually receive from their master, provisions and clothing for the whole season, and must give him in return half or even two-thirds of all the animals which have been killed. The more hardened and expert a huntsman is, the larger is his share. Every society of twenty huntsmen elects a "starosta," (the old one,) whose duty it is to guard the coast and prepare the food, without receiving for this a larger share than the other huntsmen.

On the western coast of the White Sea, (called the Terski coast,) the phocæ-chase is not as productive as on the eastern coast, because the pieces of ice, driven toward the north, float along the shore. Scarcely more than 15,000 "pouds" (540,000 pounds) of phocæ are caught there every year.

In these latitudes, the principal meeting-place of the huntsmen is sixteen "versts" (about nine miles) north of the river Pouoi, and is called Deviataya. Huts are built here, and about five hundred huntsmen assemble, who form themselves into societies. Every society is composed of a master and three huntsmen. While one of the members of the society remains on shore with his sleigh and his reindeer, the other three venture on the pieces of ice to discover the phocæ, which are sleeping there. Every huntsman wears over his clothes a short cloak of reindeer-skin, called "sovik," and has on his feet large boots lined with fur. At the end of a long strap passed over his shoulder he draws a small boat, weighing 20 kilograms. A game-bag with provisions is attached to his belt. His gun on his shoulder, and having in his hand a long stick, with an iron point, he rapidly and skillfully advances, by means of his snow-shoes, over the vast fields of snow and ice. The hunter who leads directs his course by a mariner's compass, and with his iron-pointed stick constantly tries the firmness of the ice. He acts as guide, and his two comrades follow him in single file, drawing their boat after them. When they have arrived at an expanse of water where phocæ are swimming, two of the huntsmen fire, while the third pushes the boat into the water in order to take up the dead animals, which he hoists into the boat by means of a boat-hook.

The chase commences early in the morning, and the huntsmen do not return to their hut till evening; a flag hoisted on the shore indicating to them its position.

b. The chase of the white orca.—The white orca, (*Delphinapterus leucas*, Pall.,) in Russian "belouga," (the fishers of the Caspian Sea also call the great sturgeon "belouga,") is found nearly all the time in the White Sea in large numbers, but chiefly in June and July. The young orcæ begin to swim in May; their color is a bluish-gray, while that of the old ones is yellowish.

The orcæ are caught in all the bays of the Polar Sea, especially on the Kanine coast near Mezene; in the White Sea; and at the mouths of the Petshora. The fishing-implements used are seines joined together and fish-gigs.

In the summer, when the weather is calm and beautiful, large flocks of orcæ can be seen approaching the shallow places near the shore, or between the numerous islands of the White Sea. Several fishermen associate for hunting orcæ, each one furnishing a boat, and a large seine made of cords of the thickness of a finger, the meshes being 10½ inches square. The length of the net is 125 "sagenes," (875 feet,) and its depth 6 "sagenes," (42 feet.) The upper bolt-rope is furnished with wooden floats 1 "arsheen" (2 feet 4 inches) long, and placed at the distance of 2 "arsheens" (4 feet 8 inches) from each other; the lower bolt-rope has no ballast. These nets weigh about 23 "pouds," (828 pounds,) and cost 150 "roubles," ($105 gold.)

A society has usually eight boats, each being manned by four fishermen besides the master, to whom the boat and the seine belong. The fishing commences at the end of June. The fishermen cast anchor near a group of islands, and wait impatiently for the watchmen to give the signal that a flock of orcæ is approaching. As soon as the signal is given, they row rapidly toward the place designated, taking good care, however, not to fish in deeper water than 5 "sagenes," (35 feet,) lest the net, which is only 6 "sagenes" (42 feet) deep, as has been said before, should prove useless.

At first, the boats row without order; but as soon as they approach the orcæ, they place themselves in the following manner: the two middle boats approach each other and remain in the rear, while the others advance to the right and left, keeping at a distance of 120 "sagenes" (840 feet) from each other, *i. e.*, almost the length of the seine. In order that the fishing should be successful, it is necessary that the boats should advance, remaining always two and two, at the same depth; afterward, they must halt at some distance from the orcæ, and cast all the nets at the same time, after having tied them to each other. In this manner, the orcæ are surrounded, and endeavor in vain to break through. The circle is constantly growing narrower, and the orcæ are finally harpooned with fish-gigs having short handles, which are easily detached. The iron of the fish-gig is not beyond the fisherman's control, as it is joined to the hand by a cord used for pulling up the instrument and the pierced orca.

If the orcæ enter into a small bay, their retreat is cut off by means of large stationary seines, and they are easily captured.

Hunting the walrus and the polar bear.—About a dozen sailing-vessels devote themselves habitually to hunting the walrus from Cape Kanine to the mouth of the Kara. Every boat can carry 500 "pouds," (18,000 pounds,) and is manned by ten huntsmen, mostly inhabitants of Mezene and the Petshora Basin; sometimes, also, by well-to-do Samoyeds. The "Zyriany" and the poor Samoyeds serve among the Russians as laborers for very small pay and food.

In order not to expose these badly-built and badly-rigged boats to the dangers of the ocean, they are transported to the open sea, a distance of at least three hundred "versts" (one hundred and seventy-three miles) on sleighs drawn by reindeer. The expenses of this transportation, which are considerable, are repaid to the master, as he, besides receiving his share for each boat, receives three more portions of the whole product of the chase, which is divided into ten portions. The walrus-chase, in general, is but slightly productive. Scarcely more than six hundred of these animals are killed during a year. There are not sufficient funds to equip boats and to pay skillful and experienced huntsmen.

The polar bears live on the ice, on the islands, or on the coast. An experienced huntsman lets the animal approach within ten paces before he fires. If the bear is only wounded, the huntsman draws his hunting-knife, avoids the attack of the furious animal by leaping aside, and the moment he finds himself behind the bear he kills him. Nothing is more curious than the guns with which these hardy huntsmen attack the polar bears; they are simply manufactured by the village-smith! If the gun is not discharged, and the bear escapes, the huntsman values his loss at 15 "roubles," ($10.50;) but if the same accident happens with a walrus, his loss amounts to 60 "roubles," ($42.) It is not necessary to remark that the huntsman is often in danger of losing his life.

Preparing the oil.—From the fat of the animals which are hunted or fished for in the sea, as well as from the blubber of the whales which sometimes approach the coast of Lapland when the tide comes in, and which remain on dry land when the tide goes out again, an oil is prepared, which forms an important article of commerce.

In nearly all the coast-villages of the White Sea, there are oil-manufactories. The oil is prepared in the following manner: The fat, which has been secured by scraping, is thrown into large tubs and well shaken; the tubs are then exposed for some days to the heat of the sun. After this time, a layer of clear, limpid oil forms upon the surface, its color being yellowish; this is the first quality. The second quality is obtained by melting the residue of the scraped fat with the pieces of cut fat in a caldron containing a small quantity of water; this oil has a dark-brown color. The caldrons used for this purpose generally hold from 30 to 60 "pouds" (1,080 to 2,160 pounds) of fat; but the Archangel merchants, who send large quantities abroad, have in some villages caldrons holding from 80 to 120 "pouds" (2,880 to 4,326 pounds) of fat. In from ten to twelve hours, the whole mass is melted, and the oil is poured into casks holding from 20 to 32 "pouds," (720 to 1,152 pounds.) A "poud" of fat of the white orca usually yields 32 pounds of oil, while a "poud" of fat yields only 30. As regards the fat itself, the walrus, on an average, yields from 10 to 28 "pouds," (360 to 1,028 pounds;) the white orca, from 15 to 25 "pouds," (540 to 930 pounds;) and of the different species of seal, the *Cystophora cristata* yields 9 "pouds," (324 pounds;) the *Phoca grœnlandica*, from 4 to 6 "pouds," (144 to 216 pounds;) the *Phoca annellata*, 3 "pouds," (108 pounds;) and young seal with white fur, 1½ "pouds," (54 pounds.)

Preparing and cutting the skins.—The skins of the *Phoca grœnlandica* are bought by some merchants of Archangel, who salt them down in casks and send them abroad. These casks contain from 50 to 80 skins each, and they usually reckon from 2½ to 4 pounds of salt to each skin. Most of the skins of seals, orcæ, and walruses are used in the villages themselves.

When the skins have remained in the water for some time, and have lost all their hair, they are dried and tanned, and straps are made of them.

The skin of a large orca is cut into four straps, two from the back and two from the sides; that of a small orca, into three, two from the sides and one from the back. These straps are tanned and made into soles of boots and shoes and into harness. The skin of an orca can be made into from four to six pairs of reins and twelve pairs of soles. From the skin of the *Phoca grœnlandica* 70 "sagenes" (490 feet) can be cut.

The huntsmen derive the greatest profit, however, from the skins of the walruses. The Russian fishermen, especially the "promortsi," barter rye-flour very advantageously in Norway for walrus-skins. They usually get for 10 "pouds" (360 pounds) of flour two walrus-skins, which they sell at Archangel for 10 "roubles" ($7 gold) apiece.

The monks of the convent of Solovetsk prepare the skin of the *Phoca annellata* in an admirable manner. The skins of polar bears cost 8 "roubles" ($5.60) apiece at Archangel. They are warm and durable, but they are seldom tanned.

C—FISHING AND SEAL-HUNTING IN THE CASPIAN SEA.

The Caspian Sea, with an area of 147,000 square miles, furnishes, perhaps, a greater quantity of fish than any other basin in Europe having the same extent. This also applies to the rivers falling into it: the Ural, the Volga, the Térek, the Koura, and the Séfid-Roud. It can be proved that the amount of fish caught is constantly increasing. Not less than 11,000,000 "pouds" (396,000,000 pounds) of fish are annually caught in the waters of the Caspian Sea.

The cause of this great abundance of fish must be found in the character of the water, which is but little salty, in the shallowness of the sea, and in the existence of numerous excellent spawning-places, especially in the immense delta of the Volga.

In the northern basin of the Caspian Sea, where the most important fisheries are located, the sea is shallowest, the greatest depth being about 8 "sagenes," (56 feet.) The southern and middle portions of this sea are, however, very deep; but no fishing is carried on there. In the northern basin, the water is scarcely brackish, often entirely sweet, particularly when there is a north wind, which carries the waters of the Ural and the Volga far out into the sea. The rivers falling into the Caspian Sea carry into it great masses of organic matter, which furnishes abundant food for the fish.

The delta of the Volga forms a vast net-work of long, narrow, and shallow lakes, called "limans," which are joined to each other, or to various branches of the Volga, by a large number of small water-courses; and here the fish find a peaceful retreat during the spawning-season.

1.—FISH FOUND IN THE CASPIAN SEA.

The cartilaginous fish or sturgeons are principally found in the Caspian Sea, and its tributaries, among which the Volga, with its immense basin, is the most important. The Russian fishermen call these fish "red fish." In the Caspian Sea and its tributaries, the following species of fish are found, of which the Russian name is always given first.

1. "Bélouga," (*Acipenser huso*,) with an average weight of 3 "pouds," (108 pounds,) but frequently weighing from 20 to 25 "pouds," (720 to 900 pounds,) and occasionally as much as from 40 to 60 "pouds," (1,440 to 2,160 pounds.) In the year 1769, a "belouga" was caught in a bay

not far from the mouth of the Ural, weighing 70 "pouds," (2,520 pounds,) and containing 25 "pouds" (900 pounds) of roe. In 1813, one was caught in the Volga, near Saratow, weighing 80 "pouds," (2,880 pounds,) and containing 16 "pouds" (376 pounds) of roe. In 1843, one of 60 "pouds" (2,160 pounds) was caught; and, in 1849, one of 40 "pouds," (1,440 pounds,) measuring 2 "sagenes" (14 feet) in length. In 1854, a sturgeon was caught near Kazan and Nijni-Novgorod, weighing 60 "pouds," (2,160 pounds,) whose head alone weighed 17 "pouds," (612 pounds;) and another weighing 53 "pouds," (1,908 pounds.) In 1871, a "belouga" weighing 63 "pouds" (2,268 pounds) was caught near Derbent at a depth of 130 "sagenes," (910 feet.)

2. "Osètre," (*Acipenser Guldenstädtii.*) Its average weight is 30 pounds; but many are caught in the Volga measuring from 4 to 6 feet, and weighing from 1 to 3 "pouds," (36 to 108 pounds,) sometimes weighing even 5 "pouds," (180 pounds,) and measuring from 6 to 9 feet in length. This fish is exceedingly prolific. M. Baer, a member of the academy, has found 600,000 eggs in one large-sized fish, and 260,000 in a medium-sized one.

3. "Sévriouga," (*Acipenser stellatus.*) Average weight, 15 pounds. It is caught in enormous quantities in the Koura, most of them weighing about 1 "poud," (36 pounds.)

4. "Chyp," (*Acipenser Schypa.*) In the Ural. Weight, 1½ "pouds," (54 pounds.)

5. "Sterliad," (*Acipenser ruthenus,*) sterlet. Two feet long; weight, from 15 to 20 pounds.

6. "Som," (*Silurus glanis,*) Wels; sheat-fish. Length, from 3 to 6 feet; weight, as much as 6 "pouds," (216 pounds.) It is very common in the Koura, where it sometimes attains a weight of 8 "pouds," (288 pounds,) and a length of 1½ "sagenes," (10½ feet.)*

7. "Bélorybitsa," the "nelma" of the northern rivers, (*Coregonus leucichthys*, Güldenst.,) an excellent fish, also known as the white Siberian salmon, is found in the Volga, rarely in the Ural, and not at all in the Térek and Koura. It weighs from 12 to 17 pounds, sometimes as much as 30 pounds, and measures 3 feet in length.

8. "Lòsoss," (*Salmo salar,*) salmon. Is common in the Térek and the Koura, very rare in the Volga, and never found in the Ural.

9. "Chémayà," (*Aspius clupeoïdes*, Pall.) Is only found in the Koura and the Térek.

10. "Sazàne," (*Cyprinus carpio*, L.,) carp. In the Caspian Sea and near the mouths of the Volga. Often from 3 to 4 feet long, and weighing from 40 to 50 pounds. Average weight, from 10 to 17 pounds.

11. "Karàss," (*Carassius vulgaris,*) crucian carp. Common in the Volga. The largest are one foot long, and weigh 5 pounds.

12. "Soudàk," (*Lucioperca sandra,*) saudre. From 15 to 20 pounds.

*This is the European representation of the fresh-water catfish or bull-heads of the United States.—S. F. B.

13. "Bersche," (*Lucioperca volgensis.*) Five pounds.

14. "Linn," (*Tinca vulgaris,*) tench. The largest measure 2 feet in length, and weigh 7 pounds.

15. "Ousàtche," (*Barbus obtusirostris,* Yakovlew.) Rare in the Volga; common in the Koura.

16. "Piskar," (*Gobio fluviatilis,* Cuv.) Three inches long.

17. "Lestche," (*Abramis brama.*) From 8 to 10 pounds.

18. "Yersche," (*Accrina cernua.*) Usually 7 inches, but sometimes reaching 10 inches.

19. "Okoune," (*Perca fluviatilis,*) perch. From 3 to 4 pounds.

20. "Sinétse," (*Abramis ballerus,* Cuv.) Found chiefly in the Volga; 10 inches long, and weighing rarely more than half a pound.

21. "Sopà," (*Abramis sopa,* Pall.) Common in the Volga.

22. "Goustera," (*Blicca biœrna.*) Thirteen inches; 2 pounds.

23. "Tchékhonne," (*Pelecus cultratus,* Agass.) Two feet; 2½ pounds.

24. "Oukleïka," (*Alburnus lucidus,* Heck.) From 4 to 6 inches.

25. "Jérekh" and "chéresper," (*Aspius rapax.*) Length, 2½ feet; weight, 16 pounds.

26. "Tarànne," (*Scardinius erythrophthalmus,* L.) Scarcely a foot long; common in the Volga. "Tarànne" is the collective name of several species of *Leuciscus* and *Abramis;* but, in the Don and the Azov Sea, the name "Tarànne" is only given to *Leuciscus Heckelii,* Nordm.

27. "Vòbla," (*Leuciscus rutilus,* L.) Length, 1½ feet; weight from 2 to 3 pounds, and found in the Volga in vast numbers.

28. "Koutoume," "Wyrezoub," (*Leuciscus Friesii,* Nordm.) Common in the Séfid-Roud, the Koura, and the Térek; very rare in the Volga, and never found in the Ural.

29. "Stchouka," (*Esox lucius,*) pike. From 30 to 40 pounds; as much as 3½ feet in length.

30. "Béschenka," (*Alosa pontica.*)

31. "Jéleznitsa," (*Alosa caspica,*) Astrachan herring.

These two last-mentioned species are known by the name of "Astrachan herring;" usually from 2 to 2½ pounds, and sometimes 4. Length, 1½ feet. They are very common in the Volga, which they ascend very far. Some are caught even at Koliázino, in the district of Tver. They are not found in the Ural, the Térek, the Koura, and the Séfid-Roud. The Azov Sea, the Black Sea, and the Caspian Sea contain no species of *Clupea,* Val.

32. "Podouste," (*Chondrostoma nasus,* Val.;) 1½ pounds.

33. "Minoga," (*Petromyzon fluviatilis,*) Lamprey. Found in large numbers in the Koura and the Térek; common in the Volga below Astrachan; and, since 1870, very common near the towns of Ynotayeosk and Tchornoï Yar; and, since 1855, in immense masses in the district of Saratow.

Of these fish, those which furnish the principal articles of trade are the *Acipenser,* the *Silurus,* and, of scaly fish, the *Lucioperca,* the *Abramis,* the *Alosa*, the *Leuciscus rutilus*, and the *Cyprinus carpio*, L. The *Coregonus leucichthys* and the *Salmo salar* are less important, and still less the *Esox lucius* and other small scaly fish. Pickled lamprey (*Petromyzon fluviatilis*) might form a considerable article of commerce, but, on the Térek, it is entirely neglected, and, on the Koura, it is dried and used as candles.

The first establishment for pickling lampreys was opened in the city of Tsaritsyn, after the close of the year 1871; and up to February, 1873, 700 casks, containing about 1,200,000 lampreys, had arrived at St. Petersburg, weighing not less than 56 kilograms (about 123 pounds) to the thousand, and being exceedingly well pickled; they are sold from 12 to 14 "roubles" ($8.42 to $9.80 gold) a thousand.

2.—SPAWNING-SEASON OF THE FISH IN THE CASPIAN SEA.

At Astrachan, the Volga is usually free from ice from the beginning of April, and the different kinds of fish arrive from the Caspian Sea about that time. The first to arrive is the *Scardinius erythrophthalmus*, L.; the "vobla," (*Leuciscus rutilus*,) chased there during its capricious leaps from the water by the voracious "bélouga"; this is followed by the *Esox lucius*, pike; then by the *Abramis*, and by the *Lucioperca*, sandre. From the 20th of April till the 5th of May, the *Alosa*, or so-called herrings, appear in immense schools; then the "sévriouga," (*Acipenser stellatus*,) sturgeon; the *Silurus glanis*, Wels; the *Cyprinus carpio*, L., carp; and, finally, the *Acipenser Guldenstädtii*, sturgeon.

Most of the scaly fish spawn in April or in May, and for this purpose seek the shallow water, where there is but little current, and where aquatic plants are numerous, and where fishing is strictly prohibited from the 15th of April till the 15th of May, in order that the spawning-process may not be interrupted. The salmon and the "clémaya," (*Aspius clupeoïdes*,) which are caught in large numbers in the Térek and in the Koura, usually spawn in August and September, the first-mentioned on sandy bottoms.

The spawning-season of the sturgeon commences in the Volga in June and lasts till the end of July; in the Ural, it lasts from the middle of April till the middle of June. They prefer a hard and stony bottom. Only three hundred and eighty "versts" (two hundred and nineteen miles) above Astrachan, near Sarepta, the bottom of the river is of this character. In order to let the different kinds of sturgeon enjoy the rest which they require, the fishing-regulations forbid fishing in the Volga, as well in the river as in its branches, from the 15th of May till the 15th of July. Nevertheless, fishing is permitted exceptionally, to supply the local want, from the 15th of June till the 15th of July, between the Caspian Sea and the town of Tchornoï-Yar, two hundred and twenty-five "versts" (one hundred and twenty-nine miles) above Astrachan, with floating nets 90 "sagenes" (630 feet) long and 1 "sagene" (7 feet) deep.

Careful observations have shown that during the time immediately preceding the spawning-season, the sturgeons eat nothing, while after spawning they are exceedingly voracious. In the rivers, the young sturgeon feed on the larvæ of insects and small shell-fish, and, in the sea, on small crabs and shell-fish. The little "bélouga" is an exception, feeding on other fish. The common sturgeon, the "sévriouga," and the "sterliad," (*Acipenser ruthenus*,) also feed on shell-fish. When the sturgeons are one year old, they leave the rivers and go into the sea, to return as soon as they are able to spawn.

A very peculiar phenomenon in the Ural is the winter sleep of fish, especially of the sturgeon. From the end of June, the different kinds of sturgeon as well as scaly fish come to the Ural for the second time. For some time they can be seen swimming and playing in the stream, but as soon as the water grows cold this vivacity disappears; they seek the deep places, ("yatoves,") in which the bed of the river abounds, and hide there as soon as the surface is frozen. In their state of torpor, these fish secrete a viscous matter, which formes a thin layer over their whole body. The fishermen call this the "cloak" of the fish. This torpor, or sleep, of the fish is caused by severe cold and want of air under the water, and is therefore a consequence of the excessive weakening of the respiration. The fish eat nothing during this state, for nothing is found in their stomach but the viscous matter spoken of above. The great sturgeon alone (*Acipenser huso*) seems to take food during his winter-sleep, for some have been caught having scaly fish in their stomach.

The deep places, or "yatoves," of the Ural are from 7 to 8 "sagenes" (252 to 278 feet) deep, and the fish there pile themselves upon each other in thick layers. According to the account of experienced fishermen, sturgeons there associate only with sturgeons, and scaly fish with their own kind, never intermingling: the "sinètse" (*Abramis ballerus*) is the only scaly fish which has been found among the sturgeons.

Watchmen posted near the "yatoves," every one of which has its own name, notice exactly in what quantities the fish seek refuge there, and of which kind the fishing will be most productive. These watchmen develop a most astonishing sagacity in this respect.

3.—WEALTH OF FISH IN THE CASPIAN SEA.

Pallas, who visited the shores of the Caspian Sea in 1773, speaks of the immense quantities of fish in this sea. He says, in addition to other things, that, in the spring in the Koura, near the bar of Salyan, 15,000 sturgeons were frequently caught in one day; and that when the fishing was interrupted for one day only, the river, whose depth is 4 "arsheens," (80 inches,) was, at every bar, filled with a vast number of fish, piling themselves one upon the other to such a degree that the topmost had their backs out of the water. At that time, there was a bar at Gouryew, at the mouth of the Ural. It is related that at this place schools of sturgeon rushed at the bar in countless numbers, and would have upset it if the Cossacks had not driven them to flight by cannon-shots

Similar stories are, it is true, not related in later times, but it is undeniable that the result of the fisheries during the years from 1820 to 1830 was perfectly enormous, and that this is not infrequently the case in our time. Thus, in 1826, during 12 consecutive days, an average of 15,000 sturgeon a day were caught, mostly "sévriougas" and common sturgeons, (*Acipenser Güldenstädtii*,) at the fishing establishment ("vataga") of Providence, ("Bojii promysl,") on the Koura, fifteen "versts" (about eight miles) from the mouth of this river. There were not hands enough to carry on the work, so that an immense quantity of fish spoiled on the spot, and 40,000 of them had to be cast into the water. This "vataga" (fishing-establishment) was visited, in 1855, by the "Imperial commission for examining the fisheries of the Russian Empire." The commission was led by M. Baer, from the Imperial Academy of Sciences at St. Petersburg, the statistical work being confided to M. Danilevsky, while I had charge of the technical part.

I observed many a time that ducks and other aquatic birds, which, in the river Koura, swam on the surface of the water, fell victims to the voracity of the *Siluri*. Whenever a bird killed by a shot from a huntsman fell into the water, it was immediately seized and devoured by these enormous fish.

Every day from 3,000 to 5,000 "sévriougas" were brought to the "vataga," (fishing-establishment,) where the following quantities were caught annually: about 15,000 "bélougas;" 30,000 common sturgeon, (*Acipenser Güldenstädtii*;) 250,000 "sévriougas;" and 230,000 *Siluri*.

Large numbers of the different species of sturgeon are also caught in the Ural, the Térek, and the Volga. The wealth of the northern basin of the Caspian Sea in fish is almost inexhaustible. More than 100,000 nets and at least 15,000,000 of hooks are here employed for sturgeon-fishing alone, and thousands of fishing-boats are continually engaged in this occupation. Immense nets are in constant use in the Ural, the Volga, and in the delta of this latter river; and it is no rare occurrence that at one single haul 40,000 "lestche" (*Abramis brama*) are caught, or 150,000 "voblas," (*Leuciscus rutilus*, L.,) or 200,000 "jélezuitsa," (*Alosa caspica*.)

4.—ESTIMATED VALUE OF THE FISHERIES IN THE CASPIAN SEA.

The quantity and value of the fish which are caught every year in the Caspian Sea and its principal tributaries, as well as the number of seals captured in this sea, can be estimated only approximately. This estimate amounts annually to the following:

"Bélouga," (*Acipenser Huso*,) 475,000 "pouds," (17,100,000 pounds;) value, 1,288,000 "roubles," ($901,600 gold.)

"Osètre" (*Acipenser Güldenstädtii*) and "Chyp," (*Acipenser Schypa*,) 405,000 "pouds," (14,580,000 pounds;) value, 1,620,000 "roubles," ($1,134,000 gold.)

"Sévriouga," (*Acipenser stellatus,*) 65,000 "pouds," (2,340,000 pounds;) value, 1,962,000 "roubles," ($1,373,400 gold.)

"Sterliad," (*Acipenser ruthenus,*) 50,750 "pouds," (1,827,000 pounds;) value, 275,000 "roubles," ($192,500 gold.)

"Sazane," (*Cyprinus carpio*, L.,) 200,000 "pouds," (7,200,000 pounds;) value, 120,000 "roubles," ($84,000 gold.)

"Soudah" (*Lucioperca sandra*) and "Stchouka," (*Esox lucius,*) 2,650,000 "pouds," (95,400,000 pounds:) value, 2,450,000 "roubles," ($1,715,000 gold.)

"Lestche," (*Abramis brama,*) 1,375,000 "pouds," (49,500,000 pounds;) value, 1,275,000 "roubles," ($892,500 gold.)

"Beschenka," (*Alosa pontica,*) and "jeleznitsa," (*Alosa caspica,*) 3,000,000 "pouds," (108,000,000 pounds;) value, 1,050,000 "roubles," ($735,000 gold.)

"Vabla," (*Leuciscus rutilus,*) 600,000 "pouds," (21,600,000 pounds;) "okoune," (*Perca fluviatilis,*) 760,000 "pouds," (27,360,000 pounds;) value, 500,000 "roubles," ($350,000 gold.)

"Som," (*Silurus glanis,*) 185,000 "pouds," (6,660,000 pounds;) value, 315,000 "roubles," ($220,500 gold.)

"Lososs," (*Salmo salar,*) 33,000 "pouds," (1,188,000 pounds;) value, 106,000 "roubles," ($74,200 gold.)

"Belorybitsa," (*Coregonus leucichthys,*) 32,000 "pouds," (1,152,000 pounds;) value, 103,000 "roubles," ($72,100 gold.)

"Béluga" bladder, 5,500 "pouds," (198,000 pounds;) value, 600,000 "roubles," ($420,000 gold.)

"Veziga," 4,000 "pouds," (144,000 pounds;) value, 70,000 "roubles," ($49,000 gold.)

Sturgeon caviar, 139,000 "pouds," (5,004,000 pounds;) value, 1,390,000 "roubles," ($973,000 gold.)

Caviar of *Abramis brama* and the two kinds of *Lucioperca*, 300,000 "pouds," (10,000,000 pounds;) value, 300,000 "roubles," ($210,000 gold.)

Fish-oil, 50,000 "pouds," (1,800,000 pounds;) value, 150,000 "roubles," ($105,000 gold.)

Seals, 100,000 "pouds," (3,600,000 pounds;) value, 150,000 "roubles," ($105,000 gold.)

Seal-oil, 100,000 "pouds," (3,600,000 pounds;) value, 350,000 "roubles," ($245,000 gold.)

The grand annual total is therefore 13,000,000 "pouds," (468,000,000 pounds,) representing a value of 15,000,000 "roubles." ($10,500,000 gold.)

5.—FISHING-BASINS OF THE CASPIAN SEA.

The Caspian Sea forms four fishing-basins: 1. The trans-Caucasian; 2. The territory of the Térek Cossacks and the inhabitants of Mangyschlak; 3. The territory of the Ural Cossacks; 4. The basin of fisheries belonging to the state.

The trans-Caucasian fisheries.—This basin contains four fisheries; those of Salyan and of Kizil-Agatch being the most important. The fishery of Salyan, to which the "vataga" (fishing-establishment) of Bojii-Promysl or Providence belongs, extends from the mouth of the Koura to the town of Salyan, where the river Akoucha leaves the Koura to follow its own course to the sea. At this point the fishery of Kizil-Agatch is located. The fisheries extend fifty "versts" (about twenty-nine miles) from the sea-coast. Above Salyan, on the Koura and on the Arape, the fisheries of Mougane, Chémakha, Elizabethpol, and Arase are found. The waters of Bakou extend from the mouth of the Alatchaï to Mount Akh Syvir, comprising a fishing-ground in the sea as far as fifty "versts" (about twenty-nine miles) from the shore, as well as the seal-hunting in the islands. The fisheries of Koubà commence at the mouth of the Samouch and extend to the district of Bakau.

The government always leases out the trans-Caucasian fishing-basins for a period of eight years; the contracts being made at Tiflis. From 1846 to 1854, the amount of rent received by the government was only 180,000 "roubles," ($126,000 gold.) It then rose to 320,000 "roubles," ($224,000 gold;) then to 385,000 "roubles," ($269,500 gold;) and at the present time it amounts to 390,000 "roubles," ($273,000 gold.) The person who rents a fishery keeps Tartar and Russian laborers at a fixed monthly salary, amounting, from 1846 to 1854, to 4½ "roubles," ($3.15 gold.) He also supplies the laborers with food, fishing-implements, and boats. Besides their fixed monthly pay, 1¾ "kopecks" (not quite one cent) is given for each sturgeon that is caught.

At the "vataga" (fishing-establishment) of Bojii-Promysl, fifteen "versts" (eight and a half miles) from the mouth of the Koura, and in the Akoucha, there are bars formed by poles and stakes driven into the bed of the river, forming a curved line from one shore to the other. In every bar, openings are left 3 "sagenes" (21 feet) broad, called "gates," for letting boats and fish pass. But, contrary to the regulations, these openings are usually closed by means of stationary nets. Fishing is always very good in all the space between the bar and the sea. People fish here with hooks, stationary lines, "palangres," and with large and small nets and seines. The lines, being furnished with pointed hooks, which are not baited, are either held up by floats or are ballasted and arranged in rows. The fish coming from the sea are caught on the numberless hooks, and are taken up by the fishermen, who patrol all the rows of lines regularly. Besides these implements, stationary and floating nets are also used. For catching the "som," (*Silurus glanis*,) the so-called "eissauge" (very large nets) are employed. The "som" is only fished for in the spring; during the other months of the year it is entirely neglected, because a great deal of salt is required to preserve this extraordinarily fat fish, and much fuel to extract the oil, both of which articles are scarce and expensive. In the autumn, the "chémaya" (*Aspius clupeoïdes*) is caught by means of floating nets, the thick part of which is made of silk. Seines are but rarely employed for catching scaly fish, and this is only done in the Upper-Koura.

The person who rents a fishery is bound by his contract to fulfill the following obligations: Fishing is prohibited from the 1st of June to the 1st of August. During this period, the gates of the bar must remain open; and it is forbidden to put any lines or nets there, in order that the fish may be enabled to come up from the sea and reach their spawning-places. A fine is imposed for breaking this law, amounting to 1,000 "roubles" ($700 gold) the first time, 2,000 "roubles" ($1,400 gold) the second time, and, if it occurs a third time, the contract is annulled. If the lessee erects new bars of his own accord, he is punished by having his building-material confiscated; in case of a second offense, he pays a fine of 2,000 "roubles" ($1,400 gold) the first time, and 4,000 "roubles" ($2,800 gold) the second time. If he receives permission to construct fishing-parks, bars of stakes, or nets, he must leave two-thirds of the breadth of the river open if he has any competitors farther up the river; and, if this is not the case, only one-sixth part. In navigable rivers, bars of any kind must not occupy more than one-fourth of the breadth of the river. Moreover, it is forbidden to obstruct rivers, branches of rivers, mouths of rivers, and lakes with apparatus of this kind. Finally, to allow the fish to ascend the rivers easily, it is not allowed to cast a second seine before the first one has been taken on shore.

The lessee procures the necessary salt for preserving fish and for preparing caviar from the government salt-depots. In the district of Bakou and in the region of the salt-lakes of Salyan, salt costs 12 "kopecks" (about 7 cents) a pound. The lessee cannot get more than 130,000 "pouds," (4,996,000 pounds;) but he has the right to buy salt at Astrachan or other cities of the empire.

According to the exact statistics of M. Danilevsky, the trans-Caucasian fisheries yielded during the period from 1848 to 1855 the following:

Years.	Number of fish caught.							
	"Belouga," (*Acipenser Huso.*)	Sturgeon, (*Acipenser Guldenstädtii.*)	"Sévriouga," (*Acipenser stellatus.*)	"Chyps," (*Acipenser Schypa.*)	*Siluri.*	"Clemaya," (*Aspius clupeoides*, Pall.)	Salmons.	"Sazane," (*Cyprinus carpio*, L.)
1848	6, 734	52, 126	514, 923	14. 693	127, 663	208, 563	21, 778	46, 653
1849	8, 093	27, 723	492, 452	14, 751	79, 537	306, 094	91, 192	33, 764
1850	12, 020	29, 601	538, 502	16, 906	88, 444	98, 972	23, 636	69, 830
1851	12, 507	28, 576	464, 923	14, 975	64, 006	161, 337	30, 594	31, 378
1852	12, 523	36, 363	556, 563	11, 170	116, 131	206, 755	24, 754	69, 498
1853	9, 527	35, 287	513, 132	13, 695	107, 413	191, 561	22, 371	41, 574
1854	6, 572	23, 256	436, 495	14, 919	59, 499	70, 995	9, 531	46, 362

Years.	Caviar.		"Bélouga" bladder.		"Vóziga."		"Balyk."	
	"Pouds."	Pounds.	"Pouds."	Pounds.	"Pouds."	Pounds.	"Pouds."	Pounds.
1848	26, 522	952, 792	533	19, 188	724	26, 064	278, 786	10, 036, 296
1849	30, 095	1, 083, 420	567	20, 412	770	27, 720	312, 036	11, 233, 296
1850	31, 969	1, 150, 784	657	23, 652	880	31, 680	323, 207	11, 635, 452
1851	28, 484	1, 025, 424	586	21, 096	767	27, 612	300, 593	10, 821, 148
1852	34, 089	1, 227, 204	690	24, 840	850	30, 600	281, 833	10, 145, 988
1853	31, 784	1, 144, 224	617	22, 212	820	29, 520	264, 659	9, 527, 724
1854	24, 721	889, 956	531	19, 116	720	25, 920	304, 342	10, 956, 312

Fisheries in the territory of the Térek Cossacks and of the inhabitants of Mangyschlak.—This basin comprises two districts, that of Tchétchène and that of Bakhtémir. The former extends eleven "versts" (about six miles) along the coast; the latter fourteen "versts" (about eight miles) from the Gulf of Bakhtémir to the possessions of the Schamkal of Tarki. In the sea, the extreme limit of the two districts is seventy-six "versts" (about forty-four miles) from the coast.

The right to fish in these waters belongs both to the Cossacks of the Térek, and to those fishermen who, by paying a certain sum of money, receive a permit from the military authorities.

The fishing-basin of the inhabitants of the Peninsula of Mangyschlak in the northeastern portion of the Caspian Sea extends from Cape Tiouk-Karagane twenty-five "versts" (fourteen miles) toward the north, and the same distance toward the west. It has an area of six hundred and twenty-five square "versts," (about two hundred and seventy-three square miles.) Only the inhabitants have the right to fish here.

Fisheries in the territory of the Ural Cossacks.—This exceedingly rich basin comprises (*a*) the river Ural, to a length of six hundred "versts" (about three hundred and forty-five miles) from its mouth to one hundred "versts" (about fifty-seven and one-half miles) above the city of Uralsk; (*b*) part of the Caspian Sea from the mouth of the Ural extending eighty-eight "versts" (about fifty and a half miles) to the west, and seventy-eight "versts" (about forty-five miles) to the east, and having a depth of 7 "sagenes," (16 feet 4 inches;) (*c*) all the rivers and lakes in the interior of the territory; (*d*) a great lake, called Tcherkalskoë Mortso in the Kirghize steppe, which is connected with the sea.

All these waters are the undisputed property of the army of Ural Cossacks. The fishing-regulations are very old, and have, till the present time, been kept up by tradition and custom. The military authorities see to it that these regulations are strictly enforced. For every kind of fishing-industry, the military authorities publish regulations, stipulating the time of opening and closing the fisheries, the different formalities, conditions, &c.

As soon as the Ural is free from ice, the spring-fisheries commence. In the river, "sévriougas" (*Acipenser stellatus*) are caught with floating nets; sturgeon are caught in the sea; and scaly fish in the Tcherkalskoë Mortso. Fishing in the river is prohibited from the middle of June till the middle of August. The sturgeon appear in great numbers in the Ural in the month of July to seek refuge in the "yatoves," (deep places,) to which they, however, do not retire till October. The autumn-fisheries commence about the middle of August, first with stationary nets, then with floating nets and seines, and last till November. As soon as the Ural is frozen, they begin to catch the sturgeon under the ice by means of hooks and fish-gigs, ("bagrènié;") and scaly fish with seines in the river, and with stationary nets in the sea. Hook-fishing lasts till the middle of January, while nets are used till the first of March.

In order to allow the fish to enter freely into the Ural, fishing in the sea just at the mouths of the river is prohibited over an area eighty "versts" (about forty-six miles) long, and forty "versts" (about twenty-three miles) broad. Outside of this area it is allowed to place "palangres" perpendicularly on the shore for catching sturgeon. The number of "palangres" is fixed beforehand, and the most favorable locations are distributed by casting the lot.

In autumn, they fish in the lower part of the Ural over an extent of two hundred and eighty "versts," (about one hundred and sixty-one miles;) and 8,000 Cossacks, with 3,000 boats, are engaged in this occupation. The whole stretch is marked off into fifteen divisions. There is always one seine, with wings, to every two boats. The boats at first go slowly down the river in regular order, then, as they approach the "yatoves," (deep places,) where the fish congregate, all the boats use the oars to their utmost capacity, in order to arrive first.

After the "yatoves" of one division have been exhausted, they pass to another division, and so on in order. While the Cossacks go down the river in their boats, the merchants follow them along the shore, accompanied by wagons, on which the fish, which have been bought by them, are placed. Salting is carried on on the spot, as well as the manufacture of fish-glue (isinglass) and of caviar.

From the city of Uralsk to the Cossack village of Antonov, people fish in the Ural under the ice with hooks and fish-gigs. This fishery is also carried on by divisions appointed for every fishing-day. The hook, called "bagor," is a fish-gig with a pointed steel hook attached to a wooden handle. Fishing with hooks is the favorite occupation of the Cossacks. Even the poorest among them can take a part in it; for the whole outlay consists of a hook, a sleigh drawn by a horse, and the necessary food and fodder for one day. At this season of the year, the price of fish is high, so that fishing becomes a very profitable occupation. Chance, however, has a good deal to do with success in this mode of fishing.

The fishermen form associations ("artelles") of from six to fifteen members, and divide the fish among them.

The value of these fisheries (by hook and by net) may be estimated with certainty at 400,000 "roubles" ($280,000 gold) per annum.

The annual revenue of the fisheries of the army of Cossacks of the Ural is 1,200,000 "roubles," ($840,000 gold.)

Fisheries of the government.—The following localities belong to the vast basin of government-fisheries: (*a*) the Volga, with its tributaries from the city of Kamychine, in the district of Saratow, to the sea, which includes an area of 15,900 square "versts," (about 7,000 square miles,) with 135 fishing-establishments, ("vatagas";) (*b*) those portions of the sea in which fishing is free, according to the imperial decree of May 25, 1865. This part of the sea is divided into seven fisheries: 1. The southwest fishery, from the northern frontier of the territory of the Térek Cossacks to a point on the coast five "versts" (almost three miles) from the mouth of the Talovka, with an area of 1,501¾ square "versts," (about 657 square miles;) 2. That of the buoys of the Térek, from the boundary of the preceding division to five "versts" (almost three miles) beyond the mouth of the Prorva, with 1,252½ square "versts," (549 square miles;) 3. That of the west from the boundary of the preceding division to the Island of the Four Hills, with 4,206½ square "versts," (1,844 square miles;) 4. That of the buoys of the Volga in front of the mouths of the river from the Island of the Four Hills to the eastern extremity of the great gulf of Sinoyé Mortso, with 3,655¾ square "versts," (1,720 square miles;) 5. That of the northeast from this gulf to the western limit of the waters of the Ural, with 11,054 square "versts," (4,047 square miles;) 6. That of the Emba, from the eastern limit of the waters of the Ural to the fishing-basin of the inhabitants of Mangyschlak, with a surface of 60,596 square "versts," (22,667 square miles;) 7. The division of the high sea and the waters that wash the eastern coast of the sea to the river Atrek, which forms the boundary-line of Persia; the extent of this division has not been exactly measured.

All these divisions, not including the seventh, have an area of 82,267 square "versts," (32,286 square miles.) If one adds 15,914 square "versts" (3,398 square miles) of river-fisheries, the fourth fishing-basin comprises an area of 98,181 square "versts," (35,684 square miles.) It includes, at least in part, the districts of Saratow, of Astrachan, of Orenburg, of Stavropol, and of Daghestan. The administrative authorities have their seat at Astrachan. They were constituted by an imperial decree of the 25th of May, 1865, and are called "Administration of the fisheries and of the seal-hunt." This administration belongs to the ministry of domains, and it has officers appointed to secure the strict observance of the fishing-regulations. It also makes out the contracts and receives the payments for fishing-permits.

Not only are the river-fisheries of private individuals subject to the regulations, but also the fisheries of the cities, convents, and villages, as also those of the Astrachan Cossacks.

The river-fisheries of the Térek are leased out by the chamber of domains at Stavropol for the annual sum of 28,000 "roubles," ($19,600 gold.) The leases of the other fisheries yield the following sums: those of Prince Dolgorouki, 7,000 "roubles," ($4,900 gold;) of Count Kouchelew-Bezborodko, 22,626 "roubles," ($15,838.20 gold;) of the Astrachan Cossacks, 29,574 "roubles," ($20,701.80 gold;) of the convent of Tchourki, 7,500 "roubles," ($5,250 gold;) of the city of Astrachan, 1,863 "roubles," ($1,304.10 gold.)

The government possesses in the Volga and its several branches, as well as in the innumerable lagoons and small brooks, ("yíryks,") sixty-three fisheries, which are leased separately. The lease is for seven years; the price of the lease amounting to 248,839 "roubles," 32 "kopecks," ($174,187.51 gold.)

The administration of the fisheries issues special permits for fishing in the sea. The price of these permits varies, and depends as much on the season of the year as on the locality where people desire to fish. Every boat must have its permit. In the spring, the permit costs 20 "roubles" ($14 gold) for fishing with stationary nets; in the autumn, 30 "roubles," ($21 gold;) and for the whole year, 50 "roubles," ($35 gold.) For fishing with seines, a permit is required for each seine, which costs 100 "roubles" ($70 gold) a year, and 50 "roubles" ($35 gold) for half a year. The seal-hunters pay for an annual permit 6 "roubles," ($4.20 gold,) and for a half-yearly permit 3 "roubles," ($2.10 gold.) A permit for fishing in winter costs 25 "roubles," ($17.50 gold;) but those who have already a permit for the whole year, or two permits for six months each, receive the winter-permit gratis.

There are in these waters every year about 14,000 fishermen, with 3,000 large sail-boats.

Immediately in front of the mouths of the Volga, the limit of fishing is indicated by twenty-two lines of buoys. These lines are formed by beacons, or buoys, placed from 120 to 150 "sagenes" (840 to 1,050 feet) apart, in the direction of 32 degrees southeast, and extend into the sea fifty "versts," (twenty-eight miles,) with a depth of 3 "sagenes," (21 feet.) These lines are distant from two to six "versts" (about one and one-fourth miles to three and one-third miles) from each other. The two lines of buoys established before the mouth of the Térek follow the direction of 45 degrees northeast, and go out into the sea sixty "versts," (thirty-four and one-half miles,) with a depth of 4 "sagenes," (28 feet.) "Corridors," as they are called, from five to ten "versts" wide, (about three to six and one-third miles,) form openings before the mouths of the rivers to let those fish pass which are leaving the sea to ascend the rivers. Fishing in these "corridors" is prohibited. In the space between the lines, the fishermen can follow their vocation till the sea reaches the depth of 1 "sagene," (7 feet,) which is the case at about twelve "versts" (almost seven miles) out at sea, but only with "palangres;" while farther out at sea, at a depth of 3 "sagenes," (21 feet,) they can use "palangres" and stationary nets. In the first case, the permit costs 30 "roubles" ($21 gold) in the spring; 20 "roubles" ($14 gold) in the autumn; and 50 "roubles" ($35 gold) for the whole year; in the second case, 70, 50, and 100 "roubles," ($49, $35, and $70 gold.) The fishing implements must be placed parallel with the lines of buoys. The rows of "palangres" are 22½ "sagenes" (147½ feet) apart, while the space between the rows of boats must be 135 "sagenes," (945 feet.) On an average, there are 5,100 fishermen, with 1,700 boats, employed annually in the fisheries among the buoys of the Volga.

Table of income from the government fisheries during the years 1867–1872.

Years.	Income from the leases of river-fisheries.			Income from the sale of permits.				Taxes on seal-oil and seal-skins transported to Astrachan.			Total.		
				Fisheries.		Seal-hunting.							
	Roubles.	Kopecks.	American gold, dollars.	Roubles.	American gold, dollars.	Roubles.	American gold, dollars.	Roubles.	Kopecks.	American gold, dollars.	Roubles.	Kopecks.	American gold, dollars.
1867 ..	210, 861	47	147, 603 03	209, 035	146, 324 50	1, 479	1, 035 30	40, 302	58	28, 211 80½	461, 577	05	323, 103 93½
1868 ..	229, 139	13	160, 397 39	176, 350	123, 445 00	1, 068	747 60	43, 795	46	30, 656 82	450, 352	59	315, 246 82
1869 ..	229, 868	13	160, 907 69	163, 930	141, 751 00	963	674 10	34, 549	01	24, 184 30	429, 310	14	300, 517 10½
1870 ..	229, 868	13	160, 907 69	183, 635	128, 544 50	1, 131	791 70	33, 552	62	23, 486 82	448, 186	75	313, 730 71
1871 ..	248, 839	32	174, 187 52½	183, 700	128, 590 00	999	699 30	24, 888	12	17, 421 67	444, 983	32	311, 488 31
1872 ..	248, 839	32	174, 187 52½	204, 454	143, 117 80	663	464 10	43, 371	19	30, 359 84	497, 327	51	348, 129 25

The taxes on seal-oil are paid by persons who buy the seals from the huntsmen as soon as these have returned from the sea to the mouths of the Volga. The taxes are paid as soon as the huntsman has sold his seals, or at the time when the buyer, after having notified the fishing-administration, gets ready to ship the casks of seal-oil. The tax is 30 "kopecks" (21 cents) for each "poud" (36 pounds) of seal-fat or seal-skins; and 40 "kopecks" (28 cents) for each "poud" (36 pounds) of oil.

Table showing quantities of oil and skins registered at the offices of the administration of fisheries.

Years.	Oil.		Skins.		
	Russian weight.	American weight.	Number.	Russian weight.	American weight.
		Pounds.		"*Pouds.*"	*Pounds.*
1867	93, 395 "pouds" 15 pounds	3, 362, 235	131, 723	12, 667	455, 012
1868	104, 161 "pouds" 5 pounds	3, 749, 801	150, 947	14. 786	532, 296
1869	81, 979 "pouds" 30 pounds	2, 951, 274	128, 701	11, 915	428, 940
1870	78, 790 "pouds" 15 pounds	2, 836, 455	137, 030	12, 674	446, 264
1871	59, 154 "pouds" 25 pounds	2, 129, 569	90, 468	8, 454	304, 344
1872	102, 874 "pouds"	3, 703, 464	156, 759	13, 692	492, 912

Whoever introduces dead seals as contraband articles, or clandestinely sells or buys them, pays a fine triple the amount of the tax on seal-oil.

The fishing-regulations also impose fines for illicit fishing in the sea.

Thus, for the use of floating nets there is a fine of 20 "roubles," ($14 gold,) and the fishing-implements and the fish caught are confiscated. Any person fishing in the "corridors," where fishing is prohibited, pays double the amount of an annual permit, either 100 or 240 "roubles, ($70 or $168 gold.) A person who is fined for the third time has not only to pay the fine, but is deprived for ten years of the right of fishing within the limits of the buoys. Persons using forged permits are arraigned before the criminal court. When a permit has run out, it must be delivered at the offices of the fishing-administration, and, if this is neglected, a fine of 5 "kopecks" (3½ cents) must be paid for each day of delay, till the maximum of 3 "roubles" ($2.10 gold) is reached.

The river-fisheries of the government are subdivided into a certain number of small fisheries, which are leased. This, as well as the liberty of fishing in the sea, the system of buoys, and the fixing of certain periods when fishing is prohibited, has fully proved its beneficial influence and great usefulness. Formerly, there were at Astrachan only seven houses which dealt in fish and fishing-products; at present, there are in that city about thirty large and small fishing-houses, which compete with each other, not only in the preparation of fish and the different articles prepared from them, but also in the sums they pay to their employes and laborers. Poor fishermen—and their number is very great—who have commenced with but little, have been favored by fortune, and many of them have become the independent proprietors of large fishing-boats, on which numerous laborers earn a safe and good living. The prices paid by the fishing-houses are just double that which they were formerly. The system of buoys facilitates the passage of fish into the innumerable currents which form the mouths of the Volga, so that they cannot only reach the spawning-places, but ascend as high as the fisheries located beyond Kamychine in eight districts of the Volga basin. Special officers watch zealously over the strict observance of the new fishing-regulations, and the important process of spawning can now go on without the slightest risk of being disturbed.

An improvement, which is very desirable, and which has not yet been carried out, is the total abolition, or at least a great diminution, of the tax on salt. If this were done, the fish would be better salted, and certain kinds, which now, on account of the high price of salt, are not salted at all, would become an eagerly sought-for article of commerce. The Astrachan fisheries use at present not less than 2,500,000 "pouds" (90,000,000 pounds) yearly. The duty on salt is 30 "kopecks" (21 cents) on the "poud," (36 pounds.)

6.—FISHING-IMPLEMENTS.

The implements used by the fishermen of the Caspian Sea are various kinds of nets, "palengres," hooks, and fish-gigs, which generally resemble those used in the Mediterranean, and are of ancient origin.

Stationary nets.—The nets that are in use are stationary nets floating nets, seines, and cast-nets, ("éperviers.") The fishermen and proprietors of fisheries buy the material for the nets, viz, twine, thread, small cords, cords, &c., from the Astrachan merchants, who get them from Nijni-Novgorod, Kazan, and Saratow. They use for sturgeon-fishing in the sea nets which are 12 "sagenes" (84 feet) long and 4 "arsheens" (9 feet 4 inches) deep, made of five-ply or six-ply thread, with meshes 3½ to 4 inches square, and furnished with floats and leads. These nets are laid as deep as 4 "sagenes," (28 feet.) Generally, from 20 to 40 are joined, and sometimes even as many as 80 or 100, so as to form a straight line extending several "versts." The whole line of nets is held up by bolt-ropes on a row of stakes, which are driven into the bottom of the sea. Fishing with stationary nets continues from April till the end of May, and from August till the beginning of October. During the second part of the autumn and in the winter, they are but rarely used.

For catching the great sturgeon, ("bélouga,") especially in the winter, large nets 12 "sagenes" (84 feet) long and 6 "arsheens" (14 feet) deep, are used, with meshes 8 inches square.

In the lagoons, and in the narrow channels ("yéryke") connecting them, as well as in the mouths of rivers, stationary nets are also set for catching sturgeon and different kinds of scaly fish. According to the regulations, these nets must be set in such a manner as to leave one-third of the river unobstructed. The nets for catching scaly fish are made of 3 and 4 ply threads; are likewise 12 "sagenes" (84 feet) long, but not more than 2 "arsheens" (4 feet 8 inches) broad. The meshes are of different sizes. For *Lucioperca sandra* and *Lucioperca volgensis* and *Abramis brama*, they measure 2½ inches; for other small scaly fish, 1½ inches; and for *Coregonus leucichthys*, 4 inches. In places that are not very deep, these nets are attached to poles, while in deep places they rest on stationary stakes.

Among the stationary nets must also be classed the sweep-nets made of from four to seven osier hoops of different diameter, covered with a net forming a sort of hood over them. The circle which forms the entrance, and to which the hood and the wings are attached, has a diameter of from ¾ to 1½ "sagenes," (5 feet 3 inches to 10 feet 6 inches.) The other circles, whose diameter diminishes gradually, are 1 to 1½ "arsheens" (1 foot 8 inches to 2 feet 6 inches) apart. The net extends 1½ "arsheens" (1 foot 8 inches) beyond the smallest circle forming the last bag; or, ending in a leap between the first and third circle, there is another net inside, in the shape of a funnel or truncated cone, called "straight entrance," ("goulet" in French,) whose inner opening, 4 inches broad, allows the fish to pass into the leap or bag. This entrance is kept open by means of cords. Each wing of the sweep-net is from 1½ to 3 "sagenes" (10 feet 6 inches to 21 feet) long, and the meshes are from 1½ to 2 inches square. The nets, which are fixed to poles, are placed in such a manner that the opening, like an enormous mouth, faces the fish, which are going up the river. Several sweep-nets are usually placed side by side in such a manner that their wings form sharp angles. It is strictly forbidden to obstruct the whole breadth of the river, or the whole extent of a fishing-ground with a row of sweep-nets.

These nets are generally used in the winter; while, in the summer, small sweep-nets with one wing are used, chiefly for catching "som," (*Silurus glanis.*)

Floating nets.—The use of floating nets in the sea is strictly prohibited, because during the summer-months immense schools of sturgeon leave the sea to spawn in the rivers. It has sometimes happened that sturgeon have been caught in this manner, and for want of laborers and salt have been thrown into the sea after their roe and their swimming-bladder had been taken out. Whenever the officers of the fisheries find a fisherman with floating nets in the sea, they confiscate his nets and the fish he has caught, and make him pay a fine of 25 "roubles," ($17.50 gold.)

The floating nets are from 12 to 15 "sagenes" long, (84 to 105 feet,) with meshes 4 inches square, of which 28 or 32 go to one net. The floats consist of wooden blocks one "arsheen" (2 feet 4 inches) long, cut in the shape of a spatula, and attached to cords, which are tied to the upper bolt-rope of the net, so that they can be lengthened or shortened at will, according as the school of fish keeps at a certain depth or near the surface. These nets have no lower bolt-rope and no leads. Two nets are generally tied together longitudinally, in order to double the total depth of the leap to 56 or 64 meshes. Every boat carries from 30 to 80 nets, which, bound together end to end, and thrown into the sea, form a wall of meshes several "versts" in length; and this, attached to one of the boards of the boats, is dragged along with the boat, while the latter is driven by the wind, till it extends facing the school of the advancing fish. Frequently, two boats keep the nets extended between them, and move with full sail to meet the school of fish.

In the Volga and its various branches, as also in the Ural, floating nets are used only for catching the several kinds of sturgeon. In the Térek, the "chémayà" (*Aspius clupeoïdes, Pall.*) is caught with simple floating nets, and in the Koura with silk nets. Floating nets in the shape of a bag are used in the Koura and the Volga for catching the "som," (*Silurus glanis.*)

The floating nets in the Volga have different names. For catching the "bélouga," (*Acipenser huso,*) they use the "pogonaïe" nets that are 150 "sagenes" (1,050 feet) long and from 7 to 11 "sagenes" (49 to 77 feet) broad, having meshes 6 inches square. For catch ng the sturgeon and the "sévriouga," (*Acipenser stellatus,*) they use, immediately after the ice has broken up, the "samoplavy;" and from the end of May to the middle of June, the "svintchatki;" then, immediately after the rising of the sea, which occurs in July, the "réjaki." The first-mentioned nets are 90 "sagenes" (630 feet) long and 33 meshes broad, each of which is 4½ inches square. They have no lower bolt-rope. The "svintchatky" are from 60 to 130 "sagenes" (420 to 910 feet) long, and have two leaps, one of which, the outer, is woven with large meshes of 6 inches, and the other, or inner, with meshes of an inch and a half. One of the ends of the net has a float of reeds or of wood attached to the net by means of a cord 2 "arsheens" (4 feet 8 inches) long, while the other end is attached to the boat. The fisherman who is in the boat allows himself to be driven by the current, and is careful to see that the net and the float always follow in a straight line, and at an equal distance. The fish, which throw themselves on the net, go through the great meshes of the outer leap, and then find themselves caught in the inner one. The "réjaki" are 90 "sagenes" (630 feet) long, 2 "arsheens" (4 feet 8 inches) broad, and have meshes 3½ inches square, and a lower leaded bolt-rope.

In the Volga and its several branches, fishing is prohibited from May 15 to July 15, except with "palangres," and a seine of 50 "sagenes," (350 feet,) which the fishermen drag to and fro, running about on foot in the bed of the river in places which are not very deep, thus catching small, scaly fish. The fishermen are, moreover, authorized to catch sturgeon for their own use, between the city of Tcharnoï-Yar and the sea, by means of floating-nets 90 "sagenes" (630 feet) long and 1 "sagene" (7 feet) broad. This fishing is permitted from June 15 to July 15.

The floating nets used in the Koura for catching the "chémaya" (*Aspius clupeoïdes*) have meshes 1½ inches square and are 12 "sagenes" (84 feet) long. Instead of floaters, the fishermen use hollow pumpkins. The bag nets for catching the "som" (*Silurus glanis*) have meshes 2½ inches square. The bag itself is 12 "sagenes" (84 feet) long and 5 "arsheens" (11 feet 8 inches) broad. In the Volga, these nets are used for fishing only in the spring and fall, and in the Koura, in January and February.

Seines with bags.—In the Volga and its tributaries, large seines ("eissaugues") are used, measuring from 300 to 400 "sagenes," (2,100 to 2,800 feet,) whose bag is from 6 to 12 "sagenes" (42 to 84 feet) long, with meshes one inch square. The meshes of that part of the wings which is nearest to the bag have the same dimensions, while those farther removed from it are from 1¾ to 2¼ inches in size. The wings are not of the same length. That which is cast first, the "coast-wing," as it is called, measures only 50 "sagenes," (350 feet,) while the other, which is cast so as to form a crescent, measures from 250 to 350 "sagenes," (1,750 to 2,450 feet.) The seines are used for catching *Lucioperca sandra* and *Lucioperca volgensis* and *Abramis brama*. It is no rare occurrence to take 30,000 to 40,000 fish at a single haul. From the middle of May till the beginning of July, seines are not used, because the banks of the river are overflowed and the current is exceedingly strong.

Two boats are absolutely required for this fishing; one of them, the "nevodnik," does nothing else but cast and haul in the nets; while the other, the "rybnitsa," takes the fish which have been caught to the fishing-establishment, ("vataga.") The "nevodnik" is manned by 8 or 12 fishermen, with a pilot, who directs the fishing, and has the general superintendence of the whole. On board the "rybnitsa," which has two masts and is 36 feet long, there are 7 men, one of them being a pilot. It can carry 1,000 "pouds" (36,000 pounds) of fish. A "rybnitsa" costs from 150 to 250 "roubles," ($105 to $175,) and a "nevodnik," from 100 to 200 "roubles," ($70 to $140.)

The places in the river where seine-fishing is to be carried on must have a uniform and even bottom, so that the nets can be dragged with an even movement, and may not be exposed to the danger of tearing.

According to the regulations, there can be only two seines in one and the same place, while the number of fishermen is also limited; for there must not be more than one fisherman to every 20 "sagenes" (140 feet) of net. The fishing-places must moreover be one "verst" (3,500 feet) apart. For catching the "Astrachan herring," (*Alosa pontica* and *Alosa caspica*,) the number of nets is not limited; but, according to the regulations, the meshes of the bag of the net must measure three-eighths of a "verschok," (little more than half an inch,) and those of the wing 1¼ square inches. From the 15th of April till the 15th of May, these schools of herring are so numerous that the fishermen attach a second bag to the first, then again a third one to that, and do not draw the net on shore, but take the fish out with a hand-net and throw them into the "rybnitsa."

In the sea, at a depth of from 5 to 7 feet, and especially in the spring and autumn, seines are used measuring from 300 to 400 "sagenes, (2,100 to 2,800 feet,) and the fish caught are chiefly *Lucioperca sandrà*, *Lucioperca volgensis*, and *Abramis brama*, which at this time arrive in vast schools. The wings of the seine are of equal lengths. As soon as the approach of a school of fish is announced, the "rybnitsa" casts anchor, while the "nevodnik" uses all its oars or sails going toward the school and gradually casting the nets. On board the "nevodnik," there are a pilot, six rowers, and two laborers. When the net has been cast, the "nevodnik" joins the "rybnitsa," to which one of the ends of the seine is attached, and, all hands assisting, they begin to draw the net into the "nevodnik." This last-mentioned boat is placed at a distance of one "arsheen" (2 feet 4 inches) from the "rybnitsa," to which it is joined by strong transverse sticks. The net is drawn back underneath the hull of the "rybnitsa." This must be done in an even manner, without any sudden jerks. In order to deprive the fish of every means of escape, the net is drawn in such a manner that the lower bolt-rope of the two wings slightly grazes the outside of the boat. For this purpose an iron implement is used, shaped like a heart, to the pointed end of which a long cord is attached. People fish only by daytime, and during the night the boats are drawn on shore. It is very interesting to see the fishermen go out into the sea to search for a school of fish. The experienced pilot who leads the expedition stands at the prow of the boat, constantly sounding the water with a long pole, to ascertain the presence of a school, or to see whether one is approaching. He also gives the sign as soon as he thinks the moment has come for casting the nets. Generally, the whole school is caught.

Cast net.)—These nets are chiefly used on the southwestern coast of the Caspian Sea, at Lencoran, and in the bay of Enseli. They are made of silk, and small scaly fish, and even roe, are caught with them. The cast net is a round, conical net. If taken up in the middle, it assumes the shape of a funnel, the lower opening having a diameter of 5½ "arsheens," (12 feet 10 inches;) while in the middle of the net, which forms the apex of the cone, there is a thin cord 8 "sagenes" (56 feet) long. A slack silk rope is attached to this, ending in a noose, through which the hand can be easily passed. The opening is edged with a strong bolt-rope of the thickness of a finger, which is ballasted by small leaden tubes 6 inches long and 3 inches apart. In the spaces between the leads, cords 10 inches long are attached, with one end to the bolt-rope and the other to one of the meshes of the net above the bolt-rope. Thereby, the lower portion of the net hangs in the shape of a bag below each one of these cords, and the leads gradually approach each other. This is the old cast-net with blouses, or pockets.

When the net is cast, it spreads at first like a disk at the bottom of the water; then, as soon as the cord is drawn, the vertical cords are brought nearer together, and close the opening like a purse. The net thus forms folds, and the fish, which are underneath, get entangled in the meshes. It requires a certain degree of skill to cast the net. It is done in the following manner: The fisherman puts his left wrist in the noose, holds a portion of the net gathered in his left hand, and with his teeth takes hold of the cord with the leads. At the same time he gathers on his right arm about one-third of the extent of the net forming its opening, in such a manner as to let the end hang below the arm, while the remainder hangs down in front of his body. In this position, he seizes with his right hand the cord with the leads, describes a semicircle toward the left to give force to his throw, then turns quickly to the right, and, slackening the cord which he holds between his teeth, casts the net into the water with all his strength. The cord, weighted down by the leads, immediately sinks to the bottom, and the net, completely extended, catches the fish which are below. In order to draw it back, the fisherman lifts the net gradually by means of the cord, whose end he has not slackened, turning alternately to the right and to the left in order to bring the leads together more easily, and winds up by drawing in the whole net as rapidly as possible.

In order to attract the fish, small glittering stones, or little clay-balls, baited with worms, are thrown into the water. Fishing with the cast-net is only carried on during the night, and an even bottom, without stones or trunks of trees, is absolutely required.

"Palangres," cable-lines, (cablières,) and bottom-lines.—The cords, thread, and twine required for manufacturing the "palangres" are made in the villages and in some cities of the districts of Nijni-Novgorod and Saratow, whence they are sent to Astrachan. The hooks are made of wire and are barbed. These hooks are only used for the different species of sturgeon. A thousand of these hooks for fishing in the sea cost, if they weigh 3 "pouds," (108 pounds,) 17 "roubles," ($11.90 gold;") those weighing 2½ "pouds" (90 pounds) to the thousand, cost 12 "roubles," ($8.40 gold;) while the third kind, weighing 1½ "pouds" (54 pounds) to the thousand, generally cost only 7 "roubles," ($4.90 gold.) In the rivers, hooks are used weighing 1½ "pouds," (54 pounds,) 1 "poud" 10 pounds, (46 pounds,) or 1 "poud," (36 pounds,) to the thousand; costing, respectively, 5 "roubles" 15 "kopecks," ($3.60½ gold;) 4 "roubles" 60 "kopecks," ($3.22 gold;) and 4 "roubles" 40 "kopecks," ($3.08 gold.)

A "bottom-line" is a cord of the thickness of a finger and 20 "sagenes" (140 feet) long, to which pieces of whip-cord are attached about as thick as a quill, 12 inches apart, and furnished with hooks. The floats are of wood, 5 inches long and 2 inches broad. They are attached to the line, the distance between them being equal to that from the end to the fifth or sixth piece of whip-cord, making from twelve to fifteen floats to a line of 10 "sagenes," (70 feet.) From ten to fifteen of these lines are usually tied together and placed at a depth of 3 "sagenes" (21 feet) or more. They are kept in position by means of cords attached to stationary poles. In very deep places, anchors are substituted for the poles. In the summer, they are only left in the water one week, while in the other seasons they remain there two weeks. They are examined every day, and the sturgeons that have been caught on the hooks are taken off. They are placed in the sea in a straight line, and extend several "versts." The sturgeons approach "these palangres," and, anxious to pass through the free spaces between the pieces of whip-cord, are caught by the hooks, and the more efforts they make to disengage themselves the more do they bring the water in motion, and a larger number of hooks enter their body.

The "bottom-line" used in the Volga for catching the "sterljad" (*Acipenser ruthenus*) has usually 200 hooks, attached to pieces of whip-cord 11 inches long, and 15 inches apart, on the main line, which is 60 "sagenes" (420 feet) long. The hooks are made of wire, and a thousand of them weigh only 5½ pounds.

The "bélouga" (*Acipenser huso*) is caught in the sea with "palengres" at a depth of from 70 to 100 "sagenes," (490 to 700 feet,) the line having a diameter of half an inch and a length of 70 "sagenes." The hooks are attached to pieces of whip-cord, 1½ "sagenes" (10½ feet) long, and are much larger, stronger, and thicker than those used for catching the common sturgeon. A thousand of them weigh 3 "pouds," (108 pounds.) These hooks are baited with small, living, scaly fish, known by the name of "taranes," (a local name for bait fishes of several kinds of *Alosa*, *Abramis*, *Leuciscus*, and *Cyprinus*,) which are caught in the Volga immediately after the ice breaks up. In order to keep these small fish alive, the fishing-boat, which has sails, and is called "kouzovaya lodka," contains a large perforated box, which, by means of pumps, is constantly kept supplied with fresh water. When the fishermen have exhausted their stock of bait, they return to Astrachan. While the fishing is going on, the livers and the caviar of the "bélouga" are being prepared on board the boat.

Spinning-lines and other implements with hooks.—The "bélouga" (*Acipenser huso*) is caught under the ice in the sea by means of large perforated hooks of forged iron, baited with seal-fat. The hook is attached to a thick cord 30 "sagenes" (210 feet) long, only half of which is placed in the water, while the other half is rolled up at the edge of a hole which has been made in the ice. The other end of the line is attached to a strong piece of wood placed across the hole, and the middle of this line is tied to it with a thin thread, which tears as soon as a sturgeon has bitten, so that the remaining portion of the line unrolls and glides under the ice.

For catching the *Silurus glanis* in June and July, hooks are likewise used, baited with living frogs. The following is the method: The fishing boat is manned by two men. One rows and the other throws the line, which is attached to a rectangular wooden lever; at the same time he beats the water with a sort of shovel formed by a small piece of plank, which is slightly concave, and which is attached to a handle. This plank produces a peculiar noise, which attracts the *Silurus*, and, seeing the frog, it seizes it, and finds itself caught.

The *Coregonus leucichthys* is caught by means of the "blesnà," which consists of perforated hooks with a long shaft bearing a little tin fish, or a flat piece of tin shaped like a fish. Scales of the *Cyprinus carpio*, whose sparkling attracts the fish, are pasted on the flat part of the hook.

The Ural Cossacks use large steel hooks, sharply pointed and barbed, for catching the sturgeon under the ice. The line is attached to the thin end of a rod, whose length is in proportion to the depth of the river. Frequently, several poles are tied together; in order that the hook may descend vertically into the water, and may not be carried away by the current, leads are attached to the rod a little below the hook. Small poles are held in the hand, but generally they are evenly balanced on a tripod of wooden blocks or poles, at a convenient distance from the hole in the ice. Near this hole, an arch of osiers is stuck in the ice, to which the automatic apparatus is attached, by which, through a wooden pin, the line is kept in the position which is required for this kind of fishing—the thin end of the pole near the arch on the ice—and the hook at the desired depth. Whenever a fish seizes the hook, the pin is pulled out, the rod again becomes straight through the weight of its heavy part, and so pulls the fish out. Camps, "sidebki," of from 100 to 1,000 of these automatic arrangements may be seen every year on the ice of the Volga.

practical implement for freeing the nets of rubbish, which they invariably bring up with them from the water. It requires some skill and practice to use this tool, but it cleans the nets much better than any other used for that purpose. Strange enough, this useful implement is scarcely known outside of Snekkersteen and Skotterup.

43. *A net for catching porpoises.*—This is but seldom used, and there is only one such in the two fishing villages. Most fishes of the flounder kind are caught in "small nets," but the halibut proves too large for these. This fish is therefore caught with special halibut-hooks, (called "bagger" in Danish,) or with lines. All along the sound, nearer the Swedish than the Danish coast, there is found a very considerable depression of the bottom of the sea. From Helingsborg, the Swedish town opposite Elsinore, the fishermen call this great deep "*Skraepperne.*" This seems to be the favorite resort of the halibut. In summer one may also find there large haddocks and skates. The fishing in these waters pays very well, and most of the fish caught here are brought to the Copenhagen market.

44. *A number of halibut-hooks.*

45. *A halibut-line.*

46. *Different specimens of haddock-catchers,* (*Danish,* "*torskepilk.*")—In fishing in the "Skraepperne" the fishermen are often obliged to make use of this instrument for want of bait, but it is not a favorite with them.

47. *A flounder-net,* ready to be cast out, or, as the Danish technical term has it, to be "stoned." By holding the split peg with one hand, and throwing out the stones with the other, the net is laid without much trouble, and, sinking to the bottom, places itself in position.

48. *A buoy*; a so-called herring-buoy.

49. *A grapple,* or *anchor.*

50. *A claw.*—These are of many different sizes, and are sometimes used as anchors, but more frequently to search the bottom of the sea for nets and other objects that have been lost.

51. *A fisher-buoy.*—In the sound, where the shipping, the current, and large masses of seaweeds all prove injurious to the buoys, this kind, simple as it looks, has proved the most effectual in diminishing all these causes of injury.

52. *A net-trough.*

53. *A hundred claws,* "baggers," ready for being cast out.

54. *A hundred cleft claws,* hung up for drying. Of these the two fishing villages possess an endless number.

55. *An eel-iron.*—A sort of spear for spearing eel, which, however, is but seldom used.

56, 57, and 58. *Different kinds of caufs.*

59. *Tools for manufacturing nets.*

60. *Apparatus for weighing eels.*

61. *A catcher.*

fish are thrown on to it with boat-hooks. An inspector receives, counts, and registers all the fish which each fisherman delivers. The various kinds of sturgeon—the "red fish," or the "fish proper," as it is called—are measured from the middle of the eye to the caudal fin; for the fishermen receive more or less pay according to the different lengths of the fish. The scale of prices, according to the length of the fish, is nearly the same in all the "vatagas" of the Astrachan district.

Four different lengths are fixed for the "bélouga," (*Acipenser Huso,*) 3 "arsheens," (7 feet,) and over; 1 "arsheen" 10 "vershocks" to 3 "arsheens," (3 feet 9½ inches to 7 feet;) 1 "arsheen" 4 "vershocks" to 1 "arsheen" 10 "vershocks," (2 feet 11 inches to 3 feet 9½ inches;) and 1 "arsheen" to 1 "arsheen" 4 "vershocks," (2 feet 4 inches to 2 feet 11 inches.)

The common sturgeon should measure 1 "arsheen" to 1 "arsheen" 6 "vershocks," (2 feet 4 inches to 3 feet 2½ inches;) the "sévriouga," (*Acipenser stellatus,*) and the "chyp," (*Acipenser Schypa,*) from ¾ "arsheen" to 1 "arsheen" 1 "vershock," (1 foot 9 inches to 2 feet 5⅜ inches;) the "sterliad," (*Acipenser ruthenus,*) from 4 to 7 "vershocks," (7 inches to 12¼ inches;) the "som," (*Silurus glanis,*) from 1 "arsheen" to 1¼ "arsheens," (2 feet 4 inches to 2 feet 11 inches;) and the "sazàne," (*Cyprinus carpio,*) from 8 to 12 "vershocks," (1 foot 1¼ inches to 1 foot 9 inches) and over.

The "soudak," (*Lucioperca sandra;*) the "bersche," (*Lucioperca volgenis;*) the "lestche," (*Abramis brama;*) the "béschenka," (*Alosa pontica;*) the "jeleznitsa," (*Alosa caspica,*) while other scaly fish are not measured, but counted.

After the fish have been delivered, they are cut, and the entrails taken out. For all this work, there are special laborers, who display an almost incredible amount of skill and rapidity, and who receive wages which are fixed beforehand by free contract.

The head and tail of the large sturgeons are cut off, and the belly is removed from the pectoral air-bladder to the tail. The belly of the smaller "bélouga" and the common sturgeon is opened, and the head is split as far as the nasal cartilage. The "sévriougas" (*Acipenser stellatus*) are split into two halves, and the entrails thrown away. The roe, the swimming-bladder, and the dorsal cord, however, are carefully taken out. These parts of the fish are handed to other laborers whose special occupation is the manufacture of caviar and isinglass, which is carried on in separate buildings. Laborers engaged in the manufacture of caviar receive the highest annual wages.

A large number of young girls and women are occupied in cutting the fish. They all wear a peculiar working-dress, consisting of breeches and a jacket; their head and half their body being covered. A sharp knife in one hand, and a little hook in the other, the working-woman begins her labor. Crouched with crossed legs on a straight bench, she picks up a fish with her hook, opens its belly, takes out the entrails, and throws the fish into a corner, where a large heap is soon piled up. During this time, other women are splitting and cutting the fish with no less skill, and stringing them on threads made of the fiber of the bark of the linden-tree, which they pass through the eyes of the fish by means of a large needle. The skill and rapidity of these women are truly admirable. Enormous piles of fish which encumbered the floor disappear in a few hours, and pass to another building to be salted. A skillful woman can dress as many as 2,000 *Lucioperca* during a single day.

The building in which the scaly fish are salted has a long shape, usually several doors, and contains tubs and wooden boxes of different sizes. A box 3 "arsheens" (7 feet) deep 4 "arsheens" (9 feet 6 inches) broad, and 8 "arsheens" (18 feet 8 inches) long, can hold 100,000 *Alosa* or 45,000 *Abramis* or 30,000 *Lucioperca* or 2,000 "pouds" (72,000 pounds) of sturgeon of different kinds. The tubs have generally a diameter of 4½ "arsheens," (10 feet 6 inches,) and a depth of 3½ "arsheens," (8 feet 2 inches,) and can hold 45,000 *Alosa* or 20,000 *Abramis*. The number of tubs and boxes varies according to the locality. Thus, the "vataga" (fishing-establishment) of Pétropovlovsk, fifty "versts" (about twenty-seven miles) above Astrachan, on the banks of the Volga, has four large cellars, each holding from 30 to 40 large boxes, destined chiefly for salting the various kinds of *Alosa*.

The so-called "cold cellars" are particularly grand; here blocks of ice are piled up behind a wooden lattice, leaving a space of 1½ "sagenes" (10 feet 6 inches) free along the walls of the cellar. Entering a salting-cellar through the large door, one sees first the rooms where salt is pulverized by machines; then the cellar itself, in which there is a long floored corridor, running between high and strong wooden pillars. To the right and left of this "corridor," the boxes are ranged side by side. The roof, which rests on numerous pillars, has sky-lights which give sufficient light for the whole cellar. In the roof, there is also a large opening, from which an inclined plane, made of planks, leads into the cellar. On this inclined plane, the "bélougas" and large sturgeons are easily let down into the cellar. Several ventilators keep the air constantly pure.

8.—PREPARING THE FISH AND ITS SEVERAL PARTS.

Salting.—After having been dressed, the fish are, under the superintendence of the salter, placed in layers in the boxes above mentioned in such a manner that the heads and tails alternate. The salter then throws, with a shovel, the necessary quantity of salt on every layer of fish; the quantity of salt varying according to the kind of fish, and according to the season. In the Astrachan "vatagas," (fishing-establishments,) it is customary to take from 27 to 30 "pouds" (972 to 1,080 pounds) of salt in the spring, and from 18 to 20 "pouds" (648 to 720 pounds) in the autumn to every 1,000 *Lucioperca*; from 7 to 9 "pouds" (252 to 324 pounds) in the spring, and from 4 to 6 "pouds" (144 to 216 pounds) in the autumn, to every 1,000 *Abramis*, *Perca fluviatilis*, and *Aspius rapax;* and, on an average, 10 "pouds," (360 pounds,) to 1,000 *Alosa*. A thousand small *Cyprinus carpio*, L., require from 15 to 18 "pouds" (540 to 618 pounds) of salt.

A thousand fresh fish have the following average weight: *Cyprinus carpio*, L., 120 "pouds," (4,320 pounds;) *Lucioperca sandra* and *Esox lucius*, 100 "pouds," (3,600 pounds;) *Lucioperca volgensis*, 55 "pouds," (1,980 pounds;) *Abramis brama* and *Aspius rapax*, 50 "pouds," (1,800 pounds;) *Perca fluviatilis*, 35 "pouds," (1,290 pounds;) *Scardinius erythrophthalmus*, L., 32 "pouds," (1,152 pounds;) and the various kinds of *Alosa*, from 20 to 25 "pouds," (720 to 900 pounds.)

The differents kinds of sturgeon and the *Silurus* require from 12 to 13 pounds of salt to every "poud" (36 pounds) of fish; and the large *Cyprinus carpio*, L., the *Salmo salar*, and the *Coregonus leucichhys*, Güldenst., 12½ pounds to every "poud" of fish, (36 pounds.)

In the autumn, the back, and not the belly, of the scaly fish is split open, so as to let the salt saturate more thoroughly.

The fish remain a longer or shorter time in the box according to the different species: *Lucioperca*, one month; *Cyprinus carpio*, L., 6 days; *Silurus*, till autumn; *Abramis*, 12 days; the different kinds of *Alosa* till the month of June. The brine of the *Lucioperca* is again used for salting the *Abramis* or the *Leuciscus rutilus*, while the brine of the other scaly fish is thrown away.

In the spring, the fish are taken from the boxes, washed, and dried on poles. This is done particularly with the *Lucioperca*, the *Abramis*, and the *Leuciscus rutilus*, L.; while the *Cyprinus carpio* is dried on hurdles made of reeds. The drying process being completed, the fish are taken from the poles, or from the hurdles, laid up in warehouses, and in July shipped by steamer to Nijni-Novgorod. In September, large boats arrive at the "vatagas," (fishing-establishments,) where they buy the fish on the spot, being salted before they are shipped.

The so-called herring, *Alosa caspica*, is not dressed, but is salted as it is. Up to the years 1854 and 1855, the Astrachan herring were only used for extracting the oil from them. Even poor people, frightened by its name, "beschenka," (the furious fish,) hesitated to use it for food. It is owing to the efforts of the committee appointed for examining the fisheries under the direction of Mr. Baer that several lessees of the fisheries finally consented to salt the "beschenka" and the "jéleznitsa" under the name of "herring." From that time, the Astrachan herring, as a salt fish, has become more and more an article of commerce, while the extraction of oil from it has diminished in proportion. Thus, there were salted in the river-waters of Astrachan, in 1858, 43,000,000 of this fish, while the number rose to 140,000,000 in 1871, and to 160,000,000 in 1872; while during the same year, 1872, only 30,000 herring were used in the manufacture of oil.

The "bélouga," (*Acipenser huso*,) and the "sévriouga," (*Acipenser* *stellatus*,) taken in the spring, remain for six months in the boxes, till the salting and hardening process is complete. Afterward they are taken out, dried superficially, and packed in casks.

Those kinds of sturgeon which are caught from spring till the middle of July are transported, during September and October, on wagons to the Saratov fair; while the fish of this kind caught between the 8th of July and the 15th of August are shipped the following spring to Nijni-Novgorod on large boats, which are towed by steamers.

The sturgeon caught in the district of Emba, the northeastern basin of the sea, are salted on board of large fishing-boats called "koujovaya."

The fish, having been dressed, are usually laid in brine for two days, and then they are placed in layers at the bottom of the boat, each layer being covered with salt.

The fishermen return from their fishing-expeditions on the sea to Astrachan at the end of June, and keep the fish they have caught in warehouses till a transport starts for Nijni-Novgorod.

The sturgeons caught from the 15th of August till the first frost are preserved in the wells (boxes in the hold of the vessel filled with fresh water and used for keeping fish) in order to be shipped at a later time.

Manufacture of caviar.—Two sorts of caviar are manufactured, fresh or grained caviar, and hard or pressed caviar. In both cases, the roe of the several kinds of sturgeon is spread out on a net with narrow meshes forming a sieve, and stretched over a wooden frame; then the grains are passed through the meshes by slightly pressing the whole mass till nothing remains on the sieve but the cellular tissue, the fat, and the muscle. The grains, which are black or brown, fall through the sieve into a wooden receptacle placed underneath. For manufacturing grained caviar, the roe is sprinkled with very clean and fine salt, and the whole mass is stirred with a wooden fork having eight or ten prongs. The quantity of salt required varies, according to the season, from 5 to $1\frac{3}{4}$ pounds; in August they take from 3 to 5 pounds of salt to 1 "poud" (36 pounds) of roe, and from $2\frac{1}{2}$ to $1\frac{3}{4}$ in winter. The less the fresh caviar is salted the more it is esteemed. The roe mixed with the salt presents at first a doughy appearance when it is stirred; but when every grain has been impregnated with salt, the whole mass swells, and in stirring it a slight noise is perceptible like that of stirring small grains of glass. This noise is the sign that the caviar is ready. Then it is packed in casks made of lindenwood, which does not impart any bad flavor to it, while this is not the case with casks made of other wood.

For manufacturing pressed caviar, a tub half filled with brine is placed under the sieve; the brine being stronger or weaker, according to the temperature and the season. To impregnate the grains evenly with brine, the whole mass is stirred with a wooden fork, always turning it from the same side; then the grains are taken out with fine sieves, and after the whole brine has been drained, 3 "pouds" (108 pounds) of grains are put in a sack made of the bark of the linden, which is placed under the press in order to get all the brine out of the caviar, and to transform it to a solid mass. In thus pressing the caviar, a large number of grains are crushed, and a portion of their contents flows out with the brine, so that on every "poud" (36 pounds) there is a loss of from 10 to 12 pounds. After having taken the pressed caviar from the sacks, it is packed in casks containing 30 "pouds" (1,080 pounds) each, the inside of which is covered with napkin-linen, this being the reason why the caviar is also called "napkin-caviar," (*caviar à la serviette.*)

The finest quality of pressed caviar, that which has been least pressed and salted, is placed in straight linen bags of a cylindrical shape, and is then called "sack-caviar," (*caviar à sac.*) Caviar is also shipped in tin boxes hermetically closed and soldered.

Fresh caviar is always preferred to pressed caviar, and also costs more. At Astrachan, fresh caviar costs from 30 to 35 "roubles" ($21 to $24.50 gold) the "poud," (36 pounds,) while the pressed caviar only costs 24 "roubles," ($16.80 gold.) It is infinitely more advantageous to manufacture grained caviar than hard caviar, because the former pays better, requires less salt and less trouble, and there is scarcely any loss on it.

Every year about 11,000 "pouds" (396,000 pounds) of caviar are sent abroad from Astrachan, especially to Berlin, to Dresden, and to Vienna. This caviar is bought by contract from the proprietors of the fisheries, who either get it from their own fisheries or from fishermen hired by them for this purpose, and who prepare the caviar on their own boats while fishing on the sea. There are in the "vatagas" (fishing-establishments) special laborers for manufacturing caviar, who receive an annual salary of 300, 400, and even 600 "roubles," ($210, $280, to $420 gold,) besides board, lodging, fuel, and light.

In trade, the caviar of the "bélouga" (*Acipenser huso*) is esteemed more highly than that of the common sturgeon, (*Acipenser Guldenstädtii,*) or of the "sévriouga," (*Acipenser stellatus,*) because its grains are larger and better looking. The most savory of all caviars is the small grained caviar of the "sterliad," (*Acipenser ruthenus,*) but it does not form an article of commerce.

All the different kinds of sturgeon have not equally fat roe. This depends both on the good quality of the fish and on the season when it has been caught. The fattest caviar is that made, during the hot season, from the roe of those kinds of sturgeons which are caught in the sea between the 8th of July and the 15th of August. This roe is left only a few hours in the brine, and then taken out and packed, without being pressed, in casks holding from 5 to 10 "pouds" (180 to 360 pounds) each.

If the roe is tender to the touch in the ovaries, and is already spoiled, roe and ovaries are thrown into the brine till they are thoroughly impregnated with salt. This is then caviar of the worst quality, and is shipped in casks holding from 27 to 30 "pouds," (972 to 1,080 pounds.) This quality is worth only from 3 to 4 "roubles" ($2.10 to $2.80 gold) the "poud," (36 pounds.) The kind called "summer-caviar," however, sells at from 6 to 9 "roubles," ($4.20 to $6.30 gold.)

The milt of the "bélouga" (*Acipenser huso*) and of the common sturgeon (*Acipenser Guldenstädtii*) is left from three to four days in the brine, and then shipped in barrels. The milt of a "bélouga" of medium size often weighs 27 pounds, and that of the common sturgeon 12 pounds.

The roe of the "lestche," (*Abramis brama*,) of the "soudàk," (*Lucio perca sandra*,) and of the "vobla," (*Leuciscus rutilus*, L.,) is also used for making a kind of caviar which is chiefly sent to Constantinople and to Greece. Greek merchants come to Astrachan, buy the roe of these fish at the "vatagas" (fishing-establishments,) and there prepare the caviar themselves. They draw from the body of the fish the little bags which contain the roe, throw them together promiscuously, and cover each layer with a certain quantity of salt. They then press the whole between boards weighted down by heavy stones. This caviar remains thus for a month, after which the Greeks put it in casks and ship it. Caviar which has been thus prepared is cut in slices shaped like disks, and is much sought after in Greece.

Manufacture of isinglass.—The bladder of fish, which is known in trade by the name of "feuille d'esturgeon" in French, "Hausenblase" in German, and "isinglass" in English, is extracted from the inner side of the swimming-bladder, not only of the "bélouga," but also of other kinds of sturgeon, as likewise of the *Silurus glanis* and of the *Cyprinus carpio*. It is true that the large sturgeon yields the greatest quantity of bladder, but the best is that of the common sturgeon, (*Acipenser Guldenstädtii*,) while the most inferior quality is that which comes from the *Silurus*. Good isinglass must be pure, white, shining, half-transparent, dry, and horny, without taste, but not without some perfume. Good fish-bladder dissolves in water heated to 30 or 40 degrees Réaumur (about 100 to 122 degrees Fahrenheit) without leaving any residue, and when it grows cold it becomes a transparent and almost colorless gelatine.

The fish-bladder is mostly prepared by young boys, superintended by experienced laborers. First, the swimming bladder of the fish is thrown into the water, where it is left for several days; the water being frequently changed, in order to detach all the fatty and bloody particles from the bladder. The hotter the water the quicker is this done. The bladders are then taken out, and cut lengthwise into strips, which are exposed to the sun and air. These strips, or leaves, are usually spread out, in order to dry them, with their outer side on small boards of lindenwood; the inner side is formed by leaves (*lamellæ*) of pure isinglass, which, after having been well dried, are carefully detached from the outer side. The leaves of isinglass thus obtained are laid between pieces of linen, to preserve them from the flies and from dust; then they are placed under a press, so that they may not become warped, but may form smooth cakes. It is only after all these different operations have been performed that the laborer proceeds to pick the leaves and tie them in bundles. These bundles of isinglass, produced from the large sturgeon, are usually composed of from ten to fifteen leaves, and weigh 1¼ pounds each; while those of the common sturgeon, or of the "sévriouga," contain twenty-five leaves, and weigh one pound each. Generally, eighty of these bundles are sewed up in a linen bag; they are also made up into small bales, covered with rush mats or with linen, and are then shipped, after being securely headed.

The "poud" (36 pounds) of "sturgeon-leaf" costs in Astrachan from 120 to 180 "roubles," ($84 to $126 gold.)

The swimming-bladder, deprived of its inner skin, that is, of the inner shining cuticle of which isinglass is made, as described above, still contains a certain quantity of glue, which is moistened with water, and then removed by scraping it with a knife; this is also moistened with water, and then kneaded. This mass is molded into small round tablets of the size of a dollar, which are dried. This kind of fish-glue is shipped in sacks, and costs less than the isinglass in leaves.

The leaves of the glue from the *Silurus* are arranged in book-form, and are dried on thin cords. They are shipped in bags containing 4 "pouds" (144 pounds) each. The glue gained from the *Cyprinus carpio* is also in leaves, arranged in packages of 30 each.

Some persons at Astrachan have manufactured good fish-glue from the scales of fish. Even at this day there lives in the Cossack village of Samyani, 60 "versts" (about 34½ miles) above Astrachan, a surgeon named Sokologorski, who, from the scales of the *Alosa*, extracts glue in thin and transparent leaves. According to his account, two pounds of this glue are as good as one "poud" (36 pounds) of sturgeon-glue. Unfortunately, he has not the necessary means to enable him to place any considerable quantity of his manufactures in the market.

Formerly, the shining cuticle of the swimming-bladder was dried, and cut into long, straight strips, which were tied alternately together, one by the side of the other and one on the top of the other. These strips thus tied were then laid in water to become soft, and afterward pressed to let the water run off. This matter was then molded into different figures, such as horseshoes, lyres, hearts, cylinders, &c. Small wooden bolts kept these figures in their original shape till they were completely dry. The Ural Cossacks, even to this day, make "glue hearts," which they put up in packages of 42. It requires 1,500 "glue lyres" to make one "poud," (36 pounds,) and from 7,000 to 10,000 "glue horseshoes" to make the same weight.

Isinglass is used for clarifying various liquids, for making fine glue-colors, for giving a gloss and finish to textile fabrics, for making plasters, for taking the impress of coins, and finally in the kitchen for making jellies.

Manufacture of "véziga."—"Véziga" is the name given to the dried dorsal cord of various kinds of sturgeon. After the entrails, the roe, and the swimming-bladder have been taken out of the fish, a small incision is made in the flesh, and, the finger being inserted, the dorsal cord is drawn out. This cord has the shape of a long and straight ribbon. It is carefully washed, and pressed, so that the soft matter which it contains oozes out, after which it is dried during from three to eight days, according to the season. When the "véziga" is entirely dry, it is put up in packages, fifty of which form a bale weighing one "poud," (36 pounds.) A package of "véziga" of the "bélouga" (*Acipenser huso*) contains twelve dried dorsal cords, while there are twenty in a package of "véziga" of the *Acipenser Guldenstädtii*, the *Acipenser stellatus*, and the *Acipenser schypa.* A thousand "bélougas" of medium size generally produce 5 "pouds" (180 pounds) of "véziga;" but the same number of common sturgeon, (*Acipenser Guldenstädtii*,) and of *Acipenser stellatus*, yield only 1 "poud," (36 pounds.) When the "véziga" is boiled, it rises, and in this condition it is cut into small pieces, which form an important ingredient in excellent little fish-pies. The "véziga" is not used for anything else. It costs from 15 to 20 "roubles" ($10.50 to $14 gold) a "poud," (36 pounds.)

Manufacture of "balyk."—The Tartar word "balyk" means "fish," and is used in Russian for the backs of sturgeons which have been slightly salted and then dried in the sun. For making good "balyk," a large and tolerably fat fish is selected, whose head, tail, sides, and belly are taken off. That which remains, the dorsal part, has to undergo a special salting, while the other parts are salted in the usual manner. The back of the common sturgeon (*Acipenser Guldenstädtii*) and of the "sévriouga" (*Acipenser stellatus*) remain entire, while those of the large sturgeon (*Acipenser Huso*) are cut, either lengthwise only, or else both lengthwise and crosswise. The pieces are placed in a tub so as not to touch each other nor the sides of the tub; and they are left thus after having been covered with a thick layer of salt from nine to twelve days, and even fifteen days when the pieces are large and the weather is hot. The salt is mixed with a little saltpeter, to give to the "balyk" a reddish color, (2 pounds of saltpeter to 50 "pouds" (1,800 pounds) of "balyk.") Allspice, cloves, and bay-leaves are frequently put into the brine. When the salting is finished, the "balyk" is put into water for a day or two, in order to detach all particles of the brine from it. Thereupon it is dried, first in the sun and then in the shade, on roofed scaffoldings, which are erected for the purpose. This last-mentioned operation requires from four to six weeks, and is considered finished when the "balyk" begins to cover with a slight mold, the absence of which shows that it has been salted too much.

Good "balyk" must be as soft and tender as smoked salmon; must have a reddish or orange-brown color; and must have an odor something like that of the cucumber; it must also be transparent, show no traces of putrefaction, nor have a bitter taste; and, finally, it must not be too salty. There are very few manufacturers who can prepare "balyk" that has all these qualities. A "poud" (36 pounds) of good "balyk" costs at the manufactory at least 18 "roubles," ($12.60 gold,) and at retail it can seldom be bought for less than 1 "rouble" (70 cents gold) a pound. The "balyk" made in March is considered the best.

On the banks of the Koura, and in the trans-Caucasian waters, where the "sévriouga" (*Acipenser stellatus*) is caught in large numbers, "balyk" is made of at least 300,000 of these fish every year. This "balyk," commonly called "djirim," is not of the first quality. It is dry, very salty, and is much sought after by the inhabitants of Kachetia, because it produces thirst and gives them occasion to quench it with the excellent production of their vineyards.

A large sturgeon of 20 "pouds" (720 pounds) yields 5 "pouds" (180 pounds) of "balyk;" a very large "sévriouga," 15 pounds; a common-sized "sévriouga," 4 pounds; and the common sturgeon, from 8 to 12 pounds.

Manufacture of oil.—Oil is extracted either from the fat which incloses the entrails of the sturgeon and the *Lucioperca*, or from the whole body of the Astrachan herring, (*Alosa pontica* and *Alosa caspica*.) In the first case, the fat is taken out, washed, and cut into pieces, which are thrown into a tub, with from 10 to 15 pounds of salt for the whole mass. The whole is then well shaken in a caldron, and placed on the fire; this caldron being put inside a larger copper caldron, in which the water is boiled, thus causing the fat in the inner caldron to melt. When the oil swims on the surface, it is skimmed off and poured into oakwood barrels. This oil is pure and has a light-yellow color. It is used for cooking-purposes, and for softening caviar when it has become too dry.

Oil was made from Astrachan herring on a very large scale till the year 1854, when people commenced to salt this fish. Other scaly fish, even the "sterliad," (*Acipenser ruthenus*,) were used for making oil. The period from April 15 to May 5, fixed for this manufacture, was scarcely ever observed. This period is still considered the legal period for the "vatagas" (fishing-establishments) located below Astrachan; while for those above this city, the time for making oil is between April 20 and May 10. Any person taken in the manufacture of oil before or after this period has to pay a fine of 25 "roubles" ($17.50 gold) for every day beyond the legal period.

The manufacture of oil is carried on in the open air. The *Alosa* are piled up in casks and tubs, and are constantly moistened with boiling water till the oil separates and swims on the surface. The oil is poured into barrels, and sold at from 2 "roubles" 75 "kopecks" ($1.92½ gold) to 3 "roubles" 25 "kopecks" ($2.27½ gold) a "poud," (36 pounds.) It is used in soap-factories and in tanneries; it is also burned in lamps and used in making oil varnish.

The residue must be buried in the ground, and it is strictly forbidden to throw it into the water. Any violation of this regulation is punished with a fine of 100 "roubles," ($70 gold.)

Since the year 1870, people have commenced, although it is properly not allowed, to make oil of lampreys, (*Petromyzon fluviatilis*,) which, in December and January, appear in great numbers in the Volga above Astrachan. These fish yield no less than 8 pounds of oil per thousand fish; and this oil, which costs 3 "roubles" ($2.10) a "poud," (36 pounds,) is pure and clear, although containing a good deal of glue. It is not probable that this industry will develop much; for several "vatágas" (fishing-establishments) have already begun to pickle the lamprey, which forms in this shape a very savory dish. Thus, in October last, a merchant of Tchornoï-Yar, Sabourow by name, sent to St. Petersburg for experienced laborers to pickle 3,000 "pouds" (108,000 pounds) of lamprey. A thousand lampreys weigh not less than 140 pounds.

9.—MARKET-PRICE OF FISH AND THEIR PRODUCTS.

Table of the market-prices since the year 1866, when fishing in the sea was declared perfectly free.

	PER "POUD," 36 POUNDS.									
	From July 1, 1866, to July 1, 1867.		From July 1, 1867, to July 1, 1868.		From July 1, 1868, to July 1, 1869.		From July 1, 1869, to July 1, 1870.		From July 1, 1870, to July 1, 1871.	
Acipenser huso	$1 33	to $1 57½	$1 47	to $1 50½	$1 61		$1 61	to 1 92½	$2 38	
Acipenser Guldenstädtii of 3′ 6″	1 57½	2 06½	1 57½	2 03	1 57½	to $2 03	2 38	2 45	3 08	
Of 2′ 4″	1 01½	1 54	1 47	1 50½	1 01½	1 50½	2 10	2 31	2 87	
Acipenser stellatus of 2′ 4″	1 29½	1 82	1 29½	1 68	1 29½	2 75	1 92½	2 03	2 73	
Less than 2′ 4″	73½	98	91	1 08½	1 08½		1 71½	1 82	2 52	
Acipenser schypa	1 33	1 57½	1 47	1 50½	1 50½		1 78½	1 89½	2 38	
Silurus glanis of 3′ 6″	1 12		1 12		1 12		1 26	1 68	1 26	to $1 54
Of 2′ 4″	63		63		63		70	98	63	84
Coregonus leucichthys	1 22½		1 40		70	1 75	1 75	2 80	1 75	2 45
Acipenser ruthenus	....	....	87½		1 15½		1 75		1 75	
Cyprinus carpio, dried	70		77		....	....	94½	1 05	1 05	
Salt	35		63		....	....	5-½	59½	49	59½
Tinca vulgaris and *Perca fluviatilis*	28		28		28		35		35	
Esox lucius, salt	80½	84	45½	59½	38½		84		91	
Heads of *Acipenser huso*, salt	70		77		77		1 05		1 22½	
Belly of *Acipenser huso*	2 45	2 80	2 45	2 80	2 80		2 80	3 32½	3 15	3 85
Caviar, pressed	8 75	12 60	8 75	12 60	8 05	14 00	9 80	15 40	10 50	15 40
Made in summer	4 55		4 20		4 20		6 30		5 60	
Inferior quality	2 80		2 35		2 35		3 15		2 75	
Fresh caviar of *Acipenser huso*	11 40	17 50	11 20	17 50	11 40	18 20	11 20	19 60	11 90	19 60
Of *Acipenser Guldenstädtii*	8 92½	12 60	8 92½	11 20	8 40	9 80	11 20		7 70	11 20
Milt of sturgeon	35		70		1 05		1 05		1 05	
Oil	1 75		1 47	1 96	1 47	1 68	1 54	2 17	1 92½	2 27½
Abramis brama	56		56	59½	63		77		91	
Lucioperca volgensis	24½		24½		24½		24½		35	
Seals	1 33		84		91		1 40		2 33	
	PER THOUSAND.									
Alosa	7 52½		7 52½		4 20	6 30	4 72½	6 30	4 27	7 70
Abramis brama, salt, large	16 10	18 90	16 80	18 90	16 80	19 00	19 60	25 20	22 40	25 20
Salt, small	8 05	9 45	8 40	9 45	8 40	9 80	9 80	12 60	11 20	12 60
Aspius rapax	4 37½		4 20	4 44½	4 20		3 50	4 90	4 90	7 00
"Sertes"	2 10	4 55	3 36	4 55	4 20	4 55	3 50	4 90	4 90	7 00
Leuciscus rutilus	70	1 75	1 26	2 27½	1 05	2 10	1 40	3 15	2 10	4 55
Perca fluviatilis	2 10	2 80	2 80		2 45	2 80	3 15	4 20	4 90	

10.—PRICE OF FISH AS FIXED BY AGREEMENT BETWEEN THE FISHERMEN AND THE FISHING-HOUSES.

The fishing-houses pay to the fishermen whom they hire either an annual salary, or a fixed price, determined by agreement for every kind of fish and the articles manufactured from fish. The fishermen have no fishing-implements, and receive these from the fishing-houses. They are principally engaged for seine-fishing, serve as rowers, or work at the "vatagas," (fishing-establishments.) Russians very seldom hire themselves out by the year, while the Kalmyks do this exclusively. The annual salary is in proportion to their skill, experience, and diligence.

Those fishermen who are paid according to the number of fish caught nearly all own a little house, horses or cattle, boats, or other property, which assure them credit at the fishing-houses, and serve as a guarantee for the payment of indemnities in case they do not fulfill the conditions to which they have bound themselves by agreement. They receive the earnest-money in advance to buy fishing-implements and equip their boats. This subsidy is much more considerable for those who fish in the sea than for those who fish in the river; for the former must have a spacious, safe, and solidly-built sail-boat, and also a larger number of workmen. Moreover, they are exposed to all kinds of privations and dangers.

Contracts are made in July. The fishing-year commences July 1. If the year has been favorable, the fisherman, after paying back the earnest-money, has a considerable sum left; if, on the other hand, it has been unfavorable, the fisherman finds it difficult to meet all his expenses, and he is obliged to contract debts, which he is never able to pay.

Table showing the beneficial influence which the liberty of fishing in the sea has had on the wages of fishermen.

	The fishermen have received the following prices per "poud," (36 pounds.)					
	From July 1, 1866, to July 1, 1867.	From July 1, 1867, to July 1, 1868.	From July 1, 1868, to July 1, 1869.	From July 1, 1869, to July 1, 1870.	From July 1, 1870, to July 1, 1871.	From July 1, 1871, to July 1, 1872.
Acipenser huso	$0 56	$0 56	$0 70	$1 19	$1 26	$1 54
(December 1 to February 15)	1 61	1 26	1 26	1 75	2 10	2 10
Acipenser Guldenstädtii, (3′ 6″)	91	91	98	1 40	1 47	1 75
(December 1 to February 15)	1 61	1 26	1 26	1 75	2 10	2 10
(2′ 4″)	63	63	63	1 75	1 08½	1 22½
(December 1 to February 15)	1 61	1 26	1 26	1 75	2 10	2 10
Acipenser stellatus, (2′ 4″)	91	77	84	1 40	1 47	1 75
(1′ 9″)	63	63	63	1 05	1 78¼	1 22½
(December 1 to February 15)	1 61	1 26	1 26	1 75	2 10	2 10
Acipenser Schypa	52½	52½	52½	1 19	1 26	1 54
(December 1 to February 15)	...	...	...	1 75	2 10	2 10
Heads of *Acipenser huso*	21	24½	24½	38½	38½	52½

Table showing the beneficial influence, &c.—Continued.

	The fishermen have received the following prices per "poud," (36 pounds.)					
	From July 1, 1866, to July 1, 1867.	From July 1, 1867, to July 1, 1868.	From July 1, 1868, to July 1, 1869.	From July 1, 1869, to July 1, 1870.	From July 1, 1870, to July 1, 1871.	From July 1, 1871, to July 1, 1872.
Caviar of *Acipenser huso.*						
(July 1 to September 1)	$4 27	$4 27	$4 90	$7 00	$7 35	$8 40
(September 1 to December 1)	6 37	6 37	7 70	11 90	12 25	13 30
(December 1 to February 15)	7 91	8 12	8 40	11 90	12 60	12 60
Caviar of second quality, made in summer	2 10	2 10	2 10	2 10	2 10	2 10
Caviar of inferior quality	70	70	70	70	70	70
Caviar of *Acipenser Guldenstädtii* and of *Acipenser stellatus*:						
(July 1 to December 1)	4 27	4 27	4 90	6 30	6 65	7 70
(December 1 to February 15)	9 37	8 12	8 40	6 30	6 65	7 70
(February 15 to July 1)	4 27	4 27	4 55	6 30	6 55	7 70
Silurus glanis, (3′ 6″)	35	35	35	35	49	49
(2′ 4″)	17½	17½	17½	17½	24½	24½
Coregonus leuchichthys	21	21	21	21	21	35
Seals in spring	21	21	21	35	35	70
In autumn	35	35	35	1 05	70	21
	PER THOUSAND.					
Acipenser ruthenus	10 50	10 50	10 50	10 50	21 00	21 00
Cyprinus carpio, L.:						
(1′ 9″ and more, in spring)	11 20	11 20	11 20	11 20	11 20	11 20
(1′ 5¾″ to 1′ 9″, in spring)	5 60	5 60	5 60	5 60	5 60	5 60
(1′ 9″ and more, in autumn)	....	....	17 50	17 50	17 50	28 00
(1′ 5¾″ to 1′ 9″, in autumn)	....	....	8 75	8 75	8 75	10 50
(1′ 2″ to 1′ 5¾″, salt)	3 50	3 50	3 50	3 50	3 50	3 50
Salting *Lucioperca sandra* at the "vataga"	4 90	4 90	4 90	4 90	5 60	7 70
Salting *Lucioperca sandra* on the boat	....	....	....	....	7 00	28 00
Salting *Esox lucius* in spring	3 50	3 50	3 50	3 50	4 20	4 20
In autumn	....	....	....	....	4 90	28 00
Salting large-sized *Abramis brama*, strongly	3 50	3 50	3 50	3 50	4 20	5 60
Slightly	....	....	....	....	4 90	8 75
Large-sized *Abramis brama*, salted and dried	....	9 10	9 10	9 10	9 80	10 50
Salting medium-sized *Abramis brama* strongly	1 40	1 40	1 40	1 40	2 10	2 80
Salting medium-sized *Abramis brama* slightly	....	....	....	....	2 10	8 75
Medium-sized *Abramis brama* salted and dried	....	5 95	5 95	5 95	6 30	6 65
Salting *Aspius rapax*	1 05	1 05	1 05	1 05	1 05	1 05
Salting *Lucioperca volgensis* strongly	1 05	1 05	1 05	1 05	1 05	1 05
Slightly	....	....	....	....	....	2 80
Alosa	52½	52½	52½	52½	52½	52½
Salting *Leuciscus rutilus*	07	07	07	07	07	07
Salting and drying	21	21	70	1 05	1 05	1 05
Salting *Scardinius erythrophthelmus*	70	70	70	70	70	1 05
Slightly	....	....	....	....	....	2 80
Salting and drying	1 40	1 40	1 75	2 45	2 45	2 80

11.—SEAL-HUNTING.

The seal, which is very common in the Caspian Sea, (*Phoca caspica*,) is from 3 to 6 feet long, weighs from 2 to 4 "pouds," (72 to 144 pounds,) and has a variegated fur, the back grayish-brown with yellowish stripes.

These seals gather in large herds, and, plunging continually into the water, chase scaly fish, of which they eat only the breast, leaving the remainder of the body, with the entrails, to the sea-birds, which are constantly hovering above them. Endowed with a very acute sense of smell, the seals at times escape the vigilance of their enemies, the fishermen, with the exception, however, of the young, which, inexperienced as they are, follow the fishing-boats for long distances, and seem to take special pleasure in hearing the fishermen whistle or sing. It is an interesting spectacle to see the young seals lying on their back, sleeping peaceably while being rocked by the waves, and throwing up from time to time small jets of water by breathing.

The seals love the cold; and, in the summer, they seek the deep sea, leaving it in the autumn for their favorite place of abode, the north-eastern basin of the Caspian Sea, which is the portion first covered with ice, and where the ice breaks up latest. Numerous herds of seals gather on pieces of floating ice, to rest or to pair. The pairing-season lasts from the end of December till January 10. The female every year gives birth to one young one, seldom to two. The young have a shining white, silky fur; but after ten days it becomes coarse and turns gray. Then the tender solicitude of the mother ceases; for the little one has to go into the water and swim. Seals that are one year old have gray fur speckled with black spots.

The seal is hunted also on the western coast of the Caspian Sea, at the mouths of the Volga and the Ural, and in its southern part, especially on the islands of the Gulf of Apchéron.

The principal meeting-places of seal-hunters are on the seven islands situated north of the Peninsula of Mangyshlak, called the "Seals' Islands," on account of the large number of these animals found there. Other islands also abound in phocæ. Thus there have been years when about 40,000 seals were killed on the island of Peshnoï, before the mouths of the Ural; and, in 1846, 1,300 were killed in one night.

The seals are hunted in three different ways: they are killed with clubs on the islands where they gather; or they are shot with guns; or they are caught in nets.

The first-mentioned way is the grandest, and yields the best results.

The great meeting-place of the huntsmen is Koulali, the largest of the seal islands, having a length of thirty-five "versts," (about twenty miles,) and a breadth of three "versts," (about one and two-thirds miles.) The hunters, who winter there every year, have built wooden houses, huts, and sheds on this island. The fishing-authorities at Astrachan send every year one of their officers to Koulali to superintend the chase and the hunters, where he remains from October till the middle of May. On account of the bustle and noise, the seals have deserted this island for a number of years, and selected, for their place of gathering, the islands of Sviatoï and Podgornoï.

In the spring and autumn, the seals seek the shore to rest in the sun, one herd arriving after the other. Scarcely has the first settled, when a second comes yelling and showing their teeth to drive it away, followed soon by a third, to which it in turn has to yield its place; so that the last herd arriving always drives the first farther back on the coast. The invasion terminates by the arrival of some isolated stragglers.

Now is the time for the hunters to commence the chase. They carefully observe in what place, and, approximately, in what numbers, the seals have gathered; and then elect as their chief the most experienced and skillful among them. They approach the rookery in boats, either at dusk or during the night, always going against the wind, to conceal their approach.

After their arrival on shore, the hunters disembark noiselessly, form a line in order to cut off the retreat of the seals, and thus, creeping, advance quite near to the herd, which is sleeping and suspects no danger. On a signal from the chief, the hunters all rise at once and pitilessly attack their unfortunate victims, killing them by a single blow on the snout with the club. The bodies are piled up by means of gaffs, and after a few minutes form a rampart, depriving the survivors of every chance of regaining the sea. The seals howl, groan, bite, and defend themselves; but the hunters, eager for gain, go on killing them without mercy, and soon the whole herd is massacred. It is no infrequent occurrence to see 15,000 dead seals cover the battle-field of a single night.

After the killing, the dressing of the seals commences, usually about daybreak.

The head is cut off, the belly is opened, and the skin is taken off with the thick layer of fat adhering to it. These skins are piled up on the boats, which take them to large sailing-vessels, anchored some "versts" from the shore, on which they are heaped up, each layer being covered with salt. These vessels sail with their cargo to Astrachan, while the hunters return to the coast to carefully clean the battle-field. They bury the bodies and entrails, at some distance, deep in the ground, or throw them into the sea, far from the shore, and carefully obliterate every trace of blood, so that, when another herd of seals arrives, these animals do not see any marks of the slaughter which has taken place; for experience has shown that they never select for their rookery a place from which every trace of the slaughter has not been carefully removed.

Two hundred seal-hunters, employed by wealthy merchants or fishermen, usually winter on the island of Koulali. Numerous boats, besides, go there every year to participate in the chase. The masters of these boats secure permits from the fishing-authorities and give them to their workmen, who receive their wages in money. The pilot generally gets from 175 to 300 "roubles," ($122.50 to $210 gold,) and the workmen from 85 to 125 "roubles," ($59.50 to $87.50 gold.) They are fed at the expense of the master.

Another way of hunting the seals is to take them with nets. Immense nets are stretched out, into which the hunters endeavor to chase them by yelling and making a noise. This way of hunting is chiefly employed in the maritime district of the Ural Cossacks and in the Gulf of Sinéyé Mortso, from October till the sea is covered with ice.

The nets, called "okhani," are 6 "sagenes" (42 feet) deep, and have meshes of $7\frac{1}{2}$ inches.

The following is the manner of proceeding: Forty boats join together and elect a chief and an assistant chief. Then the boats sail out to sea with a fair wind, or use their oars, going in a line, thus forming a sort of chain. In every boat, there are three nets. The chief, followed by twenty boats, is on the lookout for a herd of seals, which he endeavors to cut off, while his assistant remains with the other half of the fleet at some distance from the shore. When the chief thinks that the time for action has come, he gives the signal by throwing into the sea a bale, to which a flag is fastened. At this signal, the boats simultaneously cast their nets, which are all tied together so as to form a wall of meshes, by which the seals are soon completely surrounded. Then the hunters begin to yell and to strike the water with their oars, in order to frighten them. These seek to avoid the danger by plunging, but they rush against the barrier of nets, and are caught in the meshes, so that they can be killed without difficulty. This way of hunting is prohibited in those parts of the sea where it injures the fishing or obstructs the first-mentioned manner of hunting. The chase on the ice is fraught with many dangers, and is, therefore, at present prohibited. The hunters, sitting on little sledges drawn by strong and hardy horses, and provided with food, continue on for several weeks to shoot old seals, and kill young ones while they still have their white and silk-like fur. These hunters brave all dangers; and it has sometimes happened that the south or southwest wind, having detached large masses of ice from the shore, has driven them out into the open sea, where they have floated in all directions, with the adventurous huntsmen on them. These unfortunate hunters usually perish from cold and hunger on these masses of ice, or find their death in the waves.

12.—MANUFACTURE OF SEAL-OIL.

The fat adhering to the skin of the seal is detached from it, cut into pieces, and melted in caldrons, after which the oil is poured in barrels. This is the simplest way of making seal-oil, and the hunters often employ it. But oil is also manufactured by steam in establishments built for this purpose on the left bank of the Volga, opposite Astrachan, by some rich merchants. Thirty-five "versts" (about twenty miles) below Astrachan, the Sapojnikow Brothers have built a steam oil-factory at the "vataga" (fishing-establishment) of Ikriannaya. This factory is particularly busy in the spring, when whole cargoes of seal-fat arrive, which is either boiled immediately in order to extract the oil, or is safely stored away in cellars. These cellars are long, floored, and furnished with four ventilators and several windows. Large oak-wood tubs, plated with lead on the inside, and capable of holding 700 "pouds" (25,200 pounds) of oil each, are placed at intervals in holes dug in the ground. The oil which runs out from the seal-fat piled up in layers flows into these tubs by way of an inclined plane. The oil is then poured into barrels. In order that the skins, from which the fat has not yet been removed, may not spoil, they are salted again, just as it had been done on board the vessels; 150 "pouds" (5,490 pounds) of salt being generally used for salting a thousand skins, and only 70 "pouds" (2,520 pounds) per thousand for the final salting, before the skins are stored in the cellars. Kalmyks are employed chiefly to detach the fat from the skins. They spread the skin, with the fur down, on an inclined plank, which they lean against their breast, in order to have the free use of both their hands. Then, armed with a two-handled knife, they scrape the fat from the skin. The oil, which is pure and clear, running down during this operation, flows into a reservoir let into the ground, holding 400 "pouds," (14,400 pounds,) and forming a cube, each side of which measures one "sagene," (7 feet.) This work is extremely fatiguing. A strong and experienced Kalmyk can, however, clean 500 or even 700 skins in a single day. The workmen form associations, sharing their labor and their gain.

The fat is then melted in large tubs, where it is exposed to the action of steam. The oil flows through a funnel-shaped apparatus, and, finally, through pipes into immense oak-wood reservoirs. There are three such reservoirs connected by pipes, and let into the ground, so that the oil from the first flows into the second, and then into the third, from whence, through cocks, it passes into casks, which can be shipped as soon as filled. Each one of these reservoirs has a diameter of 3 "sagenes," (21 feet,) a depth of 1 "sagene," (7 feet,) and can hold 4,800 "pouds" (172,000 pounds) of oil.

The oil thus extracted forms the first quality. The second quality is obtained by melting the residue in caldrons, and by pressing it. The color of this oil is dark-brown. Before the residue is put into the caldrons, (capable of holding 200 "pouds" (7,200 pounds) each, it is thrown into a receptacle with an inclined bottom, and the whole mass is stirred violently by means of wooden shovels. This is done in the sunlight, so that the heat may help to melt the mass. This receptacle is joined to the caldron by a large gutter, which is walled up in the furnace. Through this gutter, the residue is led into the caldron, there to melt, which done, the mass is taken out with dippers and cast into a box, which is then pressed. By means of this last operation, all the remaining oil contained in the residue is extracted.

The oil-factory of the Sapojnikow Brothers formerly manufactured about 100,000 "pouds" (3,600,000 pounds) of seal-oil, which was sent to Moscow, where it was chiefly used in leather-factories; but during the last fifteen years, this establishment has gone down considerably, and other wealthy Astrachan merchants, among them Messrs. Vlasow, Smoline, and Orékhow, have established several factories for making the oil.

The skins of the seals are used for making knapsacks and for covering valises.

VI.—THE NORWEGIAN HERRING-FISHERIES.*

BY A. I. BOECK AND A. FEDDERSEN.

Mr. A. Boeck, who for several years had conducted scientific researches for the Norwegian government in regard to the herring-fisheries, was invited, on his return from the districts of Nordland and Tromsö, in February, 1872, to deliver some lectures in Bergen on the spring-herring fisheries. Although the season was far advanced, the southern herring had not yet made its appearance, and fishermen and salters were in great doubt as to what they should do. Boeck's lectures were therefore received with special attention, and as they contain a great deal of valuable information, we present here copious extracts from them, following the account given in the "*Bergens Adresseavis,*" (*Bergen Advertiser,*) and "*Bergenposten,*" (*Bergen Post,*) for February, referring our readers at the same time to an article by A. Boeck, "*Account of the Herring on the Coast of Norway and Bohuslän,*"† (a province of Sweden,) published in the fifth annual volume of our journal, pp. 123, et. seq. We also refer to A. Boeck's work "*On the Herring and the Herring-Fisheries,*‡ especially on the Norwegian Spring-Herring."

The herring is found, in Europe, from Spitzbergen to the west coast of France, and is caught in large numbers on the coasts of Scandinavia, Great Britain, Ireland, Holland, and France. On the other side of the Atlantic, they are caught from Greenland to the eastern coast of America. In all those places where herring are found in large quantities, and where people have become rich through these fisheries, the number caught has, at times, been exceedingly small, and for long periods the herring have disappeared entirely. This has not only been the case on the coast of Norway, but also in Bohuslän, (western coast of Sweden,) Scotland, Ireland, and France, and people have been reduced to want in consequence of the failure of the fisheries.

In the present century, when science has made such rapid progress, and has, in manifold ways, become tributary to the comforts of life, and when many of the greatest inventions of modern times have sprung from the quiet and unostentatious researches of scientists, it was be-

* Det Norske Sildefiske. Efter Referaterne af Stipendiat A. Boecks Foredrag i Bergen ved A. Feddersen; *in* Tidsskrift for Fiskeri. Udgivet af H. V. Fiedler og Arthur Feddersen. 7de Aargang. (Kjobenhavn. Jacob Erslers Boghandel. 1872.) pp. 1–40. Translated from the Danish by O. Jacobson.

† Beretning om Sildefisket ved den norske og bohuslenske Kyst.

‡ Om Silden og Sildefiskerierne, navnlig om det norske Voarsildfiske.

lieved that important results in regard to the herring-fisheries might also be secured by scientific investigation, and many problems be solved which had hitherto been doubtful. It was questionable, however, how far practical results could be hoped for, and how far the causes of the herring's disappearance could be ascertained and means be found to prevent it. Yarrell, the English scientist, lately deceased, said that the herring was a whimsical fish, which had no definite place in which it could be expected with certainty. The famous Danish ichthyologist Kroyer, who had for some time made scientific researches in this direction, in his great work, "*The Fish of Denmark*,"* makes use of these words: "How desirable it is to gain more insight into the natural history of fish is strikingly illustrated by the herring, as many points in its mode of living are still unexplained, and many fabulous accounts are transmitted from one generation to another." The zoologist Van der Hoeven also dissuaded Boeck from occupying himself with these studies, as they would be productive neither of profit nor of honor.

Several scientists have, however, opened the way for such researches. The French zoologists, Audouin and Milne-Edwards, traveled for several years on the coasts of France for the purpose of examining the fisheries scientifically; the only result of their researches, however, being a volume published in 1830 and containing chiefly statistics. The investigations made in Bohuslän, (western coast of Sweden,) by Professor Nilsson, of the University of Lund, are of greater value. The herring had disappeared from that coast in 1808, after having been exceedingly plentiful for more than fifty years. Large sums of money had been employed in establishing salting-houses and oil-refineries, and the government had specially favored emigration to the coast of Bohuslän, where the herring-fisheries for a long time formed a fruitful source of income. No herring were found near the coast; the merchants were idle; and fishermen and salters led a miserable life. Still, people hoped year after year for the return of the herring, and rumors were current that enormous quantities of fish were immediately outside the coast in the so called "Stor rende," (Great Channel.) The government assisted the fishermen, and 50,000 rigsdalers (about $25,000 gold) were spent in attempts to secure fish from this locality, (the "Stor rende.") Although all these efforts failed, it was still hoped that the herring would return, as scientists had expressed the opinion that only unfavorable circumstances prevented their approach. The fish, however, did not return, and the former extensive fisheries were almost entirely abandoned. The local press zealously advocated new investigations, and Professor Nilsson began in Lund, in 1825, a series of researches. It is to be regretted that Nilsson could not begin this labor until eighteen years after the disappearance of the herring, and that he entered upon these investigations with his opinions firmly fixed. He, therefore, met with much opposition. He renewed his investigations during the years 1828–'32,

* Danmarks Fiske.

and visited the Norwegian herring-fisheries, in order to compare them with the Swedish. He endeavors to prove, in his reports, that the herring does not come from the Polar Sea to the coasts of different countries, but, as the well-known zoologist Bloch has remarked, has its permanent place of abode near those coasts where it comes to spawn. He, therefore, thought that the Bohuslän herring never left the Skagerak, and had nothing to do with the Norwegian spring-herring, which was a totally different variety, and that the Bohuslän herring had, therefore, not emigrated to Norway. On the other hand, he at first thought, although he was not quite certain about it, that it had been completely exhausted by the fisheries. At a later date, he abandoned this opinion and supposed that the herring had only been driven away from the coast by the noise of singing and dancing in the fishing-huts, and remained at the bottom of the ocean; and, finally, he came to the conclusion that it was killed by the impurities of fish-oil which were thrown into the sea. He was also of the opinion that the herring would return, if the seines, by which all the young were caught, could be laid aside. As his opinions did not meet with general favor, a committee was appointed, consisting of Count Rosen, Professor Nilsson, and others, which traveled along the whole coast of Bohuslän from Gottenburg to Strömstad, and made numerous inquiries among the fishermen of the different districts. Nilsson's reports, as well as the report of the committee, and two memorials regarding the same matter by Professors Sundevall and Lovén, who concurred in Nilsson's opinion, were printed and distributed in large numbers. We shall have occasion, in the course of this article, to refer to these reports and memorials.

The Dutch government commissioned Lieutenant Kraft to make extensive observations during several years, on the temperature during the season of the herring-fisheries, by means of which it was ascertained at what degree of warmth the greatest quantity of fish was caught. He then prepared a map showing where, at different times, the largest quantity and the best quality of herring were caught. This map was exhibited at the fishing-exposition held in Bergen in 1865.

Observations have been made in England for some time by zoologists and scientists, mostly for the purpose of ascertaining whether the supposition that the fishing-implements had anything to do in driving away the herring was correct or not, and they finally arrived at the conclusion that the great number of old laws which embarrassed the herring-fisheries ought to be rescinded.

In Denmark, Professor Kroyer has made a number of observations, only some of which, however, have been published in his work "*Fish of Denmark.*"

Professor Münter, at Greifswalde, (province of Pomerania, Prussia,) has also made observations concerning the various species of Pomeranian herring, their food, and the temperature most favorable for spawning.

These are the most important practical and scientific investigations of the herring-fisheries which had been made up to the year 1860, when the Storting, (the Norwegian parliament,) appropriated a sum for similar investigations on the coasts of Norway. Besides these, two investigations of the fisheries have been commenced on a large scale, the one by the imperial German government under the direction of Professor Möbius, for which a very considerable sum has been appropriated, and the other by the Government of the United States under the direction of Prof. Spencer F. Baird, LL.D., who, with several younger scientists, is to examine the fisheries along the entire coast of the United States, for which purpose some Government steamers have been placed at his disposal.

When Mr. Boeck was commissioned to examine the Norwegian herring-fisheries, he could, at first, only follow the same plan in his investigations as other scientists before him had done; but he soon found that these investigations ought to be made on a very different scale, and in other directions, because he discovered that there were other natural phenomena which might influence the migrations of the herring. After having made himself acquainted with these natural phenomena, his attention was naturally led to circumstances which had hitherto not been considered of any importance. The essential point in all such investigations is to gather as much material as possible in the shape of indisputable facts. As these facts could not properly be gathered in a hurried manner, and as it was desirable at the same time to secure some result as soon as possible, Boeck proposed to adopt a provisional theory adapted to such facts as could be ascertained. He saw that two plans might be followed: one was to examine the migrations of fish in relation to meteorological changes, by exact historical data regarding the older fisheries from 1807 to 1852, when the government inspection commenced its reports; the other, to gather facts from old and experienced fishermen. Although the latter plan might seem to be of doubtful value, he soon found that such experience was by no means to be despised. Fishermen are more observant than many suppose. They think, see, and hear a great deal, and although their opinions are sometimes very fanciful, the true can readily be distinguished from the false, and so be made useful. Both plans, however, require to be corrected by scientific investigation. Boeck has adopted the following mode of procedure, endeavoring to accomplish his purpose both by observations and by historical researches:

1. To make observations during the fishing-season on the currents and the temperature of the sea, the nature and form of the bottom, the migrations of the schools of herring, and the influence of these circumstances on the time of their approaching the spawning-places.

2. To collect the most accurate information possible on the migration of the herring, and on the meteorological changes which seem to have influenced it from its beginning, in 1807, until the government inspection commenced.

3. To endeavor to find out, by historical data, the migration of the herring-fisheries at large; how the mass of herring at one time approached one part of the coast of Norway, and then another; or how disappeared entirely; and then to compare these facts with those gathered from other countries, and thus to ascertain if there be any connection between the different herring-fisheries in Norway and other countries; and also to compare the fisheries of former times with those of the present, in order to ascertain if any satisfactory results could be reached with regard to their future condition.

In accordance with this plan, Boeck has, during his sojourn of five years at the fishing-stations of Norway, made personal observations, and has also collected material from archives and libraries. He was greatly assisted in his observations by two citizens of Bergen, the consul Carl Konow, and the banker N. Nicolaysen, who permitted him to use two collections of carefully kept diaries regarding the herring-fisheries from the year 1835, which facts he partly supplemented by notes from *Den bergenske Merkur*, (*the Bergen Mercury*,) and from *Stiftstidenden*, (*the County Journal*.) He finally obtained, through the firms of Kjelland & Son and Ploug & Sundt, in Stavanger, a series of observations made on the fisheries previous to the year 1835, which he likewise supplemented by a large amount of written and oral information derived from persons in Stavanger, Skudesnæs, Kopervik, and Haugesund. From all this material there may be compiled a more or less complete account of the fisheries from 1808 down to 1852.

Boeck has draughted, on a large scale, a map of the southern coast of Norway, from Sognefjord to Gottenburg, and the northern part of Jutland. The depth of the sea along the coast is marked by lines in accordance with the information which he had received. Another map, on a much larger scale, embraces the coast from Espevær to Tungenæs. On this there are marked the channels and depths, together with several fishing-banks, to within a mile of the outer coast, which are not usually indicated on the coast maps, and which were carefully pointed out to Boeck by an old fisherman, Henrik Röevar, as well as by other fishermen from Syre and Utsire. The localities indicated on the map last mentioned are the ones to which he devoted special attention. He has chosen this locality, partly because at that time the fisheries were particularly productive in those places, the northern fishery having only just then begun to be of any importance, and the Söndmör fishery being still in its infancy; and partly, because it has always been one of the chief places for catching spring herring. He has also continued his observations there in order to make them the more satisfactory.

When Boeck first went to the fishing-grounds, he determined to follow the advice of the government inspector, which was to go out with the fishing-boats, and also to frequently visit the stations for salting. A fisherman, whose advice he followed, often spoke of putting the nets in the channels, and he found on inquiry, and by observations with the sounding line, that these channels are valleys at the bottom of the sea, running toward the coast in different directions. Having continued these observations for some time, he was able to corroborate the fisherman's statement that at different times the herring follow certain channels when they approach the coast for the purpose of spawning. It would require too much time to describe the location of these channels in detail, and we hope that Boeck will, at some future day, publish these maps. In one of his lectures he mentioned a circumstance which fortunately was among the first to come under his observation, and which showed conclusively that, during the spawning time, the herring follow these channels; and this he found to be the case invariably. He had made a great many soundings in the channel, extending between Röær and Fæö and stretching toward Hauskeskær, and had placed a chain of nets across it. A large number of fish were caught all along this chain, while another chain, the greater part of whose nets stood on the rocks, with only one end reaching the channel, only caught fish in that portion which touched the channel. He also found it of the utmost importance, for the success of the herring-fisheries, to ascertain which channel the great school of herring follows when it comes in to spawn; for several times he was able to designate with certainty the place where the fish would be on the following day, by knowing where large numbers were caught the preceding day. This, however, he could only do when storm or cold did not interfere with his calculations. He also convinced himself that if several nets are set in such a channel they do not interfere with each other, but that the herring push forward along the channel over and into the nets.

Boeck finally drew attention to the so-called "flak," *i. e.*, large level places at the bottom of the sea covered with rough gravel, which in calm weather are the herring's favorite spawning places. He raised with the dredge large lumps of roe and gravel intermixed. In these places the largest number of herring is invariably caught.

The influence of wind on the fisheries was observed long ago, and the Swedish zoölogist Ekström, and after him Nilsson, attach some importance to it; but in estimating the information obtained from fishermen, they are not sure which wind is favorable for fishing, the one blowing from the coast or the one blowing toward it. The Dutch zoölogists have not been able to discover that the direction of the wind has any special influence on the fisheries, except that a violent gale precludes all possibility of fishing. On the coast of Norway opinions are likewise very much divided on this point, some maintaining one thing, others another. By examining, however, all the annual observations made by the government inspector and by himself, Boeck found, that when the herring is out in the open sea a wind blowing toward the coast favors its approach, while when the herring are near to the coast its formation has to be taken into consideration. If, *e. g.*, the herring occupy an area like the one opposite the southern part of Karmö, between Syre and

Skude, and strong southwesterly gales rage for any length of time, they are prevented from reaching their usual spawning places, and remain a long time outside the channel for some more favorable opportunity. If, however, the storm continues, the herring generally pass into that part of the channel which, stretching by Skude, runs on into the sound of Karm. Fishing may then be carried on up to Salhus and to the end of the Förresfjord. Of this there are many instances as far back as 1815. From the accounts of the government inspector, it will be seen that this was the case in 1857, and most of us will recollect the great fisheries of 1863. A southeasterly wind on this coast will have the same effect, but to a less degree. If the herring keep more toward the south near the Hviding Islands and Roth, both strong southwest and northwest winds will prevent their approach to these islands. In that case the whole school passes by Tunge, and there may be good fishing directly up to Stavanger, as was the case in 1825. Similar facts will become apparent if we advance farther north and inquire into the like circumstances.

If the coast is exposed to strong winds blowing toward it, the herring do not approach it, and the fisheries, if they have commenced, are interrupted. Thus, rich fisheries far in the Bömmelfjord beyond Tittelsnæs, and even far beyond Nyleden, will be a consequence of continual storms, when the herring have been previously outside of Sletten or south of Espevær. Of this there are many instances. Hence it will be seen that the point on which the question turns, is not whether the winds blow toward or from the coast, but what kind of wind prevails at the respective fishing-places, since a wind blowing *toward* the coast may in one place have the same effect as a wind blowing *from* the coast in another.

The temperature of the air also exercises great influence on the fisheries; and this influence has never been underrated, but has always been taken into account, although certain phenomena observed in the fisheries can not yet sufficiently be explained by it. Boeck drew attention to the influence of temperature in his first report of 1861. It has been observed from time immemorial, that the fisheries are not as abundant in cold weather as when the bottom of the sea is disturbed by southerly winds. This has been proved by the experience of several centuries, but only recently have attempts been made to investigate this whole matter thoroughly and scientifically. Even Cuvier and Valenciennes in their great work on fish, in which the herring is discussed at much length, do not enter upon this question. Dutch scientists were the first to devote more attention to temperature, by making a series of observations, with the view of ascertaining during what degrees of temperature the herring-fishery is most prosperous. They found that more fish were caught at a temperature of from 12° to 14° Celsius, than at any other time. The Dutch herring-boats are therefore always supplied with a thermometer, which enables them to place the net at a proper depth. Professor Münter discovered also that the higher the temperature of the water the deeper the herring keep during the spawning-time, for which reason the nets on the coasts of Pomerania are set deeper in summer than in spring. During his stay on the west coast of Norway, Boeck constantly noticed the temperature, and noted down a large number of observations during different years. In his report for 1862 he showed the influence of cold on the herring-fishery. In that year he examined the temperature at different depths. The weather had been calm, but a severe cold had prevailed for some time, by which the temperature of the sea at a depth of 10 fathoms had been brought as low as 1½° or 2° Réaumur, while at a depth of 30 fathoms it was from 3° to 4°. He noticed that same year, while present at the rich herring-fisheries near Rövær and Skaareholmene, that some fishing-implements, which were placed at a depth of about 10 fathoms below the surface, and were held there by means of buoys, caught but few fish; while others, placed at the bottom in a depth of from 50 to 60 fathoms, caught a very large number. Seine-fishing was also very unproductive during that year, although the schools of herring came in in enormous numbers. The same was the case in 1864, and similar observations might be quoted indefinitely. If we examine these accounts we find frequent references to the fact that the cold prevented the herring from approaching. Thus it was extraordinarily cold in 1855, likewise in 1860; and in 1853 the cold was so severe that the bays and inlets on the outer coast were frozen over, which happens but very rarely, and presupposes a long period of very low temperature. The cold was so severe that the fishermen were obliged, after emptying their nets, to lay them in the water to prevent their freezing quite stiff, and in order that they might have them ready for use again in the evening. The herring-fishery was, notwithstanding this, successful, although the herring for quite a long time remained out in the deep sea and would not approach the coast. A great many instances might also be quoted from observations made in former years and collected by Boeck. It will suffice to mention a few years, such as 1825, 1826, 1828, 1829, 1836, 1840, 1841, and 1844. In several of these years the cold was so severe that nearly all the bays were covered with ice, and in some years even the Bay of Bergen was so much obstructed that all communication was interrupted. Still the fisheries were good, and in some years even unusually so, although the sea had grown cool at a far greater depth and to a greater degree than during the preceding year; for then the cold was not particularly severe, and the temperature, according to the observation of the government inspector, was 1° at a depth of 10 fathoms. Boeck thinks, therefore, that the failure of the fisheries the year before cannot at all be ascribed to the cold. He found that in calm weather the herring seldom approaches the coast except in small numbers when chased by the haddock, while the chief fishery always commences when a southwesterly or northwesterly wind has stirred up the sea and mingled the lower and warmer water with the upper and colder. Of this, Boeck gives many examples, partly from his own observations and partly from those of the government inspector. It is important to keep this in mind whenever the influence of the cold is spoken of.

From all this it will be seen that neither the character of the bottom of the sea, nor the direction or force of the wind, nor the temperature of the air and sea by themselves, exercise an influence on the fisheries sufficiently great to cause their cessation, but that these various influences only modify the time and place of the fisheries. The schools of herring that come in from the ocean, seek the coast notwithstanding these influences.

The question, "Where does the spring-herring keep itself, when it is not near the coast?" has been discussed from the earliest times. Shortly before the fisheries commence, the herring may be seen approaching the coast, followed by whales, and the sea then frequently appears quite green from the large masses of fish seen near the surface. After the herring has spawned and gone out into the sea, it disappears. In very early times it was supposed that the Polar Sea was the true home of the herring. The Dutch fishermen on the Shetland Islands noticed that it came from the north. It also approached the coasts of Scotland from the north. The Irish saw the herring pass their coasts from north to south, and the same was observed on the coasts of Norway. It is therefore not at all astonishing that its home was supposed to be in the north, and that the Polar Sea, which, according to the strange fancies of those times, hid so many wonders, was the place from which the herring emigrated every year. The English writer, Dodd, in a book entitled "*Atlas Maritimus et Commercialis*,"* published in 1728, started the theory that the herring emigrates from the Polar Sea. But this theory is brought out in a clearer and more attractive manner in a work by Johann Anderson, burgomaster of Hamburg, and well known for his learning, entitled "*Nachrichten von Island, Grönland*," &c., Hamburg, 1746, (*Account of Iceland, Greenland, &c.*,) which appeared in a Danish translation in the year 1784. He first remarks that several well-known persons had seen herring and the bones of herring lying on the rocks of the coast of Greenland. He then shows that the whale, the seal, and the porpoise, whose favorite food is the herring, have their home in those Arctic seas, and that, therefore, the herring must be found there. Far up toward the North Pole, under the broad, icy plain, which never melts, the herring was supposed to live quietly, because neither whales, sharks, nor men could pursue it there; there it also spawned and increased in such numbers that the Polar Sea became too narrow for them, and thence colonies, compelled by actual necessity, emigrated toward the south, just as bees swarm in summer. When such a school of herring issues forth from its icy home, it is immediately attacked by its enemies, who pursue it dur-

* See, also, Dodd (J. S.) Essay towards a Natural History of the Herring. London. 1752.—ED.

ing its passage to the south, and finally drive it into the bays and inlets where it is caught. During its passage southward, it dispatches two flank divisions, the right flank toward the coast of Iceland, of whose fate Anderson does not speak in his book, while he does state that the great mass of the herring, when near the coast of Norway, divides into two columns, one of which goes toward the coasts of Scotland and England, where it is for the greater part captured by the fishermen of those countries; while some are driven partly along the eastern coast of England, and partly along the coast of Ireland, till they finally meet in the English Channel, where they are caught by the French fishermen. That school, which, it was conjectured, passed toward Norway, continued its journey along the coast of that country. Some pass through the sound and belts into the Baltic, where the Swedes and Prussians are ready to receive them; another portion of the school follows the coasts of Denmark, Germany, and Holland, while the remainder reach the Atlantic, where they disappear.

This theory became so popular that it has been handed down from one writer to another, even to our time, and has intrenched itself even in text-books on natural history. It met, however, with some opposition, and Bloch, who published in 1782 his book entitled "*Oekonomische Naturgeschichte der Fische Deutschlands,*" (*Economical Natural History of the Fish of Germany,*) a work very remarkable for its time, raises many weighty objections to it. He first showed that the herring is not so common in the northern countries as was generally supposed, and that it was impossible for it to travel so many thousands of miles in the short period between spring and autumn. Besides, the herring is found at all times of the year in the Baltic and on the coasts of Norway, and the Dutch continue their herring-fisheries even throughout the entire winter until spring. It would also be very remarkable if just the smallest herring should make the longest journey far down to the Baltic. But as Bloch's books were not popular, being only intended for scientists, his opinions did not become widely known. An American by the name of Gilpin,* went even beyond Anderson in promulgating another fanciful migration theory. He showed that herring were also caught in America, and that here it first approached the coast of Florida, and then, passing along Virginia, went as far as Newfoundland, moving, therefore, from south to north, and thus differing from its direction in Europe. The American herring must, therefore, come from schools out of the English Channel; and his theory was that the herring, in the course of a year, described in his migration an ellipse of not less than forty-seven degrees of latitude, crossing the Atlantic twice a year, the first time to escape the strong heat in the south, and

* Gilpin, John, "On the Annual Passage of Herrings," Transactions Amer. Phil. Soc., II, (1786,) p. 236-239.

the second time the severe cold in the north.* Kröyer thinks that if there were any probability in this theory, the herring might justly be compared to the Wandering Jew, who travels unceasingly without finding rest. This theory, however, has not found many advocates outside of America,† and is of no value since it has been proved that the American herring is a species different from ours.

Anderson's theory was violently attacked by Nilsson in 1826 and 1828, who, like Bloch, proved that the herring could not possible live deep under the ice in the Polar Sea, and much less spawn, as the roe would there miss the most essential conditions for its development, viz, light and warmth. Although the herring was seen to come from the north, it need not necessarily come from the Polar Sea, as it could not possibly travel the long distance of more than a thousand miles, as Anderson maintained that it did. He showed, besides, that on the coasts of Sweden there was found a great number of varieties, which never leave that part of the sea where they are born, (such as the "Strömming," which is found in the Gulf of Bothnia,) while farther toward the south other varieties of the herring are found, those from the western coast being easily distinguished from those of the southern. On the coast of Norway, also, different species of herring are found, which again differ from the Scotch and Dutch herring. Nilsson, therefore, thought it beyond a doubt that the herring does not come from one great common tribe, but that every race has its home outside that coast where it goes to spawn; and that it has its regular dwelling-place in the open sea near such coast. He thus thinks that the Gottenburg herring, which came into the inlets of Bohuslän in such extraordinary large numbers prior to the year 1808, and of which, *e. g.*, in the year 1870, more than one and a half million tons were caught, (which, by the way, was only a very insignificant portion of the whole mass of herring which had gathered there,) has its permanent home in the Skagerak, which is neither very deep nor of very great extent. Cuvier and Valenciennes, also, showed that on the northern coast of France, and not far apart, there were two such tribes of herring, each of which had its separate home in certain basins of the open sea, and that these tribes never intermingled. Münter is also able to show that there is on the coast of Pomerania one tribe of herring which spawns in the autumn, and another which spawns in the spring, differing greatly from each other, although the basins of the sea near the coast where they live are scarcely more than a mile apart. Another proof of the theory that every race of herring has its special dwelling-place in the sea, which it does not leave, except when it approaches the coast for the purpose

* This "theory" was the result of a confusion of two very different fishes under the same name—*Culpea harengus* and *Pomolobus pseudoharengus*—one of which is the true sea-herring, and the other an anadromous species whose ascent of the rivers coincides with the advancing temperature of the new year, and therefore with the latitude—S. F. B.

† The only avowed advocate of the "theory" in America was the originator.—ED.

of spawning, is the fact that the herring is not able to swim very far, since neither the structure of its muscles nor fins is adapted for this purpose. Immediately outside the coast there are small banks on which the fishermen catch cod and other fish, and from these banks the bottom often shelves off with great abruptness to a depth of sea which in some places reaches from four to five hundred fathoms, and which, in the shape of a deep channel, varying in breadth from fifteen to twenty miles, stretches from Sognefjord in a southerly direction along the coast of Norway, making a sharp turn at Lindesnæs, and extending from that point to the mouth of the bay of Christiania. In some places its depth is from four to five hundred fathoms, and deep channels branch off from it toward the mouths of the great bays and inlets on the coast of Norway. In the Skagerak this deep channel is much narrower, and reaches its greatest depth in the neighborhood of Arendal, while higher banks stretch along as far as the northern point of Jutland. It is found near Fedge that, at a distance of twenty miles from land, the bottom of the sea rises up to 70 fathoms, and immediately afterward to between 60 and 50, and all sailors know well how the North Sea rises toward the coasts of England.

North of a line drawn from the mouth of the Sagnefjord to the Shetland Islands, the deep sea extends from the coasts of Norway as far as Iceland and Greenland, and only north of Stat are banks again found outside the coast. It will thus be seen that the herring may very well live in that great and deep sea when they do not linger near the coast. That they live there, may also be argued from the fact that Nilson has found large quantities of herring in the stomachs of haddock caught out in the deep sea. Boeck has likewise found proofs that the herring lives in very deep water, when not near the coast. He has repeatedly examined the stomachs of herring, and, though he found but few remains of food, there were, among these, fragments of crustaceous animals living in the great deep. By means of the dredge he has caught the animals at various depths, from the surface to a point three hundred fathoms below it, and has specially examined those species which serve as food for fish. Through investigations continued during several years, he found that certain species of crustaceous animals (*copepods*) always keep at a certain depth, and in such a manner that those living near the surface are never found at a depth of fifty or sixty fathoms; and that those which live in the deep are never found near the surface. The euchæta kind forms the favorite food of the spring herring, when it is not near the coast of Norway; and this is never found at a depth of less than two or three hundred fathoms. The herring must, therefore, in Boeck's opinion, live at that depth, which is not very far from the coast. He was several times informed by fishermen, especially in 1861, 1864, and 1866, that they, when at a distance from the coast, varying between five and twenty English miles, and in different places, such as to the northwest of Utsire and Sartorö, had sailed through great masses of herring, which, as they thought, had risen from the bottom of the sea in order to move toward the coast. Some fishermen also showed him herring which had been cast on deck by the waves. Boeck is disposed to concur in Nilson's opinion that the herring never makes long journeys, but that that school, which, during the time of the southern herring-fishery seeks the coast of Norway, keeps out in the deep near that coast. Cuvier and Valenciennes are of the same opinion, for they have, as already mentioned, proved that on the northern coast of France, two species of herring are found not very far apart, which are easily distinguished from each other in the Paris fish-market. These herring are brought to Paris from two villages on the coast adjacent to each other, and they are never mistaken for each other. Their abodes are two different basins near the coast.

Bœck then proceeds to speak of the causes which impel the herring to approach the shore. It is well known that it comes there to spawn; and during the spring-fisheries the largest number caught are herring about to spawn. The stomach of the herring is empty during this whole period, so that it evidently cannot be its intention to seek food at that time. Its desire to propagate dominates for the time being over all other desires, and it seeks places against which it can press its abdomen, and thus make the spawn flow more readily. It does not at all avoid the nets, but seems rather to seek them, of which fact interesting proofs may frequently be seen, such as, that the herring will squeeze itself into the meshes of the net if they are too small to receive it easily. The entire herring-fishery of Norway is limited to catching the herring when about to spawn, which is in marked contrast with the fact that in almost every other country it is supposed that catching fish during the spawning season ruins the fishery. In every roe-herring which is caught 68,000 eggs are prevented from developing, and it may easily be imagined that enormous numbers of unborn fish are destroyed by the spring-fisheries. If the sea did not contain such incredible numbers of them, one year's fishery would entirely destroy the whole species. The empty herring never approach the nets, and are caught only occasionally, since they no longer feel the need of pressing against anything.

In the opinion of several scientists, such as Professors Sundevall and Lovén, every herring is instinctively led to return to the place where it was born, although it be only an island of the smallest dimensions; and that it seeks another place for spawning only when driven away. This opinion is chiefly based on observations of the same habit in the salmon, which always seeks the identical place of its birth.

A writer in the "*Morgenbladet*," (*The Morning Journal*,) some years ago, endeavored to prove that those herring which, six years before, were born in a certain spot, returned to it, and that the fishery would always be abundant in the same place after the above-mentioned period, and cited as evidence some extracts from the government inspectors' accounts. This proved a very interesting subject for investigation to

Boeck, and he determined to make it very thorough and extend it over a great many localities. He soon arrived at another result, by using, first, the accounts of the government inspectors; and, secondly, the very minute information regarding the fisheries which he had collected prior to 1852. By thus marking all the places where herring-fisheries had been carried on, and by noting every year where the herring had approached the coast, he found that there were so many exceptions to these six-year periods, that in several places their number by far exceeded the rule; and the same was the case in any period selected at random from one to seven years. Boeck can, therefore, see no law of nature in this, and thinks that the herring does not return to the places from which it came with the same certainty as the salmon does. The approach of the herring, in his opinion, depends on the three conditions mentioned above, viz, *the channels*, *the wind*, and *the temperature*. The age of the herring when it approaches the coast to spawn for the first time, belongs to that line of investigations which Boeck has not been able to complete. Nowhere, as yet, has this been accurately ascertained. Some, have maintained, but without being able to furnish proof, that the age of the herring, when it spawns for the first time on the coast, varies between one-half and seven years. Boeck is in doubt, whether the herring when fully capable of spawning is exactly six years of age; but he has likewise no means of establishing his own opinion that it is only between three and four years old. He merely remarks that too little attention has been given to the fact that the herring when it spawns has by no means reached its full size, and he has found herring eight inches long which contained roe and milk.

Boeck also spoke of the so-called "*signs*," which in earlier times were closely observed, but to which, at present, little importance is attached. In those early days fishermen thought that all the phenomena which they observed in the sky and the sea must necessarily have some connection with their most important occupation; and we find that there were autumn, winter, and spring signs. Some of these signs for the autumn and winter consisted in the color of the sea, the redness of the sky, the kind of lower animals with which the sea swarmed, and even the roaring of the whales, and the rising of the salmon in the mountain-streams. The well-known Norwegian clergyman, Rev. C. Hertzberg, has, in the "*Budstikken*" (*the Messenger*) for 1821, written an essay on this subject, entitled "*On the Spring-herring and the Signs of its Coming.*" At present, however, people have lost all trust in most of these signs, and rely only on appearances furnished by the whale, by certain birds, and by the codfish, which, in many respects, furnish important tokens of the herring's approach. When the time of the herring fishery is near, different kinds of sea-gulls gather in larger numbers than usual; but it is not until the herring comes near the shore and near the surface of the water that these birds can find food among them, and thereby indicate, with greater accuracy, the locality of the fish. The case is different with the whale and the codfish, whose element is the sea, and who can follow the herring far below the surface. These therefore give more trustworthy signs of the herring's whereabouts than the birds; but, in pursuing the schools of herring, there is also a difference between the whale and the codfish which it may be interesting to notice. The whale can easily be distinguished, even when far out in the sea, as it is obliged to come frequently to the surface for the purpose of breathing, while the codfish always keeps below the surface, and can only be seen when caught. Both of these, while following the "herring mountain," for the purpose of obtaining food, may, however, furnish useful signs for judging of the probable condition of the herring fishery. The whale invariably keeps outside the great schools of herring, along the edges, never attempting to penetrate any farther. It is, therefore, an auspicious sign for the fishermen when they see whales in a wide circle, round some well-known fishing-place. They then know that the herring are approaching the shore in dense masses, and they may justly expect a rich harvest. In the year 1862, Boeck saw whales, in a long and imposing line, stretch from the northwest of Rövær as far as Utsire, and on the following day the fisheries commenced near Rövær and along the entire coast. If, on the other hand, the whales are seen to spread over a large area, or in small numbers, it is safe to predict that the herring will not approach certain places in large masses, but that they will be scattered, and thus the schools be smaller. If, after the fishery has been going on for some time, the whales are seen near the coast in the spawning places, it is absolutely certain that the herring are leaving the coast, although on that day fishing may be very good. In the same year, 1862, remarkable examples of the truthfulness of these phenomena were witnessed. The codfish does not exercise the same influence on the masses of herring that the whale does. Being a very greedy fish of prey, it plunges into the school of herring, scatters them, if possible, surrounds the frightened fish on all sides, pursues them fiercely, and often drives them toward the shore long before the chief mass of the school reaches there. The approach of such smaller scattered schools, before the fisheries commence, are termed, by the Norwegian fishermen, "sejejag," (codfish-chase.) When the school approaches the shore, the codfish is found not only on its edge, but in the middle of it; and if codfish are caught having herring in their stomachs, it is a sign that the herring fishery is near at hand. Of the greediness of the codfish, and its power to scatter the herring-schools, amusing illustrations may frequently be seen in the full seines. This sight is, however, more amusing to the spectator than to the owner of the seine, as it frequently happens that the scared herring press the seine down so heavily as to allow them to escape. Seine-fishermen are, therefore, afraid of the codfish. If the schools are already scattered before coming near the shore, the codfish is found mixed with the herring during the whole fishing season; and it is not a sign of favorable fishing when, in the beginning of the season, codfish are caught with the herring.

The herring may also be observed spawning within the nets; and, when it is free, it spawns in inlets and on the large flat places at the bottom of the sea, which are covered with rough gravel, ("flak,") where the roe sometimes lies in such enormous quantities as to fill the dredge entirely, when cast in such places. This roe does not, however, lie loose, but is firmly pasted to the bottom by a peculiar glutinous substance which hardens in the course of half an hour, and which, with the rough gravel, forms large cakes. It may happen that violent storms disturb the bottom to such a degree as to tear off the masses of roe, and Boeck relates a very interesting case of this kind. One year such an enormous mass of herring-roe was driven by storms up the Jæder Bay that cart-loads of it were taken away to be used as a fertilizer for the fields, and hogs also fed on it for many days. In these masses of roe the eggs have a certain invariable position, with an opening in the shell of the egg, and the so-called "micropyle" turned upward, so that the fructifying male semen can enter easily. The male fish pour their milt (semen) over the masses of roe which have been deposited by the females, and it is therefore evident that in their approach the females precede the males. In the commencement of the fisheries more females will be caught, and toward the end more males. This was the case near Skaareholmene, and may be a fact of practical value. After there had been very good fishing for some time, one day the greater part of the herring brought to the salting-houses were found to be male fish. Boeck was therefore of the opinion that the approach of the herring had ceased. This was really the case, and it was not at all necessary to explain this circumstance, as was attempted at the time, by a steamer having scared away the herring by the noise of its machinery.

Boeck did not undertake to describe minutely the development of the embryo in all its stages, although it forms a subject for exceedingly interesting investigation, to observe how it is formed from the egg; how the organs by degrees grow together; how the heart begins to beat and the blood to flow. But as all this could not throw any more light on the main question, viz, "whether the spring fisheries are to disappear from the southern fishing-places," Boeck passed over it very briefly. He did say, however, that when the herring emerges from the egg it differs so much in its shape from the grown herring that it resembles rather an eel; and even after it is a month old its shape is not at all like that of the mature herring. In fact, the difference between the young and the old fish is even much greater than that existing between different species of herring.

Boeck also referred to a few species of herring, concerning which opinions have been divided, viz, the great herring and the spring herring. He exhibited a drawing of a great herring from Langenæs, and another of a large spring-herring from Brönö. With regard to the shape of the great herring, it will be found that the upper outline from the end of the head to the beginning of the back fin is curved, while in the spring-herring it is straight. Its greatest height also is, in proportion to its length, more than that of the spring-herring; and if two equally large specimens are compared, it will be seen that in the great herring the back immediately in front of the back fin is much broader than that of the spring-herring, and that the outline of the belly in the latter is less curved. Boeck has not been able, except in these respects, to discover any difference, although he was told that, according to popular opinion, there was a great difference between these two kinds of herring. Several years ago he was offered an opportunity in Haugesund to examine and compare both kinds with great minuteness. A merchant from Nordland brought a quantity of great herring to Haugesund to be exported. The government officials demanded the usual spring-herring tax on these fish, which the merchant refused to pay, as they were not spring-herring, and as he had already paid tax on them in Nordland. The government officials wished in this case that Boeck would furnish some sure and easily marked characteristics by which the great herring could be distinguished from the spring-herring. He found this at the time to be impracticable, although he examined a great number of both kinds. But when he heard that several persons considered themselves capable of determining in what the difference consisted, he had an interview with them, at which one said that one important difference was, that the membrane of the belly is white in the great herring, but black in the spring-herring. This, however, was found to be only partially the case in some pressed and salted great herring, while with all the others not the least difference could be discovered. Another said there was a difference in the scales, but the cause of this was that the great herring, by a less careful treatment, were deprived of its scales, while they were found in the spring-herring. There was therefore not a single point by means of which these two kinds of herring could be absolutely distinguished, with the exception of the circumstances mentioned above, and these were due simply to the superior fatness of the great herring. Some time after this, however, a characteistic was mentioned by which both kinds it was thought could easily be discriminated. It was affirmed that the great herring was destitute, it was said, of certain bones in the back, which the spring-herring had. Boeck, on hearing this, thought it highly improbable, as the structural forms of the different kinds of herring had been carefully examined, and the conclusion reached that they are entirely the same in most kinds inhabiting the northern hemisphere; while only a few exceptions are found in those of the southern hemisphere. The "*procesus spinosus superior*" is double in the herring, which is not the case, for example, with the haddock. On the sides of this bone there are seen two fine bones, and the argument turns on the question whether these are found or not. If we examine, however, a great herring minutely, these bones are found just as in the spring-herring; but they are frequently overlooked, because the flesh of the great herring is much fatter and looser, and in cutting through its back the knife will easily pass through these soft bones; while in the spring-herring, whose flesh is less fat and therefore apparently coarser and harder, the knife will not pass through so readily, but will glide along the bone when it meets it. In carefully cutting open the fish, the two bones above mentioned will easily be found in both kinds.

Of all the assumed distinguishing marks, then, between the great herring and the spring-herring, only the greater fatness of the former remains. It might be thought that this fatness is caused by the better food which the great herring finds at the greater depth of its abode; but this cannot be the sole reason. Indeed, there is another and more important cause of this phenomenon. In seeing the great herring lying in the boat after it has been caught, one is immediately struck by its smooth and beautiful appearance; while the spring-herring, under the same circumstances, is frequently covered with a filthy slime, a mixture of roe and milk, and in pressing the belly of a spring-herring a stream either of roe or milk flows out, which is not at all the case with the great herring. In opening both, one finds that in the female spring-herring the roe-bags are coarse-grained and soft; while in the female great herring they are fine-grained and hard. It might be supposed that this is a specific difference between them, which, however, is not the case, since it is only caused by the roe-bags being more developed in the spring-herring than in the great herring. In taking the roe-bag of the spring-herring, especially that of a salted one, as its structure can be more easily distinguished, one will find, on opening it with a fine pin, that the roe-bags are not what one would suppose them to be—bags filled with eggs—but that their structure is more complicated. With the aid of the pin, one will easily be able to lay open and follow up certain fine vessels in which the eggs seem to lie, and this is actually the case. The whole roe-bag consists of an infinite number of fine tubes, which, perhaps, can best be compared to greatly-elongated fingered gloves lying exceedingly close to each other and connected by the so-called "binding texture," which is sometimes hard and stiff and sometimes soft. Where, to continue the figure, the fingers of the glove would join that space which is occupied by the hand, a channel leads the eggs out along the whole length of the roe-bag, and its continuation is another channel which opens in front of the dorsal fin. In the finger-shaped channels, the eggs develop from small cells which gradually grow larger. In the great herring, the egg-cells are very small, and the egg-tubes are connected with each other by a thick layer of binding texture filled with fine blood-vessels. In the spring-herring the egg-cells are more than four times as large; the egg-tubes are very thin and fine, and there is scarcely any binding texture. In breaking the roe-bag of the great herring in the middle, it seems to consist only of a somewhat brittle-grained mass;

while in the spring-herring, it is softer and tougher. There is, therefore, no other difference between the roe-bags of the great herring and those of the spring-herring, than that the roe-bag of the former is less developed than that of the latter. In the early part of the fisheries, the roe-bag of the great herring is least developed, while toward the end, certainly in those caught near Selsövik, it is much more developed and softer, and we even find herring among them which are ready to spawn. The first herring is, on the other hand, much fatter than this last from Selsövik, from which it is evident that the fatness decreases in proportion as the sexual organs develop. When the herring comes in from the sea in order to spawn, it, like the haddock, takes no food during the spawning time, and must, therefore, secure the material which is necessary for the development of the roe-bags from its own body; it therefore grows thin in proportion as the sexual organs develop.

Boeck met with a beautiful illustration of this in a great herring from Skarsfjord, six miles north of Tromsö. Among the great herring which he had occasion to examine there, he saw one that was much fatter than the other, and which, on account of its size and beauty, he determined to take home and preserve in alcohol, but he finally opened it to ascertain the cause of its excessive fatness. He found that the herring was a male, and that the right milt was well developed, while, on the left side, only small traces of milt were found. He then observed that an intestinal worm had taken up its abode in the left milt, and had hindered its development. On the same side were found large stripes of fat twisted around the digestive channels; and as this herring had thus not been able to develop its whole milt, it was not obliged to use all the fat in its body, so that some of it lay on that side where there was room for it. Hence it is clear that in this respect there is no difference between the great herring and the spring-herring. He was told by old seine-fishermen that during the first year of the spring-herring fisheries this herring did not approach the coast in a condition ready for spawning, but that it became so only toward the end of the fishery, and that then the herring was much fatter than it is now. Perhaps there is a similar change in store for the great-herring fisheries, so that after some years the great herring will also come near the coast better prepared for spawning, and will consequently be less fat.

Boeck then gave his opinion on the probable future of the spring-herring fisheries in the so-called southern fishing-places, where he had made a number of observations. In what he said he did not wish to assume the character of a prophet; he would only give facts, both for and against, and he would, as he had done before, leave it to each one of his hearers to draw from these facts the conclusions that seemed to him most correct. Four years ago, when the fishery was still good, he had warned people not to put too much faith in its continued success, and not to expend too large sums in the erection of new salting-houses, or the extension of old ones. At that time his warnings were received unfavorably, as the practical fishermen entertained different opinions, and thought that scientific investigations were of no use as regards the spring-herring fisheries. Many also thought that care should be taken not to say anything which would alarm people in prosecuting their labors. Boeck, nevertheless, deemed it his duty, first privately, and then publicly, in his work "*On the Herring and the Herring-Fisheries*," to make known the results of his investigations, which he thought were of great importance to the fishermen. If the spring-herring disappeared, and his predictions thus became true, he deserved the thanks of all for having given timely warning of the evil impending; and if his advice had been heeded, thousands of dollars might have been saved, which otherwise must be lost in a trade that was doomed to disappear. People ought not to rely too confidently on the spring-herring fishery as a constant source of income. In examining the history of the fisheries, it would be seen that at times they had been very productive, and then, again, had dwindled down to almost nothing. The fisheries had been abundant during the reigns of Hakon Adelsten and Olaf Trygvason; also, from 1217 to 1340, during which period the spring-herring fishery was of such importance that the law of Magnus Lagaböter contains several paragraphs in reference to them; then again, from 1559 to 1572; from 1640 to 1688; from 1698 to 1784; and finally our period, from 1807 till the present time. It will thus be seen that the herring *can* disappear, and that the fisheries *can* decrease. But now comes the important question, "What can be the cause of this?" Two classes of causes were assigned. The mass of herring has either decreased by being caught in too profuse a manner, by being devoured by fish of prey, or by being destroyed in some other manner, or else the schools of herring have wandered to other places. Professor Nilsson seemed, in the beginning, favorable to the causes first named, but later, he has decided against them, chiefly on the ground of better information. Government Inspector Widegren, however, still clings to them. Boeck himself does not believe that the mass of spring-herring has decreased, but thinks that they no longer approach the shore.

Wherever the herring-fisheries have disappeared the fishermen have been left in great want and the merchants have lost an important source of income. In consequence of the cessation of the fisheries the country has suffered directly and indirectly, and it is therefore not to be wondered at that people in all classes of society have thought over the matter and have tried to discover the cause of the decay. Many reasons were assigned, but none seemed to be plausible. What was given as the cause of the herring's disappearance in one place was found not to be the cause in another. Laws have thus been based on very vague suppositions, and large sums have been expended for carrying on the fishery according to new and hitherto unknown methods; such as by stationary nets in the deep sea, or by drag-nets, but all in vain. The promises of learned men proved futile, and hope alone kept up the courage of the fishermen and merchants. In earlier times, when people did not seek the cause of various phenomena in nature, but judged things by their appearances, it was thought that God had blighted the herring-fishery, because men had become ungrateful and abused his gifts. Sometimes special causes were assigned for the Divine wrath, and Absalon Pedersen Beyer thought that the herring-fishery disappeared because Cristopher Walkendorph had taken tithes away from the clergy and used them for building purposes. Even in our own days, (1835,) we see something similar to this, in the fact that several members of the British Parliament declared in the House of Commons that the herring had disappeared from a place on the coast of Ireland because a priest had demanded tithes of his parishioners. Casper Seatus tells us, that in the year 1830 the herring left Heligoland, where at that time about two thousand people gained their living from the fisheries, because some young men, in mere wantonness, had cruelly abused a herring. In Stavanger, according to the account of Professor Kröyer, the fishermen, in the year 1830, did not allow a wealthy citizen to hold a masked ball in his own house, for they thought that this would vex the Deity, and that as a punishment He would cause the herring to leave the place.

When this superstitious belief yielded to the better suggestions of the understanding, the decay of the herring-fisheries was sought for in natural causes. In former times it was believed that noise could drive the herring away, and, in 1580, to shoot on board ships was prohibited at Bohuslän. This belief was common even in later days. Thus it was thought that the herring left Bohuslän in 1697 in consequence of the discharge of the guns during a naval engagement, (in the war between the Swedes and Danes;) and the disappearance of the herring from Dynekilur (a gulf on the coast of Sweden) was generally ascribed to the guns of Tordenskjold's (a Danish admiral) fleet. When the herring returned in 1750 a law of 1756 fixed a penalty of 500 rigsdalers ($250 gold) for discharging a gun from any fortress on the coast, on men-of-war, and on merchant-vessels during the period when the herring was approaching; and as late as 1808 the thunder of guns (in the war between Denmark and England) was considered the cause of the herring's disappearance. Even now the herring fishermen do not like the noise of the steamers, and in 1862 they were not permitted to cross the Silde-fjord near Karmö. In Ramsdalen steamers were not considered so obnoxious, and during the great-herring fisheries no instance is on record of the herring having been driven away by the constant passing and re-passing of steamers. In Scotland careful observations have shown that the herring has disappeared from bays which have never been touched by a steamer, and have remained in some portions of the sea where steamers pass daily. Professor Nilsson considers all noise detrimental to the herring-fisheries, and to show how easily the herring can be frightened, he relates that, in 1756, when the fisheries near Rikfjord were very abundant, the herring left when eight men-of-war anchored there, and this only because the ship-bells were rung every evening, all shooting having been forbidden. He adds that the cause of the herring's disappearance in 1808 was the constant noise in the salting-houses, produced by the manufacture of barrels, and by other work, all the harbor being full of ships and boats waiting for their cargoes of herring, the whole coast and all the islands swarming with people of every age and sex, who had gathered there for the sake of earning money. In the evening there was music and dancing in the fishing-places, and therefore Nilsson says it was no wonder that the herring left.

In Norway the herring does not seem to be so much disturbed by noise, but other causes of its disappearance are given. In Flækkefjord people thought the cause of the herring's departure in 1859 was the strong glare of the List light-house. In other places, however, there was no objection to light-houses; while in Utsire it was even thought that the fisheries began to be very abundant just about the time when the light-houses were erected, the herring, as they supposed, being attracted by the light. The opinion that light-houses have any influence on the herring's appearance or disappearance has now been entirely abandoned. Formerly many supposed that the bad odor spreading over the sea from the burning of sea-weeds caused the herring to leave, and in many places laws were demanded forbidding the act. The burners of sea-weed, however, were of a different opinion, as well as the owners of glass-houses, who used the burnt sea-weed. Professor Rathke was commissioned to examine this matter, and he found that the herring had left places where sea-weeds had never been burned, and continued in others where sea-weeds were burned constantly. It has also been said that the cuttle-fish was a cause of the herring's disappearance, but Boeck has never found a single cuttle-fish in the southern fisheries, while he saw large numbers of them near Langenæs, and many instances were related how the cuttle-fish loved to pursue the herring; but in no instance could it be proved that it had ever driven away even the smallest school.

At one time it was supposed that impurities at the bottom of the sea had an influence on the herring-fisheries, and that the herring avoided those places where many impurities were found, because they were unfavorable to the development of the spawn. Such impurities were generally produced by employing imperfect fishing-implements, which left greater or less masses of herring at the bottom, and also by various kinds of refuse being thrown into the sea, which might make it unfit for spawning. On the coast of Norway the former opinion was quite prevalent, it being maintained that in seine-fishing great quantities of dead herring were left in the water. Boeck, during his first stay at the fishing-stations, had his attention directed to this. He also saw that the nets with narrow meshes, which the fishermen have recently begun to use, did not permit larger herring to put the whole head through the meshes, but that only the front portion entered, so that the fish died at last in endeavoring to push through the meshes, as it never moves backward. When the net is hauled in, these larger herring fall off and remain at the bottom of the sea. He had several times examined such places after the fishing was over, but had never found any large quantity of dead herring at the bottom, even when he used the dredge after particularly rich fishing-seasons. With the water-telescope he could not penetrate to such a depth, but he thinks that the account of great masses of herring lying there is very much exaggerated. On another occasion he saw a large quantity of dead herring lying at the bottom of the sea, but he felt convinced that this could not possibly influence the fisheries, and experience has shown that he was right. When the current is very violent, nets set in exposed places will be driven together and become entangled, so that it is impossible to separate them. He thus witnessed at Björkevær the sinking of such a mass of entangled nets which had been cut off from the buoys, in order to save something. It was important for him to examine the place where this was done, and he went there about two months after this occurrence. The nets were then so much decayed that only small pieces could be recovered, while of the herring only bones and gristly parts were found. But the fragments of the nets and herring were everywhere covered with carrion-eating animals, which had gathered in great numbers. Many other animals were also found. When, later in the same year, he requested some one to procure for him specimens of some of these animals, it was discovered that there was not a trace left of nets, herring, or animals; so that about four months after the close of the fisheries the bottom was quite clean again.

It is, therefore, evident that dead herring could not make the bottom so impure that a year after it should be unfit for the herring to spawn in; and experience has also shown that this is not the case. On the other hand, reports from Sweden, Scotland, and other countries, affirm that seines may be very detrimental to the fisheries, by leaving a great many dead herring at the bottom, and many instances of this are mentioned, such as the well-known fishery near Golten, where, after a great many herring had died during one night, the fisheries were never again successful. Boeck also discovered, several times after seine-fishing, by examining the bottom with the water-telescope, a considerable number of dead herring; but he thinks that the injurious influence is very much exaggerated. Where seine-fishing is carried on in open places the current, sea-animals, &c., will very soon purify the bottom, and only where very large masses of fish have died in deep and narrow inlets will some remains be found the following year. The cause of the herring not returning to such places might rather be occasioned by its irregular habits than by dead fish. In order to adduce more substantial proof of this he caused, according to the government inspector's account, to be marked on a map all those places where seine-fishing had been carried on since 1853, and he found that in some there had been considerable seine-fishing year after year. It was, therefore, beyond a doubt that seine-fishing was by no means so detrimental to the fisheries as was generally supposed. That the seines brought up all the young herring, was entirely unfounded, or, at any rate, but rarely the case; and the small herring, which are frequently caught toward the close of the fisheries, often contain roe which has not been fully developed. He was informed at the great-herring fisheries, and also saw for himself several localities, where large masses of dead herring were said to be, at Selsövik, where, at the bottom of the deep and narrow Gjeres inlet, between 10,000 and 15,000 tons were lying. The following year would show whether they had decayed or not.

In Sweden, the disappearance of the herring had been chiefly attributed to refuse of fish-oil which had been thrown into the sea. This had formed a theme of discussion as far back as the middle of the last century, and Professor Nilson had clearly stated the reasons which favor this opinion. It will be seen that with regard to Bohuslän, his opinion has met with much opposition, while just as many instances are given tending to show that the refuse of fish-oil has no such injurious results. Boeck has not been able to find that these heaps of refuse are so near each other that the herring could find no suitable spawning-places between them. Even if the refuse of fish-oil were the cause of the herring's departure, this could not have been the case in former times, when the herring disappeared from Bohuslän, as at that time there were no oil-refineries either in Norway or in the Limfjord, (in the north of Jutland.)

Boeck's investigations therefore prove that all these causes, which have been mentioned as being instrumental in driving the herring away at different times from different places, either amount to nothing, or have not held good in all cases. He endeavored himself to find causes of the herring's disappearance which would better stand the test of science, but for a long time sought in vain, till at last he thinks that, through the study of history of the herring-fisheries, he has found reasons that will hold good in all cases. During the first year of his stay at the fishing-stations it occurred to him that the herring-fisheries, which formerly had commenced much earlier in the season, sometimes even before Christmas, had more recently begun later in the year, and he was unable to find any special reasons for this. He also noticed that the herring-fisheries were very unproductive near Skudesnæs, where formerly they had been very abundant, and that this could not be ascribed to storms or to any other ordinary cause. In the following year the fisheries commenced still later, and in carefully examining this whole matter he found that at the commencement of the fisheries in 1808 the herring approached the coast in February, while during the following years it came earlier every year, till recently it again came later and later in the season, until this year it came at the end of February. In his work, "*On the herring and herring-fisheries*," he has given the exact date for every year when the herring approached the coast. From these dates it is seen that there is a certain regularity in the time of the herring's approach, which is but slightly modified by storm and cold. In examining the localities where the herring fisheries are carried on, it will be seen that there is likewise a certain regularity in them. From 1808 and 1819 Skudesnæs was the chief seat of the fisheries on the southern coast, while north of Karmö and Espevær only few herring were caught, not counting, however, the so-called Bergen fisheries from Selbjörnfjord to Feiö. From the year 1819 the herring also began to appear in large masses near the Hviding Islands, Tananger, and Roth, and in 1825 it passed south of Jæder. From 1824 to 1838 we notice a constant tendency in the herring to move south, the schools in that direction increasing every year, so that rich fisheries began to spring up, first near Egersund, then near Sagndal, Rægefjord, and Hækkefjord, while at the same time the fisheries near Skudesnæs gradually grew less abundant. From that time, the herring began again to retreat, and soon disappeared completely south of the Jæder, and more recently from the Hviding Islands and Skudesnæs; while, on the other hand, the fisheries became very important near Rövær. During the last year the fishing has shifted north of Espevær. If this regularity in the change of time and place of the herring movements could only be proved with regard to the southern spring-herring fisheries, it would be an important fact, yet not important enough to allow us to deduce laws that would be applicable in all cases. Boeck, however, found that such was really the case. In examining the information scattered in merchants' account-books, and letters which he was permitted to use in Stavanger, he found that this same law applied in former as well as in later times, and that there was the same regularity in the change of time and place of the herring-fisheries. He has treated this subject at length in his work, "*On the herring and the herring-fisheries.*" Even in examining the dates regarding the herring-fishery in the year 1575, given by Absalon Pedersen Beyer, we find that the fisheries in the beginning of that period commenced toward the end of February. This law is therefore found to apply to three different periods. The same phenomena were observed not only here, but also in other places. This can be shown most conclusively in the Bohuslen fisheries. Boeck found that this regularity was very apparent there in the great fisheries which closed in 1808. In 1756 the fisheries commenced near Styrsö and Riföfjord, south of Gottenburg; from there the herring went constantly northward, and in 1773 herring were caught near Strömstad, and, in 1778, near the Hval Islands. As regards the time of its appearance, the herring in 1750 came in October, and from that time always a little earlier, till 1762, when it came on the 16th of August; then again gradually later. For example, in 1780, toward the end of October; 1790, in the middle of November; 1800, about Christmas, and toward the end of that period (about 1808) in February. The same was also the case during the great fishing period, from 1556 to 1590. It will thus be seen that the same law has held good for several centuries and in two different places.

In 1868, when the fisheries were still very abundant, Boeck thought that he was fully justified in predicting that a change of the fisheries was near at hand; and although in the beginning he met with violent opposition, he saw his predictions verified from year to year. He finally mentioned some other facts. It has been a wide-spread opinion that the herring-fisheries change alternately between the coast of Norway and that of Bohuslän, and that the herring moved between these two places, an opinion which was strengthened by the fact that when, about 1808, the schools of herring left Bohuslän, they made their appearance on the coast of Norway. But Nilsson had already shown that the Bohuslen herring is a totally different species from the Norwegian, and Boeck has proved conclusively that this difference has existed from time immemorial. He has furthermore proved that these two species also differ in the circumstance that they spawn at different seasons of the year, the spring-herring spawning in the spring, and the Bohuslän herring in the autumn. He has also been able to prove by historical researches that, from the very earliest times, both these herring-fisheries have been carried on at the same season, and that only during the last fishing period there was any difference in time. Nor has he found any connection existing between the Norwegian, Dutch, and Danish fisheries. Such a connection may possibly have existed between the Bohuslän fishery and the Dutch-Scotch fisheries, as some data seem to point in that direction.

If the herring should leave the coast of Norway, it will, in all probability, be obliged to seek the other channel, ("Rende,") which Boeck has marked on his map. At a distance of from ten to fifteen miles from the coast of Norway, large banks are found, that have their roots in the North Sea, where the depth of water varies only between 70 and 50 fathoms, a depth which is very favorable to the development of the spawn. Boeck thinks that if the herring disappears from the southern coast of Norway, the fishermen and merchants will suffer in the beginning, but not as much as in former times. The cod-fisheries which have recently commenced, and which he always found to come after a period of herring-fishing, would probably replace the herring-fisheries, after people had become accustomed to them, and had supplied themselves with the necessary implements. Besides, since the intercourse by steamers has become so common, and is even increasing, fishing-places that were formerly considered too remote will be used just as well as those which are near, and herring-fishing will assuredly be carried on at all times on the long coast-line of Norway. The periods during which the herring has disappeared have been neither as long nor as exclusive as is generally supposed; for although we know that the herring left Skudesnæs in 1784, it was caught near Bergen in 1787, and returned there in 1806, while it did not return to Skudesnæs till 1808. Nor has it remained entirely away during the intervening period, since in 1803 there might have been considerable fishing, if people had been prepared for it, for during that year the herring approached the shore in vast numbers.

VII.—PRELIMINARY REPORT FOR 1873-'74 ON THE HERRING AND THE HERRING-FISHERIES ON THE WEST COAST OF SWEDEN.

BY AXEL VILHELM LJUNGMAN.[1]

To the committee appointed to investigate the herring-fisheries on the west coast of Sweden :

Having been informed, on the 3d June, last year, by the secretary of the Royal Academy of Sciences, that, by a letter of His Majesty the King, dated March the 28th, I had, at the suggestion of the Royal Academy, been intrusted with the continued prosecution of the investigations regarding the herring and the herring-fisheries on the west coast of Sweden, I went to Stockholm in accordance with the wish of the committee, as expressed by their letter of the 13th of June, and remained there till the end of the month to gather all the necessary information and make every necessary preparation.

In the course of the summer, I visited the most important fishing-stations on the coast of Bohus-län to secure information and to make the necessary arrangements for investigating the fisheries which commence in the autumn. I left for Stockholm on the 23d of September to consult with the members of the committee, and to make myself acquainted with the literature of the subject in the library of the Royal Academy of Sciences. In consequence of sickness, I was compelled to remain in Stockholm till near the end of October, so that I was prevented from making any observations at the beginning of the fisheries. During the months of November and December, I visited all the more important fishing-stations on the central and northern coast,[2] where the fishing for small herring was carried on.

As soon as I received information, about the beginning of the year, that herring were coming in in great quantities, I went immediately to

[1] Preliminär Berättelse för 1873–'74 öfver de beträffande sillen och sillfisket vid Sveriges vestkust anställda undersökningarna. Af Axel Vilh. Ljungman. (Tryckt såsom handskrift.) Upsala, Ed. Berling, 1874. [8vo, 2 p. l. 74, pp. 1 l.] Translated from the Swedish by H. Jacobson. Original "printed as manuscript" by the author, [*i. e.*, not for general circulation,] Upsala, 1874.

[2] By the *southern coast*, I understand the coast from Salöfjord to Tistlarne, (Reports on Herring-Fisheries, p. 86 fr. 8;) by the *central coast*, the coast from Sälöfjord to Soteskär. (counted to the northern coast by the old fishermen; see Act Concerning Blubber-Refineries, pp. 120, 134;) and by the *northern coast*, the coast from Soteskär to the boundary of Norway. A somewhat different division of the coast has been made by *Dubb*, (Reports of the Royal Academy of Sciences for 1817, p. 34.)

Gottenburg, where I had an excellent opportunity for observing the herring-fishermen assembled together from all the neighboring coast. On the 24th of January, I went to Stockholm to consult with the committee, and to inform myself of the financial arrangements made for the observations. From the end of February till the beginning of June, I visited various localities on the coast of Bohus-län, to make observations and gather whatever information I could.

I went to Stockholm again on the 7th of June, at the express desire of the committee, to report on the progress and result of my observations.

Although I had some knowledge of the coast of Bohuslän and its fisheries, much time was, nevertheless, lost by my being unacquainted with many peculiar circumstances of importance for carrying on observations in the easiest and quickest manner. This knowledge can be acquired only by several years' intercourse with the fishermen. All the investigations, which were chiefly of a practical character, were on that very account entirely new to me, and, therefore, necessarily retarded my progress. My investigations were, moreover, impeded by the unusually stormy weather during the autumn and winter, by sickness, and by want of funds and apparatus.[1] Much time has also been consumed in collecting all that has been said on the subject in the very rich herring-literature, which, as far as possible, I endeavored to obtain.

I need scarcely say that the distrust and opposition with which the investigations were met, not only by nearly the whole population engaged in fishing, but even by those from whom assistance might reasonably have been expected, exercised a depressing influence, and will continue to do so in the future, though not, perhaps, to so great an extent. The rigid observance of section 22 of the fishing-law, and the milder ordinance of July 19, 1872, regarding the use of nets with narrow meshes,[2] increased the excited feelings of the coast-population, especially in the beginning of the year, when the herring came in in great numbers.

The almost uninterrupted journeys, which were especially troublesome in winter, on account of the apparatus which had to be carried along, and the brief stay made in each place, did not permit any thorough anatomical or microscopical observations, since these require a quieter sojourn in a suitable place, where all the necessary apparatus may easily be brought. As I did not consider it desirable and of practical use for the advancement of science to report on the special investigations which have been begun, but have not yet led to any definite result, the cause of the incompleteness of this first report will easily be understood; while this incompleteness was still further enhanced by the fact that the investigations were carried on uninterruptedly till the end of the year, thus leaving but little time for putting my notes into suitable shape.

In conclusion, I must draw attention to the fact that, as the investigations continue and more information is collected, much in this report

[1] See Chapter VIII.

[2] New Reports on the Herring-Fisheries, p. 3, 58, 59.

will probably have to be modified in future ones. I also hope that I shall then be able to make my report much more complete by means of observations made on the coast of Norway, in the Kattegat, and in the southern portion of the Baltic.

I.—ON THE DIFFERENT SPECIES OF HERRING AND SMALL-HERRING.

Even in olden times different *races* of herring were recognized, or at least names were given to them designating different kinds, as the idea of a variety or race was scarcely known to the traders and fishermen, who by those different names only wished to distinguish one article of trade from some other which was obtained at another place or time, or was considered to have a different value.

Among our Scandinavian naturalists, *Linné* was the first who described a kind of herring called in Swedish "Strömming," [a sort of small-herring,] as a separate species, under the name of *Clupea harengus β membras.*[1]

From *Dr. P. Dubb's* observations on the herring fishery of Bohus-Län,[2] we learn that the Bohus-Län fishermen, during the last great fishery, distinguished the so-called "old" herring, ("gamla" sill,) as it is called at present, as a "real sea-herring" ("rigtig hafssill") from the spring-herring, which is peculiar to the coast, and belongs to it exclusively. This last-mentioned herring was said to have a smaller head, to be thicker and shorter, and to resemble the Kattegat herring. To judge from an expression of *O. N. Löberg's*,[3] the Norwegian herring-fishers likewise make a distinction between the "sea-herring" ("Havsild") and the "fiord-herring," ("Fjordstoing.")

Professor Nilsson, in the year 1832, distinguished, besides the "Strömming," a large number of different races of herring from the southern and western coasts of Sweden and Norway, all of which, however, he grouped under two heads, viz: *sea-herring* (Hafssill) and *coast-herring*, (Skärgårdssill.)[4] This division, which was somewhat modified by him

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[1] Fauna Svecica. Ed. alt., p. 128.

[2] Kgl. Vet. Akad. Handl. f. 1817. p. 35, 44.

[3] Norges Fiskerier. Kristiania, 1864, p. 89, 90.

[4] Prodromus ichthyologiæ scandinavicæ, p. 23, 24. As this work is very scarce, and as the quotation is of special importance, it is given in full:

Clupea harengus Auctorum. Svecis *Sill.*

Sub hoc nomine latent plures species, vel, si mavis, varietates locales constantes, quæ in duas formas aptius abeunt:

1-mo *Forma oceanica* (sea-herring): capite, oculis et rictu minoribus; orbita $\frac{1}{20}$—$\frac{1}{22}$ longit. corp.; ventralibus sub anteriori $\frac{1}{8}$ pinnæ dorsalis; distantia a rostro ad pinnas pectorales intervallum æquante ventralium et ani, seu initii pinnæ analis:

1. oeresundica, Nostratibus *Räbosill* (boundary-herring).
2. scheldereensis, Nostratibus *Kullasill.*
3. *majalis*, Nostratibus *Grässill* (grass-herring).
4. *bahusica*, Nostratibus *Aflingssill l. Storsill* (great-herring).
5. hiemalis, Nostratibus *Norsk vintersill* (Norwegian winter-herring).
6. autumnalis, Nostratibus, *Norsk höstsill* (Norwegian fall-herring).

subsequently,[1] seems to have been adopted by all the Swedish ichthyologists, but has been questioned by *Professor Kröyer*, who says, in his great work on the fish of Denmark, that he is not convinced of the correctness of *Professor Nilsson's* distinction of different species of herring from the southern Baltic, the Kattegat, and Norway.[2]

From the western portion of the North Sea, *Yarrell* has described two analogous forms of herring as different species: *Clupea leachii* and *Clupea alba*,[3] the latter of which, however, is only a herring in an earlier stage of its development.[4]

In the year 1833, in testimony before a committee of inquiry ordered by His Majesty, the Bohus-län fishermen distinguished the following kinds of herring: 1. The so-called old ("gamla") herring, (which formerly came in every year from the North Sea; 2, the half-grown "*lottsil*," (so called from the Swedish word "lott," a kind of net,) found both toward the end of the last fishing-period and later, and which neither propagated nor was to be seen in its full-grown state near the coast; and, 3, the "spring-herring," or "grass-herring," belonging to the coast, and caught during the old fisheries as well as since. The distinctive marks assigned by the fishermen were very nearly the same as those which are generally employed by *Nilsson* and other professional ichthyologists in distinguishing the various species of herrings, viz, the size of the head, height of body, length of dorsal and ventral fins, size of scales, and time of spawning. The opinion of the fishermen was attacked by *Professor Nilsson* as being unreasonable, and all the Swedish naturalists adopted his views.[5]

Obs. Pulli omnium harum varietatum sub nomine *Småsill*—small-herring—(et adhuc minores *Ansjovis*—anchovies—) venditantur. Nomen vero *Småsill* etiam imponitur varietatibus minoribus formæ insequentis.

2: do *Forma tæniensis* (coast-herring), capite, oculis et rictu majoribus; orbita $\frac{1}{16}$—$\frac{1}{17}$ longit. corp.; ventralibus fere sub medio pinnæ dorsalis; distantia a rostro ad pinnas pectorales multo longiore quam a ventralibus ad anum, et æquante distantiam a ventralibus ad mediam analem:

1. Clupea Cimbrica. Sv. *Kivik-Sill* vel *Cimbrishamns-Sill.* In parte meridionali maris balthici.

2. Clupea membras. Sv. *Strömming.* In parte superiori maris balthici.

[1] Skandinavisk Fauna. IV, p. 492–498.

[2] Danmarks Fiske. III, p. 155–156.

[3] British Fishes, 3 ed., I, pp. 111, 121.

[4] The *Clupea alba* (subsequently called by Valenciennes *Rogenia alba*) was established by Yarrell for the celebrated "Whitebait" of English gourmands, but has been satisfactorily demonstrated to be nothing more than the young of the herring.—S. F. B.

[5] It does not, however, seem at all unreasonable to suppose that during the old Bohus-Län fisheries the great herring came from the North Sea, and that its descendants, the young herring, visited the coast of Norway, (see *Boeck*, Om Silden, p. 130; Trangrumsacten, p. 173,) presuming that the small herring (*lotsill*) coming to the coast of Bohus-Län from the sea, was descended, *e. g.*, from the Kattegat herring, spawning in autumn, or from the Limfiord herring, spawning in spring. *G. O. Sars's* investigations regarding the young or so-called summer-herring caught in Norway, are very instructive in this respect, as they point to very similar results.

Axel Boeck, who, in May, 1870, visited the coast of Bohus-Län for the purpose of investigating the herring-fishery on that coast, maintains that the herring which spawns there is "certainly only a coast-herring,"[1] which, moreover, is distinguished from the "old herring" by spawning in spring, the latter spawning in autumn, and that it must be supposed to have come from the North Sea, and possibly had some connection with the Scotch-Dutch herring.[2]

G. von Yhlen, who, during five years' fishing, had abundant opportunity for making observations on the matter, has, in his memorial of November 16, 1870,[3] addressed to the royal governors of Göteborgs-län and Bohus-län, given the result of his own experience in the following two assertions, viz: 1. That "that in none of those years had there been in the schools of herring coming in from the sea any mature herring capable of propagating; that therefore they could not be herring spawning in autumn like the so-called 'old herring;' and that 'the great mass of herrings have not remained till the beginning of the spring-spawning season;" 2. "That the herring of one year differ in shape and size from those of another," which observation is said to be "indisputable" and "valuable." *Von Yhlen* thinks that he is able to verify by his observations the testimony of the fishermen made before the committee in 1833, that the so-called sea-herring does not spawn on the coast of Bohus-Län and is not of the same breed as either the coast-herring or the "old" herring, as well as the assertions made by himself that the sea-herring are not of the same breed each year, and do not come from the same place, and that "they possibly may be young herring from various parts of the Kattegat and Skagerack, which are drifted along by marine currents till those able to spawn go to their various spawning-places."[4] In his report of 1870 on the salt-water fish of Bohus-län, he says, furthermore, that as "herring have nowhere been found to spawn on the outer coast," it would appear from this circumstance "that those herring which in autumn showed themselves in such enormous numbers on the outer coast, do not come from the small schools which are annually found spawning in the fiords."[5] In his report for the preceding year he supposes that the large number of sea-herring caught during that year (90,800 bushels) came from young herring which migrated from the fiords in September, 1867.[5]

The fishermen of Bohus-län, as was shown in the report on the herring-fisheries, published in 1843, have distinguished several races of herring by different names, most of which, however, only indicated differences

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[1] Om Silden og Sildefiskerierne. Christiania 1871, p. 126.

[2] Tidskrift for Fiskeri. V, p. 21-54.—Göteborgs och Bohus-läns Hushållnings-Sällskaps Qvartalsskrift. October, 1870, p. 123-160.—Om Silden og Sildefiskerierne, p. 121, 122, 126.

[3] Nya Handl. rör. Sillf., p. 11-17.

[4] Nya Handl. rör. Sillf., p. 12.

[5] Göteborgs och Bohus-läns Hushållnings-Sällskaps Qvartalsskrift, July, 1870, p. 16.

of age, or size, or a greater development of the sexual organs in one and the same kind, or such as are found at the different seasons when the herring are caught, and which the fishermen themselves by no means always understand. The more experienced among them, however, generally make a distinction between—1, the *spring* or *grass herring;* 2, the *sea-herring,* (lottsill;) and, 3, the *wandering-herring,* (stråksill,) which last is by some thought to be only a full-grown sea-herring. Concerning the three races thus recognized, and which have not been admitted from interested views, I shall give whatever I have been able to gather from the literature on the subject as well as from conversations with the most experienced and reliable fishermen, reserving for a future report all the facts I could gather from personal observation. I shall make it a special object to enter into a fuller examination than has been hitherto done of the various assertions made before the committee of inquiry in 1833, as these are viewed from such different stand-points, and are urged by the partisans of conflicting opinions.

THE SPRING-HERRING *(" Vårsill")*.

(Clupea majalis, Nilss.)

This *coast-herring,* which is found in the Skagerack, along the coast from Holland Point to Cape Lindesnœs, is distinguished by its comparatively small head and plump shape, and by its spawning on the coast in March, April, and May. Whether the Limfiord-herring, which likewise spawns in spring, belongs to the same race, I have not been able to ascertain.[1] The spring-herring is chiefly found near the mouths of the large rivers flowing into the Skagerack, where it is also caught with stationary nets. This race, which is distinguished from the larger one that has sometimes visited Bohus-Län in enormous numbers and has caused the famous "great" fisheries, is either entirely overlooked or considered incorrectly as the former "old" herring's insignificant descendant. It is chiefly caught in spring, during the spawning-season, but likewise, though in smaller numbers, at the end of summer and in the autumn and winter, while its young are caught at all seasons of the year, though rarely in any great number.

The spring-herring was during the old fishery, and even some time afterward, known by the collective name of "lottsill,"[2] but began to be gradually distinguished from it as a separate race.[3] The most common and oldest name for this race is *spring-herring,* (Vårsill.[4]) According to *Nilsson*[5] and *Ekström*[6] it is said, after having finished spawning,

[1] See Handl. rör. Sillf., p. 107 fr. 24.

[2] Handl. rör. Sillf., p. 88 fr. 23, p. 89 fr. 30, p. 100 fr. 13, 14, p. 102 fr. 25, p. 119 fr. 9, p. 127 fr. 19.

[3] See Handl. rör. Sillf., p. 107 fr. 24.

[4] Dubb, Kgl. Vet. Akad. Handl. f. 1817, p. 34. Handl. rör. Sillf., p. 90 fr. 31.

[5] Handl. rör. Sillf., p. 63 fr. 136.

[6] Praktisk afhandling, p. 10.

to lose some of its scales, and appear of a more greenish-color, and become inferior in quality, at which time it is called *grass-herring*, (Gräs-sill.) This name was generally understood by the fishermen at the inquest of 1833;[1] this is still the case, as they always understand thereby a herring which frequents and is caught on grassy bottoms, although at present this name is perhaps more generally used in another sense. On the northern coast of Sweden, as well as in the neighboring portions of Norway, the young of more than one year of the coast-herring are called by this name. By *May-herring* we understand smaller, but often very fat specimens of the spring-herring, which toward the end of spring are caught in the same places where formerly the great spring-herring was caught. It is often filled with insects, and therefore becomes easily damaged, which circumstance no doubt accounts for Nilsson's report as to its poor quality.[2] It is called *summer-herring* when caught toward the end of summer.[3] By *autumn-herring*[4] they understand on the northern coast the same herring, if caught during the beginning of autumn. Some see in this herring a different race from the spring-herring, although they can mention no other difference than that the autumn-herring is somewhat larger and probably spawns somewhat earlier (in February.) Autumn-herring seems to be only a more recent name, which has replaced that of "summer herring." By "*ganesill*"[5] the same fish as the summer or autumn herring is understood. The name "*Istersill*"[6]—lard-herring—is synonymous with "summer-herring," although other herring are sometimes called by that name. "*Knubsill*"—plump-herring—is a name given to the coast-herring, on account of the short and plump form of its body. "*Fetsill*"—fat-herring—the coast-herring is called when it has fully-developed sexual organs,[7] a reminiscence of the old fisheries, when the full-grown herring was fattest and most valuable, on which account it also, toward the end of the fishing period, got the name "*Väljesill*"—select herring.[8] "*Aflingssill*"[9] means the same as "fat-herring." "*Höljesill*,"[10] or, as the Norwegians call it, "*Fiordstöing*"[11]—fiord-herring—is another name given to the coast-herring, because it sometimes frequents the deep fiords. By the

[1] Handl. rör. Sillf., p. 119 fr. 9, 10, 16, p. 126 fr. 16, 17, 18, 22, 23.

[2] Handl. rör. Sillf., pp. 131, 136.

[3] Handl. rör. Sillf., p. 107 fr. 25, p. 127 fr. 19. *Ekström*, Öfvers. af Kgl. Vet. Akad:s Förhandl. f. 1846, p. 20.

[4] It seems that formerly the sea-herring or so-called "old-herring" was sold under this name. See *Dubb*, Kgl. Vet. Akad:s Handl. f. 1817, pp. 35, 44.

[5] Handl. rör. Sillf., p. 89 fr. 30, p. 119 fr. 9, pp. 45, 136.

[6] Handl. rör. Sillf., p. 127 fr. 19, pp. 131, 136.

[7] *Ekström*, Praktisk afhandling, p. 11.

[8] Handl. rör. Sillf., p. 98 fr. 5, p. 112 fr. 17. There seems, therefore, not to have been any fishing of "May-herrings"—so-called "maatjes"—during the old fishery, and the word "fat-herring" has therefore in Bohus-Län got quite a different meaning than in Norway and other countries. *Ekström*, Praktisk afhandling, pp. 10, 11.

[9] *Nilsson*, Handl. rör. Sillf., pp. 16, 45, 46, 62, 70, 134.

[10] *Yhlen, G. von*, Göteb. o. Boh. läns Hush. Sällsk. Qvartalsskr., July, 1867, p. 51; 1873, p. 205.

[11] *Løberg*, Norges Fiskerier, p. 89.

name "*Tjogsill*," or score-herring, (in Norway "*Snesesild*,") all herrings of such a size as can be sold by the score are understood.[1]

The young of the coast-herring are called "*Sillögon*,"[2] (herring-eyes,) "*Sillmör*," or "*Sillmyr*,"[3] (tender-herring,) and "*Sillstagg*,"[4, 5]—in the neighboring portion of Norway "*Sildemaur*," or "*Sildegnu*,"[6]—till they are one year old, when they are called "*Grässill*," (grass-herring,) "*Småsill*," (small-herring,)[7] and "*Smålodda*,"[8] (small "lodda,") till at the age of two years they reach a length of five to six inches, when they begin to be caught in the large nets, and are known by the general name of "*Lottsill*,"[9] or "*Halfsill*," (half-herring.)[10] The coast-herring is said to be fatter and plumper than the sea-herring, from which, according to some, it is known by the same characteristics which distinguish the mature spring-herring from the sea-herring of the same size.

THE SEA-HERRING ("*hafslottsill*").

The kind of herring called "sea-herring," which during winter comes in great numbers to the coast of Bohus-län—more regularly, however, on the southern coast and the southern portion of the central coast—is distinguished by its comparatively large head, its more elongated shape, and the great size; all of which characteristics are, however, only distinctly discernible in the larger specimens, (called "*storlodda*," *i. e.*, "great *lodda*,") which are found in small numbers among the medium-sized, two-year-old herring, in respect to whose relation to the other herring, however, opinions are divided.[11]

It is by some supposed to spawn at the beginning of autumn, (like the "old" herring of former times,) because the larger specimens which have been caught were usually empty, and would, consequently, when it comes to the coast of Bohus-län, be nearly half a year older than the coast-herring. At the meetings held by the committee of inquiry in 1833, the fishermen of the Bohus-län coast unanimously declared that the "sea-herring" ("*lottsill*") "goes away from the coast" before it gets mature;[12] and some of them were, therefore, of opinion that it

[1] *Rasch, H. & Berg, B. M.* Betænkning og Indstilling afgiven af den til Fiskeriernes Undersøgelse i Christiania—og Langesundsfjorden ved Kongel. Resol. af 28 de Mai 1852, nedsatte Commission, p. 32.

[2] *Ekström*, Praktisk afhandling, p. 9.

[3] *Nilsson*, Handl. rör. Sillf., pp. 45, 70.
Ekström, Praktisk afhandling, p. 10.

[4] *Nilsson*, Handl. rör. Sillf., pp. 63, 70, 134.
Ekström, Praktisk afhandling, p. 10.

[5] These and some of the following names are merely differences of dialect, and therefore almost untranslatable.—*Translator's note.*

[6] *Rasch & Berg*, Betænkning og Indstilling, p. 32.

[7] *Nilsson*, Handl. rör. Sillf., p. 46.

[8] *Nilsson*, Handl. rör. Sillf., p. 137.

[9] *Nilsson*, Handl. rör., Sillf. pp. 70, 63, 66.

[10] *Nilsson*, Handl. rör. Sillf., p. 46.

[11] See what is said regarding the "*Stråksill*"—the "wandering-herring."

[12] Handl. rör. Sillf., p. 102 fr. 24, p. 112 fr. 15, p. 117 fr. 14, p. 129 fr. 33. *Nilsson*, Handl. rör. Sillf., p. 47.

spawned "out in the sea," whither it went on leaving the coast,[1] while others maintained that it was a small kind of herring which never got any larger[2] and never propagated its race, but was a "direct production of the water;"[3] views which are still held by some people.[4] Its spawning-places, the parts of the sea whence it comes and whither it goes, are thus not known; but if it should really come from another race of herring than that belonging to the Skagerack, it could not come from any other place but the North Sea, the Limfjord, or the Kattegat. The fact discovered by *G. O. Sars* that the young herring descended from the Western Norwegian winter-herring stays generally much farther toward the north, near the northwestern coast of Norway,[5] furnishes an example of a young herring or sea-herring, like that found on the coast of Bohus-Län, paying regular visits to a coast where it is not born and where it does not spawn.

The Swedish word "*lottsill*" is supposed to be derived from the old fisheries, and originally meant a smaller kind of herring, or one of uneven size, not suitable for an article of trade,[6] in contradistinction to the more even-sized herring, which was sold to the salting-establishments or herring traders. "Lottsill" was consequently a collective name, and meant not only half-grown herring, but also larger herring of another kind than the good herring,[7] and therefore, following the example of others, I have used the term to distinguish it from the other races of herring, although it ought in course of time to be exchanged for a better one, since it has not become popular, and is perhaps even based on false premises. Nowadays, since the "old" herring has been forgotten, the term "lottsill" is often used by the fishermen to distinguish a kind of herring different from the spring herring.[8] It is even called halfsill, (half-herring,)[9] and the few large ones found among them "storlodda," (great lott-herring.)[10]

THE WANDERING-HERRING, ("*Stråksill.*")

A large, but thin species of herring, which is found in small numbers late in autumn and in winter, and which is distinguished from the

[1] Handl. rör. Sillf., p. 111 fr. 10.

[2] Handl. rör. Sillf., p. 91 fr. 38, p. 92, p. 95, p. 106 fr. 21, p. 107 fr. 26, p. 112 fr. 15.

[3] Handl. rör. Sillf., p. 103 fr. 33.—*Nilsson*, Handl. rör. Sillf., p. 37.—Wright, W. von, Handl. rör. Sillf., p. 168.

[4] Quite a different opinion, viz, that the "*lottsill*" was descended from our coast-herring, seems to have been quite common on the coast of Bohus-Län. See *Lundbeck*, O., Anteckningar rörande Bohuslänska Fiskerierna, i synnerhet Sillfisket. Götheb. 1832, p. 27.—*Rosen*, A. von, Anförande i Commerce Collegii underd. Förslag till nyt, Reglemente för Fiskerierne of d. 17 Aug., 1840.—Handl. rör. Sillf., p. 95.

[5] Indberetning for 1873, p. 54.

[6] *Nilsson*, Handl. rör. Sillf., p. 63.

[7] Handl. rör. Sillf., p. 88 fr. 19, 23, p. 100 fr. 12, p. 119 fr. 9, p. 127 fr. 19, &c. The "*Lottsill*" is still called "*lottsill*" when it becomes larger than about seven inches, as is erroneously thought. *Nilsson*, Handl. rör. Sillf., p. 135. Nya Handl. rör. Sillf., p. 65.

[8] See Handl. rör. Sillf., p. 107 fr. 24.

[9] *Nilsson*, Handl. rör. Sillf., p. 46.

[10] *Nilsson*, Handl. rör. Sillf., p. 137.

spring-herring by the same marks as the sea-herring, and which is said to resemble in its appearance the Norwegian herring. On the coast of Bohus-Län it is never found with fully-developed sexual organs, but is by some considered to be full-grown sea-herring. *Ekström* thought that they were barren spring-herring;[1] and this opinion was shared by *von Yhlen.*[2] Some years ago this kind of herring came to the northern coast in much larger numbers than usual,[3] and according to some reports they are said to have staid till the end of May, when they got fat; but this last-mentioned kind, caught in May,[4] is said by others to have been mostly autumn-herring, a race which is supposed to be distinct from the wandering-herring. The wandering-herring is not liked by the fishermen, because it is almost valueless, and is believed, if appearing in larger numbers, to chase away the other herring and eat up the young ones,[5] so that its arrival often indicates the close of the herring-fisheries. On the Strömstad coast one occasionally hears the opinion expressed that the wandering-herring is of the same kind as the "old" herring, or at least resembles it. The wandering-herring is not spoken of in the reports of the "old" fisheries, so that in this respect they seem to be different from the fisheries on the west coast of Norway, which generally commenced with the fishing of wandering-herring.

The name *Stråksill* (wandering-herring) seems to have been given on account of its wandering about the coast in comparative loneliness, without occurring in regular schools and producing any fisheries. On the northernmost coast it is called *Bensill*, (bone-herring,) because it is thought to have more numerous and larger bones than any other herring.[6] In the neighboring portion of Norway it used formerly to be called *Jernsvensk sill* (Iron Swedish herring.[7]) Its proper Norwegian name, however, is *Straalsild*, (ray-herring,) *Straaksild*, (wandering-herring,) *Solhovedsild*, (sun-head herring,)[8] as well as *Blodsild* (blood-herring.[9]) This last-mentioned name seems to indicate that even in Norway the fishermen consider the wandering-herring to have more blood than any other herring.

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[1] Öfvers. af Kgl. Vet. Akad: s Förhandl. f. 1844, p. 26.—Praktisk af handling, p. 8.—Later, however, he came to the conviction that the wandering-herring was identical with the Norwegian herring.—Öfvers. af Kgl. Vet. Akad: s Förhandl. f. 1846, p. 20.

[2] Göteborgs och Bohusläns Hushållings Sällskaps Quartalsskrift, July, 1872, p. 50; 1873, p. 205.

[3] *Sars, G. O.*, Indberetning. Morgenbladet f. 1871, n:o.

[4] Handl. rör Sillf., p. 90 fr. 31.

[5] Handl. rör Sillf., p. 88 fr. 21.—Ekström, Öfvers. af Kgl. Vet. Akad:s Förhandl, f. 1846, p. 20.

[6] *Boeck, A.*, Tidskrift for Fiskeri, VII, p. 26.

[7] *Yhlen, G. von*, Göteborgs och Bohusläns Hushållnings Sällskaps Qvartalsskrift, 1873, p. 205.

[8] *Løberg*, Norges Fiskerier, pp. 23, 24.—*Boeck*, Om Silden, pp. 23, 24, 48.

[9] *Sars, G. O.*, Indberetning til Departementet for det Indre om de af ham i Aarene, 1864-1873, anstillede, praktisk videnskablige Undersøgelser. Christiania, 1869 and 1874. Indberetning for 1873, p. 59.

HERRING SPAWNING IN AUTUMN.

Herring spawning in autumn are said to have been caught sometimes near Tjörn, where, some years ago, small quantities of this same fish were caught at the end of summer or in the beginning of autumn. *G. von Yhlen* thinks that this herring is related to the Dutch herring.[1]

THE LARGE HERRING, OR THE SO-CALLED "OLD" (GAMLA) HERRING.

(*Clupea bahusica*, *Nilss.*)

It is frequently maintained, though not as often now as formerly, both by old men who remember the old fisheries, and by young persons, that herring of the same kind as the "old" herring, or at least resembling it very much, are caught among the other herring, or are observed in the open sea. I therefore feel it my duty to contribute my share toward ascertaining the truth of this assertion, and to increase our knowledge of this remarkable kind of herring by gathering all the information on the subject scattered in books and reports, giving a review of the different opinions regarding its appearance and disappearance on the coast of Bohus-län.

The "old" herring ("gamla" sill) was, during the period it visited the coast of Bohus-län, generally called "*samsill*,"[2] in order to distinguish it from a smaller and less valuable kind. It was also called "storsill," (great-herring,)[3] by which name people, as they do in Norway at the present day, intended to distinguish a kind of herring excelling the others in size,[4] and "*vadsill*,"[5] (net-herring,) signifying a herring too large to stick in the meshes of a net; as well as "höstsill," (autumn-herring.)[6]

As there are no specimens of the "old" herring in any of our museums, it was necessary, in order to get some idea of its nature, to collate accurately the different accounts regarding it obtained from the fishing period when it was caught, or from the time near its close, when everything was still fresh in the memory of men.

If we examine the answers which were given to the committee of 1833 by the fishermen, we find that they *unanimously* declared that[7] the herring which spawned in spring and which was peculiar to the coast was

[1] Göteborgs och Bohusläns Hushållnings Sällskaps Qvartalsskrift, July, 1867, p. 51.—Here, as well as in *A. Boeck's* report, (Göteb. och Boh. läns Hush. Sällsk. Qvartalskr. Oktob., 1870, p. 28; Tidskrift for Fiskeri, V, p. 131,) and his more extensive work, "Om Silden og Sildefiskerierne," (p. 122,) the word Holländska" (Dutch) should be substituted instead of "Halländska."

[2] *Wright, W. von*, Handl. rör. Sillf., p. 171.—*Ekström*, Praktisk afhandling, p. 11.

[3] *Nilsson*, Handl. rör. Sillf., pp. 45, 46, 62, 70, 134

[4] Handl. rör. Sillf. p. 88 fr. 23, p. 90 fr. 33.

[5] *Nilsson*, Handl. rör. Sillf., pp. 16, 62.

[6] *Dubb, K.* Vet. Akad:s Handl. f. 1817, p. 35.

[7] Only two salters, of whom one, however, could only remember the great fishery from his childhood, were of a different opinion. Handl. rör. Sillf., p. 112 fr. 16, p. 127 fr. 17.

certainly different from the "old" herring, and stated that it differed from it partly by variation in form,[1] and partly by staying near the coast "all the year round," (while the "old" herring came near the coast only for a short time,)[2] and by having (in the beginning of the year and in spring) roe and milt,[3] (which during that period was not generally the case with the "old" herring,)[4] by being not as large when full grown,[5] by a smaller head and higher body,[6] by the relative position of the fins,[7] by a different flavor,[8] and finally by resembling the Kattegat-herring.[9] As a characteristic distinction, it was mentioned that the herring coming in from the sea had a larger head, and was thinner and smaller, than the "old" herring, and had a different flavor;[10] which assertions, however, have been utterly and indisputably refuted by Professor Nilsson.[11] Even from that kind of herring which is now generally called lottsill, (wandering-herring,) and which in size occasionally exceeds the "old" herring,[12] it is said to differ somewhat, as the lottsill was said to resemble more closely the Norwegian gråbensill, (gray-bone herring,) or have smaller scales and proportions slenderer.[13] The "old" herring was furthermore of a different race from the Norwegian gråbensill, (gray-bone herring,)[14] and the Southern Kattegat and Limfjord-herring.[15] If we now consider everything that is alleged in the reports on the herring-fisheries regarding this matter, we find that the "old" herring, according to the account of the fishermen, differed from the "skärgardsill," (coast-herring,) from the "stråksill," (wandering-herring,) and—though not quite so much—from the "hafslottsill," (sea-herring,) and, finally, also from the herring caught on the western coast of Norway, in the Kattegat, and in the Limfjord, but that it nevertheless bore some resemblance to the "stråksill,"[16] and even to the older and larger "vårsill," (spring-

[1] Handl. rör. Sillf., p. 88 fr. 23, p. 89 fr. 30, p. 90 fr. 31, pp. 95, 102, fr. 25. Also see *Lundbeck*, O., Anteckningar, p. 27.—*Edenhielm*, G. Utlåtande till Commerce Collegium af d. 2 Mars 1840.

[2] Handl. rör. Sillf., p. 95.

[3] Handl. rör. Sillf., p. 90 fr. 31, p. 120 fr. 16, p. 127 fr. 17.

[4] Handl. rör. Sillf., p. 89 fr. 25, p. 98 fr. 5, p. 120 fr. 12, p. 125 fr. 6.

[5] Handl. rör. Sillf., p. 120 fr. 13, p. 127 fr. 17 and 23.—See also *Dubb, K.* Vet. Akad:s Handl. f. 1817, pp. 35, 44.—*Lundbeck*, Anteckningar, p. 27.

[6] Handl. rör. Sillf., p. 100 fr. 14 and 15, p. 107 fr. 24, p. 120 fr. 10, p. 127 fr. 23. *Dubb, K.* Vet. Akad:s. Handl. f. 1817, p. 44.—*Lundbeck*, Anteckningar, p. 27.

[7] Handl. rör. Sillf., p. 112 fr. 16.

[8] Handl. rör. Sillf., p. 120 fr. 10, p. 127 fr. 17.—*Lundbeck*, Anteckningar, p. 27.

[9] Handl. rör. Sillf., p. 100 fr. 15, p. 107 fr.24.—See also *Dubb, K.* Vet. Akad:s. Handl. f. 1817, pp. 35, 44.

[10] Handl. rör. Sillf., p. 88 fr. 23, pp. 87–88 fr. 19, pp. 92, 108 fr. 32, p. 119 fr. 6, p. 126 fr. 10.

[11] Handl. rör. Sillf., pp. 133–135.

[12] Handl. rör. Sillf., p. 90 fr. 33.

[13] Handl. rör. Sillf., p. 88 fr. 23, p. 90 fr. 33, p. 119 fr. 7.

[14] Handl. rör. Sillf., p. 90 fr. 34, pp. 95, 107 fr. 25, p. 121 fr. 20.—See also p. 121 fr. 21 and p. 100 fr. 16.

[15] Handl. rör. Sillf., p. 100 fr. 15, p. 121 fr. 20.

[16] Handl. rör. Sillf., p. 119 fr. 7, p. 128, fr. 25 and 26.

herring,) as "its head was smaller, the rest of the body fatter, and the fish, when salted, of a better flavor."[1]

Regarding the *spawning-season* of the "old" herring, we know (see "*Handlingarne till R. St. Fiskeri-Deputation år.* 1764")[2] that the herring "was full of roe in the beginning of the fishing-season, but empty in November," and that "another herring, full of roe and milt, came late in autumn and spawned later," which chiefly took place then in September and October, though herring were also caught which spawned later in autumn; a circumstance which reminds one of the spring-herring.[3] In the "*Trangrumsact*" it is said, as is well known, "on the first arrival of the herring, especially when it comes early to the coast, it is full of roe and milt, while toward the end of the fishing-season it is thin, empty, and has no roe;"[4] also, "the usual spawning-season of the herring is on its first arrival, when it is always wild,"[5] and this, if compared with the accounts of the early history of the herring-fisheries,[6] points to their spawning in autumn, which seems to have continued thus during the remaining portion of the fishing period, whenever the herring which was caught toward the end of the year is mentioned as having done spawning;[7] and the inconsiderable quantity of fish with roe which were caught must have been got at the beginning of the fishing-season, in November and December.[8] In the "*Trangrumsact*" it is mentioned that "in January, 1774, three great boat-loads of herring were caught in the Ellösfiord, near Morlanda, which in size and thickness, with milt and roe, exceeded all the herring which had been caught on the coast of Bohus Län during the previous autumn;"[9] but I know of no reliable account that the "old" herring should, toward the end of the fishing-period, have delayed spawning till far in spring, and nothing similar is known from Western Norway, (where the great fishery was very similar to that of Bohus-Län,) or from any other place where herring-fisheries are carried on.

As regards the place where the "old" herring staid when not an object of fishery on the coast of Bohus-Län, opinions are much divided, which is quite natural, as there was very little personal observation to

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[1] Handl. rör. Sillf., p. 88 fr. 19, p. 92, p. 123 fr. 30.

[2] *Sundevall*, C. J., Stockholms läns Kgl. Hushållnings-Sällskaps Handlingar. VI, Stockholm, 1855, p. 153.—*Cederström*, G. C., Fiskodling och Sveriges Fiskerier. Stockholm, 1867, p. 130 och 226 anm.

[3] See chapter II of this report.

[4] Trangrumsacten, p. 163.

[5] Trangrumsacten, p. 183.

[6] Trangrumsacten, pp. 129, 130, 133, 134, 139, 146, 147, 150.

[7] *Svensson*, Berättelse om Sillfisket i Bohuslän, Götheb. 1822, p. 18.—Handl. rör Sillf. p. 140.—*Nilsson*, Handl. rör Sillf., pp. 41, 42.—*Sundevall*, Handl. rör Sillf., p. 158.

[8] Even during the last period of the "old" fishery did fishing commence about a month before Christmas, and herrings were often observed long before this, although they could not be taken with nets. (See Handl. rör. Sillf., p. 104 fr. 3, p. 119 fr. 4.—*Cederström*, Fiskodling och Sveriges Fiskerier, pp. 208-214.)

[9] Trangrumsacten, p. 146.

serve as a guide, but simply more or less well-founded suppositions. In *Doctor Fagræus's* work, "*Anmärkningar rörande sillfiske och trankokeri,*" which is embodied in the "*Trangrumsact,*"[1] it is supposed, (as *Dodd* and *Anderson* first suggested, and after them *Pennant* and others,) that the herring had a common place of sojourn near the north pole, from whence large schools emigrated every year to those places where herring-fisheries were carried on.[2] This supposition was eagerly taken up by the oil-refiners and other comparatively educated persons on the coast of Bohus-Län,[3] but did not coincide with the opinion of the uneducated fishermen. These latter, who distinguished the "old" herring as a "regular sea-herring"[4] from the kind of herring peculiar to the Skagerack, seem to have considered the North Sea as its proper home;[5] an opinion which *Professor Nilsson* considered so entirely without foundation, that he did not think it worth refuting.[6] This opinion of the Bohus-län fishermen has been taken up by Norwegian naturalists, who had made a specialty of the study of the herring and the herring-fisheries.[7] *Professor Nilsson*, on the other hand, and those who unconditionally followed him, supposed that it only went a short distance from the west coast of Sweden, "and certainly never went beyond the Skagerack."[8] This opinion of *Professor Nilsson* was based on the supposition that the herring, when not an object of fishery on the coast, lived at the bottom of the deep-sea valleys or basins outside the coast; and he maintained his view chiefly by the fact that herring are often found in the stomach of the codfish.[9] Even *Axel Boeck* approved of this last-mentioned opinion,[10] against which subsequently well-founded objections have been raised by *G. O. Sars*[11] and *G. C. Cederström*,[12] which, doubtless, will lead to an entirely different view regarding this most important point in the question of the herring-fisheries.

Closely connected with this is the question regarding the fate of the old herring after abandoning the spawning-places on the coast of Bohus-län. Thirty or forty years ago our most prominent zoologists supposed that the whole race of herrings, with the exception of the young left on the coast from last year's spawning, were probably scattered

[1] Trangrumsacten, pp. 95–150.

[2] *Nilsson*, Handl. rör. Sillf., pp. 24–28.

[3] Trangrumsacten, pp. 162, 163.—*Dubb*, K. Vet. Akad:s Handl. f. 1817, pp. 43.

[4] *Dubb*, K. Vet. Akad:s Handl. f. 1817, p. 44.

[5] See Handl. rör. Sillf., pp. 53, 57.

[6] Handl. rör. Sillf., p. 68.

[7] *Boeck*, A., Om Silden og Sildefiskerierne, pp. 37, 45, 46.—*Sars*, G. O., Indberetning f. 1873, p. 58.

[8] Handl. rör. Sillf., pp. 8, 68.—Nya Handl. rör. Sillf., p. x.

[9] Handl. rör. Sillf., pp. 7, 8, 42, 43.—Skandinav. Fauna. iv, pp. 503–508.

[10] Om Silden og Sildefiskerierne, p. 47.—Tidskrift for Fiskeri. VII, pp. 18, 19.

[11] Indberetning f. 1869, pp. 60–61; f. 1873, pp. 46–51.

[12] Naturhistoriska betraktelser och iaktagelser innefattande hänvisningar till lämpliga sätt att forska för att kunna tillförlitligt utreda sillfiskarnes tillhåll och vandringar. Stockholm, 1871. Tillägg, pp. 1–3.

or destroyed in the sea,[1] or perished in the depth of the ocean, or in an unsuitable climate,[2] though there have not been wanting suppositions regarding spawning-places which it was said to visit afterward. Thus *Professor Nilsson*, in his report of November 11, 1826, seemed inclined to suppose that the herring, in consequence of the injudicious treatment which it experienced among us, turned toward Jutland and Læsö;[3] and *Axel Boeck* thinks there was a connection between the Bohus-län and the Scotch-Dutch fisheries.[4] *Oscar Andersen* mentions a supposition of *O. N. Lóberg*, according to which "the northern great herring would be of the same kind as the old Bohus-Län herring," and would therefore, at a later period, "have turned toward the north."[5] Among the professional men, the opinion seems at first to have been common that the herring, at least in the beginning, had gone to the southeastern part of the North Sea;[6] and afterward the opinion seems to have gained ground that there was some intimate connection between the Norwegian spring herring-fisheries and the Bohus-län autumn herring-fisheries.[7]

As regards the causes of the *re-appearance* of the old herring on the coast of Bohus-Län in 1747, after a long absence, there has scarcely been any dispute, although the solution of this problem would be of great importance.[8] *Professor Nilsson* and his followers suppose, according to the views expressed in *Handlingar rörande Sillfisket*, that those herring which had remained over from the last great fisheries on the coast of Bohus-län staid undisturbed near the coast, "which, through war and pestilence, had become depopulated," and increased gradually, unnoticed, so that when they were "suddenly" discovered, they produced an extremely rich fishery, lasting sixty years.[9] Those who suppose that the large kind of herring are possessed of an innate desire for roaming about, see of course in this the only cause of its coming to the coast and leaving it again.[10] Among the fishermen on the coast of Bohus-län the opinion seems to have been very common, at the beginning of the former fishery-period, that the herring were attracted by the large number of marine articulates, which, as is well known, they prefer to any

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[1] *Nilsson*, Handl. rör. Sillf., p. 68.

[2] *Sundevall*, Handl. rör. Sillf., p. 156.

[3] Handl. rör. Sillf., p. 16.

[4] Beretning om Fiskeri-Udstillingen i Aalesund, 1864, p. 34.—Om Silden og Sildefiskerierne, p. 129.

[5] *Andersen*, O., Bohuslens Fiskerier. Frederikshald, 1869, pp. 10, 11.

[6] *Lundbeck*, O., Anteckningar rörande Bohusländska Fiskerierna, i synnerhet sillfisket. Götheb., 1832, p. 35.

[7] Handl. rör. Sillf., p. 85, p. 101 fr 22, p. 141.—Nya Handl. rör. Sillf., p. XXVIII.

[8] *Boeck*, Om Silden og Sildefiskerierne, p. 83.

[9] *Nilsson* Förnyad underdånig berättelse om fiskerierna i Bohus Län. Stockholm, 1828, p. 28, anm.

[10] *Dubb* thought a periodicity in meteorological and hydrographic events was the cause. —K. Vet. Akad:s Handl. f. 1817, p. 46.

other food;[1] an opinion which has recently been more fully developed by *G. O. Sars.*[2]

Regarding the causes of the "old" herring's *disappearance* from the coast of Bohus-län there has been a great variety of opinion, and the dispute has often waxed hot. At a very early period of the "old" fisheries it was expected that they would some time come to an end,[3] and people, therefore, discussed the question of the possible causes of such an event, and the means which should be used to prevent such a national calamity, and laws were passed with a view to such a contingency.[4] Passing over the more mythical causes of the disappearance of the herring, which were given from time to time, and which, doubtless, found the greatest favor among the common people, the following may be assigned as the chief causes of such an event:

1. *That the herrings were gradually destroyed*, so that the schools became smaller and smaller toward the end of the fishing-period[5]—by "*excessive fishing;*"[6] by catching the young herring in nets with narrow meshes;[7] by preventing the herring from reaching the most convenient spawning-places;[8] and by the consequent destruction of the roe;[9] and by unfavorable weather, "an unusual appearance of fish of prey, birds of prey," "want of food," &c., &c.; "and other influences injurious to the roe, the young, and the full-grown fish."[10]

2. *That the herrings were "slowly and persistently driven away;"*[11]—by *noise;*[12] by the *excessive number of fishermen;*[13] by *the use of injurious*

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[1] R. St. Fiskeri-Deputations Handlingar, 1760–1772.—Enl. *Cederström*, Fiskodling och Sveriges Fiskerier, p. 141.

[2] Indberetning for Aaret, 1873, p. 58.

[3] R. St. Fiskeri-Deputations berättelse om fiskeriernas tillstånd i Riket gifven vid Riksdagen d. 18 Maj 1772.—Enl. *Cederström*, Fiskodling och Sveriges Fiskerier, p. 192.

[4] Trangrumsacten, pp. 151, 152, 166.

[5] Handl. rör. Sillf., p. 98, fr. 8.

[6] *Nilsson*, Förnyad underdånig berättelse om Fiskerierna i Bohus Län. Stockholm, 1828, pp. 22, 29.—Handl. rör. Sillf., p. 47.—Skandinavisk Fauna, iv, pp. 505, 514.—*Widegren*, Handlingar och upplysningar rörande Sveriges Fiskerier, i, p. 51; iv, pp. 12, 36.—Nya Handl. rör. Sillf., pp. 32, 33, 38, 39.

[7] *Nilsson*, Skandinav. Fauna, iv, pp. 507, 514.—*Wright, W. von*, Handl. rör. Sillf., p. 174. See also, *Krøyer*, H., Danmarks Fiske, iii, p. 161.

[8] *Nilsson*, Förnyad underdånig berättelse om Fiskerierna i Bohus Län. Stockholm, 1828, p. 30.

[9] Trangrumsacten, pp. 163–164, 171.—*Nilsson*, Skandinav. Fauna, iv, p. 515.—Förnyad underd. berättelse. Stockh. 1828, p. 30.

[10] *Cederström*, G. C., Fiskodling och Sveriges Fiskerier, pp. 208, 213, anm., 216.—*Krøyer*, Danmarks Fiske, iii, pp. 162, 163.

[11] *Nilsson*, Handl. rör. Sillf., pp. 17, 73–74, 138.—*Sundevall*, Handl. rör. Sillf., p. 152, 154.—*Lovén*, Handl. rör. Sillf., p. 163.

[12] *Nilsson*, Handl. rör. Sillf., pp. 17, 18, 41, 138.—Skandinav. Fauna, iv, p. 505.—*Landbeck*, Anteckningar, pp. 34–38.—Handl. rör. Sillf., p. 87 fr. 16, p. 99 fr. 10.—*Sundevall*, Handl. rör. Sillf., p. 152.—*Wright, W. von*, Handl. rör. Sillf., p. 172.

[13] *Nilsson*, Förnyad underd. berättelse, Stockh. 1828, p. 28, anm—Handl. rör. Sillf., p. 17.—Skandinav. Fauna, iv, p. 505.—*Widegren*, Nya Handl. rör. Sillf., p. 33.—*Boeck*, Om Silden og Sildefiskerierne, p. 85.

fishing-implements;[1] by *interfering with the spawning-process;*[2] by *interfering with the spawning-places* generally,[3] and particularly by drag-nets,[4] or by throwing offal in the water;[5] by *leaving dead herring at the bottom of the sea;*[6] by *throwing the guts and gills of fish into the water;*[7] by *polluting the water through offal of blubber* and similar matter;[8] by the *increasing number of the enemies of the herring.*[9]

3. *That the herrings left the coast from an innate desire of roaming.*[10]

4. *That the herrings were obliged to leave, because there was no longer a sufficient supply of food.*[11]

The validity of these causes has been disputed almost immediately after they had been put forward, and even now there is not one of them which has been unanimously recognized as the probable cause of the repeated disappearance of the great Bohus-län fisheries.[12] It was thus, *e. g.*, denied at the inquest of 1833 that the herring was *destroyed through too much fishing,*[13] and that it was driven away by *noise,*[14] *offal of blubber,*[15] &c.

A more extensive and valuable criticism of these supposed causes has been given by *Kröyer,*[16] *O. N. Löberg,*[17] *Axel Boeck,*[18] and others.

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[1] *Nilsson,* Handl. rör. Sillf., pp. 17, 138.—Skandinav. Fauna, iv, pp. 501, 505.—*Widegren,* Nya Handl. rör. Sillf., p. 33.

[2] *Nilsson,* Handl. rör. Sillf., p. 51, n. b.—*Lovén,* Handl. rör. Sillf., p. 161. Nya Handl. rör. Sillf., p. 64.

[3] *Nilsson,* Handl. rör. Sillf., p. 51, n. b.—*Sundevall,* Handl. rör. Sillf., p. 153.—*Widegren,* Nya Handl. rör. Sillf., p. 33.

[4] *Lovén,* Handl. rör. Sillf., pp. 161, 162.—*Ekström,* Praktisk afhandling, pp. 7, 19. *Nilsson,* Skandinav. Fauna, iv, pp. 514–515.—*Widegren,* Nya Handl. rör. Sillf., p. 33.

[5] Trangrumsacten, pp. 158, 161, 163, 164, 167, 186–187.—*Nilsson,* Handl. rör. Sillf., p. 41.—Skandinavisk Fauna, iv, p. 514.—*Sundevall,* Handl. rör. Sillf., pp. 152, 153.—*Lovén,* Handl. rör. Sillf., p. 161.—*Ekström,* Praktisk afhandling, pp. 7–8.

[6] Handl. rör. Sillf., p. 99 fr. 10.—*Lundbeck,* Anteckningar, pp. 32–33.—*Wright, W. von,* Handl. rör. Sillf., p. 174.—*Sars, G. O.,* Indberetning f. 1873, p. 45. Trangrumsacten, pp. 177, 182.

[7] *Lovén,* Handl. rör. Sillf., p. 161.

[8] *Nilsson,* Handl. rör. Sillf., pp. 41, 138.—Skandinav. Fauna, iv, pp. 505, 514.—*Lundbeck,* Anteckningar, p. 31.—*Lovén,* Handl. rör. Sillf., p. 161.—*Wright, W. von,* Handl. rör. Sillf., pp. 172–174.—Handl. rör. Sillf., p. 94, p. 116 fr. 9.—Trangrumsacten, pp. 153, 154, 155, 165, 172, 176, 183, 185, 186, 188.

[9] *Dubb, K.,* Vet. Akad:s Handl. f. 1817, p. 45.

[10] Handl. rör. Sillf., p. 94, p. 99 fr. 9, p. 111 fr. 7, p. 115 fr. 7, p. 128 fr. 24.—*Yarrell,* British Fishes, 3 ed., i, p. 101.—*Boeck,* Om Silden og Sildefiskerierne, p. 85.

[11] *Sars, G. O.,* Indberetning f. 1873, p. 58.—*Cederström,* Fiskodling och Sveriges Fiskerier, p. 213 anm., 216. Trangrumsacten, pp. 164, 167.—*Lundbeck,* Anteckningar, p. 26.—*Rosen, A. von,* Yttrande till Commerce-Collegium d. 8 Juli 1829.

[12] *Boeck,* Om Silden og Sildefiskerierne, p. 85.

[13] Handl. rör. Sillf., p. 87 fr. 15 p. 98 fr. 8, p. 110 fr. 4, p. 122 fr. 23, p. 128 fr. 24.—*Nilsson,* Handl. rör. Sillf., pp. 137–138.

[14] Handl. rör, Sillf., p. 92, 95, 99 fr. 10, p. 115 fr. 8, p. 122 fr. 23, p. 128 fr. 24.

[15] Handl. rör. Sillf., p. 99 fr. 10, p. 105 fr. 13, p. 110 fr. 5, p. 115 fr. 9, p. 121 fr. 23, p. 128 fr. 24.

[16] Danmarks Fiske., iii, pp. 164–167.

[17] Norges Fiskerier, pp. 8, 9.

[18] Om Silden og Sildefiskerierne, pp. 86–102, 119.

The enormous masses in which the herrings appear must doubtless, if they select a narrow bay as their spawning-place, produce quite a change in the nature of the coast, both by their becoming with their roe and young ones the food of numerous marine animals, and by the food which they and their young ones eat, which change may finally assume such dimensions that the coast becomes unsuitable as a spawning-place. On the coast of Bohus-län unfavorable weather has contributed not a little toward bringing about such a change. Because a temperature of + 3° C. has no destructive effect, it cannot be maintained that a still lower temperature, with its consequent formation of bottom-ice, will not prove injurious.[1] Not sufficient attention seems to have been paid to the very destructive effect which several severe winters, following close one upon the other, must have had on the spawning-places of the herring, especially on the outer coast.

Another question which is closely related to that of the disappearance of the "old" herring is, why, during the fishing-period, the herrings came to the coast at different seasons of the year. Already during the first half of the last fishing-period, it was observed in Bohus-län that the herrings commenced to come later, and people began to fear "that the herrings, as had happened repeatedly in former times, to the irreparable injury of the province and the whole kingdom, would leave the coasts of Sweden."[2] People began to inquire into the possible causes of such an event, and attempts were made through various laws and regulations to prevent so dire a calamity.[3] After the herring-fisheries had ceased in the year 1808, people thought that in this circumstance they had a proof that the herring had been driven away by the coast-population, and the same causes were given for it as were supposed to have brought about the stoppage of the fisheries. By *Axel Boeck's* investigations this whole question entered upon a new phase. He showed that there always had existed, in this respect, a very remarkable similarity between the great Bohus-län fisheries and the Norwegian spring-herring-fisheries,[4] a circumstance which gives increased weight to the point in question, and possibly contains the key to the question of the periodicity of the great Scandinavian herring-fisheries. *Boeck* has not, however, attempted to assign any cause for the later arrival of the herring during the fishing-period, but this has recently been done by *G. O. Sars.*[5] Regarding the appearance of the herring on different places of the coast during the fishing-period, *Boeck* seems to have pointed out the

[1] *Boeck, A.*, Om Silden og Sildefiskerierne, p. 119.—*Widegren*, Nya Handl. rör Sillf., p. 38.—*Cederström*, Fiskodling och Sveriges Fiskerier, p. 216.—*Edlund*, Öfvers. af kgl. Vet. Akad:s Förhandl. f. 1863, p. 372; f. 1865, p. 209.

[2] R. St. Fiskeri-Deputations berättelse om fiskeriernas tillstånd i Riket afgifven vid Riksdagen d. 18 Maj. 1772.—Enl. *Cederström*, Fiskodling och Sveriges Fiskerier, p. 192.

[3] Trangrumsacten, pp. 151–154, 158, 166.

[4] Om Silden og Sildefiskerierne, pp. 102–110.

[5] Indberetning for Aaret 1873, pp. 55–56.

similarities to the Norwegian spring-herring-fishery, and passed by the differences. With regard to the Bohus-län fishery, this fact may be explained by well-known meteorological and hydrographic conditions. It is also evident, that if fishing, as is done near the coasts of Scotland, had been carried on with floating nets, the above-mentioned facts would not have become prominent as they are now in consequence of fishing with stationary nets.

Nothing remains now, in conclusion, but to account for the assertion that herring "*resembling*" the "old" herring had been caught near the coast of Bohus-län, or in the open sea near that coast, and to examine this assertion a little more closely.

At the meetings held by the committee of inquiry in 1833, the opinion of the fishermen that "herring resembling the old" herring had been caught among the other herring was upheld by a majority of those present only at two places, viz, in Strömstad[1] and in Klädesholmen.[2] If we compare the reports given by the fishermen at the former of these places with those given on the same occasion by Mr. *Norberg*, a wholesale dealer, we find that the coast-herring, although distinctly different from the "old" herring, was still thought to *resemble* it in some cases,[3] and that the larger herring, which was otherwise caught, was the so-called stråksill, (wandering herring,)[4] which latter race is still declared to be the same as the "old" herring, or, at least, is said to resemble it very much, by old men in Strömstad. It does not, therefore, seem improbable that either of these species of herring was meant by the answers given to the nineteenth question put by the committee. If we further compare the latter of the above-mentioned answers with those received in the same place to the seventh question, it also appears that another kind of herring was thought to resemble the "old" herring. The answer to the thirtieth question,[5] however, undoubtedly implies the coast-herring.[6] As the answers given by the salters *Schiller* and *Mjöberg*[7] were disputed by all the fishermen present, and as the former of these men had only witnessed the "old" fisheries when very young, and both evidently meant the coast-herring, these answers may chiefly have been called forth by the conviction—discarded at a later time—of the correctness of Professor *Nilsson's* views. *Mjöberg* was the *only* person who, at the inquest of 1833, positively asserted that herring was constantly being caught on the coast of Bohus-län which not only resembled the "old" herring, but was of the same kind. If we compare the answers received at

[1] Handl. rör. Sillf., p. 87–88 fr. 19.
[2] Handl. rör. Sillf., p. 123 fr. 30.
[3] Handl. rör. Sillf., p. 92.
[4] Handl. rör. Sillf., p. 95.
[5] Handl. rör. Sillf., p. 123.
[6] See *Norberg's*, *Schiller's*, and *Mjöberg's* similar answers: Handl. rör. Sillf., p. 92, p 112 fr. 16, p. 127 fr. 17.—*Ekström*, Öfvers. af Kgl. Vet. Akad:s Förhandl. f. 1848, p. 84
[7] Handl. rör. Sillf., p. 112 fr. 16, p. 127 fr. 17, p. 128 fr. 26.

Fjellbacka and Gullholmen regarding herring "resembling" the "old" herring, which were taken from the stomachs of cod-fish,[1] with the answers received at Grebbestad, where herring found under the same circumstances were described in such a manner as to leave no doubt that coast-herring were meant,[2] (which is also confirmed by *W. von Wright's* report on the herring-fisheries in Bohus-län during the winter 1842–'43,[3]) and with the answers received at Klädesholmen and Kalfsund, (where herring obtained under such circumstances were declared to have been of different size[4] or altogether sea-herring,[5]) and if we take into consideration the fact that it is always more or less difficult to ascertain to what kind of herring a badly-preserved specimen belongs, such accounts can scarcely be considered as of any great importance. Still less weight can be attached to the accounts received at Fjellbacka, that herring resembling the "old" herring had been seen in the Kattegat,[6] as the fishermen on the northern coast, neither at that time nor later, have carried on any great fisheries, and as entirely different accounts were received from the central and southern coasts,[7] where such fisheries were carried on. It must also be remembered that although the correctness of the minutes of these meetings was certified, still there might have been expressions used which might have been misunderstood by a clerk not entirely familiar with the coast population, a case which seems still more probable, as the questions were, perhaps, not always propounded in a form most intelligible to the fishermen. During the more productive sea-herring-fisheries it happens not unfrequently that some old person who either remembered the "great" fisheries, or has, in his youth, heard some lively traditions regarding them—and who, consequently, is considered more knowing in such questions than other persons—asserts that herring of the old kind have been caught,[8] which joyful news then goes the round of the papers, awakening anew among a portion of the coast-population the hope that another great herring-fishery is near at hand.[9] Thus it happened last winter that an old woman, who could well remember the former fisheries, declared most emphatically that she recognized "great" herring among the larger herring caught with the sea-herring. The mackerel-fishers occasionally observe schools

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[1] Handl. rör. Sillf., p. 107 fr. 22, p. 108 fr. 31, p. 117 fr. 13.

[2] Handl. rör. Sillf., p. 100 fr. 15.

[3] Handl. rör. Sillf., p. 166.

[4] Handl. rör. Sillf., p. 119 fr. 8.—*Nilsson,* Handl. rör. Sillf., p. 46.

[5] Handl. rör. Sillf., p. 126 fr. 15.

[6] Handl. rör. Sillf., p. 107 fr. 22, p. 108 fr. 31.

[7] Handl. rör. Sillf., p. 116 fr. 13, p. 119 fr. 8, p. 126 fr. 15.

[8] *Wright, W. von,* Handl. rör. Sillf., p. 172.—*Ekström,* Öfvers. af Kgl. Vet. Akad:s Förhandl. f. 1848, p. 84.

[9] *Lundbeck,* Anteckningar, p. 24, 25.—*Edenhielm, G.,* Utlåtande till Commerce-Collegium af d. 2 Mars 1840.—*Ekström,* Öfvers. af Kgl. Vet. Akad:s Förhandl. f. 1844, p. 26.—*Yhlen, G. von:* Göteborgs. och Bohusläns. Hushållnings-Sällskaps. Qvartalskrift Juli 1870, p. 16.—Nya Handl. rör. Sillf., p. 11.

of large sea-herring, but I have been unable to obtain any account regarding it, which would not have been the case if such fish really were found in any considerable numbers in the Skagerak.[1]

Among the *small herring* different kinds are also distinguished, and the eminent ichthyologist *Kröyer* has described one of these as a separate species under the name of *Clupea Schoneveldi*.[2] Professor *Nilsson* has distinguished "a longer and small *northern* variety" from the *southern*, to which the *Clupea Schoneveldi* Kr. belongs.[3] *Von Yhlen* has, on the Bohus-län coast, distinguished "small herring coming from the sea" and "small herring belonging to the coast," without, however, asserting that they are two different species.[4]

My personal observations have not yet enabled me to explain fully whether the different herrings and small herrings are in reality different species or not. From what has been said it will be seen that this whole question can only be answered satisfactorily after the most careful observations have been carried on for years, and by a critical comparison of specimens of every age obtained at different seasons of the year. At the first superficial glance the difference of species seems easily decided, but on a closer examination one difficulty after the other presents itself. And still, if the question of the herring-fisheries is to be answered satisfactorily and practically, these difficulties must be so completely overcome, that a sufficient knowledge is obtained of the period when each of these species is generally caught on the coast, and of the quantities which are caught.

II.—OF THE PROPAGATION AND GROWTH OF THE HERRING AND SMALL-HERRING.

The spawning of the spring-herring goes on during the months of March, April, and May,[5] in suitable places on the coast, of which only a few are generally known, because the fishing with stationary nets, which are the most convenient for catching spawning-herring,[6] is not common in Bohuslän; and also because drag-nets can be used only in exceptional cases in those places where the herrings spawn. A bottom free from stones and rocks, and perfectly even, is very seldom found on the coast of Bohuslän, since, over a hilly bottom, which offers the best places for spawning, the drag-nets cannot generally be drawn. It seems that the herring also often spawns on a clayey bottom, overgrown with aquatic plants. Of well-known spawning-

[1] *Sars, G. O.*, Indberetning f. 1873, p. 54.

[2] Danmarks Fiske, iii, p. 138.

[3] Skandinavisk Fauna, iv, p. 518–520.

[4] Göteborgs och Bohusläns Hushållnings-Sällskaps Qvartalsskrift, Juli 1871, p. 52; Juli 1872, p. 50–51.

[5] It is supposed, however, that the larger spring-herring spawns somewhat earlier on the northern and central coasts, beginning even in February; *Dubb*, however, maintains that the herring on the southern coast continues to spawn till some time in June. (Reports of the Royal Academy of Sciences for 1817, pp. 35, 44.)

[6] See Journal of Pisciculture, VII, p. 20.

places, there may be mentioned *Björnsund*, in *Dynekilen*, where the herring spawns on a hilly bottom, and is caught in stationary nets; *Ozevik*, and other places in the sound between *Bokenäs* and *Orost*,[1] *Ulkchålet*,[2] and *Hummersund*,[3] and several localities near *Tjörn*, as well as the farms of *Hästevik*, *Andal*, *Ardal*, and *Gåsesund*,[4] on the *Hisingen* coast, &c.[5] The herrings which spawn in March and April are generally larger than those spawning in May; the latter being considered the younger, and spawning for the first time.[6] This so-called May herring is often found among those two years old, sometimes even with those one year old, and sometimes with still younger herring. After mild winters and in favorable weather, the spawning begins somewhat earlier than otherwise,[7] though the spawning-time of the spring-herring seems to have been invariably the same, if we may judge from what can be inferred with any degree of certainty from the more or less clear accounts concerning the fishing for spring-herring and its spawning, found in the "*Trangrums Act*"[8] *concerning the blubber-refineries*, in *Dubb's* report on the herring-fisheries in Bohuslän,[9] in the reports on the herring-fisheries,[10] and in *Ekström's* reports.[11]

The young herring generally begins to make its appearance in the early part of May, and grows so rapidly that toward the end of the year it has reached a length of from 2½ to 3½ inches.[12] Having measured a large number of herring which were caught during the latter half of May, I found the most of them can be divided into three groups, according to their size, viz, those measuring about 4 inches in length, which must be considered as one year's fish; those of from 5½ to 6 inches, probably two years' fish; and those of about 6¾ inches, which were supposed to be three years old, and had completely developed sexual organs. Some fish were occasionally found with flowing spawn, measuring only about 2¼ inches; and some measuring somewhat more, but not yet ripe for spawning the same year. Larger fish,

[1] *Wright, W. von*, Reports on Herring-Fisheries, p. 166.

[2] *Wright, W. von*, Reports on Herring-Fisheries, p. 166. *Ekström*, Review of the Reports of the Royal Academy of Sciences for 1844, pp. 26, 82.

[3] *Nilsson*, Scandinavian Fauna, IV, p. 509.

[4] *Dubb*, Reports of the Royal Academy of Sciences for 1817, pp. 35, 44.

[5] Compare, also, *G. von Yhlen*, Quarterly Journal of the Gottenburg and Bohuslän Economical Society, July, 1871, p. 51.

[6] This, possibly, was also the case with the "old" herring during the former great fisheries. Compare "Reports to the Royal Fishing Deputation for the Year 1764;" also, *Sundevall*, Reports of the Royal Economical Society of Stockholm, Län VI, p. 153; and *Cederström*, The Propagation of Fish and the Swedish Fisheries, pp. 130, 226.

[7] *Ekström*, Reports of the Royal Academy of Sciences for 1844, p. 120. Practical Essay, p. 8.

[8] *Trangrums Act*, pp. 76, 77, 78.

[9] Reports of the Royal Academy of Sciences for 1817, pp. 35, 44.

[10] Reports on the Herring-Fisheries, pp. 64, 66, 90, fr. 31; p. 117, fr. 16, 17; p. 120, fr. 11, 16; p. 126, fr. 27. New Reports Concerning the Herring-Fisheries, pp. ix, x.

[11] Reports of the Royal Academy of Sciences for 1844, p. 120. Practical Essay, p. 8.

[12] Counting from the point of the lower jaw to the root of the caudal fin.

measuring about 8 inches, are probably four years old. The spring-herring sometimes reach a length of more than 12 inches, but even specimens of 9¾ inches are rare. The Bohuslän herring seems, therefore, to spawn as early as at the age of *three*, although I do not wish to convey the idea that all the herring sprung from the same year's spawn begin to spawn at that age; but it seems rather as if one portion did not reach their maturity till their fourth year. The circumstances that the herring spawns during three whole months, and that therefore there is a considerable difference in the ages of those that are produced first and those produced last, that some have better chances for securing food than others, taken in connection with other more or less accidental circumstances, explain the fact that fish of all possible sizes are frequently taken from the same net.

As to the age at which the herring spawns for the first time, opinions have been much divided, both among Scandinavian naturalists and those persons who have devoted their life to the herring-fisheries. Professor *Nilsson*, from information received from "trustworthy fishermen," assumes that "no fish spawns in the second year," and that "the herring does not spawn till the fifth or sixth year."[1] Dean *Ekström* considers those herring which measure 6 inches (counted from the point of the nose to the anal fin) to be two years old; those measuring from 10 to 13 inches, from four to five years old; and adds that "the herring found in Bohuslän does not spawn till it measures from 7 to 8 inches, counting the whole length."[2] Prof. *C. J. Sundevall*, who has made observations on the growth of the herring on the coast near Stockholm, thinks that it becomes capable of spawning when it is from three to four years old.[3] Mr. *Widegren*, superintendent of fisheries, thinks that the herring is fit to spawn when it is "about three years old."[4] *Axel Boeck* was inclined to think "that the youngest herring when spawning is scarcely less than three years old, and certainly not more than four," although he could not give any sufficient reason for this view,"[5] but at the same time said that persons who had been long employed in fishing had told him that the herring, when able to spawn, must be from six to eight years old.[6] *G. O. Sars*, also, seems to have been of the

[1] Report on the Herring-Fisheries, pp. 45, 47, 51, 59.

[2] Practical Essay, pp. 10, 11.

[3] Reports of the Royal Economical Society of the Stockholm District, vol. VI, pp. 105, 151.

[4] Some Remarks on the Herring and its proper Preparation for an Article of Commerce, Stockholm, 1871, p. 4.

[5] On Herring and Herring-Fisheries, pp. 36, 37. Piscicultural Journal, VII, p. 20.

[6] On Herring and Herring-Fisheries, p. 36. Piscicultural Journal, VII, pp. 20, 21. In the Morning Journal, of November, 1872, *Boeck* gives a fuller account of similar information given him by a professional man, *Dahl*, regarding the six years' development of the herring. According to this, it is called on the west coast of Norway "musse," when it is one year old; "leaf-herring," when two years; "Christiania-herring," when three years; "middle herring," when four years; "merchants' herring," when five years; and "spring-herring," when six years old; all which terms seem to be very old in Norway.

same opinion as Professor *Nilsson*, and at first thought that the herring became capable of spawning at the age of five years, but afterward assigned the age of six years.[1]

Fishermen generally assume that the *small-herring* has roe and milt during the spring and early summer, and some of them have observed the young of the small-herring some time after spawning. The spawning of the small-herring may, like that of the herring proper, be delayed or hastened by the weather, but otherwise does not seem to change as to the time when it takes place. In the reports of Mr. *P. Clancey*, made in his capacity of superintendent of herring fisheries, to the Royal Chamber of Commerce, it is said, *e. g.*, that on the 11th March, 1811, "herring and small-herring were caught having both roe and milt,"[2] which implies that spawning would have taken place at most from three to four months later. Hence we may conclude that one cannot assume any advance in the spawning-time of the small-herring, in order to explain *Nilsson's*, *Wilhelm von Wright's*, and *Ekström's* different views, since these men take the *autumn* to be the spawning-season of the small-herring.[3] Prof. *C. J. Sundevall* has found that the small-herring on the coast of the Stockholm district spawns at the end of June and in July,[4] and therefore about the same time as in Bohuslän. *Kröyer* says of the *Clupea sprattus* that "its spawning-season is mostly in August, but that it begins as early as the latter half of June, and sometimes extends to September,"[5] and of the *Clupea Schoneveldi* that "in males caught early in the spring the milt was found to be considerably developed,"[6] which points to a somewhat earlier spawning season for the last-named variety.

The few observations which I have been able to make on this point prove that the spawning of the small-herring on the central coast begins at the end of May or the first of June. Its spawning-season may, possibly, begin somewhat earlier on the northern coast and a little later on the southern coast.[7] Small-herring caught in the autumn or winter never have any roe or milt, a circumstance which could easily be ascertained in the preparation of the so-called boneless anchovies; and yet they are not very thin either, which shows that they cannot have spawned immediately before the commencement of the fisheries. The small-herring which I had occasion to observe during the spring is

[1] Report for 1872, pp. 38, 39; Report for 1873, p. 44, note.

[2] *Cederström*, Fish-Culture and the Swedish Fisheries, p. 215.

[3] *Nilson*, Prodromus Ichthyologiæ Scandinavicæ, p. 22. Scandinavisk Fauna, IV, p. 521. *Wright, W. von*, Reports on the Herring-Fisheries, pp. 167, 175. *Ekström*, Practical Essay, pp. 9, 103; Review of the Transactions of the Royal Academy of Sciences, for 1844, p. 26.

[4] Reports of the Royal Economical Society for the District of Stockholm, VI, pp. 109, 185-187.

[5] Denmark's Fish, III, p. 191.

[6] Denmark's Fish, III, p. 201.

[7] *Nilsson*, Scandinavisk Fauna, IV, p. 521.

smaller, and is more like the variety *Schoneveldi Kr.* than those which I saw caught on the northern coast toward the end of last year.

It is said that the young of the small-herring begin to show themselves in the northernmost portion of the coast about midsummer, or in the beginning of July. I cannot give any information gathered from other persons, as to how rapidly the small herring grows, and how old it is when it spawns for the first time; and the observations made by myself are still too few and incomplete to draw from them any accurate conclusion. But as I have, in the mean time, received from Kalfsund small-herring, measuring not quite 100 millimeters, (96–97,) whose sexual organs were considerably developed; and as most of those which I procured at Tjorn during May, and which were capable of spawning, only measured from 100 to 110 millimeters, it seems to me not improbable that the small-herring can spawn for the first time when it is two years old; although I believe that this is by no means the case with all the fish born during the same season. The largest small-herring which I could get measured 149 millimeters, but even specimens measuring 140 millimeters are very rare.

III.—OF THE HERRING'S AND SMALL-HERRING'S MODE OF LIFE; ITS MIGRATIONS, AND THE DEPENDENCE OF THESE LATTER ON METEOROLOGIC AND HYDROGRAPHIC CIRCUMSTANCES.

As I was able to make but few personal observations on these points, I endeavored to ascertain from experienced fishermen on the coast what they had observed, and then compared their observations with all the literature on the subject which was accessible to me, in order to find how far discrepancies existed.

The herring and small-herring are usually found in separate schools and do not intermingle. They seem not to get on well together, and must be considered rather as enemies of each other. If, therefore, herring are caught in any considerable numbers during the small-herring fisheries, it is considered an unfavorable omen. When the larger spring-herring goes to its spawning-places in great schools, it is not generally found consorting with any small-herring.[1] The large herring is considered dangerous to the young-herring,[2] and is said, when found in any large numbers, to drive away all the other herring, and is therefore disliked by fishermen on the northern coast.

In seine-fishing, the herring generally seems to be very much afraid of the seine,[3] and cannot often be caught in this manner. The different degrees of clearness of the water plays an important part in this operation, and seine-fishing by daytime can, at present, be carried on only on the southern coast, where the more turbid water from the rivers[4]

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[1] Report on the Herring-Fisheries, p. 111 fr. 8.
[2] *Ekström*, Review of Transactions of the Royal Academy of Sciences for 1846, p. 20.
[3] *H. Rasch* and *B. M. Berg*, Memorial and Petition, pp. 10, 33.
[4] *F. Ekman*, On the Sea-Water on the Coast of Bohuslän, p. 25.

prevents the herring from noticing the seine till it is too late. The large herring is not near as bold a fish as the small-herring, and does not make any serious attempts to escape; while the latter, as soon as the seine is hauled on land, boldly pushes against the meshes trying to get out, resembling somewhat in this respect the pilchard.[1]

The chief food of the herring on the coast of Bohuslän consists of small insects, ("Ganeskar,") which are found, especially during the warm season,[2] in great numbers.

The herring seems to like those gulfs into which some large river empties; and the Skagerack spring-herring is consequently found in very great abundance near the mouths of the Göta River and the Glommen, (where it has been caught with stationary nets from time immemorial.) This may arise from the facts that it finds more food there, and because the less salty and more turbid water offers a better protection, especially upon the part of the young fish against enemies.[3]

In former times, the large herring often ascended the river as far as Göteborg, and once it was found near Tingstad, a mile from Nya Elfsborg.[4]

The herring is found at a greater depth in cold than in warm weather;[5] and when there is ice, it has sometimes been observed to pass under it.[6] Near Kalfsund, it has been found that there is frequently good herring-fishing immediately after the breaking-up of the ice.[7] This always implies a change from land-wind and cool weather to sea-wind and milder weather.

When the water grows warmer, the young herring move to the shallow places; but when cold weather sets in, they move to deep water. It has been observed, near Hisingen, that during the summer the young herring like to come to the mouth of the river when there is an east wind,[8] but otherwise they follow the stream out on the coast. After mild winters, and during particularly mild spring weather, the spring-herring begin to spawn somewhat earlier, and the fisheries consequently begin at an earlier period than otherwise.[9]

At the beginning of the "old" fisheries, when the herring still came near the coast during the warm season, the land-wind was considered most favorable to the fisheries; but since the herring have begun to

[1] *Yarrell*, British Fishes, 3d ed., I, pp. 143–144.

[2] *Ekström*, Review of the Transactions of the Royal Academy of Sciences for 1846, pp. 181–182.

[3] *Dubb*, Reports of the Royal Academy of Sciences for 1817, pp. 35, 44. *Nilsson*, Reports on the Herring-Fisheries, pp. 57, 59, 64.

[4] Act concerning Blubber-Refineries, p. 98.—*Dubb*, Reports of the Royal Academy of Sciences for 1817, p. 35.

[5] *J. M. Mitchell*, The Herring, its Natural History and National Importance, Edinburg, 1864, p. 28.

[6] *Cedarström*, Fish-Culture and the Swedish Fisheries, p. 211.

[7] Reports on Herring-Fisheries, p. 129 fr. 28.

[8] *Nilsson*, Reports on the Herring-Fisheries, p. 64.

[9] *Ekström*, Review of the Transactions of the Royal Academy of Sciences for 1844, p. 120.

approach the coast during the cold season, this is no longer the case.[1] This change has been attributed to the blubber-refining establishments. An east wind increases the saltness and purity of the sea-water,[2] but it retards the current coming from the North Sea toward the gulfs, and consequently lowers its temperature during the cold season, and favors the formation of ice. As to the most favorable time for fishing, (which, as is well known, is chiefly carried on during the warm season,) the old saying holds good: "*fine and steady weather with high water*"[3] is best. A land-wind and low water are generally considered unfavorable;[4] while a change, indicated by rising water and falling weather, is considered good.[5] On the Fjellbacka coast, and in several other places, it has been noticed that the herring goes out from the coast "to meet storm and foul weather;"[6] but that after the storm fishing is very good again.[7]

During the spring-herring fisheries near Hisingen, the herring are said to move, during the land-wind, farther up toward the mouth of the river, and there is then good fishing near Gåsesund and Ardal, and near Ny-Elfsborg; while during the west and south wind, the best fishing is near Andal and Hästevik. Very mild winters, with continuing violent sea-winds, are thought to drive the sea-herring to the coast.[8]

Although I think it proper not to increase the number of suppositions regarding the herring and the herring-fisheries, (which, by the way, is easy enough, even with only a very superficial knowledge of the herring-literature,) I deem it best not to omit noticing in this place the similarity between the approach of the so-called sea-herring to the coast of Bohuslän, and the direction which the current of the sea takes from the North Sea to the Skagerack. This current flows from Skagen toward the Paternoster Rock, just outside of which it turns toward the north, and then follows the coast.[9] Fishing for those herring which come from the sea usually commences near Tjörn and the Marstrand Islands, from which the herring spread toward the south and north.[10] In this latter case, they follow the current of the sea, and as this leaves the

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[1] Act Concerning the Blubber-Refineries, pp. 176, 177.

[2] *Ekman*, On the Sea-Water on the Coast of Bohuslän, p. 26.

[3] Act Concerning the Blubber-Refineries, p. 84.

[4] *Dubb*, Reports of the Royal Academy of Sciences for 1817, p. 46.

[5] *Mitchell*, The Herring, p. 33.

[6] Act Concerning the Blubber-Refineries, p. 73. *Wright, W. von*, Report concerning the Herring-Fisheries, p. 167. *Mitchell*, The Herring, pp. 97–98.

[7] *Dubb*, Reports of the Royal Academy of Sciences for 1817, p. 46. *Mitchell*, The Herring, p. 98.

[8] Act Concerning Blubber-Refineries, p. 177. Report on the Herring-Fisheries, pp. 86 fr. 11, p. 113 fr. 22, p. 128 fr. 27. *Mitchell*, The Herring, pp. 28, 33.

[9] *Klint, G. af*, The Bohus Bay and the Kattegat, Stockholm, 1840, p. 89. *Arwidsson, Th.* The Bohus Bay and the Kattegat, Stockholm, 1869, p. 3. *Ekman, F.*, On the Sea-Water near the Coast of Bohuslän, p. 23.

[10] Reports of the Fishery-Commission, 1760–'72. *Cederström*, Fish-Culture and the Swedish Fisheries, p. 131. Act Concerning Blubber Refineries, p. 6. *Dubb*, Reports of the Royal Academy of Sciences for 1817, p. 34. *Wright, W. von*, Report on the Herring-Fisheries, p. 174.

coast north of Sotenäs the sea-herring fisheries on the northern coast have been less certain and comparatively less productive than those on the central and southern coasts.[1] The reason why the "old" herring, in the beginning of the fishing period, moved farther south, and toward the end of the same period more toward the north, must be found, no doubt, in the uneven temperature of the respective portions of the sea toward the end of the summer and the beginning of autumn on toward winter. It is possible that the so-called "deep trough," from which there is a branch toward the Marstrand Bay, has likewise some influence on the route which the herrings take when they approach the coast.

The current of the sea, which enters the Skagerack with considerable violence, of course facilitates the movement of the herring, and by maintaining a more even temperature has doubtless great influence on their migrations.

IV.—OF THE HERRING-FISHERIES, THEIR TIME AND PLACE.

The common *coast-herring* fishery is, in Bohuslän, generally of but little importance, and is carried on mostly for the every-day supply of the inhabitants of the coast; but, by the combination of several favorable circumstances, it is sometimes more productive and even quite remunerative. This fishery is carried on along the whole coast of Bohuslän, although it is only important in the northern portion, and near Hisingen. During the autumn, especially in October, small quantities of the so-called "autumn herring" are caught between Hafstensund and the Säcke Bay. A few fish of this kind have been caught occasionally, even on the Fjellbacka coast. From the beginning of March on through the spring, so-called spring-herring have been taken with stationary nets in Dynekilen, (a bay,) and in the Ide Bay, and such fish, with loose roe and milt, have been sold during March in Strömstad for 12½ cents a score. This herring-fishery, although of no great importance, is carried on even with small drag-nets, in several localities both on the northern and central coasts, but chiefly on the latter, where, in some places, *e. g.*, Ulkaehälet and Hakenäs, both belonging to the district of Tjörn, it has furnished an ample supply for the households of the fishermen; while, in other places, *e. g.*, Hummersund and Stockeviken, both situated on the southern side of the Tjörn Promontory, the fishing has been exceedingly poor. Fish for household-supply have also been caught with stationary nets in some other places on this coast. Near Hisingen, the spring-herring fisheries have, this year as well as during previous years, been very good. This fishery commences about the middle of March, and is generally continued till the middle of June. The first herring caught, which are the proper spring-herring, are somewhat larger, and much less mixed with other herring than those caught during May and the beginning of June, (these being called "May herring,") and are generally fatter and better. Fishing is chiefly carried

[1] Reports on the Herring-Fisheries, p. 106.

on here with so-called spring, or two-men's, nets, but also with stationary nets. Herring here sell from 25 cents to 28 cents a score, but when they are very plentiful they only bring 12½ cents. The two-men's nets have, during the last year, generally caught from $56 to $112 worth of the fish, and one of them is said to have yielded its owner the sum of $224.

The one and two years' old young coast-herring are caught in smaller numbers in the beginning of the autumn on the southern coast and on some portions of the central coast, and are occasionally found among the small herring when these are taken. During the winter and the beginning of spring, some are likewise found among the so-called sea-herring. The so-called May herring, which is caught toward the end of the spring and the beginning of summer, is often mixed with similar small-herring. From the end of April till the end of summer, more sea-herring are caught during the small-herring fisheries north of Orost. Quite young herring, which are sometimes found in enormous quantities, are caught as bait for the eel-boxes[1] near Hisingen and some other places on the coast with "dog-nets," (nets with very narrow meshes.)

Fishing for *sea-herring*, coming from the sea to the coast in large numbers, begins near Klädesholm between the New-Year and the 13th ot January, and almost at the same time near Marstrand and Hermanö. On the southern coast, it begins somewhat later; on the Fjellbacka coast, about the middle of January; and, near Strömstad, toward the end of the same month, and is everywhere very productive. On the southern coast, the fisheries continue, with short interruptions, till the middle of March; and, on the northern coast near Fjellbacka, till near the end of February; but, near Strömstad, they continue one month longer. Near Tjörnekalf and on the southern coast, the great herring nets are taken to pieces about Easter, as the fisheries during the latter half of March are not very productive; but there have been years when fishing with the large nets has been continued till the beginning of May. The sea-herring caught during winter are generally of an excellent quality and bring a good price, so that the fishermen earn a very good living. The largest income from any single net was $2,520.

Herring, spawning in the autumn, have not, as far as my knowledge extends, been caught anywhere during this year on the coast of Bohuslän.

Fishing for the herring proper is mostly carried on with nets of different description, and in some places with stationary nets. Other kinds of nets are rarely used, although occasionally good hauls are made with them by poor fishermen.

The sea-herring when tolerably small is occasionally made into *anchovies*[2] by less conscientious traders, although this has not happened this year on the coast of Bohuslän. It scarcely pays to salt the spring-her-

[1] This is also done in Norway. *Rasch* and *Berg*, Memorial and Petition, p. 37. *Sars, G. O.*, Report for 1872, p. 35.

[2] *Nilsson*, Scandinav. Fauna, IV, p. 522.

ring, and if it is done, it is only for home-consumption or when the herring are so plentiful that the market is overstocked with fresh fish. Even the fresh sea-herring brings so good a price that salting, for which it is otherwise well suited, does not pay, and has therefore been done only with small quantities. It is well adapted for smoking, although, of course, but very few have been thus prepared.

V.—THE SMALL-HERRING FISHERIES, THEIR TIME AND PLACE.

The autumn and winter fisheries.—Not many small-herring are caught on the southern coast, and these during the autumn are mostly mixed with the sea-herring, while but few small-herring are found among the sea-herring when these are caught later in the season.

On the central coast, near Marstrand and south of Tjörn, good-sized and fat small-herring were caught all through the autumn from October, and these were almost entirely free from sea-herring, which but seldom occurs on this coast; and some small-herring were caught later among the sea-herring. Near Oxevik, at Brofjord, not far from Northern Grundsund, as well as in many other places, fine and unmixed small-herring have been caught during the entire autumn from October till Christmas, when the fisheries ceased, and most of the nets were taken to pieces. The same was also the case near Hunnebo Strand, and in the Battnafjord, where the small-herring fisheries are not very important.

On the Fjellbacka coast, the fisheries commenced in October and continued, with brief interruptions, till the end of the year, and the fish caught were nearly all fine specimens and not mixed with other herring; but in other years, it has happened that the fisheries commenced even as early as September, and the small-herring were, on an average, of a less size. The largest number caught at a single haul was about five hundred bushels. By witnessing and examing numerous hauls, I convinced myself that the fish were not at all mixed with young small-herring or sea-herring. In a haul of from twenty-five to fifty bushels, scarcely a score of sea-herring could be found, and small-herring, measuring less than 100 millimeters, could not be found at all. Some sea-herring are said to have been found in the beginning of the fisheries, and toward the end of the year they became more frequent. During the sea-herring fisheries, more or less small-herring were caught, occasionally in such numbers that it paid to pick them out and pickle them.

On the Strömstad coast, the small-herring fisheries commenced in October and continued in very inconsiderable hauls till Christmas, when the small-herring became more or less mixed with the sea-herring, although even then an occasional haul was found to be entirely unmixed. The month of January yields the largest quantity of small-herring on this coast, although last year this was not the case.

In the Säcke Bay, the small-herring fishery proved almost an entire failure; but near the Hval Islands, Norwegian fishermen caught small-herring, which were mostly sent to Sponvigen and pickled there. The fisheries this year, however, were by no means as productive in the boundary-waters of Sweden and Norway as they usually are.

Small-herring were generally sold, during the autumn fisheries, for from 56 cents to $1.40 a bushel.

As the sea-herring greatly predominate on the southern coast, so do the small-herring on the northern coast, where a successful haul of sea-herring is considered a rarity.[1] Even among the largest hauls of sea-herring on the northern coast, the small-herring were found in considerable numbers; and, in 1843, the last year of the first half-century of the great fisheries, (of which we possess without a doubt a faithful and reliable account,) it was estimated that about half the income from the fisheries came from the small-herring.[2] *Wilhelm von Wright* deserves great credit for having first drawn attention to the importance of the small-herring and its common appearance on the northern coast.[3] Professor *Nilsson*, on the other hand, has so completely underestimated the importance of the small-herring fisheries on the coast of Bohuslän that he proposed, in order to prevent any sea-herring from being caught among them, to forbid this fishery entirely,[4] or at least with any other nets than drag-nets or stationary nets;[5] an opinion which, as is well known, was shared by the Royal Academy of Sciences, and which, by an ordinance of His Majesty of June 29, 1852, became a law.[6]

G. von Yhlen's opinion that those herring which have been caught in good fish-years during the last sixty years, especially in 1812, 1817, 1831, 1840, and 1843, were, as far as he could ascertain, chiefly small-herring, possibly mixed with some larger herring,[7] does not seem to me correct, either as regards researches made by myself among old acts or as regards information gleaned from old fishermen, all of whom maintained that the sea-herring were those which appeared in the largest numbers

[1] Reports on the Herring-Fisheries, pp. 101, 106 fr. 17. Professor *Nilsson's* and others supposition that it is different, (Reports on the Herring-Fisheries, pp. 55, 65; *Ekström* Practical Essay, p. 29; note, New Reports on the Herring-Fisheries, p. xiv,) and his underestimate of the small-herring's importance and numbers created the belief on the coast that our naturalists consider the small-herring to be only the young of the herring proper.

[2] *W. von Wright*, Report on the Herring-Fisheries, p. 169

[3] Reports on the Herring-Fisheries, pp. 167, 168, 169.

[4] Reports on the Herring-Fisheries, p. 18.

[5] *Ekström*, Practical Essay, p. 112. *Fåhræus, O. I.*, Memorial regarding the Petition of Several Fishermen in the Parish of Tanum to have the Royal Ordinance of June, 1852, changed; presented November 9, 1853.

[6] New Report on the Herring-Fisheries, pp. ix, xv, xx, xxi. *O. I. Fåhraeus.* Memorial regarding the Petition of Several Fishermen in the Parish of Tanum to have the Royal Ordinance of June, 1852, changed; presented November 9, 1853. Letter of His Majesty the King, dated February 25, 1855, to the Governors of Göteborg and Bohuslän, regarding certain regulations for making the fisheries on the coast of Bohuslän more productive. New Report on the Herring-Fisheries, pp. 53, 59.

[7] Quarterly Journal of the Göteborg and Bohuslän Agricultural Society, July, 1867, p. 52; April, 1868, pp. 43, 44. New Report on the Herring-Fisheries, p. 11, 12

whenever they came near the coast.[1] In the large fisheries which are carried on in the boundary-waters between Sweden and Norway, and in which the Swedes have taken a part only during the last twenty or thirty years, the small-herring are said to have always predominated, with the exception, perhaps, of the last weeks of the fishing-season.

The spring and summer fisheries.—Near Ulkehålet, in the sound between Mjörn and Tjörn, a few small-herring have been taken, which had fully-developed sexual organs. At Orost, in the parish of Torp, small-herring have usually been caught during the spring, which likewise had fully-developed roe and milt.

During these fisheries, the small-herring have often been found mixed with sea-herring, and so-called "grass-herring," (herring one year old.) During the last great fishing-period, the small-herring seem to have been more numerous during the summer than is now the case.[2]

The small-herring fisheries on the coast of Bohuslän are carried on entirely with nets, as all the other fishing-implements would yield too little result. I know only one fisherman on the coast of Bohuslän who fishes with a purse-net, and only one who fishes with stationary nets.

More than 5,000 tons of small-herring have been prepared during the fishing-year as *anchovies*, especially at Strömstad, Fjellbacka, Grafvarne, Lepekie, Uddevalla, Gullholmen, Nösund, Kyrkesund, and Marstrand. The smaller kind are considered the best for making anchovies, because they have a finer flavor and smaller bones. Young small-herring are, in Norway, made into anchovies, and they are particularly well suited for this purpose; but, as in a fresh condition they cannot stand the long journey to the salting-establishments, they are very seldom used for this purpose by our manufacturers.

VI.—OF FISHING-IMPLEMENTS, THE MANNER IN WHICH THEY ARE USED, AND OTHER MATTERS CONNECTED THEREWITH.

Nets properly so called.—Large herring-nets.—These nets, which, at least on the southern coast, are used for catching the herring coming in from the sea, and which are very much like the nets used for catching herring during the "old" fisheries, are now almost confined exclusively to the southern coast, only a few being found on the central and northern coasts.[3] These nets are generally 120 fathoms long and 12 fathoms deep. On the southern coast, they have usually 18 meshes to the yard; but, on the central and northern coasts, they have 22 meshes. On the southern coast, all the meshes are equally fine; but, on the north-

[1] In the Report on the Salt-Water Fish of Bohuslän for 1869, von Yhlen mentions the frequent occurrence of "fjord herring." See Quarterly Journal of the Göteborg and Bohuslän Agricultural Society, July, 1870, p. 16., which may be compared with the July number, 1871, p. 52, of the same journal.

[2] Act Concerning Blubber-Refineries, pp. 73, 75.

[3] The nets used in the northern portion of the central and northern coasts correspond both in their construction and the manner in which they are used more with the middle-sized nets used for fishing for small-herring.

ern coast, the outer ends (wings) have larger meshes. For each wing, they have 500 fathoms of line on the southern coast; while, on the central and northern coasts, they have shorter lines. On the southern coast, the line is hauled in by a winch, and the stone weights are likewise brought up in this manner. On the southern coast, twenty men usually belong to a net, while, on the northern coast, only fourteen. Before the net is cast, the current is examined, but no search is made for the herring. The nets can only be hauled on land in a few places on the coast of Oekerö, *e. g.*, (where these places are most numerous, from 12 to 15 only, in number,) where there is deep water close up to the coast. The net while being dragged moves along the bottom, and its position is indicated by floats, which are fastened to long ropes. Fishing is carried on in about the same manner as Ekström has described it.[1]

Middle-sized nets.—On the whole central coast and on the northern coast, with the exception of its northernmost portion, these nets, which are mainly intended for the small-herring fisheries, are in common use. They are from 50 to 100 fathoms long, and from 21 to 29 yards deep, having from 20 to 24 meshes to the yard. Generally, however, there are 22 meshes to the yard. They are hauled in with winches, and their lines vary in length from 100 to 300 fathoms. On the Fjellbacka coast, they are usually brought on land in boats.

Small herring-nets.—On the southern portion of the central coast—*e. g.*, near Tjörn—these nets are much used for catching spring-herring, sea-herring, small-herring, mackerel, and other fish to be used either for bait or in the household. They are from 35 to 40 fathoms long and from 12 to 16 yards deep. Their meshes are fine, generally from 18 to 22 to a yard. In hauling them in, a winch is used, employing generally four men. As to their nature and the manner in which they are used, they seem to correspond with the "mackerel-nets" mentioned in several places in the "Act Concerning Blubber-Refineries."[2] On the northern coast north of Hafstensund, similar nets are used, and are called in Swedish "Bolke" nets. They are generally 40 fathoms long, and from 4 to 6 fathoms deep. Four men haul them in, and no winch is employed.

Half-nets.—This kind of net is, as far as I am informed, used only near Hisingen, where there are said to be four such nets, chiefly used for catching sea-herring. They are about 100 fathoms long and 9 fathoms deep, and their meshes have the same size as the large herring-nets.

Nets for small-herring.—These nets, chiefly intended for catching small-herring, were introduced twenty or thirty years ago from Sponvigen, in Norway, where they have been in use for a long time.[3] In the neighboring portions of Norway, they were formerly called "herring-

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[1] Practical Essay, pp. 21–24. *Dubb*, Reports of the Royal Academy of Sciences for 1817, pp. 36–39.

[2] Act Concerning Blubber-Refineries, pp. 73, 77, 79–81.

[3] *Ekström*, Practical Essay, p. 29, note. *Rasch* and *Berg*, Memorial and Petition, p. 33.

nets," to distinguish them from the large nets; and this name they have kept both there and on the coast of Bohuslän. These nets are generally from 40 to 45 fathoms long, and from 8 to 10 fathoms deep, and they have 30 meshes to the yard. They are only slightly weighted down with stones, so that they are easily buoyed up by the floats when lowered to a great depth. The lines to each wing measure about 100 fathoms. They are, properly speaking, intended for fishing in the deep Säcke Bay, with its steep shores, where other nets could not well be used.

Two-men's or spring nets.—These are used on the southern coast for catching spring-herring, from the middle of March till near midsummer. Besides herring, other fish, such as cod, salmon, &c., are caught with them. They are from 65 to 80 fathoms long and 12 yards deep, (only 7 at the end of the wings.) A wooden pole is fastened, by means of two lines, some distance from the wing; and to the middle of this pole is attached the line for hauling in, measuring about 100 fathoms in length. The meshes in these nets are generally very fine.

So-called "dog-nets."—These nets, which are small and have very fine meshes, are used on the southern coast for catching very young herring for bait, but also for catching salmon and other fish. They are used during the spring and summer.

On the northern coast, north of Hafstensund, a similar but somewhat deeper net is used, generally from 25 to 30 fathoms long and 4 fathoms deep in the middle and tapering off toward the wings. With these nets, three or four men have made from twenty to forty successful hauls during the night. As the use of these nets has been for some years prohibited in the above-mentioned portion of the northern coast,[1] many of them have been altered into nets resembling the small-herring nets,[2] but even these were forbidden by a royal ordinance of July 19, 1872.[3]

Stationary nets.—These nets, which have been used on the coast of Bohuslän from time immemorial,[4] are well known to the fishermen in those parts, although they are not much in use now, since they prove remunerative only in exceptional cases. On the southern coast of Hisingen, near Ny-Elfsborg, about 200 such nets are said to be in use, each yard having about 14 meshes. Herring-fishing is likewise carried on with such nets outside the mouth of the Northern River. On the Oekerö coast, fishing for autumn-herring[5] with these nets seems of late years to have ceased altogether. Excepting the few stationary nets here and there on the coast, there is no fishing with these nets worth mentioning north of the Northern River, as far as Dynekilen and the Idefjord, where, however, such nets are used in the spring for catching spring-herring.

[1] New Report on the Herring-Fisheries, pp. 7, 16.

[2] New Report on the Herring-Fisheries, p. 52.

[3] New Report on the Herring-Fisheries, pp. 3, 58.

[4] All the great Bohuslän herring-fisheries, with the exception of this last-mentioned one, have been carried on exclusively with such nets.

[5] See New Reports on the Herring-Fisheries, pp. 10–11, 43.

Small herring are, so far as I am aware, caught with these nets by one fisherman only on the coast of Bohuslän.

Drag-nets.—At the expense of a Göteborg merchant, *Aron Anderson*, experiments have been made with such nets which were brought from Blekinge, Skåne, and Norway, and taken out by a mackerel-boat from Koster; but these experiment have, I believe, been unsuccessful.

Purse-nets are used in some portions of Norway for catching herring and small-herring.[1] In Sweden, they are, as far as I am aware, only used near Strömstad, where they have been in use for a long time for catching salmon, and occasionally during May and June for catching small-herring.

Other fishing-implements are but rarely employed in catching herring.

As it has been stated that the large nets now in use in Bohuslän have much finer meshes than those used thirty or forty years ago,[2] and that the nets used during the great fishing-periods have meshes measuring from 1 to 1¼ inches;[3] and as this is of great importance in answering the question how a suitable net should be constructed, I deem it necessary to adduce some additional facts which I have gathered.

As to the nets used during the latter part of the last great fishing-period, it is well known that these generally, at least on the southern coast and the southern portion of the central coast, had sixteen meshes to the yard;[4] but at the beginning of this fishing-period, the fisheries are said to have been carried on with mackerel-nets having wider meshes,[5] according to information received during the year 1833, by the investigating committee, from the northern coast. As there is, however, no detailed information regarding this matter, it is impossible to obtain an accurate idea of the size of the meshes of these mackerel-nets. This much only is certain, that these nets, on account of the great size of their meshes, were considered useless in fishing for the large herring, (although they were not mixed with other herring);[6] that mackerel-nets with meshes measuring more than one inch are unknown in Bohuslän; that catching fine and fat mackerel presupposes meshes narrower than these; and that these nets, both during the old fishing-period and in later time, have had narrower meshes, at least in the southern portion of the central coast, where they are continually used for catching bait and other small fish.[7] Even in the neighboring portions of Norway, there are no mackerel-nets in use whose meshes measure more than

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[1] *Rasch* and *Berg*, Memorial and Petition, p. 34.
[2] New Report on the Herring-Fisheries, pp. 24, 66.
[3] New Report on the Herring-Fisheries, pp. 24, 63, 66.
[4] *Ekström*, Practical Essay, p. 20, note 2. *Dubb*, Reports of the Royal Academy of Sciences for 1817, p. 36.
[5] Report on the Herring-Fisheries, pp. 86 fr. 9, p. 98 fr. 7. *Nilsson*, Reports on the Herring-Fisheries, p. 12.
[6] *Nilson*, Reports on the Herring-Fisheries, p. 63.
[7] Act Concerning Blubber-Refineries, pp. 73, 77, 79–81. *Ekström*, Practical Essay, p. 110.

seven-eighths of an inch, the general size being only one-half of an inch.[1] As the herring during the old fisheries were persecuted by fish of prey, even in the inlets, smaller meshes were necessary to increase the strength of the net and to prevent the herring from sticking fast in the meshes, and this even when the fishing was going on during the daytime, and help could easily be secured.

When Professor *Nilsson*, more than forty years ago, made his observations on the salt-water fish of the west coast of Scandinavia, the nets on the southern coast had the same sized meshes as at present, *i. e.*, 18 meshes to the yard,[2] and they were, therefore, about the same size as that prescribed for the small-herring nets by the royal ordinance of July 19, 1872, while their meshes are somewhat narrower than those prescribed by the law of December 29, 1857, for the fisheries in the Limfjord, (Denmark.) In the nets used in the southern portion of the central coast, where the small-herring begins to be of importance for the fisheries, there were, thirty years ago, 20 meshes to the yard, and this is still the case.[3] On the northern coast, near Fjellbacka, where the nets are chiefly adapted for catching small-herring, the meshes, in consequence of a royal ordinance of 1833, are made very narrow, "scarcely an inch from knot to knot."[4] This does not mean, as has sometimes been supposed, that the meshes scarcely measured an inch; but that the distance from knot to knot, when stretched, was scarcely an inch. In olden times, the word "mesh," when used in Bohuslän, always meant the stretched mesh; and this meaning has been retained by *Ekström* in his often quoted "Practical Essay." The Fjellbacka nets are, therefore, not any narrower than they were forty years ago, but they are now generally less deep and long. If the nets had had meshes measuring scarcely an inch, herring from 3 to 6 inches long, as well as small-herring, could not have been caught in them to any considerable extent;[5] and the complaint so often heard that the nets had meshes too narrow would have been unfounded.[6] The report made at the Strömstad meeting that the meshes "are so large that the thumb can scarcely be pushed through,"[7] proves that the herring-nets used in that portion of the northern coast were not narrower than the Fjellbacka nets, nor had they larger meshes than those used on the southern coast.

The method of using the nets in former times is supposed to be very

[1] *Rasch* and *Berg*, Memorial and Petition, pp. 28, 29.

[2] *Nilsson*, Reports on the Herring-Fisheries, p. 64.

[3] *Ekström*, Practical Essay, p. 20, note 2, p. 107. (The information that the nets should be from 15 to 20 fathoms deep is based on a mistake of the printer.)

[4] Report on the Herring-Fisheries, p. 107 fr. 28.

[5] Reports on the Herring-Fisheries, pp. 18, 64–66, 69, 136, 157.

[6] *Nilsson*, Reports on the Herring-Fisheries, pp. 18, 64, 89, 143. Scandinavian Fauna, IV, p. 507, 514. *Sundevall*, Reports on the Herring-Fisheries, p. 156. *Wright, W. von*. Reports on the Herring-Fisheries, p. 174.

[7] Reports on the Herring-Fisheries, p. 91 fr. 36.

nearly the same as that in present use,[1] except, perhaps, that during the old fisheries the greater experience and the more unfavorable localities, where fishing was carried on,[2] made the fishermen more practical and venturesome, and taught them many a crafty ruse in placing and managing them, which is now forgotten. In this respect, the inhabitants of the northern portion of Bohuslän gained great fame.[3] During the great fishing-periods of the olden time, fishing was mostly carried on by daytime, which at present is only possible on the southern coast, where the water, at least near the surface, is less transparent.[4] The use of so-called "locks" is, at present, not known in Bohuslän.

As the large and deep nets cannot be hauled on land except on a steep coast, and cannot be dragged along if the bottom is not perfectly even and the water comparatively deep, it will readily be seen that these nets cannot injure the spawning-places of the herring on the coast of Bohuslän. These spawning-places consist either of a stony bottom overgrown with *algæ*, or of a clayey bottom overgrown with *zostera*,[5] over none of which can the nets be dragged. Neither do these nets bring up any large quantity of algæ and sea-weeds, and for reasons which can easily be understood, the fishermen are very particular in using them and in keeping them in repair. The places where they can be used are comparatively few in number, and at the present time, at least, it may be said that the portion of the coast over which they may be safely dragged is exceedingly small. In consequence of this fact, the ignorance of the fishermen concerning the spawning-places of the herring is very great, and has often been mentioned in the reports on the herring-fisheries. On the other hand, smaller and shallower nets can be used everywhere on an even bottom overgrown with sea-weeds, or merely covered with sand; and even these nets bring up sea-weeds and small fish, especially during the summer. In the spring, when the herrings spawn, the sea-weeds are shorter and adhere more firmly to the ground, so that the light spring-nets do not do much injury to the grassy bottoms. As to the injury which they may possibly inflict by disturbing the spawn, I have not sufficient information. The number of places where they can be hauled on land is also very limited.

It is not necessary to say anything more with regard to the so-called "dog-nets," (the fish caught in them being mostly used for bait,[6]) since these, as well as the small nets and two-men's nets, have become lawful for the coast of Bohuslän, by a royal ordinance of February 23, 1855.

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[1] *Dubb*, Transactions of the Royal Academy of Sciences for 1817, pp. 36–39. *Ekström*, Practical Essay, pp. 21–24.
[2] Act Concerning the Blubber-Refineries, p. 176.
[3] *Dubb*, Transactions of the Royal Academy of Sciences for 1817, p. 36.
[4] *Dubb*, Transactions of the Royal Academy of Sciences for 1817, p. 39.
[5] *Dubb*, Transactions of the Royal Academy of Sciences for 1817, p. 33.
[6] *Dubb*, Transactions of the Royal Academy of Sciences for 1817, pp. 45, 54.

With regard to the use of other fishing-implements, and the harm which they may possibly do, as well as all other matters pertaining to this subject, I respectfully refer to the memorial of *Rasch* and *Berg* treating of the fisheries on the coast of Norway, from the Swedish boundary-line to Langesund, which, on account of the similarity of the localities to the coast of Bohuslän, I consider to be of special value.[1]

So far as *Baron Uggla's* proposition is concerned, that, for the small-herring fisheries, nets of the same size should be used as for the herring-fisheries,[2] experience has sufficiently proved how disadvantageous, not to say impracticable, such nets must often be, the use of which would only seem to be required when extraordinarily large schools of herring come in, the small-herring caught being prepared anchovies; and this same opinion would hold good with regard to Counselor *O. I Fåhraeus's* proposition that small-herring should be fished for with drag-nets and stationary nets.[3]

The size of the meshes prescribed by a royal ordinance of July 19, 1872, for the small-herring nets to be used on the coast of Bohuslän (about 18 meshes to the yard) has called forth several petitions from the fishermen on the central and northern coasts,[4] asking for delay in carrying out this ordinance, and setting forth numerous reasons for retaining the present size of the meshes. As this question is doubtless of considerable importance, I thought it my duty to gather as much information as possible on this point from the most experienced and best informed fishermen, and to report what I heard.

With meshes measuring one-half an inch, the smaller kind of small-herring, which are mostly used for anchovies, cannot, it is said, be caught, as they, unless hindered by larger small-herring clinging in the meshes, can easily escape through meshes of the above-mentioned size; while the larger herring remain in the meshes, which, in particularly rich hauls, produces several inconvenience, such as—

1. That the herring which are fast in the meshes hinder, through their weight, the hauling-in of the net. On the southern coast, where the large herring-nets have meshes of very nearly the prescribed size, the small-herring frequently remain in the meshes in such numbers that the net looks like a silvery fur when it is drawn out of the water; and as a net, of course, weighs much heavier when so many fish are con-

[1] *H. Rasch* and *B. M. Berg*, Memorial and Petition drawn up by the Commission appointed by Royal Ordinance of May 28, 1852, for Investigating the Fisheries in the Bay of Christiania and in Langesund; Christiania, December 31, 1853.

[2] New Reports on the Herring-Fisheries, p. 43.

[3] Royal Reply to the Petition of some Fishermen in the Parish of Tanum with regard to the change of section 22 of the fishery-ordinance concerning the implements to be used in the herring fisheries. *Ekström*, Practical Essay, pp. 103, 112.

[4] As long as twenty years ago, a similar petition was sent to the king by the fishermen of the Tanum parish, asking to be allowed the use of other nets than those mentioned in the royal ordinance for catching small-herring. At the suggestion of the governor of Göteborg and Bohuslän, this petition was not granted.

fined in the meshes, it is maintained that the introduction of the prescribed size of meshes obliges the fishing-companies on the northern and central coasts to employ more men for each net than is now the case, and thereby diminishes their income, which, in poor or even in tolerably good years, is small enough; as, *e. g.*, an income of $84 from one net near Strömstad presupposes that it has caught $336 worth of fish; an equal income from one net near Kalfsund presupposes that it has caught $1,680 worth. An increase of the number of men employed on one net from fourteen men (which is considered sufficient near Fjellbacka) to twenty (which is the number required at Kalfsund) of course diminishes the income considerably; and with the small-herring nets used in the Säckefjord this is said to be even more noticeable. As on the Fjellbacka coast the nets are seldom taken up on the shore, but in the boats, the inconvenience becomes still greater, as there is not room enough for several men to work; and, furthermore, because the winch cannot be used for hauling in the net unless the boats are very much larger and consequently more expensive.

2. That the net, weighed down by the herring clinging to the meshes, drags too much along the bottom while it is being hauled on land, and, becoming filled with mud and sea-weeds, is found to be unusually heavy and difficult to manage.[1]

3. That the herring in the meshes cause the net to sink by their weight, and allow some of the fish to escape. Near Kalfsund, this difficulty is obviated by the great care taken to have enough men employed to manage the nets.

4. That it requires much labor to withdraw the herring from the meshes and therefore delays the fisheries to a considerable degree.

5. That the larger-sized small-herring, which are stronger than the others and first rush to the meshes, by remaining in them, hinder other useless fish from escaping.

It is also said that the small-herring when plucked from the meshes are of scarcely any value, because they have been in most cases considerably damaged. They do not keep fresh so long in this condition, nor do they present so good an appearance.

It is further maintained that when the meshes are large, any opening occasioned by tearing becomes still larger, and that on the whole the strength and durability of any net is considerably increased by having finer meshes.

It is quite possible that several of these reasons adduced by the fishermen for proving the necessity of finer meshes are based on prejudices, and on selfish desires to obtain a larger number of fish; but, on the other hand, it is also clear that it is very difficult to root out such old and deep-seated prejudices, and that the only way to do this with any hope of success would be to prove the superiority of nets with wider meshes by a long series of experiments. The large herring-nets used on the southern

[1] *Ekström*, Practical Essay, p. 109.

coast have meshes of the same size, or only a very little smaller than those prescribed for the small-herring nets by the royal ordinance of July 19, 1872, but these nets are intended for catching the larger herring, and could scarcely be as advantageously employed for catching small-herring as the nets used at Fjellbacka and Säckefjord, although during the autumn a considerable number of small-herring was caught on the southern coast.[1] Near Fjellbacka I had the opportunity of seeing how small-herring, measuring 100 millimeters, and some even larger, squeezed through the meshes, and that only very few small-herring measuring less than 100 millimeters could be found among the large number of fish in the nets.

In the Limfjord, (Denmark,) where people have had such a long experience in making laws concerning the use of the various fishing-implements, the meshes in that portion of the net where the fish are gathered measure only 0.55 of an inch, even in nets destined for catching herring, to be in keeping with which the meshes in the Swedish small-herring nets should measure only 0.05 of an inch.

Even when the old fisheries on the coast of Bohuslän were in their most flourishing condition, when fishermen only now and then caught the immature herring, as it was considered unfit for use by salters and oil-refiners,[2] nets with nearly as narrow meshes as those in use at present were employed,[3] partly in order that the herring should no remain fixed in the meshes and so make the net heavier, and partly in order to give the necessary strength to the nets.

Wherever net-fishing is carried on on a large scale, the fishermen seem to maintain the opinion that the size of the meshes does not necessarily imply that any considerable number of fish should remain in the meshes;[4] and *Mitchell* relates that sometimes during the great herring-fisheries in the North Sea the nets become so crowded with herring that they have to be abandoned;[5] and it is said to be no unusual occurrence in those parts that nets sink down on account of the large number of fish in them.

A question, intimately connected with that of limiting the use of fishing-implements, is that of supplying the demand for bait. The greater importance which the so-called winter-fisheries on the southern and central coasts have gained during the last twenty years, on account

[1] It is a very different question whether an implement *can* be used, or whether it can, under certain given conditions in a certain place, be used with the sure hope of *gain*. If an implement is very practical in its mechanical application, it by no means follows that its use will pay, and an implement which is suited to one place may be entirely unsuited to another.

[2] *Nilsson*, Reports on the Herring-Fisheries, p. 63.

[3] *Dubb*, Transactions of the Royal Academy of Sciences for 1817, p. 36. *Ekström*, Practical Essay, p. 20. *Wright, W. von*, Reports on the Herring-Fisheries, p. 169.

[4] *Mitchell*, The Herring, p. 105. *De la Blanchère*, La Pêche et les Poissons, Paris, 1868, p. 725.

[5] The Herring, p. 39.

of the rise in the price of fish and the greatly-increased means of communication, has enlarged this demand very much,[1] which, even twenty years ago, called forth, at the request of the fishermen, a limitation of section 22[2] of the royal fishing-ordinance, in consequence of which nets with narrow meshes continued to be used.[3]

The larger portion of the demand for bait[4] is supplied by the large herring-nets, from which bait can usually be obtained all through the winter. When the great herring-nets are laid up, bait-herring are obtained from the two-men's nets, and from other small nets used for catching spring-herring. During the summer, when the demand for bait is less, since most of the fishermen are employed in the mackerel-fisheries, sea-needles, which can be obtained in great quantities from the island of Læsö, mackerel, and small crustacea (as long as these can be secured) are used as bait. In the autumn, some bait-herring are procured on the southern coast from the "half-nets;" and on the central coast small-herring can then usually be obtained. It is most difficult to obtain bait at the end of summer and the beginning of winter, and there is then occasionally an actual scarcity of it.

The supply of crustacea can only fill a small portion of the demand for bait, since a great many are used, and because their favorite places, near the mouth of the Göta River, have been much disturbed by dredging-machines; and, also, because the severe winters destroy many of them. If these animals were more protected, their number could certainly be increased. This, however, is scarcely to be expected, in consequence of the changes wrought in the fisheries (at least as far as Bohuslän is concerned) by the recent fishing laws.

Stationary nets can be used in Bohuslän with advantage only for catching spring-herring,[5] while they spawn, (as also in the beginning of

[1] The oft-repeated saying of the fishermen that they would not be able to make a living if they could not catch herring, contains, therefore, much more truth than people are willing to acknowledge; and the strict carrying into effect of section 22 of the royal fishing-ordinance, and of the royal ordinance of February 23, 1855, would have been a severe blow to the inhabitants of the coast. See *O. I. Fåhræus*, Memorial of December 22, 1854, regarding the Promotion of the Fisheries on the Coast of Bohuslän.

[2] Ordinance of February 23, 1855, for the Better Management of the Fisheries on the Coast of Bohuslän.

[3] *E. J. E. Uggla*, Report on the Salt-Water Fish of Bohuslän for 1859, p. 14; 1860, p. 49; 1861, p. 56; 1862, p. 7; 1864, p. 110; 1865, p. 5. New Reports on the Herring-Fisheries, pp. 40, 41. *G. von Yhlen*, Report of the Meeting of Fishermen at Lysekil, Göteborg, 1859, pp. 20, 59. *O. Andersen*, The Fisheries of Bohuslän, Frederikskald, 1869, p. 14.

[4] *Baron Uggla's* proposition (New Reports on the Herring-Fisheries, p. 43) is, therefore, not practicable, because, under present circumstances, the demand for bait can be filled by the proposed small nets only in exceptional cases, and at a very exorbitant price.

[5] The assertion which, during the first half of the present century, was often made, that it was difficult or impossible to make the use of stationary nets on the coast of Bohuslän general, is proved to be incorrect, among other things by the circumstance that all the great Bohuslän herring-fisheries, with the exception of the last, have been carried on with such nets.

autumn;) and this only in those places where they are found in large numbers, and where, being sold fresh, they can command a higher price. Stationary nets, moreover, cannot compete with the other nets used during this period, either in cheapness or in the variety of ways in which they can be used; for, with the other nets, mackerel, codfish, salmon, and other fish are caught in addition to herring and small-herring; and they can also be used during those seasons when herring are not caught. Oft-repeated experiments with stationary nets, which have been made from time to time, *e. g.*, on the coast near Kalfsund, have not been able to extend their use, as they have been too little remunerative to warrant the fishermen in using them. It is said that at present scarcely any herring can be caught on the coast of Bohuslän with stationary nets having meshes of the size proposed by Professor *Nilson*,[1] (1⅛ of an inch,) because the herring on that coast reach only in exceptional cases, a size which prevents them from slipping through the meshes. As regards the oft-repeated assertion that, by introducing stationary nets, the herring-fisheries are improved, it must be said that this kind of net is supposed to have a much more injurious influence on the herring-fisheries on a comparatively shallow coast like that of Bohuslän than the large herring-nets, a fact which has also been directly acknowledged by several persons who recommended the exclusive use of the stationary nets.

Ever since Bohuslän became a province of Sweden, it has been repeatedly said that the inhabitants of that province ought, like the Dutch and the Scotch, to carry on their herring-fisheries in the open sea with floating nets; and several attempts, even with very favorable privileges or contributions from the king, have been made in this direction, without, however, having led to any satisfactory result. The best managed attempts of this kind were, doubtless, those which were made with boats and nets brought from Holland. Less fortunate, and showing want of knowledge of the subject in hand, is a proposition made in 1774 in the journal "*Hvad Nyatt*" (What News) to catch herring with Bleking (another province in the south of Sweden) nets, three or four miles out in the open sea.[2] Rev. *Ekström*, who is so well versed in everything pertaining to fisheries, has recently, in his excellent book and in a very practical manner, made propositions in this direction, pointing out the best way for carrying on the open sea fisheries,[3] which could be done without any great outlay.

For carrying on fishing with floating nets off the coast of Bohuslän, boats and nets of the same kind as those used in Scotland would, doubtless, be required. It has been found in that country that the better covered and more seaworthy the boats are, the greater protection they offer to the fishermen, and all the safer and more productive will be the

[1] Reports on the Herring-Fisheries, pp. 81, 8

[2] Act Concerning Blubber-Refineries, p. 139.

[3] Practical Essay, pp. 16, 93, 98, 99.

fisheries.[1] Weak and uncovered boats, and incomplete nets or other implements, used in the open-sea fisheries, show that the fishing is yet in a somewhat primitive condition.[2] It must also be mentioned that, in the Skagerak, during the dark season of the year, there are far greater meteorological and hydrographical impediments to net-fishing than in any other sea of Northern Europe where such fisheries are carried on. To make such fishing-methods pay, it is necessary that, during the milder season, a considerable number of larger herring should be found near the coast, which, however, does not seem to be the case.[3] If the herring are to be caught farther out, no other method seems more practicable than the *Dutch method;* but this, as is well known, requires a great outlay of money, special experience, and good nautical knowledge.

VII.—SCIENTIFIC OBSERVATIONS AND SCIENTIFIC AS WELL AS PRACTICAL EXPERIMENTS NECESSARY FOR CONTINUING THE INVESTIGATIONS AND BRINGING THEM TO A SATISFACTORY END.

In order to carry on the investigations which have been begun to the extent mentioned in the "Transactions of the Royal Academy of Sciences," March 12, 1873, the co-operation of several men[4] is doubtless required, and has been expressly insisted upon, for one person cannot, with sufficient accuracy, follow the course of the fisheries on the different fishing-stations, much less carry on the necessary hydrographical, morphological, physiological, and biological experiments, &c., which must be made.

The Skagerak and Kattegat are, from a hydrographical point of view, almost unknown, and in order to attain this knowledge, it would be necessary (if it is to be at all exhaustive) in a work of such dimensions and importance, to have a separate investigation by men specially selected for the purpose, and much time in which to do the work. In order to compare the hydrographical and meteorological facts with the course of the herring-fisheries and the migrations of the schools of herring, a very complete series of simultaneous observations would be required on these three fields, which a single person constantly traveling from one place to another could not possibly make, even if he had some assistance.[5]

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[1] Thus, some of the larger boats in Scotland realized during the year 1872 an annua income of from £100 to £550 per boat; while the smaller, uncovered boats, made only from £60 to £160.

[2] The mackerel net-fisheries, which at present are carried on in the Skagerak by Swedes and Norwegians, must be considered, as regards the seaworthiness of the boats, the excellence of the nets, and the result of the fisheries, the best in the whole of Scandinavia.

[3] Practical Essay, p. 32. *Nilsson* has never proposed that any such net-fisheries should be carried on near the coast. See New Report, Stockholm, 1828, p. 31.

[4] New Reports on the Herring-Fisheries, p. 73.

[5] In Norway, the investigations of the herring-fisheries have been very much aided by the overseers of fisheries, and by information given in the journals, while this has not been the case with us.

Accurate anatomical observations on the development of the sexual organs, and their condition at different ages and periods, require, in order to satisfy the claims of scientific accuracy, uninterrupted opportunity, a constant supply of fresh material, and all the necessary scientific apparatus. Well-arranged aquaria would also be of the greatest value for some of these investigations.

While occupied with the observations which I had been commissioned to make, I soon became satisfied that, in order to obtain an entirely satisfactory and decisive result, it would be necessary to establish a complete station for scientific observations of the ocean in some convenient place on the coast; which station ought to be furnished with the required meteorological, hydrographical, botanical, and zoological working force, and with a full set of scientific apparatus. That such a station would, moreover, contribute much new and valuable information to this branch of natural science, and would also become really indispensable in this respect, is just as evident as that its observations would and ought to extend far beyond the range of the present investigations.

As the so-called "great old" fishing-period has, during the whole discussion regarding the best method of carrying on the fisheries in Bohuslän, been presented as an interesting and instructive example, and as being intimately connected with the present fisheries, a complete and accurate *history* of this period would be of great importance, and this the more so as the facts we possess concerning it are too few, and have been collected mostly from sources dating after the end of this period. Even those works and public reports from 1809 to 1855 which treat of the present Bohuslän herring-fisheries and other subjects connected with them, ought to be searched much more carefully than has yet been done, in order to furnish a complete epitome of their contents.[1]

In order to observe satisfactorily the migrations, mode of life, and place of sojourn of the herring during the fishing-season, as well as their course in the water under different temperatures, &c., experiments with floating and stationary nets, having different-sized meshes, should be made at all seasons of the year, both near the coast and in the open sea; for the use of one sort of nets furnishes data unlike those yielded by the use of another kind.

It is furthermore necessary that continued experiments with floating nets should be made for a considerable time, in a seaworthy boat furnished with all the required implements, so as definitely to answer the question whether the "old" herring have altogether left the coast of Bohuslän, (as is maintained by many,) or whether they continue to spawn on the outer coast, which would, of course, make fishing in the open sea a remunerative occupation.

[1] Professor *Nilsson* has drawn attention to the fragmentary condition in which these reports have been published, (Scandinav. Fauna, IV, p. 501, note 1,) and there is no doubt that a new and complete edition of these reports would be of the greatest importance to all who wish to study this subject.

VIII.—OF THE IMMEDIATE CONTINUATION OF THE INVESTIGATIONS AND THE SUMS REQUIRED FOR THIS PURPOSE.

My time during the coming year might be most advantageously employed in correcting and completing the information thus far gathered and in extending my observations to the herring and small-herring fisheries of the South Baltic, the Kattegat, and Southern Norway; although it would certainly be a great advantage if, before any fishing-experiments were made, the observations which are independent of the fisheries were more advanced than they now are or can be. Nevertheless, these experiments ought not to be delayed too long, even if in the beginning they must be made on a less extensive scale and in a shorter time.

I dare not renew the request which I made last year that I might receive scientific assistance for the carrying-on of these investigations, as long as the members of the committee do not express a desire to have these investigations made on a larger scale, and with greater dispatch than heretofore. But as the apparatus for carrying on these investigations, and which I furnished from my own means, has proved entirely insufficient,[1] and as the sums which were at my disposal have been expended in buying the necessary books, I feel justified, from my experience of last year, in making a request for the following sums, both for buying apparatus and for meeting other expenses incurred during the course of these investigations:

1. For glass vessels and alcohol	$224
2. For scientific apparatus	84
3. For buying and hiring nets and paying the fishermen, supposing that these observations can begin next year	420
4. For paying assistants, who are to take notes on the fisheries in the most important fishing-stations	392
Total	1,120

AXEL VILHELM LJUNGMAN.

TJÖRN, *June* 4, 1874.

[1] The want of suitable vessels for keeping the herring of different seasons, locations, ages, and sizes separate has been particularly felt.

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VIII.—THE HALIBUT-FISHERY OF THE UNITED STATES.

By Lieut. P. de Broca

One of the most frequently observed fish in the markets of the seaboard towns of the United States is the halibut, (abundant in the northern seas,) which the fishermen of Newfoundland consider of little value, in consequence of a prejudice cherished by them as absurd as that of the English in regard to the skate. The flesh of the halibut possesses every quality which can make it desirable to the consumer, being white, firm, and delicate. It may, perhaps, lack flavor; but it makes up for this deficiency by entering readily into the most varied culinary combinations, and, when smoked, it rivals, in my opinion, the best preparations possible. Under whatever form it appears, it is so highly appreciated in the United States, that it has become the object of an important industry. This fishery is generally combined with that of the cod, when it is carried on along the shores of the open sea.

The halibut is found in abundance along the coast of New England and of the British Possessions, as well as on the banks of Saint George, of Sable Island, and of Newfoundland.† The giant representative of the family of *Pleuronectids*, it attains such dimensions that among the edible fishes of the sea it may be considered as analogous to the ox among the animals of the slaughter-house. It is often caught weighing a hundred pounds, and in many instances it has been taken weighing even more than this. A few years ago one appeared in the market of Boston which weighed 400 pounds; and in 1807 one was caught at New Ledge, sixty miles to the southeast of Portland, that weighed over 600 pounds. It is truly astonishing that fish which contain so great an amount of alimentary substance have not long since attracted the attention of the French fishermen of Newfoundland or those of Iceland, and suggested to them the thought of their great commercial value.

During the warm season halibut are caught in shallow water, only a few miles from the shore; but as the weather grows colder, they migrate toward the banks of the open sea, where they must be followed to be

*Étude sur L'industrie huitrière des États-Unis, [pp. 139-224:—] Deuxième partie. Aperçus divers sur la pêche cotière, [pp. 141-148:—] Chapitre premier Pêche du Flétan.

†The halibut inhabits also all the seas of the north of Europe, and is the object of an important fishery, especially among the Icelanders and Norwegians. The English and the Dutch consume large quantities.

captured. A part of those taken on the coast, as well as upon the banks of Saint George and of Sable Island, are carried fresh to the markets. The methods of preservation used are those generally employed in such cases. Those of smaller size are thrown into tanks, while the very large ones are placed in the ice-houses of the fishing establishments. The most important fishing is done by schooners of from 70 to 120 tons burden, owned by the States of Maine, Massachusetts, Rhode Island, and Connecticut. They take on board during the summer from 20 to 25 tons of ice on each expedition.

In consequence of the great popularity of the halibut with consumers, this fishery has become so profitable that, in certain localities where mackerel have become scarce, the latter fishery has been almost entirely abandoned for the former, since it is much more certain. The harbor of New London is a case in point.

Besides the large vessels I have just mentioned, many smaller ones are also employed, but these never go beyond fifty miles from port.

The fishermen off the Grand Bank of Newfoundland, who combine halibut fishing with that of the cod, cut the fish into longitudinal strips, in order to salt it more easily; and, on their return, deliver it to certain establishments, where it is smoked after the manner of salmon.

During the year 1858, 444,920 pounds of fresh halibut were sold in the market of Gloucester, Mass. The total amount brought in by the fishing-boats of the harbor of New London is now estimated to be about 3,306,900 pounds. In 1861, the halibut taken by the fishermen of Gloucester was valued at $120,000. From these examples, which might be multiplied indefinitely, since the entire coast of New England is engaged in this fishery, we may readily estimate the amount of sustenance annually furnished for public use by this single fish.

It is evident that our Newfoundland fishermen can never bring fresh halibut to France, but nothing prevents them from salting it, as the Americans do. Notwithstanding their prejudice against it, I have no doubt that the flesh of this fish would be received with favor by our population, especially as it could be sold to them as low as 7 or 8 cents per pound, the ordinary price of it in Boston.

Americans are surprised at our want of forethought in this matter, and one of them said to me, on more than one occasion, that if the French government would allow him to fish in the grounds of Newfoundland, reserved for our nation, he would engage to take only halibut, and to dispose at Saint Peter's of all the cod fish he might capture. The French consul at Boston has several times received overtures of the same kind.

The unreasonable prejudice of our fishermen should be overcome by the single fact that this want of interest in the fishery is the cause of a serious loss in the supply of articles of food. Besides, it is not to be supposed that a fish which is used by the wealthier classes of a country as rich as the United States is in every kind of product, is essentially unpalatable, and that our countrymen could not become accustomed to the taste of it. For my part, I would find it difficult to determine which I preferred, salmon or smoked halibut.

Before my visit to the United States, I was acquainted with the halibut only through the descriptions of naturalists. I did not know that it constituted a fishery of such importance. But since I have had the opportunity of observing the large amount of food it furnishes to all classes of the American people, I consider it great folly on the part of our fishermen to neglect such a source of profit and of food.

The best way of elevating the French fisherman from his condition of pecuniary distress is to have him understand that he ought to make his arrows out of every kind of wood, and not to disdain, without good reason, riches which lie at his very door.

When a nation has, as ours, a large population to nourish, it amounts almost to a crime to deprive it of an element of food both economical and agreeable. In many cases, too, fishing for halibut would become a useful auxiliary to that of the cod, and would increase its value.

Without dwelling further upon this subject, I think that an attempt, at least, should be made to put the question to a practical test, on the fishing-grounds of Newfoundland or Iceland. The bait used in catching the halibut, whose gluttony is proverbial, is composed of salted fish of the herring order, of very little value in America on account of their abundance and inferior quality. They are the same as those used for catching mackerel, and for manuring fields of Indian corn. A barrel of bait, all prepared, sells at the rate of $1 or $1.50. It would be a very easy matter to obtain it, and the French consul at Boston could send it to Saint Peter's, if to do so were deemed advisable.*

Many persons may object, that if this subject were really as important as I suppose it to be, it would not have remained so long unnoticed. But the truth is too evident to be affected by such reasoning. I do not claim the merit of having discovered what might have been proved a thousand times better by our consuls, or by any other competent person; but I have seen, I have handled, I have tasted, the flesh of the halibut, and found it superior to that of very many fish which appear in our markets; and, not being able to doubt the evidence of my senses, I consider it a duty to publish the fact.

*It is unnecessary, however, to agitate the question of bait, since that used by the Icelandic and Norwegian fishermen could be employed.

IX.—THE FISHING-VILLAGES, SNEKKERSTEEN AND SKOTTERUP, AND THE COLLECTION OF FISHING-IMPLEMENTS EXHIBITED BY THEM AT ELSINORE, DENMARK, DURING THE SUMMER OF 1872 *

The fishing-villages, Snekkersteen and Skotterup, are situated not far from the town of Elsinore, on the Danish island of Zealand, where the sound is narrowest. The inhabitants are, with few exceptions all fishermen and entirely dependent on the sea for their living. The circumstances under which they are obliged to gain their livelihood are somewhat peculiar, for, while the location of their villages offers in some respects, great advantages for fishing, on the other hand it presents difficulties which the greatest energy of the fishermen can scarcely overcome. The most important field for their operations is the narrowest part of the sound where it widens on both sides like a funnel; and they have consequently both the advantages and disadvantages of being in the very spout of the funnel, where everything that is poured into it must pass through. All the schools of fishes pass close by them, but the powerful current, which, flowing sometimes this way, and sometimes that, according to the wind, while it brings the fish to them, frequently drives them just as rapidly away. Hence, here more than in many other places the fishermen must understand how to seize the right moment for their work. The large number of ships sailing by or riding at anchor † proves useful to the fishermen, as they are by this means often enabled to sell their fish at a very high price. Yet their nets are often destroyed by the ships or entirely carried away by anchors or oars. The peculiarity of the location makes stationary fish migratory, and *vice versa*. The haddock and flounder are thus obliged to migrate, and though their migrations do not extend far, they occur all the more frequently; while the hornfish and other migratory fish are often compelled to remain in those waters much longer than is good for them. Thus many different things are to be considered by the fisherman in order that he may not come too soon or too late with his nets. The more accurately he can calculate the probabilities, and the more completely he is provided with suitable nets for catching the numerous kinds of fish that pass the coast, the more remunerative will be his labor.

It has not been possible to exhibit all the implements "*in natura*," hence the boats and great casting-nets are only shown in models.

1. *Model of a transport-boat.*—The boat of which it is a model was

*From Nordisk Tidsskrift for Fiskeri.

† On an average, 21,000 per annum.—[*Translator's note.*]

7 years ago, and has brought millions of genuine Snekkersteen haddock, plaice, and eels to Copenhagen. From 5 to 6 such boats are continually plying between Snekkersteen and the capital, and their numbers will soon be increased by one or two more. During the winter of 1866-'67, one of these boats made 36 trips, and brought to Copenhagen 10,142 pounds of eel, 49,655 haddock, and 2,995 plaice, which sold for a total sum of 4,264 Danish rigsdalers, (one rigsdaler = about 50 cents, gold.)

These boats must be good sailers and must be built very solidly, of a tonnage of not more than four tons, and their price, completely rigged, is about 1,000 Danish rigsdalers.

2, 3. *Models of fishing-boats.*—These are models of fishing-boats used by the fishermen of Snekkersteen and Skotterup. The two villages possess, at present, 122 of these boats, and their number is constantly increasing All these boats were formerly built in Sweden and Norway, but now they are built in the villages themselves, and are even exported from there to Sweden. These boats are constructed for fast sailing, and are of all sizes. One of the largest size, built of oak, costs, with sail and rigging, 300 Danish rigsdalers; while one of the smallest size, but just as fast a sailer, can be bought for 70 rigsdalers. No family has less than two of these boats, while some own as many as six, the use of so many different kinds of nets requiring that large number.

4. *Model of a casting-net.*—This is the largest net used by the fishermen, and the original is from 80 to 200 fathoms long.

5, 6, 7. *Prices of a casting-net.*—As such a net must be adapted to the place where it is set, and as it must be placed in such a manner that the upper edge may reach the surface of the water, while the lower touches the bottom, the nets are naturally of different length and depth. The cost of such a net is about 700 rigsdalers. It is tarred yearly, and in spite of this and the solidity of the work, it scarcely ever lasts longer than 4 years, and even then it must frequently be repaired. There are in Snekkersteen and Skotterup, 11 such nets, but they are seldom all used at the same time. The number of fish caught in these nets varies, of course, in different years. Thus, two such nets caught, in the fall of 1871, 459½ rigsdalers' worth of fish, while two nets caught, in 1861, 1,544⅔ rigsdalers' worth. TThe casting-net can be used only near the land, but here all those fish are caught that travel along the coast. The eels often manage to slip through the meshes, but for other fish, such as herring, mackerel, hornfish, haddock, &c., this net proves a sure trap.

8. *An eel-trap or bow-net for catching eel.*—Notwithstanding the eel's nimbleness, it is caught in large numbers in this trap, hundreds of which are set, one row alongside of an other, from the shore to an extent of 7 fathoms. Every fall an immense school of eels passes through the sound from the south. From the middle of September till November, the eels travel during star-light nights; when wind and current are favorable, but when there is no moon, and the traps are carefully cleaned of all sea-weed, the fishermen may calculate on a rich booty. Great care is

required, however, for the eel is very sly, and a few sea-weeds or a little white stone at the entrance of the trap is sufficient to drive it away; and if only one mesh be broken, or if it be a little larger than the others, we may be sure that the eel which has been caught will find the weak place, and tail foremost, work his way out. Three kinds of eel pass through the sound, and, strange to say, of two of these not one can ever be seen by day at the bottom of the sea, while the third is occasionally seen among the seaweeds.

9. *Apparatus for holding the eel-trap, (bow-net.)*—The eel-trap or bow-net is an old invention, and is known and used throughout the greater part of Europe. But, so far as we are aware, it is nowhere else placed as it is here, owing, of course, to the peculiar locality. While, in many other places, a pole is fixed at the bottom, to which the trap is fastened, they have on the coast of the sound a special apparatus for this purpose called "vager," which is laid before the traps are put in position, and which remains at the bottom of the sea when they are taken out to be dried. This apparatus is not in the way of ships, as a pole might be; is strong enough to resist any current; and enables the fishermen easily to take the trap out and again place it in its exact position.

10. *An eel-trap on its "vager," as placed at the bottom of the sea.*—This exceedingly practical arrangement dates from a very ancient period, perhaps a thousand years back, as is proven by the technical terms applied to its different parts, Danish words entirely out of use now, but common at that distant period. Snekkersteen owns 680, and Skotterup 240 of these bow-nets. Like the casting-nets, they are never all used at the same time, about one-fourth being kept as a reserve. Such a bow-net complete costs from 17 to 20 rigsdalers, and lasts from 4 to 6 years. They are made either of flax or of cotton, and their manufacture is a favorite employment of the fisher-families during the long winter evenings. The places where these bow-nets are set are sold by the government to the fishermen at a high price. The profits, of course, vary very much. A fisherman, who kept an exact account, says, that in 1861, he caught 352 rigsdalers' work of eels in 24 bow-nets; in 1862, 216 rigsdalers' worth in 30 nets; and in 1871, 197 rigsdalers' worth in 19 nets.

11. *Bow-net for catching shrimps.*—The location is not favorable for shrimps, and they are but rarely caught here as an article of food; they chiefly serve as a bait for the haddock.

12. "*Ulken,*" *a sort of net for catching shrimps.*—This is dragged after the boat, in order to catch the shrimps, which are so deep in the water among the sea-weeds that the fisherman cannot wade in and catch them with—

13. The "*hoven,*" an implement which he pushes before him. To this branch of fishing belong also—

14 and 15, *two different kinds of nets or "hoven" for catching shrimps.*—In winter the shrimps go into deeper water, (from 3 to 4 fathoms,) and live among the masses of sea-weeds torn off by the currents and the

storms. A sort of hook is thrown out, by means of which large quantities of these sea-weeds are brought up, and the shrimps are shaken out of the net into—

16. A little fish-trunk or *cauf*, (*the shrimp-box*,) where they are kept alive till used for bait.

17. A pole called "*stampe*" is used for stirring up the bottom of the sea in order to bring out the sand-worms which are also used for bait; these are then caught with a sort of comb or catcher—

18. Called, in Danish, "krillen," the curl.

19. *Trap for catching snails*, also used for bait.

20. *Herring-catcher*, for catching herring for bait.

One may see, on any winter morning, numerous boats, each manned by one or two fishermen and provided with all the different kinds of bait, leave the two villages for catching haddock. The fish, when caught, are thrown into a tub filled with water, which must be constantly renewed, or into a sack-like net hanging outside the boat, for it is of the greatest importance to keep the fish alive. In its endeavors to swallow the bait, the hook easily pierces the inner part of the gullet and produces a fatal wound. In order to prevent this, the hook is furnished with a piece of tin soldered to it, often in the shape of a little fish. This makes it heavy, and the fish can scarcely get it further down than the gristly parts of the mouth.

The fishermen encounter more difficulties in striving to keep the fish alive than in catching them. During severe winters, when the sound is covered with ice, the Danish fishermen do not put on skates as the Swedes do, but merely wooden shoes with small spikes in the soles to prevent slipping. Thus shod they start out dragging behind them a sledge furnished with the fishing-implements, their temporary house, and its furniture. The house consists merely of a large sail and some poles, and to put this up is the fisherman's first work. He makes himself as comfortable in this tent as possible. He cuts two holes in the ice, one for his fishing-line and one for the sack into which the fish are to be put. The sledge serves as his chair, the basket containing his food and the tub containing the bait being so placed that he can reach them without moving from his seat. Thus he sits quietly for hours, and returns home in the evening drawing the sledge, whose load is now increased by the tub full of water containing the fish.

21. *A fishing line with the so-called "tin-fish" attached.*

22. *A line for catching whiting.*

23. *A line for catching mackerel.*

It is interesting to watch from the terrace of the ancient castle of Kronborg, commanding a magnificent view of the sound, the catching, in the spring, of hornfish, which then pass through the sound in large numbers on their way to the Baltic. Two boats always go together, each manned by four men, and a large net stretched out between the boats. Everything, apparently, is quiet; most of the fishermen seem to be asleep with the exception of the two standing on a board stretched across the boat to keep a lookout. Everything, however, is prepared; the oars are in their places, and the stones are prepared, which are thrown into the water for the purpose of chasing the fish into the net. The two men stand on the board motionless as statues, straining their eyes to see in the distance the faint and indistinct shadow appearing on the surface of the sea, occasioned by the approach of a school of fish. For hours they may be observed standing thus, unmindful of wind and weather. Suddenly one of the men raises his arm, and immediately, but silently, every man is at his post. He hurls a stone a great distance, then another, constantly nearer in order to drive the school toward the net. Now the fish are inside the bay forformed by the net "Row!" is the order given, and the oars dip into the water. The former silence is now changed to a scene so wild and picturesque that one would scarcely believe that all this commotion is only produced by some hornfish. All are on the alert, and every order given by the commander is executed with the greatest swiftness and precision. When the boats have approached each other, and the fish are consequently entirely surrounded, but by no means caught as yet, the net is carefully drawn together, so that the inner space becomes smaller and smaller. The fish now try to slip out beneath the boats, but the fishermen are at their post, and by shouting and splashing they chase the frightened fish back. After such unsuccessful attempts to escape, the whole school frequently turns the other way, pushing with all their might against the net. This is the moment for which the commander has been eagerly waiting. "Draw together!" he shouts, and with a desperate pull the net is entirely closed, heavy with the splashing fish, and is soon drawn up into the boats.

There is, of course, the greatest difference in the number of fish contained in different schools. Sometimes there are only a few, and, at other times, one school will more than fill two boats. In this latter case the contest becomes more animated, and to a person who sees it for the first time it looks like a desperate combat between the crews of the different boats, never failing to attract a large number of spectators. The most animated spectacle is presented when the fishermen make the so called "Hage-stretch," *i. e.*, when they are forced by the current past the promontory called "Hage," in order to catch the fish which are just being driven back from the south. The boats shoot through the foaming waves with fearful rapidity, and it requires a great amount of skill, strength, and courage to obtain a favorable result. One little mistake, an order given or executed too soon or too late, is sufficient to frustrate the whole scheme. To make this stretch is therefore considered the crucial test for all fishermen on the coast, and unless one has accomplished this feat he is not esteemed very highly by his comrades. Affairs become still more complicated when there are two schools coming on at the same time, for if one turns to the right, the other is sure to turn to the left, and it requires the utmost attention of the fishermen to make sure of either.

24. *A net for catching hornfish.*—It costs, when new, from 60 to 80 rigsdalers, and can be used for five or six years if kept in careful repair.

25. *A model of the preceding net*, showing in what manner it is placed in the water.

Toward fall the hornfish returns from the Baltic and travels through the sound toward the North Sea. They can then no longer be caught in the same place and in the same manner as described above, for they are spread at this season of the year over the whole sound. The whole coast of Zealand, south of Kronborg, is now closely packed with large nets, and the fish are not chased by men alone, for a large number of porpoises are all day long busy in securing their share of the booty. These porpoises appear in August, and chase the hornfish with the greatest zeal. They are not at all shy, and they pursue the fish close up to the boat, so that they can easily be caught. Their flesh, however, cannot be eaten, but they prove useful, inasmuch as they actually assist the fishermen in the chase for the fish. Special nets, called in Danish "nedgarn," are used for this kind of fishing.

26. *One of the above-mentioned nets*, ("*nedgarns*.")—At night the fish will enter this net very readily, but by day they are very careful to avoid it, and now comes the porpoise in its useful capacity of hound. But for these animals the fish would remain at the bottom of the sea below the nets. The fisherman rows toward the place where the porpoises are seen and where the hornfish leap out of the water. Here he casts his net and lies in ambush like a spider. Suddenly a rushing sound is heard; it is a school of hornfish jumping toward the net on the surface of the water. Behind them is the porpoise chasing them, now shooting along under the surface with incredible swiftness, now leaping out of the water, and not infrequently casting up some fish or holding one in its mouth. Sometimes it turns a somersault, but, for the most part, its large body falls straight back into the sea, splashing the water in all directions. The school of fish turns directly into the net, and only those that leap over it manage to escape and the fisherman gathers the fish caught in the net and makes it ready to receive another school. When the weather is favorable and the porpoises are lively, this chase is very amusing. Porpoises, like trained dogs, never touch a fish that is caught in the meshes, and with the most admirable dexterity they avoid tearing the net in their bold leaps. The porpoise is often seen swimming patiently alongside of the net waiting for a fish to fall off; but should it be ever so hungry it would never think of plucking off one by itself. It is therefore considered as a friend by the fishermen, and none of them would ever venture to injure one of these animals.

27 *and* 28. *Nets for catching herring.*—These nets are of different depth, but all equally long. They are twice as long as the common nets,

and can be divided into two parts. Snekkersteen owns 140 such nets, and Skotterup 40. They cost from 16 to 20 rigsdalers each. A horn-fish-net costs from 12 to 16 rigsdalers, and the two fishing villages own about 50 of them. Of mackerel-nets Snekkersteen own 130 and Skotterup 54, the price of these being from 10 to 16 rigsdalers each.

29 *and* 30. *Mackerel Nets.*—The so-called "small nets" play an important part in the fishery on this coast, and they are consequently manufactured of many different sizes to suit all circumstances. They are twice the usual length, and can be separated into two parts. While the poorer fishermen do not possess any casting-nets or bow-nets, there is not one of them who does not own several "small nets." They are used all the year round for haddock, flounders, turbots, dabs, &c. Salmon or sturgeon are sometimes caught in them, and occasionally a lobster or crab finds his way into them; perhaps a mackerel, and even wild ducks; and more rarely yet a porpoise, which becomes strangled in the meshes from want of air.

31 *to* 41. *"Small-nets" of different sizes.*—These cost about 8 rigsdalers each. Snekkersteen owns about a thousand of them, and Skotterup two hundred and fifty.

During the summer the fishermen cast their nets for plaice in the neighborhood of the island of Hveen, (about the middle of the sound.) The fish caught there are of a very superior quality, and often very large. Some have been caught weighing $10\frac{1}{4}$ Danish pounds, (1 Danish pound is equal to 1.101 pounds avoirdupois;) and fish weighing from 4 to 6 pounds are frequently caught. Turbots are also often taken here, the largest, as far as known, weighing 30 Danish pounds. These fish are sold almost exclusively in the Elsinore market or to the ships lying at anchor there. The fisherman rises very early in summer-time, mostly between 1 and 2 o'clock, a. m. He first observes the weather, and if it be favorable he hurriedly dresses and hastens down to his boat, for the fish must be in the Elsinore market as early as 6 o'clock. He is soon in his boat, and speeds swiftly toward the place where the nets have been cast the previous day. While one of the fishermen plies both oars, the other draws in the nets. Others are cast out immediately, and, rowing rapidly, the boat soon approaches the coast again. There his wife and children meet him, help him to draw the net on land, and to take out the fish and sort them. In a few minutes they are packed on a wheelbarrow and one of the fisherman's children or his wife wheels them to the market, and at 7 o'clock a. m., not a fish is to be had.

As soon as the nets are dry they are mended, stretched out on poles, and loaded down with stones, to prevent the wind from carrying them away, so as to be ready for the next day's work. All this keeps the fisherman and his family busy during the day. Every now and then the nets are boiled in lye or tree-bark, with an addition of soda or potash.

42. The so-called "*kvistekjoeppe*," a sort of switch or broom, is a very

practical implement for freeing the nets of rubbish, which they invariably bring up with them from the water. It requires some skill and practice to use this tool, but it cleans the nets much better than any other used for that purpose. Strange enough, this useful implement is scarcely known outside of Snekkersteen and Skotterup.

43. *A net for catching porpoises.*—This is but seldom used, and there is only one such in the two fishing villages. Most fishes of the flounder kind are caught in "small nets," but the halibut proves too large for these. This fish is therefore caught with special halibut-hooks, (called "bagger" in Danish,) or with lines. All along the sound, nearer the Swedish than the Danish coast, there is found a very considerable depression of the bottom of the sea. From Helingsborg, the Swedish town opposite Elsinore, the fishermen call this great deep "*Skraepperne.*" This seems to be the favorite resort of the halibut. In summer one may also find there large haddocks and skates. The fishing in these waters pays very well, and most of the fish caught here are brought to the Copenhagen market.

44. *A number of halibut-hooks.*

45. *A halibut-line.*

46. *Different specimens of haddock-catchers, (Danish, "torskepilk.")*—In fishing in the "Skraepperne" the fishermen are often obliged to make use of this instrument for want of bait, but it is not a favorite with them.

47. *A flounder-net*, ready to be cast out, or, as the Danish technical term has it, to be "stoned." By holding the split peg with one hand, and throwing out the stones with the other, the net is laid without much trouble, and, sinking to the bottom, places itself in position.

48. *A buoy*; a so-called herring-buoy.

49. *A grapple*, or *anchor.*

50. *A claw.*—These are of many different sizes, and are sometimes used as anchors, but more frequently to search the bottom of the sea for nets and other objects that have been lost.

51. *A fisher-buoy.*—In the sound, where the shipping, the current, and large masses of seaweeds all prove injurious to the buoys, this kind, simple as it looks, has proved the most effectual in diminishing all these causes of injury.

52. *A net-trough.*

53. *A hundred claws*, "baggers," ready for being cast out.

54. *A hundred cleft claws*, hung up for drying. Of these the two fishing villages possess an endless number.

55. *An eel-iron.*—A sort of spear for spearing eel, which, however, is but seldom used.

56, 57, and 58. *Different kinds of caufs.*

59. *Tools for manufacturing nets.*

60. *Apparatus for weighing eels.*

61. *A catcher.*

Nearly all these implements are made by the fishermen themselves. The women spin and the men bind them; small children even assisting in the work.

The amount of material, however, is so large, and requires so much repairing, that the fishermen and their families cannot do all the work alone, so that there is enough work left for the poor and old folks of the villages. The considerable expense required for the material and its repairing, consumes, of course, a large portion of the fishermen's annual income, so that they can not save much money. Still they suffer no want, and are enabled to keep up with the age, being decidedly better housed, fed, and clothed, than their ancestors.

Local influences have tended to make the fishermen of Snekkersteen and Skotterup better educated than fishermen generally are. Living close by the sound, the great European highway, they have learned much from the many foreigners of all nations, with whom they come in constant contact. They are enlightened and liberal in their views and possessed of a strong feeling of independence.

As far back as the year 1745 they established among themselves a society for the relief of the sick and the burial of the dead. It is interesting to see from the old account-books of this society, that the majority of the members, who were only simple fishermen, could write and cipher, some of them even very well, and this at a time when such learning was not often found among the poorer classes.

Much could be done to increase the value of the fisheries of Snekkersteen and Skotterup, both in the way of new methods and more modern implements. But what is particularly wanted is a good harbor. Such a harbor would cost from 6,000 to 8,000 rigsdalers. The ministry of the interior has appropriated 1,000 rigsdalers for this undertaking, the district council, 800; and many private individuals have made contributions. The work was begun last spring, and there is every prospect that these two flourishing villages will soon possess an excellent boat-harbor, and have it free of debt.

X.—ON THE HERRING, AND ITS PREPARATION AS AN ARTICLE OF TRADE.*

BY HJALMAR WIDEGREN.

CONTENTS.

In the sea which surrounds the Scandinavian peninsula, several kinds of herring are found differing in size and fatness. These are caught on certain parts of the coast, and afterward brought into the market under different names and prepared in various ways. Throughout the whole of Sweden, there are found in the market Norwegian herring, Graben herring, Ludd herring, fat herring, Goteborg or Bohuslän herring, Kulla herring, anchovies, small-herring, spiced herring, &c. All these articles of trade are prepared from two kinds of fish, viz, the herring properly so-called, (*Clupea harengus*, *L.*,) which in the Baltic is named "strömming," and the sprat or small-herring, (*Clupea sprattus*, *L.*) The former, both in its natural state and as an article of trade, is found in much larger quantities than the latter, which is caught only in comparatively small quantities, and prepared mostly as anchovies. As the strömming is nothing but a variety of the common herring, as will be shown in the course of this article, the term "herring," or "common herring," is used both for the herring of the Western Sea, (Atlantic and Kattegat,) and the herring of the Baltic, *i. e.*, the strömming. The sprat is at first sight distinguished from the herring by having a smaller head and the lower fins placed more toward the front of the body. Its belly is, moreover, sharper and furnished with serrated scales, which are not found in the common herring.

The common herring, which on certain parts of the coast is eaten so extensively, has its proper home in the North Sea and the Atlantic, but is also found in the seas connected with them—the Kattegat and the Baltic. Like other animals and fish, the common herring has undergone, in course of time, in the different parts of the sea and bays where it lives, various changes as to size, fatness, &c., and which are

* Några ord om Sillfiske samt om Sillens eller Strömmigens rätta beredning till handelsvara: *in* Tidsskrift for Fiskeri. Udgivet af H. V. Fiedler, og Arthur Feddersen, 6te Aargang. (Kjobenhavn. Jacob Erslevs Boghandel. 1871.) pp. 63—80.

chiefly to be accounted for by the difference of food in the Atlantic, the Kattegat, and the Baltic, differing even in different parts of the Atlantic and the Baltic. We find, therefore, that every part of the sea, and even different bays, have, so to speak, their own peculiar kind of herring, which certainly do not belong to a different family, but which, nevertheless, can easily be distinguished as belonging to a different kind, by certain peculiarities due to the locality. Thus, there is found, *e. g.*, at certain seasons of the year, in some bays of the Baltic, a larger kind of herring, which can easily be distinguished from that which lives and spawns on the outer portion of the coast; and the herring found on the coast of Bohuslän, (the west coast of Sweden,) and in the bay of Christiania, differ greatly in size from those of the west coast of Norway, &c., &c. While this circumstance has, to a certain extent, given rise to the different ways of preparing and naming the herring as an article of trade, it affords the means of forming conclusions as to the herring's manner of living, and also as to the improvement of the herring-fisheries in the future. Many a fisherman, even in our days, believes what formerly, before science shed light upon the subject, was a common opinion, that the herring only accidentally came from remote portions of the sea to the coast where it is found, and therefore thinks he acts wisely in making use of this accident for catching as many as possible; or, in other words, to fish with implements however destructive to the fish. Since experience, however, has shown that one can never catch Norwegian herring on the Bohuslän coast, Kulla or malmö herring on the Bleking coast, (the south coast of Sweden,) and Gottlam herring near Östgöta, &c., &c.; and since the discovery has been made of the time and place where the herring spawns, and the mode and place of living of the tender young, it will become evident that the herring, like the salmon and other kinds of fish and animals, has certain distinct limits to its migrations and certain definite places which it frequents in larger numbers, for the purpose of spawning. In order to perpetuate good herring-fisheries on the coasts with some reasonable hope of success, fishing must be conducted in such a manner that only a portion of the tribe which has its spawning-place in a certain bay be caught, and that the young deposited on the coast or at the bottom of the sea be spared.

In several places on the Baltic and the Atlantic, people have suffered severely for their recklessness in conducting the herring-fishery, and especially with regard to the preservation of the young. Thus, observations made during several years have shown that the dying out of the fish has in no small degree contributed to the almost total decline of the great herring fisheries in Bohuslän, which, I am sorry to say, have not yet been revived, chiefly because, as soon as some younger herring appear, they are caught with narrow-meshed nets. For many years the herring were accustomed to approach Bredsund, in Norway, but ceased to appear as soon as people began to use nets. To take a nearer example: not long ago the herring went into Braviken (a bay on the eastern coast of Sweden) as far as the mouth of the Motala River, and nets were placed near Lössingsskär and Botilsbäst, where considerable quantities of fish were often caught. The fishermen in the village of Quillinge then used the same large nets which are still employed by the inhabitants of Quarse, (both villages on the east coast of Sweden.) But by a reckless use of the net during spawning-time, the whole tribe of herring has been caught; the herring has ceased to appear there, and the fishermen draw but empty nets. In many other inlets on the Baltic the herring has entirely disappeared since excessive net-fishing has been introduced.

With this trustworthy experience as a guide, it will be evident to every one how important it is, if the very existence of the fisheries is not to be destroyed, to follow certain rules based on the nature and habits of the fish.

To enable the fisherman himself to decide, in cases of necessity, what ought to be done for the improvement of the herring-fisheries, (beside those regulations which possibly may be fixed by law,) some further information must be given regarding the herring's nature and mode of living.

The herring is a gregarious fish, mostly found in large schools, especially at the time when he approaches the coast, which he does regularly at certain seasons of the year, partly for the purpose of spawning and partly to seek food, or to "bathe" in calmer waters before and after spawning.

During winter the herring is found in the deep sea outside the coast, where he has spawning-places; but even during this period he visits the deeper gulfs, and thus keeps moving as during summer. This is proved by the fact that it can be caught in the Baltic during winter with nets laid under the ice at a depth varying between 5 and 24 fathoms, and even with seines laid in the fjords and bays at different depths. During its migrations to and from the coasts, as well as during its stay in the depths of the open sea, the herring keeps alternately near the surface of the water and at the bottom. These changes, it is thought, are occasioned by the temperature of the water, by the different currents, and by other like circumstances. Our experience in this respect is as yet too limited to deduce safe conclusions as to the depth at which the herring may be found at the different seasons of the year. The best plan for the fishermen, therefore, is to ascertain this by experimenting with nets at various depths.

The spawning-time of the herring occurs at different seasons in the sea where this kind of fish is found. Even the different species of herring, living in the same sea, have different spawning-times; and of the same species some spawn earlier and some later in the season; this latter circumstance being probably occasioned by difference of age, by the slower or quicker development of some fish, &c.

In the Baltic, the herring spawns partly in the spring and partly in the summer, and is therefore called spring-herring and summer-herring. In the southern portion of the Baltic, the herring continues to spawn till about the middle of October, while in the northern portion the spawning season closes in August. The spawning occurs partly outside the coast on elevations of from three to fifteen fathoms from the bottom of the sea, and partly in the fjords (gulfs) nearer to the main land, particularly in places where the bottom of the sea is thickly covered with sea-weeds. The spawning process goes on very rapidly, as the school only keeps together at the bottom probably from five to six hours. The spawn is dropped on sea-weeds, stones, sand, and similar objects, where it remains. The development of the spawn takes a longer or shorter time, according to the temperature of the water.

In May, when the water is cool, it takes from fourteen to eighteen days for the spawn to develop, while in July and August, when the water in the spawning-places usually has a temperature of from 14° to 15°, Réaumur, it requires only from six to eight days. The young herring, which is smaller and more transparent than the young of most other fish, (and on this account difficult to distinguish,) is a little more than one-quarter of an inch long, and has, till about eight days after the development, a residue of the yolk remaining obliquely across the belly, which, at first, greatly impedes its movements. Only when the young herring has lost this so-called "belly-bladder," does it begin to swim around, to collect in schools, and seek food. It is difficult to determine the growth and size of the young herring until it reaches a certain age, especially as all the young ones have not the same ability to gather food, on which circumstance the development of course depends.

Attempts have been made to raise young herring by having them inclosed in small basins, but they have never lived longer than about five weeks, at which time their length was about one-half of a decimal inch. During the whole first year of its existence, the young herring is found in its spawning place both outside the coast and inside the fjords. Young herring about one common inch in length may be supposed to be about two months old. At the age of three months, their length is about an inch and a half. All the fins are fully developed, and the whole shape of the body resembles that of the mature herring, so that it can easily be recognized as the young of this fish, which before that time is somewhat difficult. From comparisons made with the young herring found in the spawning-places, it is safe to assume that those of about 3 inches in length found in the spawning-places in spring are of the preceding year's spawning, and, therefore, about one year old. Young herring from 5 to 6 inches in length, which are often caught in nets, are probably only two years old. In fish of this size the roe and the milk begin to be tolerably developed, and when the fish has reached the length of 8 inches and the age of about three years, it is capable of spawning.

The food of the young, as well as the grown herring, consists chiefly of small crustaceous animals, invisible to the naked eye, which are found in enormous quantities in the sea, both in shallow and deep waters. In passing sea-water through a straining-cloth, great numbers of these small animals will be found. Their quantity, however, varies at different seasons, during a change of temperature, and at different depths. This might possibly explain, to some extent, the appearance of herring at different depths. In summer these crustaceous animals are found nearer the surface of the water, and at this season the herring is also found to swim comparatively higher. Like other fish, the herring abstains from food some time before and after spawning, and its stomach is therefore generally found to be empty at this time. But after spawning it begins to eat again, and gradually regains the strength and fatness which it seems to lose during that process. This explains the fact that at some seasons of the year the herring is leaner than at others.

About two months before spawning, the herring may generally be considered the fattest and best. This fatness continues until spawning is over, when the fish becomes lean and thin, and not fit to be caught. The herring, after spawning, usually migrates to the deep sea to seek food, and does not return till it has again gained in flesh and strength. That the herring, like other kinds of fish, as soon as the spawning-time approaches, again seeks the spot where it was born, is proved by the circumstance, mentioned above, that certain easily recognizable tribes or kinds of herring spawn every year at a certain time and at the same place. That during one year it appears in larger numbers in one place than during another, has doubtless its cause in the change of temperature, currents of the sea, and similar influences, which may even occasion the entire absence of the herring from certain bays in some years. Cold and inclement weather, during spawning-time, often destroys almost the whole breed of one year, so that, naturally, for some years to come, the kind of herring, in places where this has happened, will be very poor. These, and other causes on which the development of herring is dependent, are, however, as yet so little understood that nothing definite can be said about them. But, on the other hand, it is well known that man himself can destroy the herring in a bay of the sea by catching the whole tribe, both old and young, in large nets, thereby also destroying the spawning-places.

It has already been stated that certain kinds of herring, particularly the larger ones, spawn nearer the land, on a bottom overgrown with sea-weeds. If this bottom is made unfit for spawning, by taking up or destroying the sea-weeds, either by nets or in any other way, the herring is, of course, obliged to seek other and more suitable places, and, consequently, deserts those inlets where formerly it came regularly.

By experience gained in Bohuslän and other places it is proved that the herring is extremely sensitive in this respect, and deserts old spawning-places entirely if their character is changed.

Every one, therefore, who desires to keep his herring-fishery in good condition, ought to be very careful not to change the nature of the spawning-places by disturbing the vegetation, or by casting refuse and other matter into the water.

From what has been said concerning the herring's nature and mode of living, it will be evident that, in order not to risk its annihilation, destroy the young, and disturb the spawning-places, it is best not to catch the fish with nets during the spawning season, but to use the net only during those portions of autumn and winter when the herring seeks the deep water in the inlets; while one can catch herring in seines without danger at every season of the year. This mode of fishing is, in the long run, the most advantageous in every respect.

If the herring-fishery, however, is really to become remunerative, it is necessary not only to find a good market for the fish, but also to prepare the fish in the proper manner.

As it is frequently impossible for fishermen to sell the fish immediately on being caught, it is of the utmost importance for him to have a knowledge of the best method of preparing it for the trade, particularly in our time, when the vast improvements in the means of communication permit the acquisition of the necessaries of life from the most remote localities, so that every one is obliged to strive, by a constantly improved preparation of his products, to procure and maintain an advantageous market for them.

In consequence of more rapid communication, the herring of the Baltic can be sold with profit not only at home, but also in those distant regions to which, in former times, exportation was impossible. The preparation of the herring must, of course, vary according to the place where it finds its market, as there is a demand for different kinds of herring in different localities. The various methods in which the herring is prepared, so as to secure the best market, are at present the following:

1. The common salt Baltic herring, to supply the demand at home, and in the German ports on the Baltic.
2. The so-called "delikatess" or extra-fine herring prepared in the Norwegian and Dutch manner for home consumption.
3. The so-called spiced herring, for home and foreign consumption.

The choice of any one of these three methods is determined partly by the fatness and condition of the fish, partly by the ease or difficulty with which buyers are found for one or the other kind, and partly by other considerations. The fat herring, which is sometimes caught in summer or autumn on certain coasts, is, of course, best suited for the finer kinds of trade-herring, *i. e.*, the extra fine herring or the spiced herring, while the common herring is best suited for the common salt herring, observing, however, in its preparation those rules which are indispensable for obtaining a good article.

In the preparation of every kind of fish, the most important rule to be observed is, to bring the fish, as soon as possible after caught, in contact with the salt; and special care must be taken that the fish, before it is salted, is not too much exposed to the heat of the sun, for this soon spoils it. In summer, therefore, every boat ought to be furnished with sufficient tarpaulin to cover the fish while returning home. It is also very useful to have in the boat a large tub or vessel with crushed ice, in which the fish should be placed immediately after it is caught, as this keeps it quite fresh until salt can be applied. Those fish which have been brought to market fresh, and exposed for some time to the sun, cannot be used for salt fish, since, as a general rule, the fish are more or less injured while being transported to the market. Another important rule in preparing any kind of fish is to preserve the greatest possible cleanliness. Care should be taken not to let fish-refuse or other objectionable matter lie around in the salting-houses, or in the tubs or vessels used for salting. Old brine, which is full of slime, blood, or other little particles, must never be used for salting, as a foul, disagreeable taste is apt to be thus imparted to the fish. Another very important consideration in the preparation of fish is the quality of the salt used, for it is not only necessary to have a loose, strong, and hard salt, which is best suited for preserving different kinds of herring, but a prime article must be used. Salt that has suffered from sea-water, or that contains impurities, ought never to be used.

I.—PREPARATION OF COMMON BALTIC HERRING FOR CONSUMPTION IN SWEDEN AND IN THE GERMAN PORTS ON THE BALTIC.

In the salting of herring, as at present carried on by the fishermen on most parts of the coast, two mistakes are frequently made: first, salting the fish too much; and secondly, pressing it too hard. It is very important to prepare the fish in such a manner as to keep for a long time without spoiling. It is likewise important for the merchants to secure well-packed barrels. But both these advantages may be gained without producing a fish entirely saturated with strong salt, or made so thin by pressing as to lose all its natural fat and only taste of salt. In many places the fish are pressed so hard into the barrels that they form a thick mass, from which the brine soon flows off, leaving the fish dry and rancid, and by no means pleasant to the taste. Even if the fish are to be sold in one place, a precisely similar mode of preparing them is by no means to be recommended. And although no one can prescribe rules for preparing fish or producing an article which will satisfy many different tastes, especially as one buyer cares little for the flavor or fatness of the herring, but only for its weight, while with another the case is just the reverse, most buyers nowadays endeavor to secure a well-flavored article, which is also carefully packed. The mode of preparation given below has been tried for a number of years in the best salting establishments in Gottland and on the southern coast of Sweden, and fish preserved in this manner will never fail to find a ready market.

In the preparation of the common herring, St. Yves, (Setubal,) Lisbon, and other strong kinds of salt ought to be used, but Cagliari salt, and other looser kinds of English and French salts may also be employed, especially if the fish is intended for immediate consumption. The salt must be somewhat crushed so that the larger crystals may melt in the brine, and the salt thus come into contact with the meat of the fish as much as possible.

As salt herring are mostly exported to distant places, and during their transportation in ships are exposed to injury from contact with heavy freight piled upon them; and as, even on railroads and wagons, they run the risk of being somewhat roughly handled, they ought to be transported only in tight and strong barrels, firmly hooped, so that there may be no danger of the brine escaping. It may be well to mention here, that a leaky barrel of herring is not worth one-fourth the price of a sound barrel. As soon as the herring are taken from the net, they ought to be thrown into vessels filled with pure and clear brine. In no case ought so many herring to be put into a vessel as to cause the upper layers to press too heavily on the lower ones. If the number of fish caught is very great, a larger number of vessels ought rather to be employed. After the herring has thus been brought into immediate contact with the salt, it is, after a while, taken out to be cleaned, in which process care must be taken to remove the entrails and gills, but not the roe and milk. Every fisherman knows how to do this. After the herring has been cleaned, it is again placed in another vessel filled with pure brine. When all the fish have been cleaned, or while the process is going on, the cleaned herring are taken out of the brine and washed in fresh and pure sea-water, and then placed in small baskets with wood-shavings at the bottom, so that the water may drain off. The fish are then sprinkled with salt in the following manner: They are placed loose in a barrel, together with crushed salt, the proportion being 3 gallons (kappa) per barrel, (tunna,) of about 4 bushels. In every layer the fish and the salt are stirred so as to mix properly. After twenty-four hours, the fish are again taken out of the salt and placed in baskets, so that the brine may run off. This process is finished in about an hour, and the fish are then properly packed and salted in other barrels, arranged in layers, with the back downward, and crushed salt placed between every layer, reckoning about 5 gallons to every tunna, (see above.) When the barrel is full it is exposed to a slight pressure, so slight that the fish is kept under the brine, but not so heavy as to cause the fat and juice to exude from the fish into the brine, since this would injure their flavor.

The barrels are left standing open in this state for some time, (about two or three days,) and as the mass of the fish sinks down, new layers are placed on the top. When, after some days, the sinking of the fish may be considered finished, the barrels are filled up and closed. Every fourteenth day, at least, these barrels ought to be gently rolled about and turned up and down, so that the brine may penetrate the whole mass. Before the fish are to be shipped, the barrels must be examined again, and if any further sinking is noticed, the barrels are filled up with fish for the last time.

The brine, which during the filling of the barrels, flows over, as well as that which is obtained during every salting, may be put into those vessels in which the fish are placed immediately after being caught, and where they are kept during the cleaning process. It is, however, important that such old brine be exchanged for new after it has been once used and has become filled with impurities.

To salt fish, as is done in the province of Östergötland, with 9 gallons of salt per tunna, is not advisable, because then the fish is pressed too hard and salted too thoroughly. After it has been sprinkled with salt all that is required is 25 gallons per tunna, and for this purpose the fish ought to be placed immediately in the barrels and not be pressed more than is absolutely necessary for the proper filling of them. In the province of Norrland it is customary to let the herring lie uncleaned in the brine for twenty-four hours; and, moreover, to use brine which has been often used for the same purpose. That this mode is objectionable, and that the herring ought to be cleaned as soon as possible, will be evident from what has been said above.

In Carlskrona, south coast of Sweden, it is customary to use only 1 gallon of salt per tunna for sprinkling the fish, and then to salt them with 7 gallons per tunna. This method cannot be recommended, as the fresh fish, if they have absorbed enough of the brine, do not require as large a quantity of salt as 7 gallons per tunna.

The Baltic herring, prepared in the manner explained above, find a ready market, not only at home, but also in foreign ports on the Baltic. The price paid for herring differs of course in different years, being partly regulated by the quality of the fish and partly by the price of Norwegian and other foreign herring. In some years, when the herring-fishery both in Norway and Sweden has been good, the fishermen can scarcely dispose of their fish at home at such a price as to fully remunerate them. It is, therefore, advantageous to seek a foreign market, and prepare the fish accordingly. German ports on the Baltic, especially Stettin, Stralsund, and some others, afford, at certain seasons, a very good market for the common salted herring. The most profitable season for selling herring in these places is from midsummer to the beginning of September. The fish intended for exportation to Germany are prepared in the above-mentioned manner, but ought to be very carefully packed in good sound barrels, not in barrels ("tunna") of the same size as in Sweden, but somewhat smaller, such as are used in Bornholm and on the German coast. In Stettin, such barrels, if the fish are sound and well packed, bring from 13 to 21 riksdalers, (1 riksdaler, silver= about \$1 currency,) which is a very good price, considering the fact that these barrels are much smaller than the Swedish ones.

II.—PREPARATION OF EXTRA-FINE HERRING FOR HOME CONSUMPTION.

It is well-known that Sweden annually imports a considerable quantity of Dutch and Norwegian herring, which are partly sold in barrels, ("tunna,") but mostly in smaller vessels ("fjerdingar,"*) for household use among the better classes. Experiments have proved that the large and fat Baltic herring, which are caught in several places on the Swedish coast, can very easily be prepared in the same manner as in Holland and Norway. In this way an article is produced which, although perhaps not in every respect equal to the foreign herring, nevertheless resembles it very closely, and therefore finds a ready market at a profitable price at home, and this all the more since the Swedish extra-fine herring can be furnished at much less expense than the foreign.

The term "extra-fine herring" ("delikatess—sill") implies that it is not an article for every-day use. It ought, therefore, to be put up in smaller kegs than the common herring, such as the "fjerdingar," (see above.) As a matter of course the extra-fine herring must not be salted nearly as much as the common salt-herring, because the fine flavor which ought to distinguish it would thus be lost. As a consequence it cannot be kept as long as the common herring. In preparing the extra-fine herring, looser kinds of salt ought to be used, those that are milder, finer, and more easily dissolved, such as Liverpool salt, Lüneburg salt, Cagliari salt, &c.; the best on the whole being Lüneburg salt.

Preparation of extra-fine herring after the Norwegian manner.—The fresh-caught herring are placed, during the cleaning-process, in pure brine. Some, in cleaning the fish, take out only the entrails; but it is, in all cases, best to take out both the entrails and the gills. As soon as they are cleaned they are placed in layers in kegs, the back downward. Between every layer salt is put, reckoning about six gallons to one "tunna;" salt also being placed on the top of the uppermost layer. As the layers gradually sink in the keg, others are put in. After about six days, an opening is made with a stick between the mass of herring and the side of the keg, into which salt is poured, and the keg then closed. Before shipping them, the kegs are all examined again and filled up, if necessary, in the same manner as mentioned in the preparation of the common salt-herring. If sufficient brine has not formed, a small hole is bored in the side of the keg, pure brine is poured in, and the hole closed. It is well, too, frequently to roll and turn the kegs. Herring prepared in this manner have kept quite good and fresh for six months.

Preparation of the Baltic herring after the Dutch manner.—Fresh and fat Baltic herring are put, immediately on being taken out of the water, into a keg in small quantities, and frequently stirred for at least an hour with fine-crushed Lüneburg salt. Then the fish can be cleaned as described above, or without being cleaned, placed in kegs in layers, with fine-crushed Lüneburg salt between every layer; reckoning about from

*1 "fjerding" = 2 pecks.

1 to 1½ gallons of salt to every "fjerding." When a keg is full it is closed, but also examined and filled up again, as before mentioned. The uncleaned herring, which are called in foreign countries "round-salted herring," do not keep near as long as the cleaned herring; for, of the latter kind, I have seen some prepared at the Herta Salting Establishment, on the island of Gottland, preserved fresh and good for over a year. Baltic herring prepared after the Norwegian or Dutch manner find a very ready and profitable market in Stockholm and other Swedish cities.

III.—PREPARATION OF SPICED HERRING, ("KRYDDSILL").

The so-called spiced herring is an article found here and there in the market, kept like anchovies in small kegs or glass jars. It may be prepared from any kind of herring, and it is much sought after in some places in Sweden, but especially in North Germany. Its preparation, however, cannot, as yet, be said to form any important branch of trade, and must be considered rather as an experiment by housewives for the purpose of introducing a little variety into their meals, especially for the lunch-table. As there seems to be some demand for this article, particularly for the foreign market, the most approved method of preparing it is given below.

The fresh-caught herring are immediately put into vinegar, with one-fourth water, and some salt. After remaining in this mixture for twenty-four hours, the herring are taken out and the vinegar drained off. The fish are then placed in a keg with a mixture of the following spices, reckoning these quantities for every (fourscore) 80 herrings:* 1 "skålpund" fine dry salt, "1 skålpund" pulverized sugar, 1 "lod" pepper, 1 "lod" bay-leaves, 1 "lod" saltpeter, ½ "lod" sandal, ½ "lod" ginger, ¼ "lod" Spanish hops, ¼ "lod" cloves.

Others use the following mixture: 1 "skålpund" salt, ½ "skålpund" sugar, 2 "lod" pepper, 2 "lod" allspice, 1 "lod" cloves, 1 "lod" Spanish hops.

The herring must be left in this mixture for two months before it is fit for use. Some put the herring immediately into vinegar, without water and salt, from which it is taken, after twelve hours, and treated as above described.

If the spiced herring, after some time, should not have sufficient brine, good brine of Lüneburg salt is poured over it, by means of which it will keep for years.

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* *Swedish weights mentioned.*—1 "skålpund" of 32 "lod," = nearly 1 pound avoirdupois; 1 "lod" of 4 "quintin," = nearly ½ ounce avoirdupois.

XI.—NEW CONTRIBUTIONS TO THE HERRING-QUESTION.—THE DISPUTE BETWEEN AXEL BOECK AND OSSIAN SARS REGARDING THE NORWEGIAN SUMMER-HERRING.—SARS'S RECENT OBSERVATIONS AND HIS NEW THEORY ON THE MIGRATIONS OF THE HERRING.*

I.

In accordance with a proposal made by Mr. G. O. Sars, the "practical and scientific observations on the Norwegian sea-fisheries" were, in 1872, combined with the soundings made by the Norwegian navy in the sea outside the Jæder stream; and as this portion of the sea is in the immediate neighborhood of the spring-herring district, the "department of the interior" commissioned Mr. Sars—we presume, in accordance with his own suggestion—to throw, if possible, some new light on the hitherto somewhat obscure question regarding the nature and the migrations of the herring. Mr. Sars intended to direct his attention particularly to the so-called *fat-herring* or *summer-herring*, as he always suspected that its true nature had not been properly understood by other naturalists, and particularly by Mr. Axel Boeck. Mr. Sars's report was noticed in the "*Morgenbladet*," and was subsequently printed in full in that journal (October 29, 1872†). It called forth some remarks by Mr. Axel Boeck in a later number of that journal, (November 5, 1872,) and a discussion ensued between the two gentlemen, which, in the beginning especially, was of a violent character, perhaps to some extent excused by the circumstances, but in itself very deplorable. It seems, however, that both of them during the subsequent discussion (which elicited but little that was new) endeavored to treat the matter in a calmer spirit. It is not our intention to judge between the persons of these two gentlemen, or to revive a discussion which for one of them bears the melancholy souvenir that his colleague and opponent—to the great sorrow of all Scandinavian naturalists—did not long survive it. All we desire in this article is to give a brief review of the data which have been gained, by Mr. Sars's observations of the "summer-herring," respecting the herring whose natural history is still enveloped in so much obscurity. Every step toward throwing more light on the sub-

* "Nye Bidrag til Sildespørgsmaalet. Striden mellem Axel Boeck og Ossian Sars angaaende den norske Sommersild. Sars's senere Undersøgelser og hans nye Theori om Sildens Træk:" in Nordisk Tidsskrift for Fiskeri. New series. Aargang 2. Part 2. 1875. pp. —, with map.

† Later it has been printed separately, (1874,) together with the reports of 1870, 1871, and 1873.

ject is of unusual interest; for no one knows to what important discoveries it may lead. We will, therefore, in this place give an extract of Mr. Sars's "Report," and in connection with it review the more important remarks called forth by it on both sides.

On the 17th July, Mr. Sars began his sojourn in Stavanger, and from that place made excursions in the neighboring fjords. In the city itself he had an excellent opportunity of examining herring, which about this time were brought to market from various places in large quantities. He subsequently visited one of the fishing-stations on the outer coast, where, during the winter, the so-called spring herring fisheries are carried on, partly for the purpose of obtaining information regarding those fisheries, partly for the purpose of making personal observations. The place he visited was "Hvitingsö," an island far out in the sea, and an old and well-known spring-herring fishing-place. From that point he made excursions in all directions, examining particularly the bottom of the ocean in those places where the herring-fisheries are carried on. Mr. Sars also collected much information regarding the spring-herring fisheries from conversations with experienced fishermen. He reports that at that season enormous numbers of young herring were found in the more sheltered sounds and bays, which, on closer examination, turned out to be almost exclusively young spring-herring,* and, as could be ascertained, of this year's spawning. The fishermen know this herring-spawn very well, and call it "*Aesja*."† They use it partly as bait, partly as food in eel-boxes, and take it as often as required with fine nets in quiet, grass-grown inlets. In examining the "Brisling," (*Clupea sprattus*,) brought to the Stavanger fish-market from various places, it was frequently found mixed with a great number of young spring-herring. The Hvitingsö fishermen testified that during that year the spring-herring was found in unusual quantities; in fact, they did not remember so good a spring-herring year since the old extraordinarily rich spring-herring fisheries. Sars concludes from this that during the previous winter a large number of spring-herring must have remained near the coast and have spawned there; and that, therefore, the poor spring-fisheries of the previous year cannot have been caused by any decrease in the number of herrings, nor by any change of route in the migrations of the herrings, but only by the circumstance that for some reason or other the great mass of the herrings did not come as near the coast as formerly, but spawned farther out at sea. All the fishermen agreed that large schools of herring approached the coast at the usual time, which could be judged of from the unusual number of whales and birds; and for some time there was a prospect that the

* It seems that the author by this term only wishes to convey the idea that they were the young of the genuine herring, (*Clupea harengus*,) in contradistinction from the "Brisling," (*Clupea sprattus*,) not that they were the young of that variety of herring which is called "spring-herring;" but as he does not seem to allow that there are several varieties of herring on the coast of Norway, it amounts to the same thing.

† Danish: *Aes*, *i. e.*, food.

fisheries near Hvitingsö would be very good; but people waited too long, hoping that the herring would come in to the usual fishing-places, and the consequence was that they quietly spawned in the outer deep, and had already done spawning before attempts were made to take them out at sea. That large numbers of herring spawned there is also corroborated by the fact that soon after the close of the herring-fisheries there were found in the outer deep an unusual number of torsks, whose stomachs were full of herring-roe, which must have entirely covered the bottom of the sea. There is therefore reason to suppose that the usual number of herring have also visited the coast in 1872, and have deposited their roe in suitable places. It need not follow, however, from the circumstance that the spring-herring in this and partly in the preceding year, from some unknown reason, has spawned at a greater distance from the coast than usual, that it will always do so, much less that it will entirely leave the coast. Mr. Sars thinks that there are no sure signs of such a sudden change in the migrations of the herring, but that there is good reason to hope that, under more favorable circumstances, the herring-fisheries on the west coast of Norway will again be carried on in the usual places; of course, with more or less variable results. He was confirmed in this view by his observations of the so-called *fat-herring*, or *summer-herring*.

Regarding this fish, the (according to Mr. Sars, erroneous) opinion has formerly been prevalent that it was a different variety from the spring-herring, or an entirely different species of herring, which was said to go to different parts of the west coast of Norway, and not to belong to the ocean proper, but to the islands and sounds. It was even said that it had a special spawning-season of its own, viz, *autumn*, while the spring-herring spawns in winter or early in *spring*. We cannot entirely agree with Mr. Sars when he says, "if it were really the case that the summer-herring spawned at an entirely different season of the year, it would, in spite of its great zoological similarity, have to be considered not only as a distinct variety, but as a separate species. There certainly may be herring which spawn in autumn, and this is particularly the case with the so-called 'Kulla'* herring, occurring on the Swedish coast of the Kattegat, but this different spawning-season is caused by different physical circumstances—by varying conditions of life." "On the same coast, therefore, where herring are found which spawn in spring, *none can* (!) occur which spawn in autumn, and *vice versa*." Natural phenomena cannot unfortunately be so easily and with such certainty deduced from simple premises; and Boeck did not find it difficult to point out certain facts, which cannot be argued away, and which show that two races of herring, one spawning in spring and the other spawning in autumn, occur on one and the same coast. Thus Münter has shown that on the east coast of Rügen, on a space scarcely extending four German miles, there are two varieties of herring—a southern,

* Kulla, a promontory on the western coast of Sweden.

spawning in spring, and a northern, spawning in autumn. In connection with this we may mention Nilsson's and Ekström's report, that in the Baltic there are two varieties of small herring, ("Strömming,") the more slender of which spawns in May and the beginning of June, and the stouter one in August and the first half of September. On the other hand, in the present case, where the Norwegian summer-herring is spoken of, Sars has given satisfactory proof that in general it does not spawn in autumn. Its fat and general good quality are caused by its having, as one says, "fat, instead of roe and milt." The roe and milt are there, in the lowest part of the abdominal cavity, covered by the fat, but in so undeveloped a condition, that it may be taken for granted that they cannot possibly mature as early as autumn. The Norwegian fishermen, therefore, do not know the autumn-spawning herring. According to their short-sighted view, the summer-herring does not spawn at all; and they are led to take this view because it has neither roe nor milt, but only fat, quite forgetting that every variety or species of fish must be able to propagate itself in order to exist. By denying the power of propagation, (which of course is only correct in so far as it does not spawn as summer-herring,) they actually deny it all independence as a separate variety. When the "summer-herring" finally spawns, it has ceased to be a summer-herring, or fat-herring, (the distinguishing mark of the latter being that it is filled with fat and not with roe or milt,) and has become a spring-herring; in other words, it *is only the younger herring, not yet fit to spawn, in different stages of its life*, but ends invariably by becoming at last a genuine spring-herring. The reason why people have been so long blind to this very simple state of facts, in Sars's opinion, flows from the erroneous idea that the summer-herring goes into the fjords and bays for the same purpose as the spring-herring, while, as every one acquainted with the nature of the herring knows, in reality it does not go at all for the purpose of spawning, but merely to feed.

If this theory is correct, the summer-herring must occur in different forms, corresponding with the different stages of its life; and this is actually the case. It is consequently brought into trade under different names, which, on the whole, represent as many years or ages. In the second year it is called *Christiania herring;* in the third, *middle herring;* and in the fourth, *merchants' herring*. In its fifth year, it has become a genuine *spring-herring.** There is no essential difference between these varieties except the size and the greater or less development of the sexual organs; but in all other points they are alike, even in the subdivisions of these varieties, viz, small and large Christiania herring, small and large middle herring, merchants' herring, &c. It must not be imagined that these divisions in all cases agree exactly with the age; for all fish do not reach the same size in the same period of time, and the

*A correction, where, instead of five years, the whole period of this development embraces six years, is given below.

spawning-season of the spring-herring, and the consequent development of the young fish, extend over quite a portion of winter and spring. Sars, however, supposes that a large number of the "merchants' herring" (or, in other words, a large portion of the common herring) spawns by the end of the fourth year. "It will then be found together with the older or genuine spring-herring, and, as in that case it will have completely matured roe and milt like this one, no one will, as a general rule, think of considering it as former fat-herring, but as young spring-herring, (which it is in reality.) It is probable, however, that, on closer examination, (especially when this young herring is found in large numbers without being mixed with the older spring-herring,) some slight differences will be found, chiefly caused by its not yet being familiar with life far out at sea, to which the older spring-herring have become accustomed, while it only commences that life now after having done spawning. It is likewise possible that the spawning-season of this younger herring does not occur exactly at the same time, but somewhat earlier." Sars, therefore, supposed that the so-called Blandsild, mixed herring, (whose occurrence has been looked upon as a precursor of the disappearance of the spring-herring proper, but which he had no opportunity to examine,) according to the description given of it, which says that it is fatter (and consequently better) than the spring-herring, but somewhat smaller and spawns earlier, is not a previously unknown kind of herring, which has shown itself only during the last few years on the coast of Norway, but a summer-herring, in its transition period toward being a "Graabensild" (graybone herring); in other words, the youngest spring-herring, which, during the following year, will return as a genuine Graabensild. (We shall later return to this subject.) The reason that it has been formerly overlooked is that it was mixed with the Graabensild; but during the last few years it has not been found so much mixed with it, because, as has been said above, the great mass of the old herrings coming in from the sea have spawned farther out at sea. "Just as the young of the torsk spend the first years of their life near the coast, and only go out in the open sea at a more advanced age, so do the young of the spring-herring spend the first years of their life near the coast, and during summer gather (under the name of fat-herrings) in large schools, to feed in the inner fjords and bays." Since the summer-herring fisheries on the heights of Stavanger were very productive in 1872, rather more so than usual, Mr. Sars thinks there is no reason to fear any diminution in the schools of spring-herrings, or that they should begin to go to other coasts; if this were the case, the summer-herring fisheries must have decreased in the same proportion.

With regard to this, it must be said that nothing of the kind has ever been supposed. Boeck himself has shown that if the spring-herring fisheries are not successful, the reason is that the spawning herring does not, as in other cases, go near the coast, where it could be easily caught, but spawns farther out in deep water, where it cannot be caught so well, at least not according to the usual method. What causes the herring to remain so far from the coast has, up to this date, (1872,) not yet become known. Mr. Sars could not say either what *favorable* circumstances should induce the hope that the herring-fisheries on the west coast of Norway would again return to the old places, or what *unfavorable* circumstances kept the majority of the herring during the two preceding years away from the fishing-places. (We shall again return to this question.) Mr. Boeck furthermore proves, what need not be mentioned here, as it has been spoken of in the "*Tidsskrift for Fiskeri*," 7de Aargang, p. 13, that under no circumstances has the cold anything to do with it. He also protests against having advanced the opinion that a herring-period (*i. e.*, a period of successful herring-fisheries) should now have come to an end as far as Norway is concerned. He has only, from the sources accessible to him, cited a number of facts "which show under what conditions the herring-fisheries came to an end in former times and in different localities; how they again returned, and in what manner the fisheries were carried on year after year. From these historic facts, a certain law can be deduced regarding the movements of the great masses of herring, which do not come and go irregularly on certain parts of the coast, but whose movements occur with a certain regularity." He lets every one from this draw his own conclusions, which he considers justified, and gives his opinion on the whole with great reserve: "That even if it does not follow, from all which has been said, that the spring-herring will leave our coasts, (the southern spring-herring district,) all the appearances are not favorable to the opposite opinion." We must agree with Mr. Sars that in so far as Mr. Boeck has given any opinion on this question, it must be that the appearances are not favorable for the nearest future of the Norwegian spring-herring fisheries; but whether or not Mr. Boeck will stand by this prophecy, whose correctness only the future can show, it seems that the experience of last year will bear it out. The important question, why does the herring during a certain period of years go to the inner spawning-places, while during another period it remains outside, has so far (1872) not been answered; just as little as the question, what may cause the gradual change in the spawning-season, which, according to Boeck's investigations, always seems to precede the end of the herring-fisheries. Mr. Sars believes, as we shall see in another chapter, (1873,) that he has found satisfactory answers to all these questions; but we have not yet reached this point.

Mr. Boeck says, in the "Remarks" with which he accompanies Mr. Sars's "Report" in the "*Morgenbladet*" of November 5, that in his work on the herring he has already hinted at the same view regarding the relation of the summer-herring and the spring-herring which Mr. Sars has advanced, and that the reason why he (Boeck) did not describe this relation more fully was merely a want of opportunity to visit the summer-herring fisheries farther north—during the years in question there was no, or at least a very inconsiderable, summer-herring fishery in the southern district—and that he was prevented from visiting the northern fisheries by Mr. Sars's using the greater portion of the appropriation made for both of them for his journeys to the Lofoten Islands, or in some other manner. However this may be, we cannot but side with Mr. Boeck in his protest against the accusations that he systematically maintained the *historic* mode of investigation, in opposition to the *scientific* mode. He also shows that the different years of the herring given by Sars are nearly the same as those given some years ago by Mr. Dahl, of Bergen,* with the difference only that the latter gave to the spring-herring an age of six years instead of five, which opinion one often hears expressed on the western coast, (and which, as will be seen from Sars's report for 1873, he also shares.) Mr. Boeck, in this important point—the relation between the summer-herring and the spring-herring—does not express an essentially different view. He fully agrees with Mr. Sars that the summer-herring is nothing but the spring herring at a different age; but he does not think that this is the case with *all* summer-herring; and he maintains that there are really *peculiar coast-races* of herring on the coasts of Sweden and Norway,† and that they may spawn at a later season than the spring-herring, viz, in April on the coast of Norway, and in May on the Swedish coast of Bohuslen. In the fact that toward the end of November, on the northern coast, he had an opportunity of examining a "merchants' herring," which was full of loose roe, he finds a proof that the autumn-herring (probably when it remains in the fjords) *can* spawn before the herring's usual spawning-time in spring, at which time Boeck is also inclined to think the majority of the autumn-herring spawns; and this early-spawning autumn-herring could then, if we understand Mr. Boeck correctly, also be considered as a separate race of herrings.

Boeck further remarks that experience shows that if in a certain place there is during one year a rich spring-herring fishery, such fact does not justify the hope that the next winter or spring there will be a rich spring-herring fishery in the same place. "If there should be

* Dahl's years, with which Sars now entirely agrees, were the following: First year, Musse; second year, Aesja; third year, Christiania herring; fourth year, middle herring; fifth year, merchants' herring; sixth year, spring-herring. It has, therefore, also been supposed that the spring-herring fisheries occur in periods of six years, on the idea that the herring, for the purpose of spawning, would return to the place where it had been hatched; and in many cases this idea has been correct.

† An article in the "*Throndhjems Stiftsavis*" for 1862 makes the following distinction between two varieties of the summer-herring: "*The sea-herring*," which during summer comes in from the high sea, and "*the fjord-herring*," which remains in the fjords, and during the summer-herring fisheries mixes with the incoming sea-herring. Boeck, however, supposes that such coast-races have originated, and still originate, by more or less developed sea-herring going into the deeper and more secluded inlets, and remaining there. Their young may possibly again become sea-herring, but more permanent varieties may also form in such places, *e. g.*, the Höxfjordherring, the Idefjord-herring, &c.

rich spring-herring fisheries in the same places where, during the preceding summer, great masses of summer-herring have shown themselves, we ought to have had for a long number of years steady and particularly rich spring-herring fisheries on the coast north of Christianssund as far as the Tromsö district, and even farther north; but nothing of the kind is known, no real spring-herring having been caught along that coast during this century." Sars, in answer to this, says, if we understand him correctly, that the northern "sea-herring," or "great herring," is the same as the "spring-herring;" but Boeck draws attention to the fact that the "great herring" does not go farther south than the boundary of the Nordland district, and that, from that point as far as Christianssund, there is a long stretch of coast where large summer-herring fisheries have taken place and still take place, and where no spring-herring are caught. The "great-herring" fisheries did not commence till 1861, and prior to that year there had not been any spring-fisheries in that location for sixty, perhaps for eighty, years. During those years when the spring herring had left the heights of Stavanger entirely, (1784 to 1808,) there were rich summer-herring fisheries in the Stavanger fjord, and in other places, and these fisheries were most successful in the middle years of this period; when the spring-herring fisheries again increased, the summer-herring disappeared altogether. Several printed and manuscript reports particularly deplore the fact that the valuable "summer-herring" has gone away, while the inferior "spring-herring" has come again. Just as little is it known from experience that where there have been rich spring-herring fisheries for a number of years, great numbers of summer-herring could at the same time be caught in the inlets along this coast. It appears, from the Stavanger and Bergenshus districts' reports, published every five years, that, for many years, when the spring-herring fisheries were successful, few or no summer-herring were caught on the same coast. It is only during the last few years that the summer-herring fisheries have been successful in the Stavanger fjords, but during these very years the spring-herring fishery has not amounted to anything. The hopes which have been built on the great quantity of young fish coming in have also but too often been disappointed, and no conclusion can be reached as to the probable fate of the Norwegian spring-herring fisheries in the near future. "When the spring-herring, in 1833, went past the cape (Lindesnæs) as far as Mandal, all the bays were later in the year full of young herring. The inhabitants of that coast for that reason entertained great hopes of continuing the fisheries during the following years, especially when the young from that year would have grown up; but these hopes were not fulfilled, for later no herring appeared on that side of the cape. During the year when the spring-herring left the coast, it had spawned near Flekkefjord, and numerous young fish justified the hope of future rich fisheries, although the fishing during that year had been poor, and the herring had kept in such deep water that some were taken at a depth of 80 fathoms; but the joy was but short-lived, for it only lasted till the time in the following year when the fisheries were to commence, when no herring appeared, nor have they appeared since." Similar masses of young herring showed themselves on the coast of Bohuslen (Sweden) in the year when the great-herring fisheries on the coast ceased.

With regard to the objection raised by Mr. Boeck against the opinion that the summer-herring is only a young spring-herring, viz, that the greater or less success of the spring-herring fishery on the coast of Stavanger is in no wise connected with the summer-herring fisheries on the same coast, great spring-herring fisheries having occurred during those years when the summer-herring fisheries did not amount to anything, Mr. Sars says that the difficulty in solving this problem disappears if one maintains the difference between "herring-fisheries" and the "occurrence of herring." "The former is, of course, dependent on many accidental circumstances, and may, therefore, although the number of herring is the same, be very different. This must especially be supposed to be the case with the summer-herring fisheries. The summer-herring may certainly be near the coast in very large masses without any great fisheries being carried on. A rich summer-herring fishery depends exclusively on the accidental occurrence of small crustaceans and their entirely accidental accumulation in certain places which are favorable to the fisheries, and to this, of course, no regard is had in the historical report on the fisheries." This explanation of Mr. Sars of the fact that a rich spring-herring fishery is not always followed by a rich summer-herring fishery is doubtless correct, but it does argue away the experience that, *vice versa*, a rich summer-herring fishery is not followed by a good spring-herring fishery. Other causes must be found for this. He certainly answers the objection that on the coast from Christianssund to Nordland no proper spring-herring fisheries are carried on, by saying that the spring-herring may be there and spawn out in the deep water, without any actual fishery being carried on; and, moreover, that there is nothing which tells us that its offspring, the summer-herring, is entirely stationary in those places where it is hatched, but it is probable that it goes along the coast and gathers in those places where the small crustaceans are chiefly found." We think, however, that in this case it is Mr. Sars who does not distinguish between "herring-fisheries" and the "occurrence of herring;" for of what use is it to the fisherman, as Mr. Boeck remarks, that there are herring enough out in the sea, if they won't come in and let themselves be caught in those places where fishing can be carried on? There is certainly, as has been said before, no doubt that the herring stays outside the coast of Norway every winter and spring during the spawning-season; and whether it remains outside and spawns there, or approaches the coast, the young will at any rate seek shelter near it. There will, therefore, always be enough young herring, (whether they flock together so that they can be caught to advantage;

or not, which will depend on stream and wind collecting their food;) but from the circumstance that there are many "summer-herring," or young herring, no conclusion can be drawn as to the probable result of the spring-herring fisheries. It is in reality only the "occurrence of herring" which Mr. Sars has been able to promise his countrymen, and of this there was no reason to doubt; but so far it is not within anybody's power to predict "herring-fisheries," because we know not the causes—at any rate, not the proper causes which can form the subject of observations and calculations—of the periodical changes in the spawning-season and coming in of the herring, but only know from experience that whenever these changes take place there is reason to fear that the spring-herring for a number of years will not come to its old spawning-places on the coast in order to spawn there, but stay farther out, as is partly also the case with the Nordlands-herring, or the "great-herring."

Mr. Sars, with regard to this, has raised the objection that the "sea-herring" has been known long before 1861, but that it has not been made an object of fishing, probably because formerly it did not come so near the land as during the last years. The Lofoten fishermen took as many of these fish as they used for their households by taking them out of the sea in a very primitive manner—in buckets. Mr. Boeck quite agrees with him in this point, but did not mean anything else than that its "occurrence" before 1861 did not take place *near* the coast so that it could have been fished with the common fishing-implements. Regarding the "great-herring," Mr. Boeck says, on this occasion, that it does not differ from the spring-herring, but that its apparently different shape is only caused by the greater amount of fat it contains, as on approaching the coast it is not ready for spawning. Only at one place did Boeck, toward the end of the fishery, in January, find "great-herring" with loose roe and milt. As a general rule, it does not spawn near the coast, but far out at sea, where large masses of herring have every year been seen, both in this and the last century, from Hammerfest to Hitteren, from which cause a large number of young fish are every year seen near the coast and in the fjords; but in this century, from some unknown reasons, they had not approached the coast so that they could be caught, before 1861. As the great-herring, therefore, does not approach the coast for the purpose of spawning, the great-herring fisheries are always somewhat uncertain. As was said before, we do not know the cause why this full-grown herring, which, however, is not ready to spawn, approaches the coast in this manner; it is only supposed that it has lost its way by following the large troughs of the sea which lead to the coast.

Although there remain several obscure "herring-problems," it is evident that, by Mr. Sars's report of 1872 and by Mr. Boeck's comments upon it, made during the same year, we have advanced some steps in understanding the connection between the various phenomena, particularly by proving that the summer-herring only represents different stages in the life of the spring-herring; that it has no separate spawning-time; and that its movements are determined by its favorite food, *i. e.*, small crustaceans. Besides acknowledging the progress that had been made, we thought that we owed it to the whole question, as well as to the memory of Mr. Boeck, to save from oblivion what he had written concerning it during the last days of his life, and which, on account of its being contained in a daily journal, could only be accessible to a few, whose number would naturally decrease every day. Our review of the state of the Norwegian herring-question at the end of the year 1872 will at the same time serve as an introduction to a review of the considerable progress which has been made by Mr. Sars's report for 1873, published in 1874, to which we will now turn.

II.

The above review of the discussion carried on in 1872 had long since been written for insertion in this periodical, when we received Mr. Sars's above-mentioned report for 1873, in which he gives in detail his complete theory of the migrations of the Norwegian herring and the causes which determine them. We likewise take the liberty to give, in the following, a brief extract from this report.

Mr. Sars does not believe that the grown spring-herring, after having spawned on the western coast of South Norway, (from Christianssund to Stavanger,) goes out to the nearest deep water due west—*i. e.*, between the coast and the ridge in the bottom of the sea running parallel with it from north to south, at a distance of from ten to fifteen miles—and stays there near the bottom of the sea during three-fourths of the year when it is not near the coast. This portion of the bottom, which, as Mr. Sars has found by former observations, possesses but little animal life, and must, comparatively speaking, be called a desert, is but little suited for these enormous masses of fish, and there is no reason to suppose that the herring is a bottom fish; it is, on the contrary, in harmony with its form as well as its favorite food—the small fat and oily crustaceans of the surface—a fish which has its home near the surface of the water. We do not deny that the Baltic, the Kattegat, perhaps, also, the Skagerak, and the North Sea, have each their race of herrings, which do not go beyond the basin of the sea which, by nature and habit, has been assigned to them; but the Norwegian spring-herring comes from a greater distance, from the open sea between Iceland, Scotland, and Norway, not from the bottom of this sea, but from its surface. Here it has lived, especially during summer, very much scattered, on its favorite food, which is there found in great quantities, (more or less near the surface, according to the rising or sinking of this food, caused by the time of day and the weather); and from here it approaches the Norwegian coast, in a southeasterly direction, toward the beginning of the spawning-season, gathering in large and constantly-increasing schools, and following the deep troughs, till at last they are quite near the coast, and form a so-called "herring-mountain,"—a high, deep, and closely-packed mass of herrings. It has been found, by certain observations which have already been communicated in Boeck's well-known work on the herring, (p. 47,) that the herring always comes from the northwest. That it follows this direction is easily explained by the fact, settled by Professor Mohn's meteorological observations, that the sea on this portion of the western coast of Norway, during the winter-months, (December to February,) has a higher average degree of warmth than near the coast farther south, or on the coast a little to the north, a very uniform degree of warmth, (5° to 6° Réaumur,) about the same as in the nearest portion of the sea-basin from which the herring is supposed to come. If the herring would go due east, therefore, to a more northerly portion of the coast, *e. g.*, the neighborhood of Throndhjem, it would come in contact with water whose degree of warmth would decrease very rapidly toward the north, from 4° to 2° Réaumur. Another school of herrings, the Nordland *great-herring*, lives, in Sars's opinion, to the northwest of Nordland and Finmarken, but somewhat nearer the coast, because there the sea is richer in small crustaceans than farther south, in the neighborhood of the coast; it, therefore, comes near the coast comparatively early in its migration toward the southeast or south, being fatter, but less ready to spawn.

Immediately after being hatched, the young herring, being born on the bottom of the sea, naturally stays near it on the outer coast, where the spring-herring loves to spawn. As soon as the umbilical bag has been completely absorbed and the fins have become developed, it goes near the surface of the water to snap for small living animals; but as near the outer coast it is exposed to many dangers, (the current, heavy waves, &c.,) and to the persecutions of birds and fishes, instinct has taught it to go nearer to the land, in the more secluded sounds and bays, where it often can be seen in enormous numbers. As soon as it has reached the size of a few inches, it begins to rove about in constantly-increasing schools, in fact to assume its—according to Sars—characteristic roving mode of life, which is again dependent on its food, viz, the small crustaceans of the surface, whose very irregular occurrence is again dependent on the current. It also depends on accidental circumstances how far it goes from its birth-place during this first period of its life, and to what extent it scatters over a larger or smaller portion of the coast. During its first year, however, it probably keeps near the coast; only gradually as it grows larger and its desire for food increases will it be obliged to go farther out into the sea, where the small crustaceans, as a general rule, are found in great quantities, and thus, like the torsk, it gradually approaches those portions of the sea where its ancestors came from. All this would go on with the greatest regularity, if the small crustaceans were not frequently packed together, by sudden changes in the weather and consequent changes of the current, in large masses near the coast and its bays and fjords, drawing the schools of young herring—the so-called "summer-herring"—after them, and after a while taking them out to sea again when the current changes. In exceptional cases, schools of herring remain in the deep fjords for a whole year and longer, and such herrings will naturally assume a character of their own, so as to pass for a special variety or coast-race. Although, as has been said before, we know all the stages in the life of the herring near the coast of Norway, and would, therefore, reasonably suppose that its *whole* youth, till the period when it spawns for the first time, was spent near the coast, Sars remarks expressly that, on the whole, the occurrence of the summer-herring near the coast must be considered as altogether temporary. It comes, like the older herring, (the spring-herring,) from the open sea, but not from such a distance as this one. "Some time before the large masses of summer-herring came to Espevær, in 1873, the mackerel-fishers often caught considerable quantities of large and fat summer-herrings in their nets at a distance of from five to six miles from the coast, and schools of large and small herrings could often be observed from the mackerel-boats. Soon afterward the current, on account of a very sudden change in the weather, turned with unusual violence toward the islands near Espevær, and carried with it enormous quantities of small crustaceans, which were closely packed in all the neighboring bays and sounds; then the herrings began to come in from the sea, first the larger and then the smaller ones." As during winter the small crustaceans are not found near the coast in such large quantities, the migration of the young herring toward the sea will, on the whole, be much less disturbed than during summer, and there are no instances of the spring-herring having returned to the coast to seek food after having spawned. As soon as the herring has got farther away from the coast, out in the open sea, it will not be enticed so much toward the coast by the small crustaceans, as the currents there are generally more regular than near the coast; consequently only young herring—at least the majority of them—which have not yet got far enough from the coast, visit the coasts of Norway during summer. Sars, however, does *not* consider it improbable that among the large "merchants' herring" there may also be some which formerly, as "spring-herring," have spawned near the coast. It is a natural consequence of the temperature of the sea and the direction of the current (which from Stat is chiefly northerly) that the distribution of the young herring along the coast and its outward movement chiefly take place in a northerly direction, and, as a consequence of this, the summer-herring fisheries are generally richest along the Throndhjem coast, although the spring-herring is not known to spawn anywhere outside that coast. The "fat-herring" caught along the coasts of Nordland and Finmarken bears the same relation to the Nordland "great-herring" as the "summer-herring" does to the "spring-herring."

Among the phenomena which have been brought to light by the historic studies or the regularities and irregularities in the course and results of the herring-fishery, the most remarkable one is this, that the spring-herring fishery has not at all times commenced at the same period of the year, but that at times it has had a tendency to extend farther and farther into spring, which became particularly evident toward the end of the so-called "herring-periods." The difference in the time of the spring-herring's arrival on the coast may be a month and a half from some time before New Year till some time in February. From these experiences, Boeck could also in a certain manner predict the decrease of the spring-herring fisheries which has taken place now. This circumstance has so far been entirely unexplained; if the herring had its proper home in the deep sea-basins *near the coast*, what should cause it to leave these later and later every year, or to come early after the lapse of many years? It could, on the other hand, easily be understood that its arrival caused a shorter stay, and a disinclination to go near the coast, so that the result of the fisheries would naturally be less.

Sars supposes that on account of the varying strength and direction of the currents in the open North Sea, which depend on the differences of the weather, the distribution of small crustaceans in the sea will differ very much in the different years; and, as the herring naturally stays where it finds food, it will, when its migratory instinct awakens, be nearer the coast, and consequently arrive sooner than in another where it has been farther out and when its journey toward the coast required longer time. As the movement toward the coast, in this case in a southeasterly direction, will probably always occur about the same season of the year, (some time before the roe and milt, which likewise develop at a certain season, are ready for spawning,) it follows of itself that the spring-herring which comes in *early* is of a better quality, stays longer near the coast, and will be able to go farther up the bays and sounds; in other words, that the fishery will yield a much better, richer, and safer result than in the opposite case, when the herring only remains for a season near the outermost coast, and is much thinner and more exhausted, and when only occasionally a small school is chased near the land by large fishes of prey. The herring-fishery may therefore yield a very different result, even if the same mass of herrings has year after year been outside the coast and has produced the same quantity of young ones. The final cause of the irregularity in the spring-herring fisheries must therefore be sought in the changes of weather, current, and temperature of the water in the outer sea, not so much during the fishing-season as during the rest of the year, particularly during the preceding autumn and summer.

Whether there is in this respect a periodicity which corresponds with that of the herring-fishery will be more satisfactorily explained by future observations than by the study of the past. For the present, it cannot be denied that such a thing is possible. "It is a fact that the occurrence of small crustaceans during summer on the western coast of Norway differs very much in the different years. Some years the sea near the coast during the whole summer has been filled with great masses of different crustaceans; in other years, they disappeared almost entirely, or were only accidentally driven to different points of the coast by the current, soon to disappear again." One of the most convincing evidences that the small pelagic animals, among them the genuine "herring-crustacean," are in certain years driven near the coast by the current, is the existence of salpæ, which are as transparent as glass, and which are found either singly or in long-connected chains resembling pearl necklaces; out in the open sea they are found every year, but near the coast many years may pass before one sees a single one; and all of a sudden in a certain year they approach the coast in such enormous masses that every bay and sound is filled with them. The occasional occurrence of these animals in large masses has attracted the attention of the fishermen, and is counted among the "signs" which augur a good spring-herring fishery during the coming winter, and it would seem probably not without reason. During such a year, the herring will already during summer have come tolerably near the coast, and will consequently arrive early in winter, &c.

The so-called "mixed herring," which of late years has appeared in the spring-herring district, is described as an inferior kind of herring, which formerly was not known, and in whose occurrence people believe they see a sure warning that the spring-herring fisheries will soon come to an end. It has been described in many different ways. It probably consists chiefly of herring in different stages of life, which are not yet able to spawn, and are driven toward the coast by the "spring-herring mountains," which approach the coast from the sea; *e. g.*, the barren "Straalsild," (ray-herring,) or "Solhovedsild," (sunhead-herring,) which are probably fishes that have been left behind from the spring-herring school of the preceding year, have remained near the coast, and, on account of the want of suitable food, have not become ripe for spawning during this year. The longer the route which the advancing masses of the old spawning herring have to travel, the greater number of these young herring, which have never yet approached the open sea in their slow course, will they drive before them, and all the more mixed will the different schools and ages of the herring be. They drive before them first the older ones, which had got farthest out, then the younger ones, which had not got so far, and mix them with the barren Straalsild; (ray-herring,) which they always meet on their approach to the coast, as well as with some stragglers from the great mass of herrings; these latter, of course, being common spring-herring, which are nearly ready to spawn. The bulk of the mixed herrings, viz, the young herring which are not yet ready to spawn, are therefore in reality the same herrings which earlier in the season were called summer-herring. Their occurrence in unusual numbers may, therefore, undoubtedly be a sign of a less productive spring-herring fishery during *that year*, but does not augur anything regarding the more distant future. As long as the young herring are every year in largest numbers in their accustomed places, there is no reason to suppose that the spring-herring fishery will come to an end, although the fisheries may, on account of many accidental circumstances, be more or less productive in the different years.

Professor Sars's theory will become clearer to the reader by casting a glance at the accompanying map.* This theory must be plausible in a high degree, and no serious objections to it can be raised, as it seems to explain the most characteristic phenomena of the Norwegian herring-fisheries in a satisfactory manner. The criticism of its details we will leave to those who have made, or are going to make, the herring-fishery and the natural history of the herring the subject of special studies. Its weak points (if they may be termed such) can easily be pointed out: first of all, to use a simile, so many and large drafts are issued on the unknown, the unproved, and the unprovable. It will be difficult to attack Professor Sars in the rear by proving to him that the herring is not found in those places which he assigns it during three-fourths of the year, or that the former relations of wind, current, and weather in the North Sea do not show any periodicity which corresponds with that of the herring-fishery. But, on the other hand, it must be remembered that no proof has been given that all this is not so. Another weak point in Sars's theory is that it cannot easily be applied to herring-fisheries outside of Norway. At least, one cannot read Mr. Sars's application of his theory to the Bohuslen (Sweden) fisheries with *entire* satisfaction: "At a time when the small crustaceans, on account of the peculiar currents of the ocean, have filled the North Sea and the Skagerak to an unusual degree, it can easily be imagined that a portion of the great mass of herrings coming originally from the northwest have got so far into this part of the sea that, on the approach of the spawning-season, by following the usual southeasterly direction, they have come toward the coast of Bohuslen, where they have spawned, and later, in obedience to the instinct common to all fish, have returned to the same coast where they have spawned once, thus gradually forming a race of herrings peculiar to the Skagerak, whose disappearance must at any rate in part be ascribed to the less bountiful supply of small crustaceans in this part of the sea." These possible weaknesses of the theory do not, however, as Professor Sars very justly remarks, reduce it to a mere play of ideas, or detract from its merits as a satisfactory explanation of some of the most important and most obscure points of the whole question, but leave it as a combination of phenomena according with well-known facts, which may form the basis of further investigations, carried on with a fixed plan and in a thoughtful manner. Let us hope that out of the fiery ordeal to which future investigations will put it, it will only come out stronger! For the present we welcome it sincerely as an important step in advance.

C. L.

* The map referred to has not been reproduced.

P. S.—We learn that, at the suggestion of Professor Mohn, the director of the Norwegian Meteorological Institute, an expedition will this summer (1875) be fitted out for exploring the open North Sea between Norway, Iceland, and the Faroe Islands, to which Professor Sars will be attached. We hope that this eminent naturalist will thus have a chance to submit his theory to a test in that direction where we think that its weakest point lies, viz, in the hitherto unknown. We heartily wish that he may have the triumphant satisfaction to clear up every doubt, and dissipate the last clouds of obscurity which envelop the natural history of the Norwegian herring.

XII.—ON THE SPAWNING AND DEVELOPMENT OF THE COD-FISH.*

By Professor G. O. SARS

Commissioned by the Norwegian government to examine our cod-fisheries, in order to arrive at practical results that may be useful to our fishermen, I have been enabled to observe the spawning and development of the cod-fish, (*Gadus morrhua*,) and shall endeavor to present the results of my observations. I have already, in my former reports to the department, briefly spoken of the most important observations and showed their practical bearing, so that in the following I shall refer only to the scientific features of the subject. It is true that a subject of such general physiological interest as the propagation and development of the higher classes of animals has already been thoroughly treated by many scientists, so that it would seem almost superfluous to write a treatise on this subject; but with regard to the propagation and development of fishes there are but few works, and these comprise only a few kinds, (all fresh-water fishes,) while the observations regarding the numerous salt-water fishes are only scattered here and there in the shape of incidental remarks. Thinking that for the sake of comparison it might be interesting to secure a somewhat connected representation of the spawning and development in one class of salt-water fishes, I determined during my stay on the Lofoten Islands, in the year 1865, to give particular attention to this point, especially as, during former visits to these islands, I had already made very remarkable and unexpected observations of this kind.

Of all our cod-fisheries that which is carried on during the first four months of the year along the Lofoten Islands is the most important and the most profitable. The winter cod-fish at that season approaches the coast in vast numbers for the purpose of spawning. The regularity with which, from time immemorial, the cod-fish has at a certain season come here to spawn, notwithstanding the many difficulties thrown in its way, especially by nets, would lead us to the conclusion that it must find spawning-places here which, on account of the nature of the bottom, are particularly favorable, and where, by instinct, it was compelled to deposit its roe. I was therefore much astonished to hear that this was not the case, and that the cod-fish has no spawning-places which are determined by the nature of the bottom, but that it drops its spawn free in the sea

*Om Vintertorskens, (*Gadus morrhua.*) Forplantning og Udvikling: *in* Forhandl. Vid. Selsk. Christiania, 1866, pp. 237–249. Translated by H. Jacobson.

at a considerable distance from the bottom, and, what is all the more remarkable, that the spawn does not sink to the bottom, but goes through all the stages of its development swimming free in the sea quite near the surface. Nothing like this has hitherto been observed in fishes or any other class of animals, and even the fishermen, who every day for years have had occasion to observe this phenomenon, have a very incorrect idea of the actual facts. They have all observed that at the time when the cod-fish spawns the sea was thick and opaque, as if it were muddy, and all agreed that this must be caused by the spawn of the fish. Some more inquisitive fishermen even tried to examine the matter more closely by taking some of this water home with them. They then saw that the water was swarming with very small transparent bodies looking like pearls, but none of them would admit that this was the spawn of the cod-fish. They thought it might be the empty shell of the spawn which, after the young had crept out, came up from the bottom and floated about on the surface of the sea. The circumstances are so peculiar that I myself, the first time I met these but slightly developed and sporadically occurring little bodies, transparent as a drop of water, was doubtful as to their real nature. By microscopic observation, however, I very soon became convinced of the actual facts. Some time later, when the spawning was going on, I also found these small bodies in great numbers and in every stage of development, even up to the young fish, with all its most important organs clearly developed, lying in the egg ready to slip out. By a study of this egg, from its impregnation till the time when the young fish emerges, I sufficiently convinced myself that this spawn floating about in the sea belonged to the cod-fish and to no other. But as it has thus been proved that the spawning proceeds just as well in the open sea as near the coast, what must, then, be assigned as the cause of the cod-fish's seeking the coast with such eagerness? Two reasons may be assigned for this: the cod-fish does not originally seem to be a gregarious fish, and while it lives in the open sea it, in all probability, is found over a very large area. In order, now, that the spawn may come into close contact—in other words, that the roe may become impregnated—it is absolutely necessary for the cod-fish, which spawns free in the sea, that the originally solitary living fishes should come together in greater numbers, and this could scarcely be done unless they all moved toward the same common rendezvous. Another reason may be the instinctive care which they have for their tender offspring, as it is easier to find food for it near the coast in this the first stage of its development; for, at the same period, many smaller marine animals are just developing themselves. At this season, particularly, I have seen the sea swarming with the small, peculiar-looking larvæ of the balanus, which might very well furnish a suitable food for the young cod-fish.

The approach of the cod-fish takes place early in the season, often long before New Year, and occurs in schools, in such a manner that the schools, which in the beginning are only small, gradually grow larger, till the time for spawning arrives, when they frequently assume such enormous dimensions that the term "fish-mountain," which is sometimes applied to them, does not seem exaggerated. In all these schools, even in those which come first, the male and female fishes are intermingled, which but rarely occurs among other kinds of fish. Thus, as to the herring, the female fishes always come first, and are followed by the males, which pour their milt over the roe. This peculiarity in the cod-fish is easily explained by the above-mentioned character of its roe; thus, in order that an impregnation may take place, the roe and the milt must be poured out at the same time and mix in the sea. In those fishes which arrive first, the roe and the milt, although tolerably developed, are as yet far from being matured. The roe is still so small-grained that without the microscope the small eggs can scarcely be distinguished. These eggs are of a light yellowish-red color, and show under the microscope a very light outer ring, and an inner opaque fine-grained mass, (yolk.) All the eggs in this stage are connected by a fine texture full of blood-vessels, mostly in irregular, conical processes, all which converge toward the center of the roe-bags. These encircle an inner hollow, into which the eggs are received as soon as they are matured, in order to be carried out through the two longer channels, which start from the inner side of the roe-bag, and which unite toward the back in one. In their further development the eggs constantly increase in size, and, at the same time, become more transparent, till they are almost colorless. They are now almost mature, but still loosely connected by a thin texture, and surrounded by a thin covering, in which the feeding blood-vessels spread in a branch-like manner. Soon, however, this covering bursts, and the mature egg is now cut off from its connection with the rest, and falls into the inner hollow of the roe-bag, from which, by a gentle pressure on the fish's abdomen, it can be brought out through the sexual opening (*porus genitalis*). The eggs are now as transparent as water, about one millimeter in diameter, and appear to the eye like small pearls of clear crystal. Placed in a glass with sea-water, they first sink to the bottom, on account of the downward movements of the water, but rise again, as soon as the water has become calm, to the surface, where they form a closely-packed floating layer. Their specific weight is less than that of the sea-water, and greater than that of fresh water, of which fact one may easily be convinced by placing them in a glass of common drinking-water, in which they rapidly sink to the bottom, without rising again.* The yelk of those eggs which have but recently come out from the ovarium appears, under the microscope, quite clear and transparent,

* This accurately-measured specific weight is of the greatest importance for the development of the egg. If, for instance, it should storm and rain for several days, there might easily be formed a thin layer of mixed sea and fresh water, which would contain less brine; so that if the specific weight of the roe floating in the sea were only a small particle less, this circumstance would have a very injurious effect on its development.

with a very faint yellowish tinge, almost completely filling the egg, and leaving only an extremely narrow space between it and the outer cover, filled with a colorless and utterly incongruous mass. The outer cover or skin is tolerably firm and elastic, and consists, as I have convinced myself by dissecting it, of four different closely-joined layers. One can discover, with the aid of a strong microscope, numerous small oil-bladders of different sizes, and scattered irregularly over the whole surface of the yelk. The egg has another peculiarity, which in the beginning I overlooked, but which, after having had my attention drawn to it, I found invariably in every egg. This is a small dark spot, only discernible through the microscope, which is found in the outer skin, and which is always near that part of the egg that is turned downward. Its location is not exactly the same in every egg, for sometimes it is quite close to the lower part, and sometimes a little higher up on the side of the egg; but among the many hundreds of eggs which I have examined I did not find a single one where this dark spot was above the lower quarter of the egg's diameter; nor a single one where it occupied exactly the lowest point of the egg. This spot is the so-called *micropyle*, which answers a two-fold purpose, namely, to allow the spermatozoa to enter the egg, and, also, during the various stages of development, to draw in water; in other words, it forms the channel of impregnation, and serves as a respiratory organ. Through the most powerful microscope this spot appears as a circular disk of yellow color, surrounded by a somewhat raised edge, and looking as if it were polished. From this spot a narrow channel passes through the skin of the egg, which ends in a funnel-shaped opening. I have not been able to discover any distinct opening in the above-mentioned round disk. It is certain, therefore, that it is not merely a hole in the egg, but seems to be of a porous nature and to possess a peculiar power of suction. But how can the spermatozoa get into the egg through this disk? To the solution of this problem I have devoted special attention by pouring a drop of milt to the eggs, while under the microscope. I have frequently seen the spermatozoa, as often as they came in contact with this disk, remain hanging there, and I could for a long time observe the movements of the tail outside, but I never could see them enter into the egg, although this is so entirely transparent that one necessarily must have seen them if they had entered the clear space filled with water between the skin and the yolk. The most plausible explanation of this phenomenon seems to be this, that the spermatozoa, which in reality are only cells, after having been for some time in close contact with the micropyle, were ruptured in consequence of the latter's suction-power, and that their contents only are absorbed by the egg, a view which, so far as I am aware, has never before been expressed. The spermatozoa of the cod-fish are oval, or rather pear-shaped bodies, to whose pointed end the tail is fastened. The milt, like the roe, is of less specific weight than the sea-water, and it therefore floats upon the surface as soon as it is poured out. This circumstance may account for the fact that the male fish during the act of spawning generally swims deeper than the female; and likewise for the fact that the micropyle is located near the lower portion of the egg, while with other fish which have been observed this order of things is reversed. After the egg has floated in the water for some time, it undergoes a very striking change. At the lower end the yelk becomes thicker, and viewed from the side appears like a crescent-shaped edge, of a deep yellow, and much more compact than the rest of the yelk. This compact mass grows constantly more distinct, till at last it forms a tolerably large semicircular projection. The yelk has thus secreted those parts which are to serve in the formation of the young fish from the remainder, which is to serve as its food. This portion, however, has still to undergo considerable changes till it is fit to produce the young. At the same time one can observe how the oil-bladders, which were originally scattered over the whole surface, gradually flow together and form larger bladders, gathering in a close circle round the micropyle, and so growing together form a transparent circle round it. These changes take place both in the impregnated and in the unimpregnated egg. The first visible effect of the impregnation takes place after the lapse of a few hours. In the middle of the disk a faint furrow is seen, which gradually becomes deeper, till at last it divides the disk into two symmetrical halves. After this furrow has become somewhat less marked, another one appears in each of the halves, striking the first one perpendicularly, by which process the disk is divided into four divisions of a spherical shape. Each one of these is again divided, so that there are eight divisions, and these again into sixteen, thirty-two, sixty-four, &c., divisions. Finally the disk becomes divided into so many divisions, and these divisions become so small, that the surface of the disk seems just as smooth as at first. With this process *the first period* in the development of the egg terminates. It has continued about four days, (112 hours.) Nothing as yet can be seen of the fœtus, and the disk has only just been prepared to produce it.

The *second period* commences by the disk's upper side, which is turned towards the yelk, and which till then has been quite flat, rising like a watch glass in the direction of the yelk, so that it assumes the shape of a strongly convex lens, one half of which stretches into the yelk, while the other half is outside. In the middle it has a thin circular rim, outside of which numerous small globular bodies can be discerned, arranged like a wreath round it. These seem to be some of the small particles produced by the last dividing process, which have been loosened from the disk and are floating about in the clear oily border surrounding it. When that part of the disk which is protruded into the yelk has reached its greatest height, which is often much greater than the outer part, it begins to collapse, but in such a manner that the process is completed more rapidly on one side than on the other. At this place it becomes more compact, and here it is that the fœtus is first seen. The disk, therefore, which orginally had a flat and then a convex upper side, now begins to be considerably hollowed out in the middle, so that, at last, it presents the shape of a thin helmet-like covering round the lower part of the yelk. Seen from below, the egg now shows the disk consisting of two leaves, (the vegetative and the animal,) an inner lighter zone, and a more compact circular rim, which soon appears on that side, where the above-mentioned thickening took place, broader and more compact than on the other sides. During the further development, the disk (statoblast) rapidly increases in size, encircling a larger and larger portion of the yelk ; the outer rim produces a triangular continuation turned inside, which with its lower pointed end, gradually approaches the lower part of the egg, so that the inner lighter zone of the disk assumes more and more the shape of a crescent. In this continuation the incipient embryo can very soon be seen quite distinctly, even before the disk has surrounded half of the yelk. First, a faint longitudinal elevation is observed, thicker at the lower end, on the sides of which two hemispherical projections can be seen indistinctly. This longitudinal elevation is the spinal marrow of the embryo; the lower and more compact portion is the head, or, properly speaking, the brain; and the two lateral projections are the beginning of the eyes. During the eighth day after the impregnation, the disk may be seen surrounding the whole of the yelk with the exception of a small portion of the upper part, which appears like a ring-shaped opening surrounded by a thicker edge. At the same time the triangular continuation has become considerably elongated and has assumed the form of a narrow ribbon, which stretches almost from one end of the egg to the other. On the inside of this ribbon, but in the upper portion of it, the embryo is now seen quite distinctly, the extremity of the tail being in immediate connection with the disk, or rather with the ring encircling it.

The *third period* in the development of the egg may properly be placed as the time when the disk or skin has completely enveloped the yelk. This phenomenon is accompanied by other essential phases of the development, as several organs of the embryo, which before this could not be seen, now first begin to show themselves, such as the lens of the eye, the *chorda dorsalis*, the ear-bladders, the liver, the breast-fins, and the heart. The beginning of the heart is seen by a faint swelling in the region of the neck back of the eyes, in which a small circular bladder is perceived, which, however, as yet shows no sign of any movement. This bladder soon changes into a hollow cone placed obliquely on the embryo, and shows a few irregular contractions, till at last it commences its peculiar rhythmical movements. At the same time may be noticed the first movements of the embryo itself inside the egg. These, at first, consist of a faint, almost imperceptible trembling, which at greater or less intervals is repeated in a more energetic manner. The pigment now begins to show itself distinctly on the iris of the eyes in the shape of small dots, and on the rest of the body as irregular stripes. The young fish has meanwhile grown so much, that its body already shows a complete circular bend following the outlines of the egg, so that the tail-end, which is now surrounded by a membrane clearly perceived, (the embryonal fin,) reaches to the mouth, and later, even somewhat beyond it.

At the end of the sixteenth day, the young fish is ready to slip out of the egg. Its movements inside the egg have now become so powerful, that it frequently assumes an entirely different position from that which it had at first. The iris is completely colored and even shows traces of that peculiar silvery gloss which is so prominent in the more developed fish. It has a deep incision in its lower rim which only gradually disappears. The pigment of the body is diffused in such a manner that it appears in larger quantities at the root of the breast-fins and along the upper side of the entrails; also on the back part of the body, where it forms two dark ribbons, consisting of numerous star-shaped dots, which remain unchanged long after the fish has left the egg. At last the skin of the egg bursts, and the young fish slowly frees itself from the remnants still clinging to it. At first the body has still the bent shape which it had while inclosed in the egg, but finally it straightens, and the young fish moves about with its special tremulous motions. It has now that peculiar undeveloped appearance so characteristic of all young fish, and so different from that of the adult. This peculiar appearance is chiefly produced by the large yelk-bag still clinging to it, and which is arranged so as to furnish its only supply of food, till the mouth has opened and the intestinal channels have formed themselves into a closed tube, connecting with the mouth. The body is very thin and tender, and with the exception of the above-mentioned pigment gatherings, almost entirely colorless, showing distinctly in the middle the *chorda dorsalis*, and on both sides of this the regularly-arranged muscles of the body. The front part of the body still shows a faint downward bend, a reminiscence of the fœtal curve; the head projects sharply from the rest of the body, looks as if it were swollen, and has a round shape, the mouth, or rather the region of the forehead, projecting a little. On the upper side of the yelk-bag can be seen the intestinal channel. It is still almost entirely straightl and terminates at about one-third part of the body, or in that place where the back part of the yelk-bag is closed. At its foremost end, which is bent somewhat to the right, a round fine-grained mass is seen, which is the liver; and immediately above this are, on each side, the round breast-fins, turned upward, and transparent as clear water. The body is surrounded by a transparent membrane, which begins immediately above the mouth and stretches round the whole body as far as the yelk-bag. Its foremost part is widened out to a sort of cap, while toward the tail it is strongly compressed; and while the animal is in motion this takes the place of those fins which are still wanting. The yelk-bag now begins gradually to collapse, and at the same time begins the formation of the mouth by the lower jaw, which formerly was firmly joined to the upper one, becoming gradually detached from it. When the yelk-bag has become completely absorbed, which takes place about two weeks after the slipping out of the young fish, the mouth is already distinctly developed, but as yet of a shape very different from that of the grown fish, as the lower jaw, as in the case of those deformed fishes called "cod-fish kings," projects considerably beyond the upper one, which rises quite straight. The young fish now already shows its peculiar gulping movements, and eagerly snaps after microscopical animals and algæ. It is no longer so much exposed to the currents and the winds as formerly, when the yelk-bag kept it up on the surface of the water, but often makes short excursions to a considerable depth, in order to hunt small animals, with which the sea at this time is swarming. The changes that follow are chiefly in the inner organs; thus the bile develops itself distinctly; the blood, which at first was entirely colorless, assumes a faint yellowish tinge, and can be seen circulating through the body in regular courses; the intestinal channel has increased in length, and in order to find room, must describe one or several convolutions; the shoulder girdle is already distinctly developed, &c. In the most advanced stages of development which I observed, and which took place in the beginning of May, the body was less transparent, and showed, especially on the head, a distinct yellow color. The distribution of the pigment was also somewhat uneven, being most distinctly visible on the upper side of the head and along the back and the belly. The intestinal channel, in which a wider fore part, (the stomach,) and a thinner loop-shaped and bent hind part, (the entrails,) could already be distinguished, showed yellowish contents, changing into green in the hind part. In the region of the heart, the blood had already a distinct red color. Near the hind part of the body, on the lower side, some fine rays showed themselves in the embryonal membrane, as the first sign of the tail-fin beginning to form under the extremity of the *chorda dorsalis*.

My observations on the development of the cod-fish extend no further than this; but I hope next year to be able to continue them through all those interesting changes through which the young fish passes before it becomes fully mature.

I must remark, in conclusion, that the above-mentioned peculiarity in the roe of the cod-fish, viz, that it develops swimming free in the sea, occurs also in the roe of other fish. During my last stay on the Lofoten Islands, I caught, also, with the aid of a fine net, the roe of three other different kinds of fish, entirely unknown to me, and floating in the sea in exactly the same manner. I am convinced, too, that this is also the case with the roe of the haddock, (*Gadus æglefinus*,) which spawns about the same time as the cod-fish. On the whole, this may indeed be the case with a much larger number of salt-water fish than is generally supposed. I consider it, in all probability, applicable to the whole large cod-fish family, and on closer investigation it may be found to extend even much further than this.

NOTE.

The following note, in continuation of the preceding investigation, from Professor Sars to Professor Agassiz, was published by Mr. Theodore Lyman, in the report of the Massachusetts commissioners of fisheries for 1871:

"It was my intention to continue the investigation of the young of the winter-cod, which I had pursued the previous year. I then showed that the fish often considered as a separate species, and known on the northwest coast of Norway by the names of smaagjed, tarefisk, and gründfisk, is nothing but the young of the winter-cod. I further observed that the great variations in color are only the effects of different bottom and different food.

"It was my task this year to follow the further development of the smaagied during the summer. The conditions were now quite different; for whereas during the winter I could, from a boat or from the beach, easily study my objects, now the fish had retired to the deep water and could only be got by hook and line—a difficult matter, by reason of the scarcity of bait, for the muscle rocks had been ransacked by the winter fishermen, and herring were not to be had. Beginning on the 20th of May, at a place called Skraaven, I set my line in 20 to 30 fathoms water, in the sandy channels of the outer holms, but got only fish too large to be yearlings. I then set in the 'sculls' near the rocks, and took great numbers of small cod, corresponding perfectly with the tarefisk, and which were colored of a brownish-red by the *tare* or rock-weed, (*Laminaria.*) These sculls are very dangerous to approach, especially in the winter-time, and are characterized by a periodic ground-breaker. The sea will appear perfectly tranquil for a time, when suddenly there will arise gently, over the scull, a low, broad pyramid of water, which as gently descends, and again the surface is unruffled. The wary fishermen mark well these upliftings, and keep the boat away from them. Presently you observe that the pyramid has again risen, but with increased size and with smoke curling from its apex; there is a sort of forward pushing motion and a sullen roar, and in an instant the sea rises in a vast, glittering, green bank, capped with devouring foam. With a fearful crash it precipitates itself to the very bottom, leaving a great circle of white froth. Your boat, safe in the offing, is lifted high on a huge wave, and the distant thunder on the beach announces that the great breaker has struck. The hapless boat that gets caught over one of these sculls is dashed in a hundred pieces against the rock bottom. These violent periodic ground-breakers are what attract the smaagjed, for they wash out the small crabs from their hiding-places among the sea-weed, and the young cod, dashing forward with the returning sea, devour them greedily. I thought now I should get plenty of yearlings on the sea-weed ground during the whole season, but I was mistaken. Toward the end of June they almost wholly disappeared from that locality, and were captured only near sandy channels. Their color, too, changed from the red-brown of the sea-weed to a fine greenish, with silvery sides. In their stomachs were found quantities of sül, (*Ammodytes lancea*—sand-eel,) which now were approaching the coast, and the tarefisk had evidently left the crustucea to prey upon them. The sül, less common and important in Southern Norway, is abundant on the northwest coast, and is held in high esteem. Although too slender to be captured in nets, it is taken by a large, coarsely woven cloth, worked by several boats. This cloth is slipped under a school of sül, and the corners being raised the catch is dumped into one of the boats and piled in heaps on the shore. These heaps are left there without further care, and the mass, half putrid, is accounted good food by the inhabitants, and is also served to animals. The cod are more dainty, and will not touch stale fish of any kind. Therefore, the sül for the fishery are got by digging in the sand where they have buried themselves, and where, at this season, they deposit their spawn. I took in the sandy channels plenty of cod, of one, two, and three years; also some very large 'süclod,' three feet long, and these I saw were the same as the 'winter-cod,' except that the spawn was but little developed. At this season, also, came the sei, (*Gadus carbonarius*—pollack.) It was a singular spectacle to watch the sea-mews sitting in solemn lines and in perfect silence along the rock ledges, their heads all at one angle. Suddenly, as if by common impulse, they would spread their wings, and with a shrill cry hasten toward a foamy surface on the sea. This was occasioned by the sei, which had rushed to the surface in pursuit of a school of sül, and the birds were coming to share the prey. Thither, too, came the fishermen and trolled with artificial minnows, taking, strange to say, some cod with their other fish, which shows that cod occasionally are attracted to the surface. Later in the season, the cod refused sül, which seemed to be because they were in pursuit of the young herrings, then abundant in Vestfjord."

XIII.—THE NORWEGIAN LOBSTER-FISHERY AND ITS HISTORY.*

By Axel Boeck.

As is well known, of all fisheries those on the coasts of Norway are the largest, and a great portion of the population of our extended coast is dependent on them for their living. But while all the other great fisheries on the coast of Norway have been carried on from time immemorial, their origin being so much enveloped in obscurity that our ancestors supposed that the gods themselves had taught men fishing, the lobster-fishery, which in our days is of such great importance, has originated in a later historical time, and has since developed, till it is now more extensive than all the other known lobster-fisheries, and supplies not only Norway, but also the neighboring countries. Although we will see, as I shall show later, that the lobster has been known in Norway even in olden times, it had during the Middle Ages scarcely ever been used as an article of food in the northern countries. Lobster-fisheries are not spoken of in the Sagas or in the Old Laws; and even now, although the lobster has been caught on our coast for several centuries, it is but rarely, if ever, eaten by our fishermen, and only the higher classes seem to like its flavor.

The scientific name of the loster is *Homarus gammarus Linn.*, from the Latin name *gammarus*, which again comes from the Greek word *χαμμαρος*. The Italians call it *Gambare di mare*, and the Spaniards *Crabujo*, both of which names evidently come from the Latin. The Illyrians call it *Caranthola*. It does not seem certain whether the Norwegian and German name *Hummer* and the French name *Homar* can be derived from *gammarus*, as our name is very old, and may have its root in the Old Norse verb *homa*, which means to go backward. The English name *lobster* is only a modification of the name *longusta*, applied to a closely-related genus, which is specially found in the Mediterranean; and the Dutch name *Zeekruft* simply means a sea-crawfish. In our Sagas, especially in their poetical portions, it is often mentioned. In Snorre's Edda, in the song Skåldskaparsmål, (chapter 75 of the Copenhagen edition,) it is mentioned among fish and other marine animals. In Olaf den Helliges Saga, it is mentioned in a song of Björn Heldölekæmpe, where the sea is poetically described as "the paths of the lobster." In a similar poetical sense, the word is used in Olaf Trygvesens Saga, chapter 88, by the Skjald Thord Kolbeinsson, where he says that "the wave-

* Om det norske Hummerfiske og dets Hsitorie. Af Axel Boeck: *in* "Tidsskrift for Fiskeri," 3die Aargangs, Kjobenhavn, pp. 28–43, 1868; pp. 145–189, 1869.

horses run over the fields of the lobster," meaning the ships that sail on the waves of the sea. In a song by Snigly Holle, in Harald Haardraades Saga, chapter 105, the expression "to be at the bottom with the lobster" is used for drowning. In the Selkolle Songs of Einar Gilson, in Bishop Gudmunds Saga, the term "the light of the lobster," equivalent to the fire of the sea, or gold, is used. In the same place, the expression "the horse of the lobster mountain," meaning the ship, is used. Finally, there is found in the poem Liknar-braut, the expression "land lobster," meaning a serpent or dragon.

The lobster belongs to the class of crustaceans, and among them to the highest section, the so-called order of decapods, which embrace short-tailed (brachyura) and long-tailed (macrura) species. The lobster has a great similarity to the common crawfish, (*Astacus fluviatilis*,) living in brooks and small rivers, but is distinguished from it by having the last segment of the thorax united with the preceding one, while in *Astacus* it is separate. It was therefore considered by Milne-Edwards to be the type of a new genus *Homarus*. Of this genus, the representatives of which live exclusively in the sea, three species are known, viz: *Homarus americanus Say*, *i. e.*, the American lobster, which is considerably larger than our common lobster, and is found on the coasts of North America. From this the European *Homarus gammarus* is only distinguished by having a narrower spine on its forehead, and teeth only on its upper margin, while the former species has also teeth on the lower margin. There is finally the little *Homarus capensis*, from the Cape of Good Hope, which is not more than five inches long. The European lobster seems to have its central location on the southwestern coast of Norway, and goes as far north as Finmarken, where, according to *Lem*, in his description of the Finmarken Laplanders, 1767, it is found north of Traenen, where he ate very fine ones on the island of Rödö, while formerly their northern limit was thought to be the island of Bröndö, but he also thinks that they would be found in Finmarken, if people only searched for them. It is very rarely found on the coasts of Iceland, where, according to Mohr's "Islandske Naturhistorie," it has been found by Dr. Poulsen in Gröndevig, but it does not extend to Greenland or Spitzbergen. It does not go into the Baltic, but is found all over the Kattegat, especially near Anholt, Hirsholmene, Laesö, and Hjelm, and, according to Mr. Fiedler's report, in the Great Belt as far as Sprogö. On the coast of Bohuslen it is very common, and is said to go into the Sound as far as the island of Hveen. On the west coast of Jutland, it is found wherever the bottom is stony, and it is very common near Heligoland. It rarely goes into the inlets on our western coasts, chiefly on account of their great depth. It is very rare in the inner portion of the Bay of Christiania, and not very common in the Limfiord. On the coasts of England, Scotland, and Ireland, it is common wherever there is a rocky bottom, especially near Montrose, Orkney, Lewis, and Harris Island, and on the southern coast of England, near Land's-end and the Scilly Islands. Near the Channel Islands, it is common, as well as near several groups of islands on the French coast. In the Mediterranean, it is not so common, although it is not entirely wanting; but its substitute as an article of food is another large species of crawfish, the *Langusta* (*Palinurus*). It is therefore not spread over a very large extent of sea; but it is found in its central locations in very large numbers, and there becomes an important article of food and trade.

Its general size is 8 to 10 inches from the point of the spine on the forehead to the tip end of the tail.* It rarely exceeds this size where large fisheries are carried on; but now and then specimens of a much greater size are found in places from which none are exported, and where it consequently has time to grow before it is caught. Thus, Pontoppidan, in his "Norges naturlige Historie," part ii, p. 279, says that the very large lobsters are called "Störjer," and that near Utvaer, on the Bay of Evien, a lobster had been seen which was so large and ugly that nobody dared to attack it, and that it measured a full fathom between the claws. This seems certainly to be somewhat exaggerated; but I myself have seen the claw of one which must have been about 18 inches long. Sir John Graham Dalyell says, in his work "The Powers of the Creator," 1827, that he had seen a joint of the left claw of a lobster that measured 9 inches in length. According to this, the whole claw must have measured 18 to 24 inches, and the whole animal 3 to 4 feet. As a general rule, those that are taken in the fiords are larger than those which are caught near the islands toward the sea. The color of the animal when alive is generally a blackish green, with several blue spots; but it may also be lighter, especially near the mouths of fiords, while farther out toward the sea it becomes much darker. I may mention as a curiosity that during this year (1868) I found a lobster near Haugesund, one-half of which was of a greenish black and the other of a light orange color, there being a sharp and clearly-defined dividing line, which ran lengthwise, and divided the lobster in two halves of equal size.

The lobster lives close to the coast, where there is a rocky bottom, among the large algæ; but in winter, when the water grows cooler, it descends as far down as 16 to 20 fathoms, while in spring, when the temperature of the sea rises, it stays at a depth of from 1 to 4 fathoms. It is altogether a coast-animal, which very rarely seems to go any distance from its birth-place, if it can readily find there a sufficient supply of food. Sometimes, however, they have been seen in large masses swimming toward the land from the sea, and they have then been caught in nets, having been mistaken for a school of herrings; but this is only a consequence of local migrations, when it goes from the deeper into the shallower waters. It is not able to make its way through the

* In the Kattegat, on the eastern coast of Jutland, it reaches a larger size than on the western coast, generally 10 inches.—*Ed.*

sea for any length of time by swimming. Its structure certainly allows it to make quick and definite movements, and it can swim freely about in the sea, but this swimming never lasts long, as it cannot keep itself afloat very long. Neither is it able, while swimming, to catch and swallow its food; but it seizes its prey only when it can hold on to something. At the bottom of the sea it can chase its prey, if necessary, with great rapidity, but while eating it remains quite still. The lobster is a very greedy animal, and can swallow great quantities of food, which it seems to find especially during the night by its scent, while during the day it keeps quiet and digests. Its food consists chiefly of the roe of fish and of dead fish, but likewise of small crustaceans and other marine animals. When kept in confinement, it can live for a considerable time without food. The lobster seems to be able to propagate when it is a little more than 6 inches long, (at least, roe is only found in animals of this size;) but when the lobster reaches a length of 8 inches it contains a great quantity of roe. A real act of copulation takes place, the male lobster placing its double male member into the outer genital opening of the female; and the eggs are impregnated while they are yet in the ovary. This pairing seems to take place from autumn to spring or March and April, for it is highly probable that the roe is emitted from the ovaries immediately after the copulation has taken place, just as with other crustaceans; and the emitted roe is found entirely during winter. After impregnation, the eggs are emitted from the outer genital openings of the female, which are found at the bases of the third pair of feet, but do not fall into the water, as they are held in a hollow which is formed by the bent tail, which, both at the end and on the sides, has leaf-shaped fringes that inclose the space formed by the bending of the tail. Under this tail, there is fastened a double row of the so-called tail-feet, to which the eggs are strung by strong slimy strings. The embryo now begins to develop in these eggs, which are quite numerous, 2,000 to 3,000 in one female, according to the size, and occasionally as many as 10,000 to 12,000. The formation of the embryo does not, however, seem to begin till the temperature of the water has become milder in spring, even if the pairing should have taken place in autumn or winter; for, although loose roe is often found in winter, it is never seen in any degree developed into an embryo. This pairing and the development of the roe seem to take place at different times on the different portions of the coast; for the fishermen themselves, who have such an excellent opportunity of observing them, are not agreed as to the actual time. The development of the embryo seems to take at least fourteen days from the time of commencement, and it can easily be observed till the young break the shells of the eggs and begin to lead an independent life. When the young lobster comes out of the egg, it measures only a few lines in length, and does not at all resemble the old lobster, but has a different structure. It does not leave the hollow under its mother's tail immediately after being hatched, but lives there for some time, and later frequently returns to it. It is particularly distinguished by a less complete development of its feelers and tail-feet, and by the feet being exceedingly small but furnished with long brush-like branches, with which it swims vigorously on the surface of the water. After having spent some time in this state, it changes its skin several times and assumes the shape of its mother, when it goes to the bottom. Its life from this moment till it reaches a size of 5 to 6 inches is entirely unknown; for no young lobsters have been caught, either by fishermen or *scientists*,* the smallest having been found in the stomach of the torsk, so that it is probable that they spend this portion of their life at a greater depth and live in a different manner and on other food than at a later period. There can, therefore, not be any artificial hatching of lobsters in the sense of artificial fish-hatching, but all that can be done is to keep the lobster imprisoned during the development of the eggs, and thus protect it from the dangers which threaten it and its young. It is impossible to do anything for the tender young, as they die very soon when confined. I see, however, that several persons in France, and Mr. von Eris, in the lagoons of Triest, near Grado, have hatched several millions of young lobsters by keeping lobsters with ripe roe at the bottom of the sea in perforated boxes.

After the lobster has emitted its roe, and the young have left the mother, she begins to shed. She, therefore, goes to safe places, and does not seem to care much for food, while the old skin is being loosened; the shell finally opens in the back, and the animal goes into the water naked. It then looks as if it was covered with velvet, on account of the considerable formation of cells which is going on all over its surface. These cells afterward grow hard through small particles of lime and form the new shell. This shedding of the shell goes on from the middle of July till September, but not at the same time all along the coast, being earlier in the southern and later in the northern part. The lobster thus gets sick, as it is called, toward the end of June near Sogndal, and the export must then cease, as the mortality among them becomes too great, while near Karmö it is still in a healthy condition till July 15. Farther north, the shedding of the shell begins still later, and lobster may be caught all through July.

The greatest enemy of the lobster, and who sensibly diminishes its numbers, is man. When swimming near the surface during its youth, with a number of other small crustaceans, it becomes a welcome prey to the herring and the mackerel. As the grown lobster keeps at no great depth, and where large fish of prey are not commonly found, it is not much exposed to them, but occasionally, when lying near the surface, it is taken by large birds of prey. An interesting scene may be witnessed near Bukkenö, north of Stavanger, where an Englishman has construct-

* The development of the lobster has, since the original publication of this memoir, been studied by Mr. S. I. Smith, of Yale College, and Prof. Japetus Steenstrup, of Copenhagen.—Ed.

ed a large pond, between some small islands, for keeping live lobsters. Whenever the pond becomes too full of lobsters, so that they do not find sufficient food, they leave the water, and crawl about seeking to reach the sea; but during their wanderings they fall an easy prey to large numbers of crows hovering round, which take them in their claws, fly high up, and let the unfortunate lobster drop down on the rocks, where their shells are broken, so that the crows can eat them in comfort. The crows are not easily scared away, but show a remarkable degree of sense, only flying away when any one approaches with fire-arms, and later they carry on their depredations in the early morning, when they have less to fear.

IMPLEMENTS FOR CATCHING THE LOBSTERS, METHODS OF CATCHING THEM, AND THE MANNER OF SHIPPING THEM.

Formerly, the lobster was caught on our sea-coasts exclusively with tongs. These tongs were made of wood, and had about the same shape as the common oyster-poles, being only somewhat longer, generally two fathoms. Such an implement was exhibited at the Bergen Exposition of 1865, and an illustration of it is given in the report. As these tongs were not very long, lobsters could not be caught at any great depth—only at a depth of little more than a fathom—and this sort of fishing was carried on during the early morning hours. But as lobsters taken with these tongs often got hurt, and died two to three days afterward, because they cannot stand any pressure, this implement was not suited for those that were to be exported; and the Dutch, after the peace of Westphalia, when the lobster-fisheries began to assume larger dimensions, endeavored to induce the fishermen to use other and better implements. Although baskets, through the influence of the Dutch, had thus become common in the neighborhood of Stavanger since 1717, tongs have been frequently used even in our century, and are perhaps in some places used to this day. *Kryger*, in his report on *Ous*, in the "*Budstikken*" (a periodical) for 1820, mentions that lobsters were caught there with tongs for home-consumption. Farther north, tongs seem to have been the common implements for catching lobsters at a much later period; for, in the quinquennial report of the governor of the Romsdal district for 1840–'44, it is said that "lobsters are taken with tongs, baskets not being thought to answer the purpose." Lobsters were caught with tongs by small boys from ten to fourteen years of age, early in the morning, in calm weather, and, if successful, one night might yield an income of $2.25. Another very simple implement for catching lobsters is spoken of in the "*Budstikken*" by Ström, who says that lobsters are taken with a hook fastened to a pole, which hook is inserted in the belly, the softest part of the lobster. With this instrument, it cannot be taken at any great depth, and only when the sea is calm so that the bottom can be seen. Lobsters caught in this manner cannot be exported, as they could not stand the journey. The implements which I am going to at once describe, and which have almost entirely supplanted the simpler ones, are used by enticing the lobster with bait into a trap, out of which it cannot escape. The simplest of these traps is seldom used with us, although, according to *Oetker*, it seems to be in common use near Heligoland. It consists of a very thick iron ring, to which a net is fastened, so as to form a deep bag below The bait is placed at the bottom of the bag, and it is lowered and taken up by means of a long line, which, when the bag is at the bottom, reaches up to the surface. To this line, a piece of wood is fastened, which floats on the water, and shows the location of the trap. If this instrument has been lying at the bottom for half an hour in a place where lobsters are known to abound, a sudden jerk is given to the line, so as to cause the lobster to fall in the bag, and it is rapidly pulled up. (The most successful time of the day for catching lobsters is generally in the morning or also between 11.30 a. m. and 3.30 p. m. With this instrument, which the English call "plumpers," and the Germans "Fallenkörber," lobsters are taken in deep places.) With us the commonest implements for catching lobsters are baskets ("*Tejner*"). It seems certain that the Dutch first introduced them for catching lobsters; but they may have been used long before that, *e. g.*, for eels, as the name is Scandinavian, and is derived from "*tün*," *i. e.*, the long and tough roots of the juniper-tree. After 1713, a beginning was made in plaiting them of willow-branches. Where these materials could not be readily obtained, they were, as Pontoppidan related in 1753, made of hoops, which were kept apart by chips of wood. All round these, nets are fastened, and at each end there is a long, narrow, trough-shaped entrance, out of which the lobster cannot escape. On the one side, there is a trap-door, which can be closed with a peg, and to another pin sticking in the basket the bait is fastened, while under the basket there are large stones to make it sink rapidly. To one of the uppermost chips of wood, a pair of tongs is fastened, furnished at the end with a piece of wood to indicate the location of the basket. Such are still in common use all along our coast. Still earlier, in 1746, the famous naturalist, Carl Linné, described similar baskets, which he saw in use on the coast of Bohuslen, in his "West-Göta Resa," p. 191. These were two yards long, one yard broad, and one yard high, resembling a half-cylinder, with entrances on both sides; such are still used and could be seen at the Bergen Exposition. At this same exposition, a basket was exhibited, differing somewhat from these in its shape; it was plaited of branches, and was shaped like a hemisphere, with an entrance at the top. An illustration of this basket is given in the report on the exposition.

Lobster-fishing is carried on at different seasons on different parts of the coast of Norway. It generally begins in spring, but in some places, *e. g.*, near Christianssand, it continues all winter. Farther south the spring fisheries begin earlier; thus, on the coast from Sireaa to Jædder in the middle or toward the end of March, as the lobsters then begin to go into shallower waters. From Karmö to Espevær, the fisheries begin in April, and farther north, near Strandsund, in the beginning of May. Near the Jædder, which is farther south, but where the coast is not so flat and convenient, the fisheries commence much later. The fisheries are continued through the following months, but cease in the first-mentioned district in the middle or toward the end of June, while in the others, near Stavanger and the Southern Bergen district, they are continued till the middle of June, and farther north till the first of August. When the fisheries are to commence, the fishermen go to the outer islands near the open sea, where the fisheries are richest, and live in sheds built for the purpose, during the whole week from Monday on, returning with the lobsters on Saturday, fishing thus going on for five days each week. Two men generally club together and have thirty to fifty baskets. In the evening, the baskets are furnished with bait, consisting of all sorts of fish except herring and mackerel; for they claim to have noticed that lobsters caught with bait of the last-mentioned kind do not live long. The baskets are then placed in the sea at a depth varying from 16 to 2 fathoms, according to the season of the year, and taken out before sunrise. The baskets can also be put in position when the tide comes in, and be taken up when it goes out. As soon as the lobster is taken from the basket, its claws are tied together with strong twine, and it is placed either into a box perforated with many holes, or into a larger basket, which is then sunk in the water near the coast. Here the lobsters remain till Saturday morning, when they are taken out and brought to the dealers, from whom the fishermen immediately receive their pay. Every lobster which measures more than 8 inches from the spine on its forehead to the tip end of its tail, and whose claws are perfect, is called a "full man;" but if it measures somewhat less, or if portions of its claws are missing, it is called "half a man," and only fetches half the price of the others. The dealers, who collect the lobsters on the coast, pack them in large boats that can hold as many as 2,000, cover them up with sea-weeds to protect them against the sun, and send them to the chief depot, where they are immediately placed in special boxes. These boxes differ somewhat among themselves; the best are about 3 yards long, 2½ yards broad, and 18 inches high, and perforated by numerous holes, so as to constantly admit fresh water. These boxes hold about 400 lobsters each. Formerly, they were not so high, but then the mortality among them was greater, especially in bad weather, when the rain adulterated the water in the box. In other places, these boxes are perfectly square, measuring four yards each way, and hold about 500 to 800 lobsters. After the lobsters have arrived at the chief depot, they must always rest for some hours in the box, before they are placed on board the vessels, as they are sick from the long voyage in open boats without water. Every Saturday, an English lobster-vessel comes to the depot, begins to take its cargo in the evening, and gets through with this Sunday afternoon, whereupon it immediately goes out to sea. In this manner, the fishery has been arranged for more than one hundred and fifty years, as it seems, by the Dutch, of which more will be said under the history of the fishery. Nowadays, the fishermen receive a far higher price for their lobsters than formerly, and as a general rule they get in Stavanger and Bergen from 4 to $4\frac{1}{2}$ cents apiece, but farther north they are cheaper. Formerly, when the price in Stavanger was lower, about one-half cent extra was given for every lobster caught before the middle of May, but this custom has been abandoned. The dealers who receive the lobsters from the fishermen receive about 60 cents as box-money for every thousand, and 20 to 25 cents for every hundred they bring to the chief depot for every full mile they travel with them. The wholesale dealers receive the same box-money, but besides $3 as weekly money. If they do not keep any boxes themselves, but receive them from the lobster-company, the retail dealers get $3 for every thousand, and the wholesale dealers $4.50 for every thousand, but, in that case, no week-money. When the lobster-vessels go to sea, they always go straight over to England, to Grimsby and Harwich, while formerly they went to London, anchoring near Greenwich in the evening, unloading the lobsters during the night, and taking them to London, where they arrived in the Billingsgate market before sunrise. Now the vessels, on arriving in one of the above-mentioned ports, go into the dock, which is specially intended for them, and the lobsters are unloaded into the fish-boxes belonging to the dock, which are rented out for one English shilling a day. These fish-boxes are shaped like a boat, are 11 yards long and 5 feet broad, but have a flat bottom. They are hoisted up so that the water runs off, and the lobsters are sent in suitable baskets by railroad to Billingsgate. Sometimes they are sorted in the ports, but this is mostly done in London. The largest lobsters are picked out, and twenty are always packed in a basket, which gets a black stroke as a mark. The smaller ones are packed forty in a basket, and get two strokes as a mark, while the smallest are packed sixty in a box, and get three strokes as a mark. The baskets with one stroke are more valuable than those with two and three, although these latter contain more lobsters. The wholesale dealers in the market get them from the railroad and sort them, and they then pass over to the fishmongers. These boil them, and send the finest to their best customers in the city and the country, while the small ones are sold in the city to cheap restaurants and private individuals.

In the Billingsgate market, the lobsters meet their brethren from the English, Scotch, and other coasts. From the south coast of England, they come by the Southwestern Railway, and by the Great Western from Bristol, to which ports they have come from Guernsey and Jersey, the Scilly Islands, and Land's-End. From Scotland, the Orkney Islands, and Lewis Island about 180,000 come every year, partly in steamers; from Ireland, they come by way of Liverpool; while a smaller number come from Sweden and Heligoland. All these are gathered in the

Billingsgate market, and are thence distributed from March to August. Not all are consumed in England, but a portion are again sent away, especially to France.

I have mentioned that the coast is divided into certain districts, and that in these there are certain stations for the retail and wholesale dealers, from which the lobsters are shipped, and where the government custom-house officers are stationed, as great facilities are afforded to this trade in the way of customs, &c., of which I shall speak more under the history of the fisheries. Of these districts, the first, the most easterly one, extends from Faerder to Mardö, but from this district none are at present exported to England. The same is partly the case in the second district, which extends from Mardö to Cape Lindesnaes, although some are placed dry in boxes and sent by steamer to London and Hamburg. In this manner, lobsters are also shipped from the next district, which extends from Cape Lindesnaes to Snaekken, the chief place from which they are exported in this district being Kirkehavn. The lobsters are placed in the boxes in several layers, the tail being bent under the stomach. The boxes are then closed, and the lobsters keep alive for a considerable time. Formerly; they were from these districts also exported in barrels; but this was discontinued twenty years ago. The next district extends from Stavanger, near the river Sire to Vig.

[A following half-page defines the exact location of the different districts.—TRANSL.]

Nearly all the lobsters which are shipped from Norway are sent alive. Pontoppidan relates that in his time—the middle of the last century—some were salted just before being shipped, but this custom seems to have been subsequently abandoned, as so many lobsters died during the voyage. In this century, Mr. Jacob Mörch, a Christiania merchant, tried the plan of putting them up in hermetically-closed receptacles; but as all those which had been put up by him in this manner did not get the red color of the fresh boiled lobsters, and therefore were not liked so well, he took out a patent in 1840 for putting them up in such a manner as to keep their beautiful red color. He dipped them in boiling water containing salt till they got this color, and then made an incision in the soft part under the tail, thus letting the water which injured them flow off, and then placed them in hermetically-sealed vessels. Very few lobsters put up in this manner, however, seem to have been exported, and nothing more has been heard about it.

THE LOBSTER-TRADE AND THE HISTORY OF ITS LEGISLATION.

Although the lobster had been known to our ancestors from time immemorial, it was, as has been said above, but little used as an article of food, and foreigners have taught us to like its flavor. In Holland, the lobster seems to have been highly prized, even in olden times; and when their lobster-fisheries were no longer able to supply the demand, the

Dutch began to visit Norway as early as the seventeenth century, but it seems that lobsters were not exported in any considerable quantity till the middle of the century, especially from Flækkefiord and from Karmö. The citizens of Zierikzee in Holland commenced this trade, and for a long time carried it on exclusively. We read that lobsters were exported from Flækkefiord in 1660. In 1674, that port was visited by ten lobster-ships, and, in 1676, Hitterö near Flækkefiord, and Egvaag near Farsund, became the chief stations in the districts of Lister and Mandal. From 1690 thenceforward the Zierikzee boats visited Karmö regularly, Skutesnæs and Buken being the first lobster-ports in that district. The Dutch were so eager to further these fisheries that they gave presents to the clergymen, consisting of cheese and cakes, and thereby induced them to exhort the peasants in front of the church to catch and sell lobsters. This succeeded so well near Lister that I find that a man on July 7, 1699, had his ground solemnly consecrated so as to prevent other people from catching lobsters there. The clergymen at Karmö received presents till 1730, when the Dutch found that it had become an unnecessary expense, the lobster-fisheries being by that time in a very flourishing condition. Till 1713, however, these fisheries were not carried on to any very great extent, as wars hindered the fishermen from following their occupation and made the export uncertain. People therefore contented themselves with catching lobsters with tongs; but, after the peace of Utrecht in 1713, the export of lobsters was better regulated, and several ports were visited both in the Stavanger and in the South Bergen districts. Then people began to make baskets, which the Dutch were very anxious to introduce, as many of the lobsters caught with tongs died. The Dutch, therefore, gave to those fishermen who used baskets clay pipes, and twine to tie the claws of the lobster. By agreement, common customs and regulations for loading the ships had been adopted, so that the shipper who first came into port should be allowed to take his full load before any of the others could buy any. The price had also been fixed by the Dutch at about one cent for each lobster, ("full man,") and about fifteen cents for every one hundred lobsters brought alongside of the ship. In order to avoid competition among the buyers, every port had a certain district assigned to it from which it was supplied with lobsters, and every captain had a certain port to which his ship must go. As long as this trade was carried on exclusively by the citizens of Zierikzee, this agreement was kept up, and both buyers and sellers were contented. The following places were then gradually designated as lobster-ports: Mandal, Flækkefiord, Egersund, Tananger, or perhaps Stavanger, Akre on the island of Karmö, and Leervig on the island of Stordö. Outside of Lister, Stavanger, and the southern part of the Bergen district, it was not allowed to catch or sell lobsters on account of the strange belief prevalent among the fishermen that lobster-fishing would ruin the other fisheries. This can be seen from Governor Povel Juel's memorial of 1717, which is found in the royal archives, where we read: "It is thought that the lobster-fisheries are very injurious to all the other important fisheries; for experienced fishermen say that fish mostly live where there are lobsters, and that they dive to the bottom to get the roe of the lobster. It is well known all along the coast that through lobster-fishing the cod and mackerel fisheries are neglected, and it is desirable that this fishery should be entirely abandoned."

This belief in the injuriousness of the lobster-fisheries seems to have been very common till the end of the last century; for, in "Versuch einer Naturgeschichte der Krabben und Krebse," by Herbst, 1797, it says "that many people think this trade is injurious to Norway, as the removal of large quantities of lobsters makes the fisheries leave the coast of Norway." Governor Holm, in his "*Forsög til Beskrivelse over Lister og Mandals Amter i Norge*," likewise says: "It is difficult to say in how far lobster-fishing hinders the other fisheries, as many fishermen stoutly maintain. Lobster-fishing has been carried on, as now, in olden times, when the other fisheries were very considerable." The lobster-ships were to go to certain ports specially designated, and, on leaving these ports, were to pay a sum to the custom-house officers, who besides liked to take small presents, which abuse is complained of as early as 1717, as likewise that the citizens sold to the lobster-ships brandy and lumber, receiving in exchange various goods which paid no duty. The lobster-ships generally came twice a year from Holland, late in autumn and early in spring, and sailed along the coast to get their cargo in the ports designated for them. The English at that time received their lobsters from their own coasts, from the North American islands, and from Heligoland; 18,000 having been exported to England from the latter place in 1713, and 34,000 in 1714. But, as soon as the English demand grew larger, English ships occasionally came to Norwegian ports, and bought lobsters, paying a higher price than the Dutch. It seemed, also, as if, through the introduction of baskets in Lister and Karmö, by which lobsters were easier caught in greater numbers, and through the increased export during the years of peace after 1713, the quantity of lobsters had decreased, and the fishermen began to complain of the low price paid by the Dutch. In 1716, the fishermen of Lister addressed a memorial to Governor Povel Juel, saying "that they no longer could sell lobsters according to the old regulations at a cent apiece, because the fisheries decreased year by year, so that they had no reward for their trouble, danger, and expense, but only less profit in their farming, which had to be entirely neglected on account of these fisheries; they, therefore, had concluded to give up the above-mentioned fisheries entirely;" and, therefore, they petitioned him to forbid the lobster-buyers to visit the ports, or at least to raise the price to 2 cents apiece. The governor, who always seems to have taken a deep interest in the welfare of his district, consequently decreed, July 15, 1717, "partly in order to please the farmers, and partly the lobster-buyers, who would quickly get their cargo if all the men along the coast gave greater attention to the fisheries, because they had the price raised, and had not to lie in port eating up their provisions," that the lobster-buyers who, after this date, came to the ports in his district "should pay 2 cents for every lobster, either living or dead, great or small, just as it might come; but, if it only had one claw, 1½ cents, and not give either a higher or a lower price. Any one acting contrary to this decree should pay a fine of about 30 cents for every lobster, half of which should go to the informer, and half to the sick poor of the parish; and the lobster which had been either bought or sold should be confiscated." The old customs, that the ship coming into port first should first take its full cargo, &c., should remain. He also induced the governor of Stavanger to issue the same decree in his district, but the governor of the South Bergen district would not do so. When the lobster-traders in Zierikzee heard of these regulations, they resolved to oppose them unanimously, and agreed in writing not to give more than one cent for each lobster, and also to send their ships on one and the same day to those places where they were accustomed to get their cargo, so as to prevent any of the shippers from abandoning the agreement entered into and paying more. They thought that if all the shippers were unanimous not to pay more, the poor fishermen would finally give in if they saw that the shippers made preparations for sailing and no one else was there to buy. Their commissioner in Stavanger, Lauritz Smith, made great exertions to induce the peasants to return to the old price, by traveling in person to Tananger, where he had great influence, and by urging the clergymen to induce their parishioners to sell at the old price, promising them some extra presents from the Dutch if they should prove successful in persuading the peasants. All the custom-house officers also assisted him, because they were afraid of losing their fees and small presents which they were in the habit of receiving from the Dutch. He was, however, only successful in one parish in the Tananger district, while in all the others and in the districts of Lister, Mandal, and Stavanger the peasants immovably stuck to their new price. In the Bergen district, the governor had issued no decrees, and Smith succeeded, with the assistance of the custom-house officers in Leervig, in furnishing the Dutch several cargoes at the old price. The wealthy peasants were the most eager to uphold the new price, forcing the poorer ones not to sell, so that all the exertions of the Dutch failed; the new price soon becoming universal everywhere, and prevailing till near the end of the century, but only for living lobsters measuring more than 8 inches in length, while for the smaller ones or those having only one claw only one cent was paid. Lauritz Smith also made complaints to the government in Copenhagen regarding Governor Juel's decrees, and as Juel was not in favor with the government, his decrees for the benefit of the peasants did not meet with its approval. In his report to the king, Smith complained very strongly that the governor had attempted to change old established customs which to all intents and purposes related to foreigners. The report suggested that all the fisheries should be rented out for the benefit of the royal treasury. Governor Juel was that same year obliged to resign and could do no more in this matter. The thought of renting them out was again given up, as the new governor could not advise such a step; but sometime afterward the question began to be asked whether the country's own merchants might not derive some advantage from this trade, and whether they might not reap the great profit which had hitherto fallen to the share of the Dutch. The export of lobsters was quite considerable at this time, as the district of Bergen was annually visited by eight ships, and more than twenty took their cargoes in the districts of Lister, Manda, and Stavanger. There is no information as to the size of these ships, or how many lobtsers they took, but each took a cargo twice a year; and even if they were not as large as those mentioned about the middle of the century which could hold 4,000 to 6,000 lobsters, the quantity of lobsters exported was, nevertheless, very considerable, and the Dutch traders must certainly have enjoyed a good income from this trade, as on every occasion they showed themselves so eager to retain it. As lobster-fishing had become much easier since the introduction of baskets, and more profitable through the higher price which the peasants got, the landed proprietors wanted to have the exclusive right to fish near their grounds and forbid all others to do so. This they thought could best be done by having their grounds solemnly consecrated. I find such a consecration of a farm near Lister, spoken of as early as 1689, but on the island of Karmö not till 1720. In some places, such a consecration was respected; while in others this was not the case, the people having an idèa that fishing in the sea should be free to all. A law-suit in 1725 resulted in the confirmation of this ancient law of free fishing in the sea by a royal decree, which also affected the lobster-fisheries. David Halvorsen Vraa and Jacob Olsen Vidöen, of the village of Staengeland, on the island of Karmö, in 1725, brought a law-suit against some fishermen, who, in spite of the consecration of their ground, had placed some lobster-baskets near some small islands belonging to them. Judge Leth gave judgment on the 29th of August of the same year in favor of the plaintiffs, on the ground that the law, book 5, chapter 11, article 2, confirmed by book 3, chapter 13, article 1, gave the owners the right to use all the profits that might be derived from their property. After this judgment had been passed, all the owners of islands began to forbid the fishermen from catching lobsters not only on those portions of the coast that were very near to their farms, but also on islands that lay at a distance of three or four miles from the coast. The poor fishermen, who at certain seasons of the year lived entirely off the lobster-fisheries, saw themselves deprived of this means of making a living, and complained bitterly to the highest authorities, maintaining "that the lobster-fisheries have never before been forbidden them, and that now they were deprived of their only way of making a living;" they pointed out that the king's own sailors were especially hurt by this judgment. Through the governor, their complaints were laid before the viceroy, Mr. Weber, who had the matter examined by competent men, and thereupon sent a memorial to the king, in which he says, among other things: "The blessings which the sea bestows will become useless, if the owner of the ground has the power to take and keep everything pertaining to the fisheries; fish are not in one place, but change from one to the other; and the fishermen, who alone understand the fisheries and earn their living thereby, must go after the fish. It is a general custom of the country, and also in accordance with the law, that every one takes the fish which the sea yields wherever he finds them, with the exception of the salmon, which always goes to certain places that pay a special tax, and where, therefore, none but the owner is allowed to fish. The law, book 5, chapter 11, article 11, says that no one must hinder another person in the fisheries he possesses from olden times, and article 2 of the same chapter, on which the judge has based his argument, says: 'Every man shall enjoy the water and the fisheries near his grounds which he has possessed from olden times, unless he has been deprived of these privileges by law;' and book 3, chapter 13, article 1, says: 'A nobleman and landed proprietor is, more than any stranger, privileged to use all the advantages of his property.' Fierce law-suits would follow, if the owner of such islands could forbid the fishermen to catch lobsters, as the blessing of the sea would then remain useless, and the little that was derived from it would not be properly treated, since the fishermen alone have the greatest experience in this matter," &c. He therefore proposes to the king to revoke the judgment given by Judge Leth, and allow all and every one to fish lobsters. The result of this memorial was a royal decree, dated April 23, 1728, to the effect that lobster-fishing should be free to all.

After this decree had made the lobster-fisheries free, the export of lobsters, concerning whose decrease complaints had been made to the viceroy, rose again, so that in 1733 twenty-three large cargoes, containing 160,000 lobsters, went to Holland, and the rest to England in thirty-two small English and nine Norwegian vessels. The Stavanger fishermen had recently got six to eight lobster-vessels, after the question whether the advantages of the lobster-trade might not just as well be enjoyed by the king's own subjects as by the Dutch had been settled, and certain privileges had been granted to the home traders, decreeing "that in order not to let foreigners reap the chief profit, a Norwegian ship should be admitted into every port before anything should be sold to foreigners." English vessels likewise began from this time to visit the coasts of Norway in greater numbers; many of these had formerly taken their cargoes near Heligoland, and had left that region because the fisheries had decreased there. Several ports of export and custom-houses were established on account of the increased fisheries; six ports being alone established in the Stavanger districts. On account of the greater demand for lobsters, the fisheries were carried on to a great extent, and complaints are made during the following years that the number of lobsters on the coast was decreasing. Count Rantzau, who was governor at the time, issued an order to his officers that they should make suggestions as to what should be done to prevent the decrease of this important fishery, which yielded so large an income to the king and the nation. Judge Lom, in Lister, in 1737 made a proposition that the fishermen should be forbidden to sell any lobsters measuring less than 9 to 10 inches in length, under a fine of about 60 cents for every smaller lobster which is sold; and as the lobster, as far as known to him, emits its roe toward the end of June, fishing should cease from June 24 till the end of February. This for those times very remarkable proposition was not supported by others, and was forgotten; more than one hundred years were to pass before the idea of protecting the lobster during the season when it spawns and sheds its shell was destined to become a reality, and a law passed concerning it. Peasants who had farms near the sea where lobsters were caught, believed that the decrease of these fisheries was chiefly caused by the freedom of fishing, and that the lobsters would finally be exterminated. There was consequently great dissatisfaction with the royal decree, which favored the small farmers at the expense of the great ones. They likewise thought that as consecrating the ground had, with few exceptions, always been respected, owners should also in the future be exclusively permitted to fish lobsters on their gounds, if these had been consecrated prior to the royal decree. Many government officials seemed to have shared this view, especially when the fisheries began to decrease very much and the peasants found it very difficult to pay their taxes. The judge, in his answer to Governor Rantzau's inquiry regarding the economical pressure, says expressly "that in assessing the taxes on each farm regard had been had to the lobster-fisheries, which have become exceedingly profitable, for which reason the Dutch and English lobster-vessels frequent our coast. In these regions, mackerel and other important fisheries have belonged to the farms lying near the sea; and as, in the district of Lister, these fisheries have been so entirely destroyed that the inhabitants have not had any use of them for many years, and had to lay aside their nets and seines, which they had bought at a great expense, they now have nothing else to fall back upon for earning a living and paying their taxes but the lobster-fisheries near their ground, since the quantity of grain and hay which they harvest is but very small, and agriculture is, in many places, connected with the greatest difficulties." He would, therefore, propose "that, in order to preserve the fisheries, land-owners may have the exclusive right of fishing on the coast near their grounds and around all those islands, which were formerly used for agriculture, as far as the deep water, but that all the remaining waters should be free to every one." He, therefore, wished to bring back the condition which existed before Judge Leth gave the two farmers mentioned above the exclusive right to fish lobsters near their grounds, which right all land-owners, from foolish covetousness, exercised so far as to forbid the poor fishermen from catching lobsters on the outer coast as formerly, for which reason the royal decree also made lobster-fishing entirely free. The decree, however, remained in force, for the special reason that it favored the enrolled sailors, to assist whom was in the interest of the government.

The dissatisfaction with the existing state of affairs did not grow less in course of time; but every time that the political situation in Europe favored or did not prevent the lobster-trade, the land-owners endeavored to regain the exclusive right of fishing lobsters near their grounds. In the district of Flækkefiord, there were thus, in 1790, serious quarrels between the fishermen and the land-owners, who tried to prevent the fishermen from catching lobsters near their grounds, forbidding them to live on their islands, or to set their baskets and gather the lobsters. Mr. Schiönning, a custom-house officer, January 13, 1770, made a proposition to the board of trade, containing more definite regulations concerning the rights of both parties, in order to put an end to the quarrels between the fishermen and the land-owners. This proposition was sent to the governor, at that time Mr. Teiste, who quietly shelved it.

The Stavanger merchants, after the year 1730, had bought several lobster-vessels for shipping lobsters to Holland, because they now had a number of privileges with regard to the sale of lobsters. They could not, however, derive from it the profit they desired, as the Dutch sought in every way to hinder the sale of lobsters in Holland from Norwegian vessels. Several Stavanger merchants, therefore, again sold their vessels to the Dutch, and became Dutch commissioners; letting the trade, however, go on in their own name, so as to retain for their ships the privilege of first buyers. Complaints were made, and the Norwegian vessels seem somewhat later to have lost this privilege of the first buyer. The last who owned lobster-ships were the firms of Kjelland & Son and Planz & Sunt, in Stavanger, who became commissioners for English lobster-companies, which, in the latter half of the eighteenth century, gradually took possession of the lobster-trade, pushing the Dutch into the background. The privileges granted to Norwegian vessels greatly benefitted the commerce of Norway, which at that time could not compete with the more powerful commercial nations, in whose hands all our import and export trade had hitherto been; but the government, nevertheless, endeavored at times to encourage the export of the productions of the country in Norwegian vessels, and for the prosecution of the lobster-trade several further privileges were granted to Norwegian vessels, without however being of much benefit. Governor Holm therefore said toward the end of the last century, in his "*Forsög til Beskrivelse af Lister og Mandals Amter*," that "the lobster-fishery would be more profitable to the country if it became more common to carry it on in Norwegian ships instead of letting the

Dutch take it and reap the profits which Norway should enjoy." In 1753, the custom-house at Leervig was abandoned, and after that year lobsters were chiefly shipped from Espevær, a group of islands farther out at sea, where the richest fisheries were carried on. Formerly, as has been said, it was not allowed to fish or ship lobsters north of Leervig, but later lobsters were also allowed to be exported from the southern and northern Bergen districts, from which there had been constant complaints regarding this prohibition. The export, however, was not considerable north of the old lobster-ports; for, according to Olrik, only 52,000 were exported in 1757 from the outer ports in the Bergen custom-house district, the greater portion of which came from Sóndfiordland. Of these, only 4,000 went to England in English ships, the remainder going to Holland. Toward the end of the eighteenth century, a great change took place in the lobster-trade, as, after the war which broke out between Holland and England in 1776, the Dutch lobster-trade was entirely ruined, the English taking possession of it.

The lobster-fisheries on the inner coast, where they formerly had been carried on almost exclusively, decreased very much, so that in the Stavanger district the shipping-ports of Stjernerö and Nordstrand were given up, as well as the outer port of Skudesnæs; and toward the end of the century the export of lobsters was chiefly carried on, besides from the old ports in the Lister and Mandal districts, from Tananger, Buken, and Akre, in the Stavanger district, and from Espevær, in the South Bergen district, to which afterward came the more northerly ports of Salthellern and Rognesund. These shipping-ports had been established through the exertions of a Bergen merchant, Mr. Wallace. He was commissioner for an English lobster-company, which controlled all the trade from Bómmel to Nordfiord. Brandösund later took the place of Salthellern as a shipping-port.

In order to encourage lobster-fishing and the lobster-trade to foreign countries, considerable changes were made in the custom-house arrangements and the taxes to be paid for lobster-vessels. As it is of great importance during the lobster-season to get the lobsters to the shipping ports alive, every delay during the lading of the vessel, or every delay in the time of sailing, will occasion the death of many lobsters. Special custom-house regulations had therefore to be made for the lobster-trade. Such a special regulation from the end of the last century is here given, omitting some unimportant points:

"Until further notice, it is allowed—

"1. That both foreign and Norwegian lobster-vessels, when taking lobsters in the ports of Salthellern and Espevær, may enter these ports without going up to the custom-house, or without obliging the shipper to go there with the papers of the ship, unless the ship has no certificate of its gauge, in which case it must obtain one from the authorities in Bergen.

"2. These ships are not required, either going out or coming in, to call the custom-house officers on board in order to examine the ship and exact the taxes on the lobsters which compose the cargo. The officers, however, are at liberty to superintend the lading, if necessary.

"3. The lobster-commissioners of this firm (Wallace) must faithfully give an account of all the goods which the incoming ships may bring, and of the number of lobsters which are to be exported, so that the dues may be paid, and must also give the carrying capacity of the vessel.

"4. These ships are not exempt from the general custom-house supervision, but all the more, on account of the liberties accorded to them, does it become a duty of the officers to keep strict surveillance; and the revenue-cutters have also to see to it that nothing unlawful is going on.

"5. With regard to proving the correct calculation of the custom-dues, it is resolved that the commissioners, in every place where lobsters are caught, shall annually, when the fisheries cease, obtain from the fishermen the exact number of lobsters caught and the number of ships employed in the trade, with their carrying capacity. These data are communicated to the custom-house officers, and the dues are to be paid accordingly.

"6. Ships exporting lobsters from Rognesund are granted the same privileges, only with the difference that on coming into port they must come up to the custom-house, so that, consequently, the commissioner alone becomes responsible for the correctness of the list of the lobsters which have been exported.

"Given at the general custom-house office January 20, 1798."

The war between Holland and England injured the lobster-trade somewhat, but it soon recovered and rose to considerable dimensions, like our whale-trade, during the North American war which broke out in 1775. In Farsund, the flourishing firm of Jochum Birch Lund had in 1786 commenced to export lobsters in vessels of their own. Several years later, when the English attempted to get a foothold in their lobster-district and pay higher prices, they petitioned the government to order the fishermen to keep the conditions of the contract entered into by them till its time was up; but the government could in this case refer them to the law. In 1790, they petitioned to obtain the exclusive right to buy up all lobsters in the neighborhood of Farsund, agreeing to give the same price as others. They referred to their heavy expenses for fitting out vessels, and to all they had done to further the interests of Farsund, and maintained that their petition was in accordance with old privileges granted to the Norwegian lobster-trade. They obtained this exclusive right to buy lobsters on condition that this right should only be enforced till their ships had got their full cargoes, and that they should pay the same price as others. It was therefore not the same privilege which had been granted to Norwegian lobster-vessels more than half a century earlier, as these had only the right to let one of their vessels take its cargo before foreigners could get any lobsters. Some years later, they petitioned for the same privilege for all their vessels, even beyond Cape Lindesnæs. This, however, was not granted.

As the fisheries toward the end of the century declined very much, Mr. Gjertsen, a Mandal merchant, in 1790, proposed to the government that it should forbid the fishermen to catch lobsters from July 1 till the end of October, under a fine of $25. He drew attention to the constant decrease in the number of lobsters, which he thought was solely owing to the fact that they were caught during the season when they spawned and shed their shell. Although he did not seem to know anything of Judge Lom's proposition of 1737, he had nevertheless arrived at the same result, viz, that, if the numbers of the lobster are not to be diminished, they must be protected during the season when they spawn and shed their shell. The government approved of this proposition quite as little as of Lom's, thinking that such a prohibition of the fisheries at a certain season would reduce the income of the fishermen too much, especially during poor years, and no one seems to have had an idea that such a protection of the lobster would prove extremely useful.

The European events from the beginning of the French revolution seem not to have had much influence on the lobster-trade, which was now in the hands of the greatest maritime power, England. Even their attack on Copenhagen in 1801 had only a temporary influence.

The export, which had decreased very much toward the end of the century, seems to have risen again somewhat during the first years of the new century, so that from 1804 to 1806 the annual average export was 345,000; 97,700 from the Bergen district, 174,300 from Stavanger and Egernsund, 64,800 from the lobster-ports in the district of Lister and Mandal, and a number from the district of Arendal, where people had only begun to catch lobsters about this time. The increased number of lobsters exported was owing more to the establishment of new lobster-ports than to an increase of the number of lobsters in the old ones. On account of the small number caught toward the end of the century, the price of lobsters had risen, so that in 1804 about 2½ cents each were paid for lobsters caught in winter, and about 2 cents for those caught in summer. The fishermen were now placed in a very favorable position, and lobster-fishing was constantly extending beyond its old limits. The year 1807, however, had a decided influence on this fishery and the trade connected with it. After the attack of the English on Copenhagen and the consequent war, the export of lobsters ceased entirely, and they were only caught to supply the home market, and partly to be used as bait in the rich plaice fisheries, which at that time had been discovered near Stavanger. These years of war for the country were years of peace for the lobsters, and their number seems to have increased to such an extent that when the fisheries recommenced in 1815 they were taken in enormous quantities, not only inside but even outside of the baskets. The custom of the lobster-fishers getting from the traders not only brandy, as well as twine to tie the claws of the lobsters so they should not bite each other, but also clay pipes, which we find common in the beginning of the eighteenth century, is also spoken of in 1817 by

Oftedahl in his "*Efterretninger om Rennesö*," where he says "that a lot of clay pipes in a house is a sure sign that the inhabitants have been engaged in lobster-fishing." The price of lobsters was, according to him, in the same year only a cent apiece, as the fisheries were still very productive, but, nevertheless, the fishermen made a good living, the most fortunate ones selling annually in the parish of Skudesnaes lobsters to the amount of $150 to $175, (Krogs *Œkonomisk statistiske Efterretninger om Skudesnaes Praestegjaeld*, 1816, in the "*Budstikken*" for 1817;) and in the parish of Rennesö the average sum earned by each fisher in 1817 was, according to Oftedahl, $166. From 1815 to 1818, 593,000 were on an average exported annually, so that the exports were greater than before the war, although the district was much smaller. On account of the low price of lobsters, caused by the rich fisheries, the exports rose still more, and English companies not only bought lobsters for their own country, but reshipped some of them to France.

The number of lobsters exported in 1821 and 1822 amounted to over a million a year, and increased still more during the following years, although it was not so large in 1823 and 1824 on account of the unfavorable weather. From 1825 to 1830, the average number of lobsters exported annually was 1,268,000, and in 1827 and 1828 the highest number was reached, viz, 1,500,000. These large numbers, however, were caused not so much by the fisheries being just as productive or more so in the old lobster-stations, but by the circumstance that new English companies, seeing the great profit to be derived from this trade, commenced to export lobsters from places from which they never had been exported before. Thus lobsters began to be exported in 1828 from the district of Tönsberg, and from Söndmör in 1826, and during the two following years from Molde and Christianssund. The exports from Stavanger and Egernsund meanwhile decreased very much, having been reduced to 67,000 per annum in the latter place in 1827 when the exports from the whole of Norway amounted to 1,429,703. After 1830, the exports began to decrease even in the new districts, so that the annual average quantity of lobsters exported during the five years 1831–'35 was only 640,000. The only places that kept the lobster-trade alive were the new districts, while all the old ones decreased rapidly, some of them to such a degree that according to the governors' reports the lobster-trade must be considered almost extinct in 1835.

All this export-trade was carried on by English vessels, except at Farsund, from which Mr. Hans G. Lund shipped twenty-four cargoes in 1819, twenty-four in 1821, sixteen in 1824, and twelve in 1825, each of them consisting of 4,000 lobsters, partly to London and partly to Holland.

When the attention of the fishermen was directed to this decrease of the lobsters in the old districts, people began to be afraid that the poor fishermen would entirely lose this means of earning a living; and it was supposed that the decrease was chiefly due to the fisheries being carried on during the spawning-season of the lobster. In 1830, Mr. T. Lundsgaard, member of the Storthing, (Norwegian Parliament,) therefore made the motion to pass a law forbidding the catching or exporting of lobsters from June 15 till October 1. The committee which had this matter in charge proposed that the motion should be laid on the table, because Mr. Lundsgaard had not produced any information which might enable the committee to judge with certainty to what extent this dreaded decrease of the fisheries really existed, and whether the evil could be remedied by the measures that were proposed. The committee likewise thought that such a measure would be too great an encroachment on the rights of many places on the coast, taking away from these regions their only source of income. The government, however thought, that the matter was of great importance; and as the report of the committee showed that only want of information had prevented any action being taken, it requested those districts in which the lobster-fisheries were carried on to have the matter examined by the local officers and other competent men, and to send in a report, stating whether it would be useful to pass a law on the subject; and, if so, to state the objections to Mr. Lundsgaard's proposition. All the reports which reached the government in answer to this request agreed that the lobsters had decreased in size, but some supposed that the great masses of spring-herring coming near the coast might have had an influence on it, or that this decrease in the size of the lobster might be caused by their young ones being disturbed by the cutting of sea-weeds for manure; others advised not to pass any law against exporting lobsters from June 15 till October 1, fearing that the exports to England might thereby be hindered, as the companies, would naturally not consider the lobster-trade profitable unless it was steady; and the fishermen would lose their income during the time when exportation was forbidden, or they would evade the law, continuing to fish and keeping the lobsters till exportation was again permitted. Others again raised objections based on their knowledge of the natural history of the lobster, considering it doubtful whether the lobster spawned and shed its shell during the time indicated, and even if it were the case, that the time was too long. Reports from other districts, such as Stavanger, said that such a law was unnecessary, as no fishing was, anyway, going on during that time. These objections to such a protective law could not have much influence, especially those founded on the natural history of the lobster, for they could not be proved. But even the fear of an entire stoppage of the lobster-trade would be causeless, as such an event would be much more injurious to England, whose inhabitants had accustomed themselves to this luxury, than to Norway, which received but little money for her lobsters. From other sides it was said, in favor of the law, that such a protection would be useful, as the lobster very easily dies during the season when it spawns and sheds its shell, although this season is not the same everywhere. Those who might suffer from limiting the fishing-season would be fully compensated for this by the greater number of lobsters that would be taken during the season when fishing was permitted; and the fishermen should, at any rate, during summer devote their attention more to working their little farms and to the herring-fisheries. The government found that the whole matter was not yet sufficiently clear to say with certainty whether such a prohibition of lobster-fishing during the season when the lobster spawns and sheds its shell would prove generally useful. The districts where lobster-fishing was carried on were therefore requested to have those fisheries thoroughly examined for several years by competent men, and then again send in reports as to whether such a prohibition would be useful. It was likewise requested that an opinion should be given regarding a proposition made by some people in the district of Nedernees and Raabygdelagen, to divide the coast into small districts, where lobster-fishing should be alternately protected, so that if a district had enjoyed the privilege of fishing for three years, fishing should there be forbidden during the three following years. The reports coming in in answer to this request contained a very extensive prohibitory law, recommended by the above-mentioned district, suggesting that fishing should be prohibited from March 1 till October 1, and advising that no lobsters measuring less than 8 inches should be caught; the length of time when fishing was to be prohibited should be three years in each district. Another district only wanted to have fishing prohibited from July 1 to November 1, but was not in favor of alternating the time between the districts. The Stavanger district reported that as fishing was going on there only in April, May, and June, no law would be required, and none would be desirable, especially if it were to forbid fishing during the month of June, when the weather was favorable and the fishermen had most time for it. The lobster did not spawn on that coast till August and September. It was also thought that the number of lobsters had not diminished, but that they now stayed deeper in the water, finding enough food in the roe left by the herrings; alternating protection was not thought advisable. The report from the South Bergen district was essentially the same; and the Romsdal report said that lobsters were only caught from the end of May till the end of July. As there were, moreover, many different opinions regarding the time when the lobster spawns and sheds its shell, the government resolved to get the opinion of scientists on this point, and requested Professor Rathke, Professor C. Boeck, and Professor Sars (at that time a clergyman) to make a report on the nature of the lobster. Professor Rathke in his report said that in his opinion the pairing-season of the lobster was over before midsummer, and that the shedding of the shell took place later, but he thought at the same time that the mass of lobsters that came near the coast during the spawning-season was so large that the comparatively inconsiderable number that were caught would scarcely be noticed; he also thought that it would be so difficult to enforce the law that it would be more injurious than useful. Professor

Sars thought that a thorough investigation of the spawning-process of the lobster would be the only safe basis for any law; but this process was still very much enveloped in obscurity. He supposed, however, that fishing could be carried on till the eggs came out of the ovary, and were fastened under the tail, which took place in June, and fishing should consequently be prohibited from June 1 till September 15. He did not think that the number of lobsters had decreased, but that it only seemed so, because nowadays more people were engaged in fishing, and fewer lobsters consequently fell to the share of each fisherman. He thought, however, that the lobsters had diminished in size. In a later report, he expressed his opinion that lobster-fishing should be prohibited from June till the middle of September. Prof. C. Boeck gave in his report, in the first place, a description of the lobster's mode of life, and a criticism of the reports on the condition of the lobster-fisheries, sent by the governor. He showed from statistics that a decrease in the number of lobsters was both possible and probable on account of the increased fisheries during the past years. The lobster is a coast-animal, and only stays where it can easily get a sufficient supply of food, therefore near the coast, and only as far from it as sea-weeds are found, between which it finds the animals that constitute its food. Even if it wanders about, it does not go far, going, *e. g.*, in winter into a greater depth, and during summer into the shallow water near the coast. It then swims about on the surface of the water, but never goes very far, its structure not being adapted for longer journeys. The fact of the matter is, therefore, that a certain number of lobsters belong to a certain extent of coast, which, by propagating freely, may increase if they have sufficient food, or decrease from a natural mortality or too much fishing; and in this latter case the losses cannot easily be made up by lobsters coming in from the adjoining districts. There can, consequently, be no doubt that the lobster can, on a given stretch of coast, be exterminated by continued persecutions, or its number, at least, be diminished to such a degree as to make lobster-fishing unprofitable. Such an event would occur all the sooner if the coast in question be not favorable to its increase. From the reports which had come in, it seemed that certain places were less favorable to their propagation, or possible immigration from adjoining districts, than others, and from such districts the complaints concerning the decrease in the number of lobsters had come. In other places, the bottom of the sea along the coast was a convenient place of sojourn for the lobsters, and the number caught was but a small part of those that lived and were born there. In such places, the fisheries would be productive and steady. But even there, continued exhaustive fishing would diminish their number, especially if there should be an unfavorable year for the growth and development of the lobster. Prof. C. Boeck considered it, therefore, not only desirable, but even necessary for the even maintenance of the fisheries, that there should be certain limitations, so that lobsters should not be caught to such a degree as to make an entire stoppage of the fisheries for a period of time necessary. He believed that the proposed law, in obedience to which lobsters should only be caught at certain seasons of the year, would not fully answer the purpose, especially as no fishing was going on during the proposed time of prohibition in those districts from which there were the loudest complaints of the decrease of the lobsters. He thought, on the other hand, that a law prescribing that only lobsters of a given minimum size should be exported and sold would keep the fisheries in an even condition. Regarding the size of the lobsters that were to be offered for sale, sold, and exported, he thought, that even if it could not be definitely settled at what age and what size a lobster was capable of spawning, it could to some extent be ascertained from an analogical comparison with the river-crawfish. This is supposed to be sexually fully developed in its third year, when it is 4 inches long, but it may attain an age of twenty years and a length of 6 inches. He therefore supposed that the lobster becomes capable of spawning when it is three years old and has reached a length of about 8 inches, while lobsters measuring less are seldom found to have any roe. In order, therefore, that the lobster before being caught may not only reach the size when it may be considered fully grown, but might also be supposed to have contributed something toward the propagation of the species, a minimum size of a little more than 8 inches should be agreed upon for lobsters which might be caught and exported. Possibly 8 inches might be sufficient, as the English generally do not buy any from the fishermen as "full men" which do not have this size.

In consequence of this report, the ministry petitioned His Majesty to recommend to the next Storthing the passage of a law forbidding the offer for sale and the sale of lobsters that did not measure 8 inches in length, inclusive of the head and tail.

The following royal proposition for a law limiting lobster-fishing was thereupon published November 5, 1838:

"We Carl Johan, &c., make known, &c.:

"§ 1. That it shall be forbidden in this kingdom to offer for sale or sell lobsters which do not have a minimum length of 8 inches, inclusive of the head and tail. For every lobster offered for sale or sold which shall not have this length, a fine of 24 cents shall be paid, half of which shall go to the police or custom-house officer, or any other person denouncing the offender, and the other half to the poor. All cases of this kind are to be brought before the police courts.

"§ 2. Lobsters which do not have the above-mentioned length shall not be exported."

The Storthing committee which had to consider this matter hesitated to recommend to the Storthing the passage of this law, basing their objections on several reports from the lobster-districts and on Professor Rathke's report. Their chief objection, however, was that the fishermen would consider such a law as limiting their liberty, and, not being able to understand its utility, would thereby only be encouraged to follow the dictates of selfishness and transgress the law. It was, moreover, thought that it would be difficult to exercise any sufficient control, and that the trade would be injured thereby. The law was therefore not passed. This was the fourth time that a moderate proposition had been made to protect the lobster in order to avoid the total ruin of the fisheries. In the *first* proposal, by Judge Lom, it had been suggested that the lobster should be protected at certain seasons of the year, when it spawns or sheds its shell, and likewise that those lobsters should be protected that had not reached a certain length. In the *second*, by Mr. Gjertsen, only a certain annual season of protection was suggested; as was also done in the *third*, by Mr. Lundsgaard. The *fourth*, or government proposal, only suggested that lobsters below a certain size should not be caught.

It was not long before there were again numerous complaints of the decrease in the number of lobsters, which, according to the testimony of impartial men, was owing to lobsters being caught at a time when they spawn and shed their shell. Before anything further was done in the matter, a fishery-commission that had been appointed made a proposal regarding the lobster-fisheries, which must be mentioned here. In 1840, the government appointed a commission to revise the fishery-laws. The following were members of this commission: Judge Landmark, Consul Meltzer, Messrs. Tangen and Moses, merchants, Rev. (now Professor) Sars, and Chief Pilot Monsen. One passage of the law proposed by this commission reads as follows: "On their own property, as far as ten fathoms from the coast at low water, the owners shall have the exclusive privilege to catch all small fish, lobsters, and oysters, but any one may catch lobsters outside of unimproved land bounding the sea without regard to the distance from the coast."

In this proposition, which, however, never became a law, the old idea is revived that the lobster-fisheries, properly speaking, belong to the land-owners, which, in spite of the decree of 1728, had formed the subject of discussion all through the last century. Even if this proposition had become a law, it would not have exercised any great influence on the lobster-fisheries, which are almost exclusively carried on along unimproved coasts which can scarcely ever be subjected to cultivation. No new law regarding the protection of lobsters was introduced in the next Storthing, but in 1845, when the Storthing had assembled, the department of finance and customs received a letter from the agent of the English lobster-company in Stavanger that another English company intended to continue the lobster-fisheries, which, in that district, usually cease toward the end of June, during July, August, and September, hoping thereby to gain over the lobster-fisheries, and thus to destroy the trade of the other company. As this agent was afraid that fishing during these months would ruin the lobster-fisheries in this district for several years to come, he urged the department to introduce the royal proposition of a law in the Storthing, forbidding lobster-fishing from June 15 to October 15. The department requested the governor to give his opinion on the subject. He stated, as he had done on a former occasion, that such a law would be unnecessary, as the lobster is not fit to eat during those months, and none could therefore be exported. During this and the following years lobsters were, nevertheless, caught and exported during those months, as the two companies vied with each other, each endeavoring to secure the trade. The price of lobsters rose considerably, and all those that were caught were bought up, even during the season when they spawn and shed their shell, although every one saw what injury was being done, and although the mortality among the lobsters was great, and the consequent loss considerable. All this soon bore its fruit, but few lobsters being caught in 1847 in those places where in 1845 fishing had been going on till the end of August, while the fisheries were productive in those places where they had ceased in July. All were now agreed that it was injurious to catch lobsters during the season of the year when they spawn and shed their shell, which, in the districts in question, was supposed to take place in August and September, and it became evident that such continued fishing would in a short time drive the lobsters entirely from the coast. To prevent such a misfortune, the governor at last resolved to request the department to issue a provisional regulation, forbidding lobster-fishing during the months of August and September. The department, however, again considered it necessary to get reports from the lobster-districts and from the agents of the English lobster-companies. Some of these reports declared that lobster-fishing should be forbidden from the middle of July till the middle of October; others that there should be no fishing during August and September. The agent of an English lobster-company in Jarlsberg and Laurvig, however, advised against any prohibition of the lobster-fisheries, saying that such a prohibition during the summer months would cause the English lobster-companies to stop this trade, ice hindering the fisheries in winter and spring, and storms those in the latter part of autumn, so that the fisheries commenced gradually in May and lasted till the end of September. They are most productive in July, August, and September. The decrease of the lobster-fisheries he ascribed not to the summer fisheries, which were said to diminish the number of lobsters, but to the circumstance that the people of the district devote their attention more to the profitable mackerel-fisheries. The governor was of the same opinion. A totally different opinion, however, was entertained by other competent and trustworthy persons in Laurvig and the neighborhood, who, from information obtained of the lobster-fishers of that district, judged that such a prohibition of fishing from the middle of July till the middle or end of September would have a favorable influence on the preservation of the lobsters. The governor of the Lister and Mandal districts showed in his report by examples from the years of war, that the more the lob-

He had found, moreover, that the lobster was capable of propagating before it had reached a length of 8 inches. He would therefore propose—

"§ 1. His Majesty may take measures for protecting the lobsters during a continuous period of two to three months annually in every district of the kingdom, at the request of the respective governors.

"§ 2. The season of protection shall in every case embrace the whole month of August.

"§ 3. The protection may extend both to males and females, or only to the latter.

"§ 4. Whoever catches lobsters, or offers them for sale, during the close season, in the district or districts where there is such a law, shall pay a fine of 24 cents for every lobster which is caught or offered for sale contrary to the law.

"§ 5. In the district or districts where protection extends only to the female lobsters, a fine of 24 cents apiece shall be paid by every one who, during the season of protection, allows female lobsters to be caught and offered for sale, or in any way trades in such.

"§ 6. The same fine shall be imposed on lobster-dealers or their agents if they receive and ship lobsters caught during the close season, in accordance with the law in force in the district in which the lobster-station is located.

"§ 7. The sums realized by these fines go half to the person who denounces the transgressor, and the other half to the poor-fund of the respective district. All such cases must be brought before the police court."

Professor Rasch has given his reasons for the provisions of the above law as follows:

"Although there are frequent complaints that general game and fishing laws are not suited to all the districts of this large country, where the different degrees of latitude and local circumstances produce great differences with regard to the pairing-season, the periodical arrival, &c., of the same races of animals, he had in most cases found fewer differences than one in general might be led to suppose. He proposed § 1 so that every district should have the season of protection best suited to its circumstances."

Regarding § 2 he says:

"As in his opinion it seemed sufficiently proved that the most prolific hatching-season occurs in the month of August, even in the most northerly portions of the country where lobster-fishing is carried on, he thought that, in all cases, this month should be included in the season of protection."

Regarding § 3, he thought that the strictness of the protection might be relaxed a little in those districts where the summer fisheries, on account of peculiar circumstances, cannot be entirely stopped without immediate loss to the poor coast-population. He thought, moreover, that by protecting only the female lobsters the purpose of the law with regard to the preservation of the species will be just as fully answered as by protecting both sexes during the same period of time. The objection may be raised that it will be difficult to distinguish between a female without outside roe and a male; but the difference of sex is so great that a fisherman may be able to tell it at the first glance. Nor would he only protect those lobsters which have outside roe, as this may easily be scraped off. Irregularities of the normal sexual relations will be of very little importance, as most of the females which have been protected will be caught by the fishermen when the season of protection is over, as they go but a short distance from the place where they stay. The objection made to the law that it would force the fishermen to return the products of the sea to it, he considers to be of great importance; but he hoped that they would see what a great risk they ran by unlawful fishing, and be convinced that protection will in the long run benefit their trade.

From the above it will be seen that, with the exception of the governors of Jarlsberg and Laurvig and two of the lobster-agents, all local authorities and competent men were in favor of the opinion that the decrease in the number of lobsters noticed during the last few years had been caused by too extensive fishing during that part of summer when the lobster spawns, and had considered a law prohibiting lobster-fishing during a certain period of summer and autumn as the only effective means of protecting this important animal. But others, we see, wished to have the protection extended from June or May till October; others only from July to September; and others, again, only to August and September. Both in Sweden and Heligoland there are laws prohibiting the catching and selling of lobsters from July 1 till September 15, and in Scotland it is forbidden, under a penalty of £5 each, to catch lobsters from June 1 till September 1; and in England no lobster is allowed to be sold which measures less than 8 inches. The government also considered that protection during the season of the year when the hatching is chiefly going on would answer the purpose, and that it could be more easily maintained than a law prohibiting the fishing and selling of lobsters below a certain size. As the young are chiefly hatched during the month of August, but also during July and September, the government thought that August should be included in every close season, while it should be left to the local authorities, with royal approbation, to extend this legal season of protection to July and September, in accordance with the local circumstances of every district. By adopting these measures, the trade would not be restricted to any serious extent. This was also granted by the commissioners of the English lobster-companies, and, as far as the fishermen are affected, they can easily find work in nearly every part of the kingdom during August, while, on the other hand, the protection of lobsters during a certain period will make the fisheries all the more productive during the months when fishing is allowed. With regard to the other objections to limiting the fisheries during the summer months, viz, that in the districts of Romsdal, Jarlsberg, and Laurvig they are only carried on from the beginning of spring or summer till some time in fall, the government remarked that this could scarcely be caused by any special arrangements of the lobsters on these parts of the coast, but is a natural consequence of the circumstance that the fishermen in the district of Romsdal during spring and autumn are employed in the great fisheries, while in the districts of Jarlsberg and Laurvig this is caused by the natural hinderances of ice and storms during spring and autumn. But especially in these districts a law prohibiting fishing during the month of August could not limit this trade very much, compared with the beneficial consequences which such a law would have. The government thought that the prohibition should extend both to male and female lobsters, which opinion was finally also shared by Rasch. The government also proposed that the law forbidding the export of lobsters should extend the time when export was not allowed eight days beyond the end of the close season, so as to enable the fishermen to fish up to the very commencement of the close season.

On January 26, 1848, the king signed the following proposition for a law for the protection of lobsters, to be laid before the Storthing during its next session:

"We, Oscar, &c., make known:

"For some time complaints have been made that the number of lobsters on the coasts of the kingdom has decreased considerably, especially since the year 1830. Competent men have been consulted as to the possible causes of this phenomenon, as likewise as to the means by which the lobster might be preserved, and a royal proposition for a law forbidding the catching or export of lobsters measuring less than 8 inches in length was laid before the Storthing, but was not passed. Renewed complaints of the great decrease in the number of lobsters have recently come from several parts of the country, petitions have been sent in asking that the catching of lobsters at certain seasons of the year might be forbidden, and from the information received on this point it has been considered absolutely necessary, for the preservation of the lobster, to fix by law a certain season of protection for this marine animal.

"His Majesty would therefore invite the attention of the Storthing of the kingdom of Norway to this subject, and ask them to pass a law regarding the protection of lobsters, in accordance with the accompanying draft:

"DRAFT OF A LAW REGARDING THE PROTECTION OF LOBSTERS.

"1. It shall be forbidden to catch or sell lobsters during the month of August.

"2. In accordance with a request made by the respective local authorities, the above-mentioned period may be extended in the different districts by the king, but it shall in no place last longer than from July 1 to September 30.

"3. The fishing or selling of lobsters during a period when it is forbidden in accordance with § 1 and 2 is punished with a fine of 24 cents for every lobster caught or offered for sale contrary to law.

"4. All cases arising from transgressions of the regulations contained in § 1 and 2 must be brought before the police courts. If any one is accused of such transgression, the chief of police in the district shall get his declaration whether he is willing to pay the fines. If he is willing and does not possess the necessary amount of money, it shall be levied on his property. If, on the other hand, the accused denies his guilt, or refuses to pay, the above-mentioned officer shall have the matter investigated and settled. The fines shall be divided between the informer and the local poor-fund.

"5. During the period when in accordance with § 1 and 2 it is forbidden to catch or offer for sale lobsters, as well as during eight days following the end of this period, it shall likewise be forbidden to ship lobsters to foreign parts. Attempted or actual transgression of this article shall be punished in the same manner as provided in the law of September 20, 1845, regarding attempted or actual smuggling.

"6. This law shall take effect January 1, 1849."

In the committee to which the royal proposition was assigned for consideration, the first two articles were changed, so as to make the season of protection stricter. In the royal proposition, the local authorities could under special circumstances propose that the season of protection be extended to the months before and after August; but the committee were of the opinion that the law should be enforced during a longer period, but in special cases the local authorities might propose that it should be limited to the month of August, to such a degree had public opinion changed in favor of such a protective law.

When the matter was discussed in the Storthing April 29, 1848, not a voice was raised against a protective law, but the discussion was chiefly as to whether the law should be adopted in its stricter form as recommended by the committee, or as proposed by the government. The law was finally adopted in the form recommended by the committee, modified by an amendment that the season of protection should last from July 15 till the end of September. The first portion of § 5 was also changed so as to read as follows: "Eight days after the beginning of the period during which in accordance with § 1 and 2 it is forbidden to catch lobsters or offer them for sale till eight days after the end of this period, it shall be likewise forbidden to ship lobsters to foreign parts." As for the rest, the law was passed in the shape recommended by the committee; a motion to change the above-mentioned eight days to twelve days or three weeks being lost, as likewise another motion that the law should not come in force till January 1, 1850.

The law, which was adopted in the same shape by both houses of the Storthing, and was sanctioned by the king, came to read as follows:

"1. It shall be forbidden to catch or offer for sale lobsters during the period from July 15 till the end of September.

"2. In accordance with a request from the respective local authorities, this period may be limited in different districts by the king; but the season of prohibition must in every case embrace the whole month of August."

3 and 4 are entirely as in the royal proposition.

"5. From eight days after the beginning of the period during which, in accordance with 1 and 2, it is forbidden to catch lobsters or offer them for sale, till eight days after the end of this period, it shall likewise be forbidden to export lobsters to foreign parts.

"6. This law shall come into force January 1, 1849."

By this law, which forbids all fishing during two and a half months, the yield of the fisheries was of course somewhat diminished during the first years following its passage, till the protected young could reach the necessary size. Thus fewer were exported in 1849 and 1850 than during the preceding years, so that, while from 1846 to 1848 about 600,000 were exported, the number had sunk to 408,310 in 1849 and 427,600 in 1850. This decrease, however, is not merely owing to the circumstance, that the number which were usually caught during the close months remained in the sea, but likewise to the fact that the English joint-stock company which carried on the exportation from the districts of Jarlsberg and Laurvig began to pay a lower price for the lobsters, so that the fishermen resolved no longer to catch any even during those months when they were permitted to do so. While from this district there were from 1846 to 1848 on an average about 26,000 exported every year, only 7,960 were exported in 1849, 1,664 in 1850, and none at all during the following years; but, in 1855, 14,470 were again exported, chiefly to Copenhagen. Since 1850, the lobster-trade has steadily increased, and the governors, in their quinquennial reports on the economical condition of their respective districts, state that protection seems to have produced this result.

In the district of Stavanger, the exports rose, from 1850, when they amounted to 120,653, to 204,803 in 1854; in the South Bergen district, it is also stated that the fisheries have increased. Of the following years, the least productive was 1858, when the exports from the whole kingdom only amounted to 553,238, on account of unfavorable weather during the whole fishing-season; but, in 1860, the number had again risen to 1,333,037, and kept tolerably steady during the following years, so that the exports during these years were about the same as during the years 1825–'30, when they were at their highest, only to decrease very rapidly during the following years. In 1860, the exports rose to

1,000,000, and increased constantly, till in 1865 they very nearly reached 2,000,000, viz, 1,956,276.

The complaints regarding the protective law have now ceased, since the government has in several districts limited it by royal decrees, and in many places the people are rather inclined to extend the season of protection than to limit it as, in the district of Stavanger, where two years ago public opinion was in favor of prohibiting all fishing during autumn and winter, as it was thought that thereby the spring and summer fisheries would become all the more productive. As a general rule, no lobsters are exported from there in autumn and winter, except when some new English companies want to get into the lobster-trade and therefore buy the lobsters at a higher price than is usually paid, so as to ruin their rivals. Then all the lobsters that can be got are generally bought during autumn, as was the case in 1845 and 1846, and to some extent in 1864 and 1865. During the last-mentioned year, such a large quantity of lobsters was caught on account of the unusually calm weather, that the Englishman who had urged the fishermen to fish could not take more than one-third of all that had been caught, and the rest died, without being of use to any one. One reason why the fishermen wish to see this autumn fishing forbidden by law is that even if they were unanimous as to its injurious character, all of them would, though unwillingly, take their part in it, if a small number of fishermen moved by covetousness were to catch lobsters, and if there should be a chance of selling them at that season, because they suppose that those lobsters which they would otherwise get in spring would now be caught by others in autumn, which would injure their trade very much.

As the privileges which at different times had been granted to the lobster-shippers were not the same in every place, because the ports for shipping lobsters were established as necessity arose, and on that occasion got certain privileges, these must naturally differ a great deal according to the views prevalent at the time when the ports were established. Such regulations regarding the ports of Espevaer, Salthellern, and Rognesund from the year 1798, have already been communicated, and similar ones have existed in other ports. These regulations were certainly modified a great deal in course of time; but the Danish-Norwegian government inclined to keep privileges that had once been granted unchanged as far as was possible, and these privileges could consequently not become uniform till our days. In order to do this, the department of finance and customs issued a circular, dated December 11, 1865, to the following effect:

"As the privileges which have been granted by decrees published from time to time to the lobster-trade in different places of the kingdom partly differ somewhat as to their character without there being sufficient reason therefor, and are partly scattered in a manner which makes supervision difficult, the department has thought proper to make the following general regulations regarding the privileges that shall be in force with regard to this trade, and which, with the exception of the additional regulation regarding the calculation of ship-dues, agree entirely with those which are for the time being in force in most of the custom-stations on the southern coast:

"1. Arriving lobster-vessels which intend to take lobsters in an outer port, if they do *not* contain any goods subject to duty, but only ballast, may be exempt from stopping at the custom-house to which the outer port belongs, if the shipper immediately on his arrival reports himself to the custom-house officer who may be stationed at that place, but if there is no such custom-station there, at the nearest custom-station, where the custom-house officers may examine the vessel.

"2. Such vessels as have arrived in the outer port are exempt from making their declaration at the custom-house before they commence to take their cargo of lobsters; but, when they commence, they shall be obliged to mention the exact number of lobsters which they intend to export.

"3. Such vessels are permitted to make their declaration before the custom-house at the same time with giving the quantity of lobsters about to be exported.

"4. Such vessels, after having thus obtained their custom-house papers for a certain quantity of lobsters, if they cannot get the quantity mentioned in the port where they take their cargo, may take the lobsters that are wanting to make up the quantity mentioned in the papers, in another port, either in the same custom-house district or in another. The following, however, must be observed:

"*a.* The custom-house officer stationed in the port shall mention in the papers the exact number of lobsters that have been taken there, and the custom-house officers in the port or ports which may be entered afterward shall examine in how far the number of lobsters received agrees with the number of lobsters specified in the papers.

"*b.* If the lobsters are shipped in places where there is no custom-house, the company's commissioner, or, if there is none, the person who sorts the lobsters, may mention in the papers what number of lobsters have been taken, whereupon the vessel may sail; but a copy of the papers made under oath must immediately be sent to the nearest custom-house.

"*c.* The respective custom-house officer thereupon shall, in the case mentioned under *a*, send a report regarding the insertion in the papers to the custom-house to which he belongs, and shall, in the cases mentioned under *b*, send the declaration of the persons who sorted the lobsters.

"*d.* If the lading is completed in a district belonging to another custom-house than the one where the lobster-vessel has commenced to lade, the reports and declarations mentioned under *b* and *c* shall be immediately sent by the custom-house where they have been received to that custom-house where the lading has commenced, so that the officers belonging to the latter may be able to determine in how far the exports from all the ports correspond with the number of lobsters for which duty has been paid. It is of course understood that the above-mentioned reports and declarations must give the name of the vessel and its captain, as well as the number and date of the custom-house passport, and state by which custom-house the latter has been issued.

"5. If the captains of lobster-vessels find occasion to take a larger number of lobsters than is mentioned in their papers, either in the same port or other ports, this may be done without any hinderance by the custom-house officers, and in this case everything regarding the insertion in the papers and the reports and declarations that are to be given is to be done exactly as mentioned in No. 4. This is done, however, under the condition that the shipper immediately pays the export-dues for the extra number of lobsters taken, and that the custom-house officer in the above-mentioned reports and declarations certifies that the vessel has exported this extra number. In so far, however, as an arriving lobster-vessel brings goods which have to pay duty, the regulations mentioned in Nos. 1 and 2, without regard to the quality and quantity of the goods, cannot be applied to the vessel, but it must first get the required permit to pass in, and therefore go up to the custom-house, and there undergo the same treatment as other arriving vessels, whereupon it may proceed to the place of lading. If it is found that exporters, sorters, or shippers do not observe the conditions under which the above-mentioned privileges have been given, these shall be revoked, according to circumstances, either for a vessel, for a port, or for a certain part of the coast. The custom-house officers shall see to it, as far as circumstances and the above-mentioned regulations allow, that no abuses creep in, and that if there should be any, they are immediately made known to the respective authorities.

With regard to the ship-dues of such vessels as take in cargoes of lobsters outside the custom-houses, in conformity with the privileges granted to them, it has been found convenient, in order to have a uniform mode of proceeding, to calculate their dues in future always as of vessels whose cargo exceeds one-fourth of the carrying capacity."

XIV.—TRANSPORTATION OF LOBSTERS TO CALIFORNIA.

The following is the report of M. L. Perrin, employed by Mr. Livingston Stone, for the California Fish Commission, in the transportation of live lobsters upon the California aquarium car, June, 1874.—[S. F. Baird.]

The lobsters were procured from Messrs. Johnson & Young's lobster-house, Charlestown-street bridge, Boston, and pains were taken by these gentlemen to give all the aid in their power toward the undertaking. Upon a special car from Boston to Charlestown, N. H., June 3, were packed the 150 lobsters in seven pine boxes 3½ feet long, 15 inches wide, and 15 inches deep. The boxes were divided into two compartments, an upper and a lower, by a partition, making two tiers, and 11 lobsters were placed in each tier, save one. On this trip to Charlestown they were not packed with straw beneath them, but lay upon the wood, with sponges over and around them. We were sorry at the time for this mistake, but from experiments afterward I decided that they were as well situated as if laid upon straw. Six casks of ocean-water, each containing 149 gallons, were obtained that morning and loaded upon the car. Most of the sea-water was put into the two salt-water tanks in the aquarium-car. These tanks were made of hard wood and smeared with a mixture of resin and tallow in order to be water-tight, and during part of the overland journey salt-water fish were in these tanks. One cask of sea-water was loaded, unopened, upon the aquarium-car to be used for the lobsters during the last days of the trip, that from the tanks being used for awhile. The sea-water was obtained outside Boston Harbor, beyond the "Graves," in order that it might be purer. That which had been got two days previously for the same purpose was procured from Nahant, but the aquarium-car not starting that day made it necessary to get some more so as to have it fresh. We procured 35 pounds of sponges, most of which were used in the beginning before many lobsters had died, but afterward were not needed. The sponges were soaked with salt water, and each lobster was completely hidden by the wet sponges. Salt water was poured upon all the lobsters, and all the sponges newly wetted once during the trip to Charlestown. The lobsters were all alive when reaching Charlestown.

At Charlestown, Thursday morning, June 4, the lobsters were taken from the boxes in which they had been brought from Boston and repacked in boxes without covers, divided by partitions into twelve apartments. The surface-extent of these apartments was just enough to admit one lobster lying within it—smaller than was well for them. The depth of the apartments was about 6 inches, and the bottoms were bored with an auger-hole to allow drainage. A handful of wet straw was put in each apartment and a lobster laid upon it, then sponges dripping with salt water were placed above and around it until quite concealed from sight and from dry air by this stratum of wet sponges.

There were twelve of these boxes, each containing twelve above-described apartments, placed in the aquarium-car, one upon another, in two piles of six boxes each, against the side of the car. In going over the lobsters twice a day, the boxes were taken down and the sponges were removed from the lobsters one at a time and squeezed over the animal, which, if alive, will respond to it by blinking its eyes and stretching its claws, perhaps moving its body a little. The sponges were then dipped into a pailful of sea-water and wetted again, and were carefully arranged as before about the lobster. Pieces of ice which another person had been breaking up meanwhile were strewn over each box, among the apartments and sponges, to keep cool the water in the sponges and the moisture in the straw and around the lobster. It was slow work, and the lobsters were too much exposed during the operations. Often, after the boxes were piled up again, pailsful of salt water were poured over the whole. During the first two or three days only a few were found dead when they were repacked.

At noon, Saturday, June 6, sixty lobsters were put into one of the large salt-water tanks with the striped bass and some other salt-water fish. Into this tank, as into all the others, air was continually forced through hose from the air force-pumps, kept in motion by a band passing around the axle of a pair of the car-wheels. The lobsters in this salt water, the next morning, at Chicago, appeared to be doing very well; but Sunday afternoon the lid of this tank was discovered to have fallen, and upon raising it all the lobsters were found dead. The fish also in the tank were dead. Whether the falling of the lid was the cause of their death, we could not quite decide; but it seemed very probable that it was because the air pumped into the tank after the lid fell, having no means of escape at the top of the tank, exerted a great pressure upon the water and in this way killed them, and also because of the impure air which was confined inside for some time without being replaced by purer. The fact that the fish died also shows that it was some external calamity common to them both. The wooden tanks, the mixture of resin and tallow, though but little, with which the tank was smeared, the number in one tank, and the company with the fish, are also variable quantities whose effects might be discussed relative to this result and also to the result of the experiment which was thus checked. Therefore this case should not be considered a fair experiment and as deciding whether lobsters cannot be transported healthily, in an open tank of salt water, into which air is continually forced, without changing the salt water itself, and kept constantly at a low temperature. I neglected to mention that upon the top of the tank much ice had been kept and stored; in this way keeping the salt water within the tank quite cold without freshening it and diluting it, which would have been caused by ice put into the salt water to cool it. The death of these sixty reduced the number of lobsters materially.

About this time on, the trip slats were laid upon the two piles of lobster-boxes, and about 500 pounds of ice kept on them, when the lobsters were not being attended to. Lobsters will live well until the fourth or fifth day, but in the present case, if at any time of repacking them I did not find from one-third to one-half of the residue dead each time, I considered it very fortunate. I went over them twice a day; so that if, at every time of repacking, one-third to one-half were to be thrown away, the number of live lobsters would be rapidly reduced, as was indeed the case. Monday, June 8, there were only 20 left alive. Nor is there any regularity in their dying; those treated the most carefully and faithfully die as readily as the neglected; and those handled much live as well as the undisturbed. After the fifth day crowds of lobsters take offense at something, and revenge themselves by dying. The reason of their death was wrapt in mystery. Numerous experiments always failed to bring any regular results, and nothing certain could be gleaned from them. Theorizing about lobsters' chances of life is vain when applied in practice. There seems to be a wide diversity in their constitutions, though unseen and imperceptible. Certain lobsters live well and persistently, while others destined to die beforehand do so irregularly and for an unassignable cause. It is easy to decide whether a lobster is dead. If so, its muscles are all relaxed, and when lifted up, its claws, instead of remaining horizontally out from the body, hang down. This is especially true of the large front claws, but not always of the small ones, which sometimes hang down when the lobster is alive, or are straightened when dead; the front claws, however, are decisive. If, on the other hand, the creature is alive, it will sometimes move its long feelers when the sponge is lifted, and move its claws, and often its body; but the constant as well as sure criterion is that when a sponge full of salt water is squeezed over its head, it will always answer it by blinking or drawing in its eyes, if alive. When lifted it will struggle; but it is a bad plan to raise them, unless necessary, though this is better than to molest and agitate too much, without lifting them, when arranging the sponges or ice about them.

We were using a good deal of salt water, and Monday, the fifth day from starting, it became evident that we had not enough on board for the whole journey. We disliked to use the salt water from the tanks in which fish were or had been; and there was not much of that. Therefore we opened the reserve cask of 149 gallons of unused salt water, and telegraphed the same day to the commissioners of California to send by freight some Pacific Ocean water to meet us on the route as soon as possible.

Being afraid that the ice which I was in the habit of putting around the sponges and among the apartments was, by its melting and the resultant water, making too fresh the atmosphere with which the lobsters were surrounded, inasmuch as it diluted the salt water, I tried with some the effect of leaving off the ice for a few times. The results were not satisfactory, and proved that omitting the ice was not a good thing; the lobsters would not do as well without it. The coldness gained by using the ice was even more indispensable than the saltness of the water, which of course must be quite necessary. It is not well to use too small pieces of broken ice, because they melt more rapidly; and in order to exert the required influence in producing coldness, the pieces of ice must be so near the lobsters that, in melting as fast as small pieces do, the salt water in and around the sponges becomes more freshened than if larger pieces of ice were used. It is much better that the ice, in either case, should not touch the sponges, if the requisite coldness can be attained without, and if room is abundant; and still better would it be if the ice could be so arranged that, while producing the necessary low temperature, the water resulting from its melting should not mingle with the salt water nor strike anything connected with the lobsters. There can be no doubt but that having as low a temperature as possible is one of the greatest desiderata in the care of lobsters. A refrigerating apparatus would avoid the troubles with the ice spoken of above and be much more effectual than the primitive method followed on this trip. The protection which the ice provided in this case against currents of warm air was not thorough and complete, and great harm was surely done at the places and times where the defense was insufficient; and still more grew out of the fickleness of its protection. Every time the car-doors were opened or the atmosphere around the lobster-boxes disturbed, there inevitably rushed upon them a draught of warm and dry but injurious air, fatal at once to a lobster in case the current strikes it. There must be some medium, as a wide or at least constant stratum of moist atmosphere, to guard the lobster against this destructive air; and at the same time that it would prevent this evil, it should produce the needed low temperature. A refrigerating arrangement would naturally make the care of the lobsters much more convenient as well as more successful. Sometimes when lobsters died I put ice in the apartments left by them instead of upon the sponges of the live lobsters. The dripping of this ice upon the apartments below was not good; but when the lobsters were few in number, I arranged them so that the ice apartments all came under each other, and their dripping did not affect the lobsters. This plan seemed to work favorably for the lobsters. I doubt if it was best to do as was done with the boxes on this trip. Two small sticks were laid across the top of each box before the next was placed upon it. In this way a circulation of fresh air was secured, but I suspect that other qualities in the air counterbalanced this, and did much harm.

Tuesday, June 9, I took the straw from beneath every living lobster, and packed them all entirely with sponges. The rate of mortality decreased decidedly, and I am inclined to believe that without this change none would have lived to the end. The best way undoubtedly to pack a lobster is with sponges above, around, and beneath it, and also a small one directly under its nose. The straw is quite bad for them to lie upon, because their claws become entangled in it, and it restrains them. This is very bad for a lobster. They should suffer no pressure or restraint. For this reason we were afterward glad that no straw had been used (by mistake as we thought) in their trip from Boston to Charlestown. I also tore out the partitions of several boxes, and found it much better; they were more active when opened, and appeared more healthy. The partitions offer a restraint to them, and are consequently injurious. When in an apartment with partitions, they never staid in the middle, but worked themselves over to one side, and struggled against the wooden partition; in this way tiring themselves out, which is of course an evil. A lobster needs room to stretch all its limbs, if it wants to do so. For this reason they are better in boxes without partitions, provided they are not near enough together to bite each other. Rubber bands around the claws are an extreme case of restraint, and are extremely pernicious. Treated in this way, the animals live only a few days. Struggling is very detrimental to the vigor of a lobster; therefore they should not be restrained; for as surely as they are they will struggle against it, and not violently, but slowly, almost imperceptibly. There is a reacting impulse in the lobster against confinement. Though they do not move much, they need freedom to move, or there is an incentive to struggle. Therefore it would seem, as is truly the case, that, other things being equal, unrestrained lobsters have the best chances for life.

Pressure is as injurious as restraint. Sponges exert but very little pressure upon them, and they can easily move their claws among them. Ice must not cause any pressure upon the animal, nor must it freshen the water—another requirement met by a refrigerating apparatus. To prevent this pressure on the trip, I laid the ice as much as possible across the tops of the partitions and not above the lobsters.

Wednesday, June 10, at Ogden, Utah, we left one pair to be put into Salt Lake. Two very healthy and active lobsters were chosen, to make sure of this attempt, if possible. They were put into a box packed entirely in sponges, and I gave instructions, and some salt water, to Mr. A. P. Rockwood, of Salt Lake City, Superintendent of Fisheries, who was personally to take charge of them. When leaving Utah, Wednesday night, we were reduced to eight lobsters and one pailful of salt water. Extra salt water is needed, not only to prevent the moisture in and around the sponges from becoming too fresh by melting of the ice, and other causes, but also to wet the sponges with when they become dry. It is a good thing, and quite necessary, often to pour salt water over the lobsters and sponges, without unpacking, in order to give them a change of water. It is well to repack them twice a day; but a liberal supply of new salt water should be poured over them at least once in three hours. The shell of the lobster must always be wet. Not only should the lobster touch nothing else but wet sponge, but it is indispensable also that it should be everywhere in contact with a wet sponge. It must nowhere be bare and exposed to the air, for the water upon its surface will quickly evaporate; and should you see a lobster with a dry spot on its back, you may be sure of its death shortly. A current of warm dry air, if endured even for a moment, is the lobster's worst enemy.

Thursday, June 11, near Beowawe, Nevada, a freight-train met us, bringing from the Pacific Ocean four barrels and four tin tanks of salt water. The water in the tin tanks was of course useless, but the rest was welcome and immediately used. The effect of an abundance of salt water was evident in the appearance of the lobsters. Repacking as often as three hours would be impossible for one person, if many lobsters were taken, and furthermore useless, and, what is a more important fact, which should be avoided; it would disturb the lobster, and if packed entirely in sponge, it would be necessary to lift the animal each time. It is much better to prepare the boxes for thorough drainage, and then pour on a good supply of salt water as often as once in three hours. The ideal condition of a lobster is, unrestrained, very cold, (and evenly so,) constantly wet with salt water, which should not become freshened by any agency, but often changed; and when in as good condition as possible, then disturb them just as little as possible. Lobsters can easily be killed with care.

Upon reaching San Francisco Bay, four lobsters were alive. These were put into the sea at Oakland wharf, Friday afternoon, June 12, nine days after they had been taken from the Atlantic ocean. It would have been better had the commissioners ordered them to be put farther out to sea, where the water was not so warm, and more salty. The four lobsters themselves probably did not live; but two were very full of spawn, and this probably matured. The death of a female lobster does not kill the spawn attached, which may live quite awhile afterward; and if, as in the present case, the spawn reaches again the natural condition of things (of the ocean) in safety, it matters not whether the parent lives. The facts that these four lobsters were females, and that their spawn lived and hatched, show that the eggs of the lobster are impregnated before leaving the female, and not afterward, as is the case with fishes. As a rule the females of lobsters are stronger and longer-lived, under difficulties, than males; and of females, spawning ones are the strongest.

Lobsters differ so much in constitution that, in order to succeed in the transportation of say ten animals, one cannot take them and attend to them carefully, thus bringing the desired result, but many must be taken in order to insure the chances for the safety and success of the ten. It is like throwing a die to bring a certain number: it is ineffectual and useless to throw once and more carefully that time, but many throws must be bargained for to insure success once. In the same way this difference in the constitution, original healthiness, and chances of life, affect the certainty of experimenting.

In order to transport live lobsters, it is without question indispensable to have a special car for the purpose, or at least one which shall run the whole journey. An excellent degree of coldness can more readily be preserved in the undisturbed atmosphere of an aquarium-car than in a constantly shifting express-car. The ice melts less, and the moisture does not evaporate so fast. In an express-car there are no facilities for soaking and drenching the lobsters and for changing the water often upon them by pouring from pails or by means of many devices, which can easily be arranged in a special car. In such a car the water which flows off the lobsters can readily run out of the car or through holes bored in the floor, and that which does not is in no danger of ruining any valuable express-matter. An excellent refrigerating arrangement can be prepared, if to be stationary, and to go from beginning to end with the lobsters. A great deal of room in which to work is very necessary, and cannot be dependent upon the amount of express which happens to be on board. Draughts of warm and dry air, which rush in from the four doors of an express-car, when open to receive or deliver goods at every station, and which, as we have seen, are extremely injurious, are avoided by a special car. Lobsters cannot be packed so as to be transferred at railroad junctions and changes of express companies. They cannot with success be portably arranged, but must be so situated that they can easily be attended to. The impracticability of interrupting the person in charge, when repacking the lot of lobsters in order to prepare for a change of cars, determines at once as infeasible the plan of carrying live lobsters by express. The jarring and disturbance which they would suffer in a few changes of cars would soon end their existence. Furthermore, the transferring of the numerous necessary tools, and especially the casks of salt water, would be a very weighty item.

Though successful in the life of the innumerable spawn which lived and have hatched since deposited in the bay of San Francisco, the effort of this year was accompanied with many results which need not be considered as necessarily attendant upon the transportation of live lobsters; but in order to get a knowledge of these needless evils, and those which are to be avoided, as well as of the means for promoting success, it is necessary once to make the attempt and search them out by experience.

Respectfully submitted.

MARSHALL L. PERRIN.

XV.—ON THE ARTIFICIAL PROPAGATION OF THE LOBSTER.*

[Translated from the Danish.]

There is one point in the natural history of the common lobster (*Homarus vulgaris*) which, till quite recently, has been but little known, although the lobster is one of those crustaceans whose anatomy and physiology have been studied most thoroughly, and that is the period of its development from the time it begins to lead an independent life. The roe which the female lobster carries under the back part of its body has been repeatedly examined as far as that stage where the fully-developed embryo is surrounded by the thin white of the egg; in examining the embryo it has been found that, as in other crustaceans, it is born as a being unlike the grown lobster, and that during its later development it undergoes metamorphoses.

Prof. G. O. Sars of Christiania has recently endeavored to throw more light on this comparatively dark period in the life of the lobster, and the results of his investigation are contained in his treatise "*Om Hummerens postembryonale Udvikling*," published in the Christiana "*Videnskabs-Selskalbs Forhandlinger*" for 1874. He, as well as Prof. Sidney I. Smith in New Haven, who about the same time examined the development of the American lobster, (Early Stages of the American Lobster, with 5 plates, by Sidney I. Smith, from the Transactions of the Connecticut Academy, vol. ii,) has shown three larvæ-stages in the development of the lobster, and found that the young lobster after it is hatched spends the first portion of its life near the surface of the water, where it becomes an easy prey to its many enemies, as, especially during the period when it changes from a larvæ to its adult form, it is but little skilled in swimming.

While the investigations of two naturalists have thus yielded new and valuable contributions to the natural history of the lobster, interesting facts regarding the young lobster's mode of life have been discovered by other men.

Along that part of the Norwegian coast where the lobster-fisheries are carried on on a large scale, and where they become a source of considerable income to the inhabitants, there are ample opportunities for observing what an enormous number of young lobsters are destroyed every year, partly by their natural enemies, and partly by the strong wind from the sea which drives them on the coast, where they remain on dry land when the tide has gone out. Several men in the district

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*Om Forsog med kunstig Udklaekning af Hummer, ny række=new series, in "Nordisk Tidsskrift for Fiskeri," ny Række of Tidsskrift for Fiskeri, 2en Aargang, pp. 184–188, 1875.

of Stavanger, viz, Mr. Lorange, a civil engineer, Mr. Olsen, a teacher, and two merchants, Messrs. Andr. Hansen and H. Hansen, in 1873, united with a view to making experiments whether it would not be possible to protect the tender young of the lobster by hatching them in boxes or small basins, where they could find a place of refuge till they were so far developed as to take care of themselves. As these first experiments seemed to augur well, they received, at their request, aid from the Royal Society for the promotion of the Industries of Norway, (Kgl. Selskab for Norges Vel.,) to enable them to continue their experiments in 1874.

For this purpose, they inclosed a sheet of water by building a strong wall at each end of a sound, between two small islands in the Veafjord, not far from Kopervig. This sheet of water was about 300 feet long and 30 feet broad; its bottom consisted partly of rough gravel and partly of rocks stretching along one of the sides, and its average depth was about 5 feet. Five hatching-boxes were then procured, of which one was placed in the inclosed water, three at Aakrehavn, and one at Kopervig. These boxes were made of cork, and were 5 feet long and 2 feet deep. Both at the bottom and at the sides, there was an opening of one-half inch between the boards, which was covered with strips of fine wire-gauze. The boxes at Aakrehavn were, moreover, furnished with a light roof, which, without excluding the light, prevented the boxes from being filled with fresh water during heavy rains. Only one of these three boxes was used for hatching; the two other ones being used for receiving the young ones as their number became too large for the hatching-boxes, and for making experiments whether the young lobster can be kept outside an inclosed sheet of water, which it might be difficult to procure in some places. Twenty-two female lobsters, having roe, were bought, of which three were placed in the inclosed sheet of water, and nineteen in the boxes, not all at the same time, however, but by degrees, just as it was possible to procure spawning lobsters.

Professor Rasch, president of the section for fisheries in the Royal Society for Furthering the Industries of Norway, made a report to the society on the hatching-experiments, accompanied by prepared specimens, showing the development of the young lobster on each day of the first week after the hatching, and during the fourth week. In this report, he says, that, in his opinion, the experiments have been made carefully and skillfully, and that thereby several facts regarding the natural history of the lobster have been made known, which hitherto were either entirely unknown or not sufficiently proved by experiments. These facts are—

a. That the young lobsters swimming near the surface of the water are killed by violent rain, which was successfully avoided by having the above-mentioned light roofs over the boxes;

b. That the older of the young lobsters, when their shears (claws) are developed, in their boxes attack and eat the younger ones which stay near the surface; the possibility of doing this was diminished by having holes in the sides of the boxes large enough to let the larger of the young ones which stay deeper under the water slip out easily;

c. That the female lobsters which have roe under the back part of their body in June will have done hatching in September;

d. That the hatching from beginning to end occupies a period of about three weeks;

e. That the summer-hatching does not begin at the same time every year, (in 1873 it began on the 4th July, and in 1874 between the 17th and 26th of the same month,) which undoubtedly depends on the higher and lower temperature of the water;

f. That the newly-hatched young of the lobster keep closely together near the surface of the water, and because but little skilled in swimming become an easy prey to their enemies; and,

g. That the young lobsters begin to go toward the bottom when about three to four weeks old, and that there they soon assume their retrograde motion.

It was also shown that when the young lobsters have so far developed as to seek the bottom, they can escape their enemies with comparative ease, partly on account of their quicker motions and partly by hiding between the stones.

These experiments have, therefore, not only thrown considerable light on the natural history of the lobster, but they have also given practical hints how it may be possible to further the lobster-fisheries by adopting regulations for their protection, and by establishing in suitable localities hatching-places where the young can be protected during the first stages of their development. To keep the young lobsters in inclosed sheets of water till they are large enough to become salable will scarcely pay. One of our largest exporters of lobsters on the western coast has tried to keep large quantities of grown lobsters in an inclosed sheet of water, feeding them and waiting for the time when it would be most profitable to ship them; but it soon became evident that the expenses were too great.

These experiments will be continued during the present year with the aid of the Royal Society for Furthering the Industries of Norway.

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XVI.—ON THE OYSTER-INDUSTRIES OF THE UNITED STATES.

By Lieut. P. de Broca.

[The great interest taken by the French in the subject of oyster-culture, in view of the threatened failure of this branch of industry on the shores of France, induced the government to send Lieutenant de Broca to the United States, in 1862, for the purpose of ascertaining its condition in this country. The report of that gentleman was first published in the *Revue Maritime et Coloniale*, and afterward reprinted in separate form, with some additions, under the title given below.*

As nothing so elaborate in reference to the oyster-culture and -industry in the United States has been published elsewhere, I have caused M. de Broca's report in the *Revue* to be translated, and present it herewith, supplemented by some additions from the Étude. I hope to present before long the present condition of the oyster-fisheries of the country from an American point of view.—S. F. Baird.]

REPORT.

To His Excellency the Minister of Marine and Colonial Affairs :

Honored Sir : At the end of the month of March, 1862, your excellency, at the request of M. Coste, Member of the Institute, instructed me to proceed to the United States, in order to study the Oyster-Fisheries of that country, and to bring back specimens of two kinds of edible mollusks, susceptible of acclimation on the shores of France.

Since my return to Havre, on the 2d of October, I have hastened to forward to your excellency a summary report of my mission, to be followed by a more detailed account, containing all my investigations in regard to the American coasts.

Leaving Boston on the 17th of September, in the steamer Asia, of the Cunard line, I reached Liverpool on the 29th, after a passage of twelve days of most delightful weather. I brought with me a number of mollusks, principally of the *Mya arenaria*, of which, notwithstanding the greatest care, I was able to save only a few specimens. I was more for-

*Questions maritimes et coloniales.—Pêches maritimes.—Étude sur l'industrie huîtrière des États-Unis, faite par ordre de S. E. M. le comte de Chasseloup Laubat, ministre de la marine et des colonies. Suivie de divers aperçus sur l'industrie de la glace en Amérique, les bateaux de pêche pourvus de glacières, les réserves flottantes à poisson, la pêche du maquereau, etc. Par M. P. de Broca, lieutenant de vaisseau, directeur des mouvements du port du Havre.—Nouvelle édition, augmentée de divers documents et de notes.—Paris. Challamel aîné, éditeur, 1865, 12 mo., 2 p. l., 266 pp.

tunate with the *Venus mercenaria*, and the oysters of Virginia, and succeeded in landing two thousand living representatives at Havre, from which place they were sent immediately to the Hougue of Saint-Waast.

Your excellency will permit me, before entering into details concerning my commission, to mention the circumstances which preceded it, as the experience resulting from them is worthy of record.

About the end of the year 1860 one of my cousins, M. de Férussac, spoke to me of the alimentary supplies afforded the people of the United States from two species of marine mollusks, known in the country under the names of the *soft clam* and the *round clam*. The information thus given me having been confirmed by several American captains frequenting the port of Havre, I hastened to communicate with M. Coste, proposing, if he considered it advisable, to import some specimens of the mollusks in question, by means of the transatlantic steamers, from New York. This proposition was immediately accepted; funds were placed at my disposal by the College of France; and in the month of May, 1861, the reliable officer in charge of the Arago, who cheerfully took the matter in charge, brought to Havre a number of round clams (*Venus mercenaria*,) as well as oysters from Virginia, of a species entirely different from those found on our shores.

Some time after this, the Emperor, whose attention is constantly directed to everything that tends to increase our alimentary resources, took himself the initiative in the general acclimation of American edible mollusks. To facilitate this design of the Emperor, M. de Montholon, consul-general of France at New York, was invited to confer with the celebrated Professor Agassiz, of the University of Cambridge, near Boston, in the United States.

M. Coste, Member of the Institute, was instructed by His Majesty to take all necessary measures for the success of the enterprise in France

Mr. Burkardt, draughtsman of the Museum of Natural History at Cambridge, left Boston in the month of September, of the same year, with some of each of the following species, collected through the kindness of Professor Agassiz: (1.) *Mya arenaria*; (2.) *Venus mercenaria*; (3.) *Pecten concentricus*; (4.) *Homarus americanus*; (5.) *Mactra solidissima*; (6.) *Mytilus edulis*.* The voyage to Europe was accomplished under such unfavorable circumstances that a large portion of these perished during the passage; and as the vessel did not arrive at Liverpool until after the departure of the steamer for Havre, Mr. Burkardt was obliged to convey the shell-fish, which were still alive, entirely across England, in order to embark at Southampton. Of all the mollusks brought from Boston only two hundred of the *Venus* survived to reach France; and these were immediately placed in the parks of Saint-Waast, in accordance with the instructions of M. Coste.

Such, your excellency, were the first attempts at acclimation; and if

* (1.) Soft clam; (2.) Round or quahaug clam; (3.) Scallop; (4.) Lobster; (5.) Hen clam; (6.) Mussel.

I mention them here, it is not to detract in the least from what was then accomplished. My sole purpose is to show that the probabilities in favor of the successful acclimation of oysters and clams are very great, since they have lived for seventeen months in the waters of the Manche quite as thriftily as if they were on their native beds.

By the close of the year 1861 these two important facts were satisfactorily established: first, that the mollusks in question can easily bear transportation across the Atlantic; and, secondly, that our salt waters do not appear to affect them unfavorably. The number of specimens was not sufficient to warrant the planting of them in bays; beside, all the species with which it was desirable to experiment had not survived to reach Europe. These two reasons induced M. Coste to request your excellency to send me to the United States, not only to bring back a large number of mollusks, but also to examine into the conditions essential to their healthy growth; to investigate the nature of the soil and the character of the waters in which they live; and, in short, to obtain information upon every point which might insure the success of the enterprise. I was also ordered to examine everything connected with the oyster-industry; and, in compliance with these instructions, I sailed from Liverpool, on the 29th of March, for New York, by the steamer Asia.

Owing to circumstances beyond my control, my departure, which ought to have taken place in February, had been delayed; so that on my arrival in America I was obliged (as my commission embraced but two months) to arrange matters so as to return to Europe by the middle of June, a season of the year when transportation is difficult on account of the excessive heat. As I was in possession of very uncertain information with regard to the best manner of treating the mollusks, I thought it the wisest plan, in order to take them safely across the Atlantic, to ask the advice of competent persons in the country; and it may be well to say that every one to whom I mentioned the subject predicted a failure if I made the attempt during warm weather.

In view of an opinion so decidedly expressed, and after consultation with the consul-general of France, I concluded to dispatch immediately a number of the mollusks, by the steamer Asia, whose captain, a very intelligent gentleman, had offered me his co-operation.

On the 23d of April, I put on board the steamer 3,000 of the *Venus mercenaria*, and 600 of Virginia oysters, gathered from beds in New York Bay. Some time after this I sent 2,000 of the *Venus* by the Persia, the fleetest vessel of the Cunard line. Your excellency will permit me to observe in this connection, that the discontinuance of the transatlantic Havre line of steamers, the vessels of which were required by the Federal Government for the exigencies of the war then in progress, disarranged my plans, and forced me to send my collections by way of England; so that the probabilities of failure in the transportation of the shell-fish were greatly increased.

After remaining two weeks in New York, during which time I commenced my investigations in regard to the shell-fisheries, I went to Boston, in order to avail myself of the counsel and experience of Professor Agassiz, to whom M. Coste had given me a letter of introduction.

With the utmost readiness and kindness, (for which I tender him my thanks,) the professor made me acquainted with the best means of promoting the success of my undertaking. He pointed out to me those portions of the coast of the Northern States which I ought especially to study, and generously placed himself at my service to direct me in the most fruitful path of investigation. Nevertheless, when he learned that my stay in America could not exceed a month, he did not hesitate to express his opinion of the great difficulty attendant upon so limited a period. In his judgment the investigations I had undertaken in regard to the oyster fisheries alone would require much more time than had been accorded to me; for, in the United States, where there is no fiscal import duty upon fish, as in France, it is difficult to ascertain the statistics of amounts consumed; and since each State is regulated by its own laws, it is only by personal observation that exact knowledge could be obtained.

The transportation of a large number of the mollusks in the month of June, seemed to Professor Agassiz extremely hazardous, and he also informed me that in consequence of the interest he felt in the success of an enterprise which had been initiated by His Majesty himself, he dreaded nothing so much as a failure, which without really proving anything against the undertaking, might yet lead to its relinquishment.

It is evident that I could not but be impressed by such important considerations, and deeming it to be my duty not to act without positive orders from your excellency, I requested Professor Agassiz to write to M. Coste, and explain the reasons why my departure from the United States should be deferred.

On the 27th of April I received from Cambridge the following communication:

"I have just forwarded to M. Coste a long letter, written in accordance with the opinion I expressed to you in regard to the necessity of prolonging your stay in the United States, in order to accomplish the object of your commission. I consider it indispensable that you should pass the warm season here, if you would become acquainted with all that concerns the fishery and the preservation of our oysters, and that you wait until autumn to transport with any chance of success the mollusks which are to be acclimated on the shores of France, &c.

"AGASSIZ."

While awaiting a reply from your excellency, I began at Boston some experiments with reference to the best mode of treating the mollusks during their passage across the Atlantic. I bought for this purpose a number of Virginia clams and oysters, which were placed in tubs or vats upon a bed of gravel, and supplied every morning and evening with pure water from the sea, taken at some distance from the harbor; these vats being emptied after the water had remained about an hour upon the shell-fish. These experiments gave the following results: Shortly after the Myas had been placed in the vats, they evidently began to decline, and on the twelfth day there was not one alive. So far the failure was almost complete. The *Venus* and the oysters, on the contrary, thrived so well, under this mode of treatment, that at the end of a month they were in as good condition as on the first day, the mortality among them having been insignificant and attributable to several extraneous causes. During my absence Mr. Higgens, a planter and dealer in oysters, cheerfully consented to continue these experiments, and to keep me constantly informed of their results.

Success with the oysters and the *Venus* inspired me with such confidence that, on the 28th of May, I sent ten baskets of them by the steamer Europa, which sailed from Boston.

Having been informed early in June, through a dispatch from the admiral of the Roncière, that your excellency had extended the time of my commission, I made arrangements for continuing the transportation.

On the 10th of June the captain of the vessel from Selva, in command of the frigate la Bellone, consented to take to France some oysters and some of the *Venus*, as well as about forty fresh-water turtles, which I sent to M. Coste as specimens of the American species. Having been convinced by some new experiments, undertaken on the shore of Long Island, that it was possible to keep Myas alive out of their native element for twenty days, even in the warm season, I sent, on the 18th of July, 800 of these mollusks by the Europa, with six baskets of oysters, gathered in Delaware Bay. The Myas, buried in cases, filled with sand, as in their natural beds, were supplied several times a day during the passage with salt-water, and I have since learned that 400 of them reached Saint Waast alive.

On the 29th of July the Persia carried over 2,000 of the *Venus;* and on the 10th of August I put on board the Australia thirty fresh-water turtles; while, on the 3d and 10th of September, I dispatched by the English steamers several thousand mollusks. I have learned, since my return to Havre, that these various transportations were not equally successful. Of thirty thousand shell-fish sent from America, including those I brought with me, and others constantly arriving, we can only count upon about a third. It is greatly to be regretted that so large a number failed to survive the perils of the passage; but it is not surprising when we remember that I was obliged to confide them to the care of persons having at the most only a moderate interest in their preservation. I sent on board the vessels with each lot written instructions as to their management; but I have every reason to believe that these were not carefully observed by the subordinate agents intrusted with their execution. As I have mentioned before to your excellency, nothing could have been more unfortunate for the success of my commission than the suppression of the American line of steamers from Havre, since the sending of the mollusks by the English vessels necessitated their reshipment at Liverpool, thus causing them to pass through a number of hands, increasing the length of the passage and greatly multiplying the causes of mortality.

The directors of the Cunard line at New York and Boston gave me, however, their ready co-operation; and as soon as they learned that the mollusks were sent for purposes of public utility they declined receiving any remuneration for their transportation.

Yet, notwithstanding these unfavorable circumstances, we have now, at Saint Waast, a sufficient number for the proposed attempt at acclimation; and, as a result of the arrangement which I have been enabled to make, both in New York and Liverpool, with the directors of the Cunard company, nothing is easier than to bring over new specimens during the winter should it be deemed necessary.

During my sojourn in the United States I visited all those portions of the northern coast where the oyster fisheries are in the most flourishing condition. It is true that in consequence of the war I was unable to investigate the oyster-beds and plantations of Chesapeake Bay; but as the mode of culture in all important points is the same throughout the country, I should probably not have obtained any additional information.

In the course of my investigations I found myself in constant contact with men engaged in various coast fisheries, and I availed myself of the opportunity offered to collect facts which might be of value to similar establishments in France. At New London, where I went to examine the clam beds, I obtained the plans of several fishing vessels, constructed by Mr. Beckwith, who is one of the best builders of this kind of boats. I also brought away with me plans of a cutter furnished with a well, of a schooner provided with an ice-house, and of another schooner having both these appendages.

During my official sojourn in America I forwarded, from time to time, to M. Coste, in accordance with the directions of your excellency, reports upon various subjects, such as the ice-trade in the United States, and its employment as a means of preserving fish; the establishment of wells and ice-houses on board fishing vessels; the floating preserves for fish introduced into the harbors; the lobster fishery at Boston; the mackerel fisheries; and the halibut fisheries; which it would be greatly to the interest of our Newfoundland fishermen to combine with that of the codfish.

These reports, rendered more complete by subsequent observation, I shall have the honor to submit to your excellency.

In the course of my investigations I endeavored to take only a practical view of things, and to free my judgment as much as possible from national prejudices. If a process appeared to me new, I examined it with attention, and was careful not to condemn it merely because it was not in use in France. On the other hand, I guarded myself against a too ready acceptance of statements which at first sight were plausible, and never accepted them without confirmation. In the United States, more perhaps than anywhere else, statements should be accepted with allowance; for, notwithstanding the coldness, seriousness, and reserve of the people, they are singularly prone to exaggeration in everything that relates to the commerce, manufactures, or greatness of their country. This extreme self-esteem, which is to some extent meritorious, is one of their most prominent characteristics. During my investigations concerning the oyster-fisheries, I frequently received the most conflicting and sometimes erroneous statements.

Notwithstanding the most presistent efforts, I failed to find in the book-stores or libraries either in Boston, New York, or Philadelphia a single treatise upon shell-fisheries. I could only obtain a few incomplete statistical documents and newspaper articles, and these discussed the subject only in its commercial aspects.

As to the raising of the mollusks and their planting, my only mode of obtaining information was to visit the establishments, and talk with the fishermen; and I ought not to omit to commend these sea-faring people, for, their reserve once thrown aside, I found them uniformly obliging, and ready to furnish me with the information I required.

In closing, your excellency, I would express my acknowledgments for the kind aid extended to me by the French consuls at New York and Boston, and also my sense of the great favor conferred upon me, being intrusted with a commission which brought me into such close relations with those eminent scientists, M. Coste and Professor Agassiz; a great privilege to any one desirous of instruction.

I have the honor to be, with the greatest respect, your obedient servant,

DE BROCA,

Lieutenant of the Imperial Marine and Director of the Port of Havre.

HAVRE, *October* 12, 1862.

CHAPTER FIRST.

INTRODUCTION.

The aphorism of Brillat Savarin, "The discovery of a new dish does more for the happiness of the human race than the discovery of a new star," has never proved itself more true than in our time, when the continual increase of population adds each day to the importance of the question of public alimentation. France, upon a comparatively limited territory, nows numbers over forty millions of inhabitants; and, notwithstanding the fertility of her soil, the perfection of her agriculture, and the number of her flocks and herds, it cannot be denied that the rate of her production is beginning to be less than that of her consumption.

In seasons when the cereal harvests have fallen below the average, we have been obliged to resort to foreign nations to supply the deficit; and if the people have not recently suffered serious privation, it is because the provident solicitude of the government has taken in time the necessary measures to prevent such a calamity. It would be fatal to rest quietly in a state of false security, and far better to recognize the existence of a permanent danger to which a remedy may be applied than to be unprepared for some casualty (a war for instance) which might be of such a nature as at any time to prevent the importation of the necessaries which we require.

To insure food to the people by applying the discoveries of science to the pursuits of agriculture, to encourage labor, repeople the impoverished streams, and make the most of the sea-coast; in a word, to create more abundant and cheaper resources of nourishment are motives which ought to enlist the most intense co-operation of all who have at heart the prosperity of the country.

Among the means which we have in our power for this desirable end, one of the most effective is to acclimate in France the vegetables and animals of other countries. How many instances of the acclimation of vegetables might be mentioned; and, if we would speak of any one in particular, there is that modest plant, the potato.* Imported from America in the sixteenth century, it produced such a revolution in public economy that entire populations now depend upon it for subsistence. Maize is another example of the same kind.

The acclimation of animals also has added greatly to the national wealth. The Arabian horse, and the merino sheep from Spain, have renewed our degenerate races. The turkey from America, the guinea-fowl from Africa, the cock from China and India, the duck from Barbary, as well as various kinds of pigeons, &c., are found on our farms in great numbers, and by crossing them with indigenous species most savory and important edible products have been furnished.

For several years the Imperial Society of Acclimation has made the most laudable efforts to secure for France new resources of food and trade, while similar societies in the departments have concurred in this eminently patriotic undertaking. Through their efforts the *hemionus*, or wild ass, has been completely domesticated, and is about to become an important element in the horse trade, of which it will form a most graceful ornament. The Angora sheep is now reared in several parts of France without perceptible degeneration; while the young ostriches, born and raised in the zoölogical gardens of Algiers and Marseilles, give us ground to hope that the time is not far distant when the flesh of these birds will rank among the choicest viands of the market.

* The potato was imported into Ireland in 1545, by Captain John Hawkins. It was cultivated in Lancashire in 1684; in Saxe in 1717; in Scotland in 1728; and ten years later it spread over Prussia. In France it was cultivated in several provinces during the reign of Louis XV; but it was Parmentier, who, at the close of the last century, was the most active in its propagation in our country. *Louillet*, (*Encyclopédie Moderne.*)

Many similar experiments are in course of trial with every probability of success.

How happens it that, among all these efforts, so few have had for their objects the fish, the crustaceans and the mollusks? With the exception of the carp and the gold-fish from China, which may be considered merely objects of luxury, and of no great utility, there have been very few cases of acclimation, since the introduction of living fish into our water-courses from localities at no great distance cannot be properly considered such.* The attempt with the gourami of China, the most delicious of fresh-water fish, has hitherto been without result, but it is gratifying to record that it has become an article of commerce with Europe, and that a great many specimens are now found in the island of Mauritius. As to the edible mollusks, the very first effort at acclimation is probably that now undertaken with the oysters of Virginia and the *Venus mercenaria*.

Before the use of steamboats and railroads, those two great levers of modern activity, the transportation of foreign marine or fresh-water productions was attended with great difficulties. The slow progress of navigation by sail constituted a very unfavorable condition, to which should be added a want of knowledge of the proper management of the animals. With perseverance, however, such transportation was not impossible, as is proved by the importation of the gourami into the island of Mauritius, and by similar instances recorded in history.†

M. Milbert, a traveler employed by the Museum of Natural History, succeeded, in 1824, in bringing to Havre some fish from the United States. Unfortunately they all perished on their arrival, through the carelessness of the captain of the vessel, who left them upon the deck during a heavy winter frost. Milbert was inconsolable in consequence of the failure. We have another instance, in the case of an American merchant, who, about twenty-five years ago, emptied into the roadstead of Boston a cargo of sea-bass, taken in the bay of New York, and conveyed to their destination in a boat-well; from that time these fish, before unknown in the latitude of Boston, have multiplied to such an extent that the fishermen capture them daily. If, at the time when sailing-vessels were the only means of transportation, there were very few

* The carp was introduced in England in 1514, by Marshall; and into Denmark in 1550, by Pierre Oxe. In our time, M. Coste has naturalized the grayling in our waters. At the commencement of the century, Péron and Lesueur attempted in vain to import the gourami into France, and a few years later Captain Philbert followed their example with no better success. He, however, kept one fish alive until within sight of the shores of France.

† In ancient times, the Romans, not content with having naturalized, in several of the lakes of Italy, different kinds of fish, such as the *rulsinum* and the *ciminus* ordinarily found at the mouths of rivers, introduced into the Tuscan Sea the *Scarus onias* of the seas of Syria. This remarkable undertaking was accomplished under the reign of Claudius, by one of his freedmen, Elipertius Optatus, who commanded the Roman fleet. The scaria were imported in boat-wells, and for several years were carefully thrown back into the sea when caught in the nets of the fishermen.

attempts made for the acclimation of fish and mollusks, there was in fact no urgent necessity for it. Before the water-courses of France were monoplized by commerce, they were filled with fish, and it is not a great while since, in certain localities of Great Britain, servants, as well as the Scotch peasants, were not content if they were obliged to eat salmon more than three times a week.

The increase of crops, through a better knowledge of agriculture, the raising and improvement of various breeds of cattle, &c., naturally occupied the public mind, as a means of increasing alimentary resources, much more than enterprises which at best were considered very precarious. In our day it is very different. The rivers and streams, through a deplorable mismanagement, yield only insignificant products. The beds of oysters and edible mollusks are becoming day by day less productive, and it is absolutely necessary to have recourse to the fruitful sciences of pisciculture and ostriculture to retrieve our losses.

On the other hand, at no period have circumstances been more favorable for the ultimate success of the projects for acclimation. The transatlantic and other steamers have opened communication with the most distant countries, while the completeness of their construction and their rapidity of passage are about as perfect as we may ever expect to secure.*

Our means of transportation are now of the first order, without taking into account the vessels of the imperial navy, which would assist in this work of public utility, and might, in certain cases, be intrusted with particular installments, incompatible with the service of commercial steamers.

It ought not to be forgotten that fish and mollusks possess great advantages over other animals, in the rapidity with which they multiply when they are acclimated, and in the less expense of their introduction. Of all the animals subservient to the use of man, they alone live in an element in which they can provide nourishment for themselves. They therefore make no demands upon our resources, which is not the case with other kinds of game. With foreign quadrupeds years must elapse before they can increase greatly in number, without taking into account the diseases which may attack them. How many disappointments has the Society for Acclimation experienced in their attempts with the llama and alpaca! Birds are somewhat more satisfactory, but their reproduction is also very slow; while fish and mollusks, as soon as they become accustomed to the character of our waters, will increase in a few years to millions. The astonishing reproductive power of the oyster and the mussel is well known. Naturalists have numbered the eggs of the pike by the hundred thousand; of the carp and the mackerel by the half million; of the plaice by six millions, which satisfactorily accounts for

* To speak only of France: Marseilles, besides a line from the Mediterranean, has recently established one from the extreme east. Bordeaux has one from Brazil and La Plata; Saint Nazaire one from the Antilles and the Gulf of Mexico; and certainly before the middle of next year Havre will inaugurate a line from the United States.

the prodigious increase of this fish in the ponds of eastern Friesland, where it was introduced by the Dutch at the beginning of this century. In the thick-lipped mullet, Professor Valenciennes has counted not less than thirteen millions of eggs. These examples show how rapidly they multiply, and how important it is to acclimate species with such remarkable powers of reproduction.

The experiment with the gourami will, undoubtedly, soon be tried again, by means of the steamers from Indo-China and those of the line from Alexandria.

During my sojourn in the United States, although my commission related particularly to the acclimation of mollusks, I extended my researches to other species useful for food. Among others, I would mention the terrapin-turtle, found at the mouths of rivers and in salt marshes, and which is a very delicious article of food; the lobster, larger, but less agreeable to the taste, than ours; and several exclusively fresh-water tortoises, of which the *red-belly* is the most esteemed. The learned director of the museum of Cambridge, Mass., has engaged to send to France, next spring, a sufficient number of specimens of the latter species to make an attempt at acclimation in the ponds in the suburbs of Paris.

Among fresh-water fish, the large salmon-trout (*Salmo amethystus*) and the white fish (*Coregonus albus*) would be great additions to French ichthyology, if they could be transported to Europe. Professor Agassiz,* whose opinion is authority in such matters, considers artificial fecundation a certain means of success, as he himself informed the Emperor, and which I had the honor to explain to His Majesty in an interview accorded me at St. Cloud.

Whatever may be the future of these projects, mentioned only to show how many valuable resources we may render available, I must now leave them and turn my attention to the acclimation of the mollusks, the object of my visit to America.

The shores of our two seas are singularly deficient in specimens of edible mollusks, there being only a few scallops on the coast of Great Britain; some species of Venus, not at all abundant, in the bays of the ocean and the Mediterranean; a few cardiums, &c. Such is the extent of our resources. America, on the contrary, whose Atlantic coast is rich in shell-fish, is probably the most favored country in the world for this kind of production.† The oysters, of which there are three species,

*The distinguished professor is of the opinion that the French government ought to undertake the acclimation of the *nandou*, which is much more susceptible of naturalization in France than the ostrich of Sahara, for the single reason that it is a native of a temperate climate.

In 1860 I pointed out the pearl mussel as capable of introduction upon the coast of Algeria, and I even opened a correspondence upon the subject with a Greek merchant of Alexandria, who was engaged in the pearl fisheries of the Red Sea.

Recently Mr. Lamiral has published in the *Bulletin de la Société Impériale d'Acclimatation* a very interesting article upon this subject.

†As regards the fish commerce, the American coast presents a conformation entirely

form immense banks along the shores, and the fisheries furnish every year, for the public consumption, a mass of alimentary matter of which it is impossible to form any idea in Europe. There are, besides, in the bays, inlets, straits, &c., numerous beds of mollusks, known under the general name of clams, of which the most important are the soft clam and the round clam, the *Mya arenaria* and *Venus mercenaria* of naturalists.

The oysters, the *Venus mercenaria*, and the Myas, to speak only of these species, enter so largely into the public means of sustenance that a failure of these products would be a material calamity.

In the city of New York, the most populous center of the United States, the commerce in oysters is estimated at 35,000,000 francs, or $5,000,000; and the trade of the whole country is valued at 100,000,000 francs, ($50,000,000,) although these high figures do not represent the total amount of products, since along the coast and the rivers there is a daily consumption which cannot be estimated.

The Merchants' Magazine and Commercial Review, for 1859, estimated the trade in oysters of the principal cities as follows:

	Bushels.
Virginia, (State)	1,050,000
Baltimore	3,500,000
Philadelphia	2,500,000
New York	6,950,000
Fair Haven	2,000,000
Other cities, such as Boston and Providence	4,000,000
Total	20,000,000

Calculating two hundred oysters only as a bushel we have the enormous amount of 4,000,000,000 mollusks consumed.

Mr. Meigs asserted, in the American Institute for the same year, that in the city of New York more money is expended for oysters than for meat. This delicious article of food has become so necessary with every class of the population that scarcely a town in the whole country can be found without its regular supply. By means of railroads and water-channels, oysters in the shell, or out of the shell, preserved in ice, in pickle, or canned, are carried even to the remotest parts of the United States. The cities of Fair Haven, Boston, and Baltimore are at the head of the interior trade, which, for six months in the year, gives employment to a large number of persons.

unique. From Cape Fear to the extremity of Long Island sandy beaches are almost universally interposed between the ocean and the main land, which run parallel with the shore at a distance of from one to several miles. These sometimes form islands, varying in width from several yards to a half mile, and of great length. These sandy formations make bays, sounds, lagunes, &c., in the most favorble condition for the multiplication of fish and mollusks. Besides, as the openings communicating with the sea are not very numerous, in places where rivers and streams empty, the water is less salt than in the open sea, which still further increases the chances for the production of certain kinds of fish and mollusks, particularly oysters.

The soft clam, similar in every respect to the Mya of the sands which inhabits the seas of the north of Europe, and especially of Scotland, multiplies so rapidly on the coast of New England, that, although they are in constant demand, they do not seem to decrease in number. Although found in abundance in the State of New York, their real home is farther north, where they are found even as far as the shores of Newfoundland; but they are nowhere so numerous as on the coasts of the counties of Essex and Barnstable, in Massachusetts. Doctor Gould, in his Natural History of Invertebrata, published in 1841, estimated the quantity of soft clams consumed in Massachusetts at more than ten thousand bushels; but this amount, based probably upon the sales by professed fishermen alone, gives no idea of the real rate of consumption, since the laws accord to each citizen of the State the right to catch as many of the mollusks as he may need for his family. Not even an proximate calculation is possible. It is very certain that Boston consumes enormous quantities of soft clams in the excellent soups which the Americans so well appreciate. The Myas also form one of the best baits for the codfish, and every year Massachusetts salts down thousands of barrels for the use of the fisheries on the banks of Newfoundland. Freshly caught, they are sold on the wharves of Boston for 75 cents a bushel.

The round clam of large size is similar in taste to the *Venus verrucosa*, and, like it, is found in sheltered and shallow bays, where it buries itself in the miry sand. As prolific as the Mya, it abounds upon that portion of the coast of the United States lying south of Cape Cod, which appears to be its most northern limit. It is met with, however, in the vicinity of Cape Ann, but in that locality is not an article of commerce.

The most important fisheries that I visited are those of the suburbs of New York, of the great bay south of Long Island, of the bay of New Haven, and of Cape Cod. A large quantity of round clams is consumed in New York and Philadelphia during the summer months, taking, at that season, the place of oysters, which are then considered by some as not fit for food. They are excellent, either cooked or raw.

Oysters from Virginia, *Venus mercenaria*, and *Mya arenaria*, are the three species of bivalves which we are now endeavoring to acclimate upon our shores, with the probability of complete success, at least with the first two. It will probably be necessary to replace the third (of which I imported only a few specimens) by a species inhabiting Scotland. It will be quite easy to bring thence a sufficient number.

When I hadp ersonally investigated the resources afforded the people of the United States by the mollusks in question, I came to the conclusion that the oyster ought to claim the especial attention of the imperial marine; not that I do not attach an equal importance to the acclimation of the *Mya*, and the *Venus mercenaria*, but since these two species develop slowly, as I have learned from an examination of specimens at different ages, that several years must elapse before they would be sufficiently numerous to be used for food. The oyster, on the contrary, as prolific as our own, develops so rapidly that according to reliable information which I have received, one of these mollusks planted in April, and about three inches in length, will increase by more than half that size before the end of the following autumn.

I have myself seen oysters planted in the bay of New Haven increase over a half inch in two months. In the course of my investigations, I have eaten oysters from the most celebrated localities, and must say that I have always found them somewhat insipid in taste, a marked characteristic of the species. In Massachusetts, I found them much saltier, which is due both to the peculiar nature of the water, and the soil in which they are cultivated.*

When eaten raw, they will never probably be as highly esteemed by the epicure as the indigenous species; but, on the other hand, they will be preferred when the mariner wishes to put them in store, or when they are to be used for culinary purposes, which deprives them of none of their nutritive properties. It would be impossible to find anything more acceptable to the palate than certain preparations of oysters furnished by the good restaurants of New York, such as Delmonico's.

In my opinion the acclimation of this species, susceptible of rapid growth and richer in nutritive substance than ours, will, in one respect, complete the oyster trade of France, bringing into it elements of true alimentary support, while up to this time its contributions have been considered merely as articles of luxury. But it will be necessary to bring the price of the oyster within the limits of every purse, as is the case in the United States, where it is considered one of the most common and cheap means of subsistence. In the public establishments of New York a most excellent soup, made of these mollusca, can be obtained for six cents.

It is only necessary to have assisted, as I have done in the course of my investigations in the daily sale of several thousand oysters by the same merchant, to have witnessed the opening of eight hundred bushels a day in the establishments of Boston and Fair Haven, for the purpose of sending the flesh, packed in ice, into the interior of the country; it is only necessary, I say, to have taken part in such scenes to become profoundly convinced that the raising of shell-fish so prolific must become in France, as in the United States, a most important element for the support of life.†

I should, therefore, consider it a national blessing if we can obtain their reproduction in France, a consummation which we have every reason to hope will take place next spring, since the oysters deposited by M. Coste in the basin of Arcachon have developed as rapidly as in the best American plantations. As soon as reproduction allows them to be

* The oyster merchants divide these mollusks into "fresh" and "salt" oysters. The latter come from submarine soil, where the sea is not mixed with fresh water.

† The American oysters have the advantage of being able to endure the regimen of the parks; and although some localities suit them better than others, on account of the richness of the soil, they prosper on almost all parts of the coast. Long experi-

brought into the market, I have not a doubt that their excellent qualities will readily secure consumers.*

From whatever point of view we regard the shell-fisheries of the United States, they present remarkable results. The food provided for the people; the resources furnished agriculture by use of the shells; the influence upon coast navigation, which is so greatly developed by them; the work provided for the poorer classes, &c., all claim the earnest attention of political economists. Oysters and clams have now become necessities of the first importance in North America, and show how much the productions of the sea may add to the riches of a country, whatever may be the means employed to obtain them in abundance.

Apart from the interesting question of acclimation, the exposition of this industry is of service, in showing us the necessity of pursuing the fruitful field opened by the perseverance of M. Coste. The marvelous results obtained in a few years, on those parts of the coast where he has experimented, no longer admit of a doubt as to the value of his ingenious method of ostriculture. It will certainly be necessary to make a more complete study of our shores in order to prevent mistakes, or rather badly conceived enterprises; but this work once accomplished, there are few industries of France which offer as many probabilities of success.

I have often heard it stated as a reproach to ostriculture, that it had not produced in the bay of St. Brieuc all the results expected; that although the fascines immersed were covered with embryos during the breeding-season, they had not prospered and formed new banks. Having never been in circumstances to verify the truth of this assertion, I cannot say how well it may be founded; but, admitting it to be true, I cannot see how it militates against ostriculture. It proves, at most, the utility of transplanting the young generations attached to the collecting apparatus, thus putting in practice means employed with many products of the soil. To expect of a science, which dates but avery few years back, the unfailing success which belongs only to long experience, seems to me to be very unreasonable.

Pisciculture, hirudiculture, ostriculture—in a word, all the industries which relate to the domain and constitute the agriculture of the sea—must necessarily pass through all the stages from infancy to maturity; but in order that they may rapidly bring forth fruit, thoughtless prejudgment should not interfere with their progress.

The most prejudiced persons with whom I have conversed upon the subject of ostriculture, admit that the embryos can be obtained in un-

ence has shown that those from the Chesapeake may be transplanted to all the Northern States without deteriorating in quality; and it is remarkable how much they will improve under certain hydrographic conditions. The salt-oysters of Massachusetts, so highly esteemed in New York, originally come from Virginia and remain several months in Boston Bay or that of Wellfleet, (Cape Cod.)

* By a remarkable coincidence, the oyster from Virginia, which we are endeavoring to naturalize in the basin of Arcachon, is found in the fossil state in the neighborhood of Bordeaux.

limited numbers; but there, they think, all useful results end. Yet experience in the United States, where the secret of the culture consists in raising upon nutritive soil the mollusks removed from the places of production, evidently shows the fallacy of this opinion.

As the example of the American planters proves, nothing is easier than to remove the young oysters attached to the collecting apparatus, and to plant them in hurdles or narrow stalls very well sheltered, the bottom of which is firm enough to prevent their being smothered by the mud. This can be done at no great expense, and with no complicated manipulation; and, in a few months, the mollusks will be strong enough to defend themselves from ordinary causes of mortality.

It is an unfortunate error, prevalent among mariners, which supposes that what appertains to the productions of the sea should not be modified by the hand of man, and they consider it, to say the least, useless to attempt to obtain these productions by artificial means. Such an idea, which is equivalent to the negation of science, is as absurd as the fatalism of the Orientals, who leave to Providence the care of all things, and so excuse their own idleness and carelessness. We do not hesitate to say, that it shows great want of a just appreciation of the mission of humanity thus to limit its intelligence and powers of investigation.

The exploration of the domain of the sea gains in public opinion every day. The people of the coast instinctively feel that the sea is destined to be to them a most fruitful source of prosperity, and to deliver them from the miserable condition which has for a long time been their portion. In a few years, thanks to the light of science, profitable fisheries will be established upon the coast, among which ostriculture will certainly be the most fruitful. While, on the one hand, by means of intelligent regulation, based upon careful study of locality, myriads of young fish will be protected from wanton destruction by ignorant fishermen, on the other measures will be taken to raise in reservoirs such as can bear the regimen. Shell-fisheries will also be developed wherever they can be established with success. The populace, attracted to the coast by the hope of a better livelihood, will become acquainted with the sea; will learn to consider it the source of many blessings; and will finally greatly augment the elements of our maritime power.

P. DE BROCA,

Lieutenant, and Director of the Port of Havre.

CHAPTER SECOND.

OYSTERS OF THE UNITED STATES.

Naturalists divide the oysters of the eastern shores of North America into three species, namely: the oyster of Virginia, (*Ostrea virginiana*); the northern oyster, (*Ostrea borealis*); the Canadian oyster, (*Ostrea canadensis*). Notwithstanding this classification, based upon details of form, which in fact vary considerably, the mollusks in question, always found in the same latitudes, are so similar in taste that they may be considered merely as varieties of the same species. Dr. Gould, an American naturalist, admits this to be the case so far as the northern and Canadian oysters are concerned. However the facts may be, the difference between the American oyster and the European is so marked that a superficial examination is sufficient to prove that they are of distinct species. The prominent points which distinguish those bivalves from ours are the violet color of the muscular impression, and the greater insipidity of taste, even when they are taken from banks situated on the open coast, and in water entirely salt.

While the form of the common oyster of Europe, growing freely, is almost entirely round, that of the American is always more or less elongated. In addition to this, its lower valve is more concave, and contains a mollusc thicker, more tender, richer in nutritive elements, and having also a less salty taste, which in some cases resembles that of the mussel. When it attains its full development, which, according to fishermen, requires twenty years, its dimensions are considerably greater than those of ours. Its shell is thicker and heavier, and the interior enamel rarely presents those soft parts from which fetid water escapes when they are accidentally pierced.

The oyster of Virginia.—This, most common of the three species, has a narrow shell, increasing gradually in size from the top and moderately curved in the plane of the intersection of the valves when it is allowed free development. The specimens taken from the natural banks are generally distorted, on account of certain conditions affecting their growth; but they nevertheless preserve all the most marked characteristics of the species.

As in Europe, the oyster which is most regularly an article of commerce is that which has been improved by culture. The beak of the Virginia oyster, very pointed when old, is somewhat bent, and the opposite part of the shell is rounded. The upper valve, almost entirely flat, is the smoother of the two, and the surface, when not worn by friction, presents numerous laminæ more regularly disposed than in the other species. The muscular impression, very often central, is of a deep violet color. The weakness of the muscle is a marked characteristic of American oysters generally, a fact which I have not seen noticed in any book upon natural history.

Specimens are sometimes found measuring 15 English inches in length, 3½ in width. This species, known in the market under the name of the Chesapeake oyster, is common all along the coast, especially in the Southern States. In the North it is found in as high latitudes as Prince Edward Island and the mouth of the Saint Lawrence River. Its most essential characteristics are its great length, compared with its width, and the pyramidal form of the beak.

The Northern oyster has a shell rounded, curved, ordinarily crooked, and always less elongated than that of the preceding species. The upper valve is flat, and the beak short and bent over. The surface of the shell is very irregular, and formed of laminæ of a greenish color, disposed without order. Its edges, more or less jagged and scalloped, are calcareous in the lower valve, while in the upper they are flexible, and seem to be membranous in nature. The muscular impression is of a deep violet color, and the interior of the valves of a chalky white, or light green. The lower valve is deeper than that of the Virginia species. Some specimens are a foot in length, by six inches in width. This oyster is commonly known as the New York oyster, as it is found in considerable numbers in that bay. It is found all along the coast, and even in the Chesapeake, were it is mixed with the principal species. It is frequently taken in Buzzard's Bay, (Massachusetts.)

The Canadian oyster.—The Canadian oyster, also less elongated than that of Virginia, is generally crooked, with the beak rounded. The shell is wide, expanded, very white, and laminiferous. The upper valve is slightly convex. It is common on the Canadian shore, at the mouth of the Gulf of Saint Lawrence, as well as upon certain parts of the coast of the United States, particularly in the latitude of New York.

The American oyster, without distinction of species, exists in such profusion that it seems to be gathered as plenteously as manna was in the exodus of Israel. From the British provinces to the Gulf of Mexico it constitutes inexhaustible banks, which in certain localities, were it not for the constant fisheries, would form reefs, modify currents, obstruct channels—in a word, interfere greatly with navigation. Abundant on every part of the coast, nevertheless some latitudes seem specially to suit it. Such are the shores of New Jersey, of Long Island, of Connecticut, of Rhode Island, of the mouth of the Delaware, and, above all, the magnificent bay of Chesapeake, a regular magazine of abundance, where every year vessels are loaded with the precious mollusks, and transported to all parts of the coast.

North Carolina, Albemarle, and Pamlico Sounds also produce excellent oysters.*

The Americans, pre-eminently practical in all that concerns the material interests of life, have not neglected this great source of wealth. They realized, at a very early period, the great advantage which might be derived from so much alimentary substance, obtained almost without expense; and the oyster-fisheries, with their culture, have been, with them, for a long time, lucrative industries, becoming each day more extensive, in order to supply the demands of the ever-increasing number of consumers.

Disregarding the methods of culture adopted in Europe, they have

* The enormous multiplication of this species has, for a long time, attracted the attention of philosophers and naturalists, many of whom, in view of this incessant production of the mineral matter composing the shells, are of the opinion that most of the calcareous deposits have no other origin. Like the polyps of the Indian Ocean, this mollusk, if left to itself, would change the hydrography of coasts.

chosen one which is very economical, and which yields excellent results, as may be seen in the well-known "plantation system." Their mollusks, like ours, require beds of miry sand, rich in animal production, and sufficiently exposed to the open sea. The brackish water at the mouths of certain rivers, into which the tide rises, constitutes one of the best conditions for the success of this industry.*

Chesapeake Bay, from which is gathered a large proportion of the oysters cultivated in America, is a magnificent basin in which Providence seems to have accumulated every necessary condition for forming an admirable locality for the fishery. Its entrance, between Capes Charles and Henry, opens from the east to the west; but the bay soon changes in direction, and extends toward the north for a distance of one hundred and fifty miles, with a width of from twenty to thirty miles in the southern part, and from ten to fifteen in the northern. It is accessible to the largest vessels. A number of rivers empty into it, of which the most important are the Potomac, the Rappahannock, the York, and the James. The amount of fresh water which flows into this bay daily from these streams, the smallest of which admits the rising of the tide, renders the water of the Chesapeake less salt than that of the ocean, a circumstance which we have already mentioned is favorable to the natural production of the oyster. The shores of the bay are indented by a multitude of gulfs, creeks, small bays, &c., in which are numerous islands. The extent of shore is thus greatly increased, and innumerable places of shelter afforded for the multiplication of fish and mollusks.

The quantity of fish furnished by the fisheries is very great; and before the war the annual estimate at Baltimore was four hundred thousand barrels of salt fish, principally herring and shad.†

The oyster-industry is still more important; and the production from the banks in the bay, in 1858, was twenty millions of bushels. At that time about ten thousand persons were employed in the fisheries and with work on the plantations.

The oyster of the Chesapeake, in consequence of the favorable conditions in which it lives, is in its natural condition so large, that, for the most part, it does not need culture, but can enter the market immediately. At Fair Haven and at Boston, where, on account of the thickness of the ice, it is impossible to secure a supply in winter, they are, during that season, brought from Virginia in sufficient quantity to supply the needs of commerce. The schooners which transport them manage

* Pearls are found in many American oysters, but of very inferior quality. They are of a chalky white, sometimes having a faint violet tint. It seems that upon the coast of New Jersey a bank of oysters was found a few years ago furnishing beautiful pearls. The country was in a great state of excitement; the fishermen supposed they had made a valuable discovery, but after a short time it was found that the hopes excited were quite fallacious.

† Chesapeake Bay abounds in fish of all kinds—mackerel, herring, perch, eels, red mullet, cat-fish, shad of every variety, &c. In the Potomac, James, and other rivers enormous sturgeon are taken, weighing from 150 to 200 pounds.

their voyages in such a manner that the merchants are regularly supplied; and the mollusks ordinarily remain in the hold of the vessels until the cargo is sold. However cold it may be, they will live for several days, provided the hatchway is not opened until the hour for removal. They have been known to live in this way for a month.

With a few exceptions, we may say that a large part of the cultivated oysters in the Northern States come from the Chesapeake and the mouth of the Delaware, where the planters can procure them at so low a price as to make it unnecessary to take part in the local fisheries.

The fishermen of Maryland and Virginia sell them at from 15 to 20 cents a bushel, containing from 200 to 250, according to the size of the oyster. It must be acknowledged, however, that these oysters, although they may be improved by culture, and in certain cases acquire a saltier taste, are never quite equal to those of the coast of Connecticut, of Rhode Island, of certain parts of Massachusetts, &c. The native oysters are generally consumed in the neighborhood; are sold at a much higher price; and are never sent without their shells into the interior. The most highly esteemed oysters come from the bays of New York, New Haven, and Providence; from different parts of Long Island Sound, and from the shores of New Jersey, (principally from Milk Pond and Absecom Creek.) In my opinion those taken at Blue Point, in the great bay south of Long Island, are the most delicate of all.

When not consumed raw, the oysters are prepared in a variety of ways. They are pickled and preserved by the Appert process; they are eaten in the form of soup, or stewed, broiled, made into pâtés, &c., and they serve, besides, as accessories to numerous culinary preparations. The consumption is so extensive that in the towns along the coast during the winter season it forms a part of the daily food of almost every family in moderate circumstances.

In all the great centers of population there are large establishments known under the name of oyster-houses, where the mollusks are sold, prepared in every possible way. These are, in fact, restaurants, and differ from the ordinary establishments of the kind, only in being especially intended for the sale of every variety of shell-fish. In New York there are more than three hundred of these oyster-houses, some of which are handsomely furnished, and situated in the finest portions of the city. They are mainly frequented by the commercial class, who take a meal here in the middle of the day. Oysters are also sold in small shops, and even at stalls in the open street, where the working classes supply themselves.*

Oyster-soup (stew) is the most favorite preparation of the mollusk with Americans; and during the winter season it is an almost universal custom with them to call for it at the oyster-houses after leaving the theater. It is so popular that it is even introduced as a refreshment at large

* During the summer the oysters are preserved in the oyster-houses by placing them upon a block of ice; which lowers the temperature, so that they live for several days.

parties and balls, invariably making its appearance toward morning, to repair the exhausted forces of the dancers.

The American oyster, when cooked, is certainly superior to ours, and as it preserves its nutritive properties better during the process, it is highly regarded by physicians as an article of food for convalescent patients. Many persons eat them throughout the year without experiencing any injurious effects. On this point I would hazard an observation, which, it seems to me, has sufficient foundation. Fishing, during the breeding season, is prohibited by law, so that all the oysters then sold come from the plantations. Now, as these oysters were transported in the month of April, a time when the process of generation commences with them, it is very probable that this process was affected, and in most cases arrested completely, by the fatigue of the voyage and the change of medium. As under the circumstances they rarely become spawn-bearers, they can hardly be injurious in the warm season, although in their natural condition they would be positively unwholesome.

The price of oysters for consumption varies greatly. It depends upon their size, quality, the reputation of the plantations in which they are cultivated, and the importance of the establishments in which they are sold. At wholesale, they are about $1 a bushel; while in the markets, oyster-houses, &c., the price is higher, and varies from 50 cents to $2.50 for the largest size used in choice preparations. The merchants, intelligent in all that concerns their profession, make many distinctions in the value of the oysters, in order to derive as much profit as possible from them; and they well know how to take advantage of the taste of their customers. Fresh oysters can be procured either in or out of the shell in all the markets. In the latter condition they are generally sold to restaurants, hotel-keepers, and families who buy them for immediate consumption.

For exportation and transportation into the interior they are sold—

1. In the natural condition
2. Out of the shell;
3. Pickled;
4. Canned.

The oysters in shells are sent in great quantities into the interior during the winter season. They are put in barrels about a quarter the size of an ordinary flour-barrel, and tightly packed to prevent the opening of their valves. These barrels have, at regular intervals, openings for ventilation.

Naked oysters, intended for the most part to be eaten cooked, are sent into the interior during the entire year, but chiefly in winter. As I have said, the cities of Baltimore, Boston, and Fair Haven are the principal centers of the trade, and form the most important branch of the oyster-industry.*

Pickled oysters.—Pickled oysters are prepared, as in Europe, with an

* Some persons eat these oysters raw, seasoning them with salt, pepper, and vinegar.

addition of vinegar and spice to the water in which they have been cooked. As the vinegar used is inferior to that employed in France they are not equal in value to ours.

Canned oysters.—These are mostly prepared in Baltimore. The mollusks are taken from the shell, slightly cooked, and then put into cylindrical tin boxes, or cases, with a circular hole at the upper end about an inch and a quarter in diameter. When filled, the cans are closed by soldering a small round piece of tin over the opening.

Use of the shells.—The shells of the oyster give rise to various industries, which are also very important. In agriculture they are used for improving the soil when it has not a sufficient quantity of calcareous matter. They are also used for macadamizing roads, and forming paths in pleasure-grounds, which, by the use of this substance, become of a dazzling white. Lastly, they are burned, and an excellent lime is obtained, which is better as a fertilizer than ordinary lime, inasmuch as it contains no magnesia. Generally the oyster-dealers give away the shells gratuitously, upon condition that their establishments shall be daily relieved of them.

It was estimated, in 1857, that the pecuniary profits derived from the shells, from the various oyster-establishments in Baltimore alone, amounted to more than $120,000. Before the war the lime-pits of Mr. Barns, at Fair Haven, burned annually more than 250,000 bushels. At the present time there are upon the coast of the United States a great many mills employed in this branch of industry. A bushel of oyster-shell lime sells at from 12 to 13 cents.

MODE OF OBTAINING THE OYSTERS.

Oysters are obtained in different ways, according as the beds are more or less deeply situated in the water. The instruments employed are the drag, the rake, and the tongs, which is a peculiar implement, unlike anything we have in Europe.

The drag is very much like that in use in France, but as the weight is not determined by law it is generally heavier. The part intended to hold the oysters is sometimes made of rope and sometimes of iron network.

The rake, similar in form to that employed by our fishermen, is about 14 inches wide, with iron teeth from 6 to 10 inches in length, and is provided with a net for the reception of the mollusk. Sometimes it is made entirely of iron, with curved teeth, which will hold a certain number. It is worked by hand, by means of a pole 15 or 20 feet in length, to which it is fastened. It is frequently used during the winter season in Rhode Island for gathering the mollusks from the ponds of Point Judith, the surface of which is frozen sometimes for several weeks. Fishing is then accomplished by thrusting the rakes through holes made in the ice.

The tongs, which I have never seen except in America, is an instrument which ought to be introduced into France, as it would be of great service to our shell-fisheries in general. It is, as its name indicates, an immense pair of pincers, with rakes attached to its lower extremities, the teeth of which interlock when the instrument is closed. These rakes are about 14 inches in width, and the teeth, placed about 1½ inches apart, are only 4 inches long. The handles are from 15 to 20 feet in length, and the point of intersection is about a yard from the lower extremity. To take the oysters with this instrument, the fisherman first anchors his boat over the bed to be worked; then seating himself at the side, he takes the upper extremities of the two poles, one in each hand, and opening and closing the instrument successively, endeavors, as it were, to nibble the bank with the rakes and pick up the mollusks. As soon as he feels that he has a sufficient number, he draws up the instrument and deposits the captured oysters upon the deck. A large part of the oysters furnished by Chesapeake Bay are taken in this manner. The tongs is also used on the plantations and in fishing for clams.

The boats used are generally of small tonnage. Most of those which I saw in the bay of New York, and in the great bay south of Long Island, were constructed with flat bottoms, in order to pass easily over the banks, and provided with a sail, and three or four men constitute their crew.

The working of the banks, by means of the tongs, is eminently preservative, as there is no loss by the destruction of many of the mollusks, as is the case with the drag. Undoubtedly, the use of this instrument is impossible on many of the banks of the French coast, but in the basin of Arcachon, in the salt ponds of the south, and those of Corsica, it might be employed to advantage.

Local regulations.—Notwithstanding the extraordinary richness of the oyster-production on their coast, the Americans have felt the necessity of protective legislation to prevent the exhaustion of the banks, and for this purpose the various seaboard States have established special laws determining the time of the fisheries, and the mode in which they must be worked.

A few years ago, on the shores of Maryland and Virginia, the oysters were taken in such great quantities for consumption, for the manufacture of lime, and for manure, that the danger of diminishing the value of the fisheries was recognized, and very severe restrictive laws were passed in these States. In general, however, the legislation which controls the oyster-industry is very complicated, since, with great want of uniformity, each State enacts its own laws without reference to those of the neighboring States. Its objects may be enumerated thus:

1. To prevent the destruction of the natural banks, by determining the time and mode of the fisheries.

2. To protect the plantations from lawless depredations.

3. To reserve, with a few exceptions, for the residents of each State, the right of local fishing.

4. To reserve, in certain cases, the fisheries to the inhabitants of the circumscribed maritime districts in which they are situated.

I give in this article, and in the one which treats of the culture of oysters, a summary of such laws as appear to me to be interesting.

Massachusetts.—In this State no one, in a maritime district defined by law, can fish for oysters without a written permit from the mayor or the selectmen* of the locality. This permit must give the length of time of the fishing, the number of mollusks to be taken, and the purpose for which they are to be used. Any resident of the place can take oysters from the banks, for the use of his family, from the 1st of September until the 1st of June. Trespassers are fined $2 a bushel for oysters illegally obtained.

Rhode Island.—In this State, where legislation is most stringent, the oyster-fisheries, reserved exclusively for the residents, are prohibited for use from the 15th of May till the 15th of September, under a penalty of $20 for every bushel taken. And, during the permitted season, there are regulations controlling the quantity of mollusks to be taken daily, which quantity varies with the locality, but must in no case exceed five bushels. To protect the fisheries as much as possible from depredation, the law inflicts a fine of $500 on any person convicted of damaging the oyster-banks by any means whatever. Half of the fine goes to the State and the other half to the person commencing the prosecution or lodging information.

The fisheries are allowed only between the rising and the setting of the sun, and it is required that all oysters not of marketable size shall be thrown back into the water. The use of the drag is positively forbidden, and the boats using them are confiscated, with all that they contain, while each of the crew is condemned to pay a fine of $300.

Connecticut.—According to the legislation now in force, every locality in this State, containing oyster and clam fisheries, has a right to enact laws for their control, and may impose a fine, not exceeding $14, for every offense.

The fisheries are everywhere prohibited from the 1st of March till the 1st of November, under a penalty ranging from $7 to $50, or by imprisonment not exceeding thirty days. In certain cases the delinquents may be punished by both fine and imprisonment.

New York.—The ordinary fisheries in this State are prohibited during the months of June, July, and August, under a penalty ranging from $20 to $30, according to the locality. One-half of the fine goes to the superintendent of the poor of the district in which the offense occurred, and the other half to the prosecutor.

To take oysters from the Hudson River, in order to transport them out of the State, is prohibited under a penalty of $250. The use of the

* The selectmen are public officers, elected by the people, to administer justice in localities where there is no mayor.

drag is forbidden in the county of Richmond, and several of the local fisheries are reserved for the maritime district to which they belong.

New Jersey.—No fishing is allowed in this State from the 1st of May till the 1st of September, under a penalty of $10. Any person convicted of using a drag, or having one on board a vessel on which this instrument is usually employed, is liable to a fine of $50. The same penalty is imposed upon the owner of the boat.*

No one who has resided less than five months in a district can fish for oysters and clams, under a penalty of $20, and the seizure of boat and cargo. A boat-load thus condemned is sold, and half the proceeds of the sale, after expenses have been deducted, are given to the informer and half to the collector of the county in which the offense was committed.

By a law enacted in 1857 any fisherman convicted of dragging for oysters in Dennis Creek (county of Cape May) was compelled to pay a fine varying from $10 to $100, to have the boats on which the prohibited instruments were found confiscated, and to be imprisoned from ten to thirty days.

Delaware.—Fishing is prohibited in this State from the 1st of May till the 1st of October, under a penalty of $10, and the same fine is inflicted if the drag is used in any of the creeks, bays, or ponds of the State, while the boats employed for the purpose are also confiscated.

During the regular fishing seasons the oysters must be sorted on the spot, and those not marketable thrown back immediately into the water under a penalty of $10.

No one not a citizen of the United States can fish in those portions of Delaware Bay belonging to the State without a permit from the clerk of the district. This permit, which is good for a year, can be used only by the boat named in it. Its cost is $50, which is that much profit to the State. Whoever violates this law is punished by a fine of $50, with confiscation of the boat, and all it contains. Any vessel may fish for oysters in the proper season if they are for its own consumption.

Maryland.—Fishing is interdicted from the 1st of May till the 1st of October, and no one is permitted to engage in the business who has not resided in the State at least twelve months, under a penalty of $100. The fishing-instruments allowed are the rake and the tongs; the drag, with a very few exceptions, being rigorously prohibited, under a penalty of $100 and the confiscation of the boat.

The laws also require the prosecution of fishermen who use the seine upon the oyster-banks, as the nets dragged over the beds either carry off a number of mollusks or bury them in the mud.

A law of 1835 forbids fishing for oysters for the mere purpose of procuring a fertilizer, under a fine ranging from $10 to $50. Finally, no one who is not a resident of the State can fish at less than two miles from the shore, and the punishment for this offense is a fine of from $5

*Those who reside on the shores of Delaware Bay are exempt from this regulation.

to $50 and the confiscation of the boat. No prosecution, however, can be undertaken without a special order from a justice of the peace, given upon the affirmation, under oath, of a resident of the State. The county sheriff, the constable, and civil and military officers are expected to assist in the execution of these laws.

Virginia.—Fishing for oysters in waters belonging to this State during the months of June, July, and August is prohibited under a fine of $50.

On the shores of rivers and in bays the only instrument allowed by law is the tongs, excepting always localities where the water is deep. In the sounds of Tangier and Pocomoke, for instance, the use of the drag is permitted, but never in the mouths of rivers, in the interior of the bays, or where the water is less than twenty feet in depth.

The legislature of Virginia, in order still better to protect an industry which is a great source of wealth to the State, passed a law in 1856 by which each county, when it is considered necessary, can appoint inspectors, whose duty it is to arrest persons and boats suspected of having violated the laws. These inspectors are sworn into office, and receive the half of the fines imposed upon the delinquents whom they bring to justice. With a very few exceptions, which are mentioned in the laws, the taking of oysters from the banks for enriching the soil, or for the manufacture of lime, is punished with a fine of $500.

CULTURE OF OYSTERS.

The methods adopted by the Americans for the culture, or rather for the improvement, of oysters obtained from the coast fisheries are in no respect similar to the complicated and expensive processes in operation at Marennes, Ostend, Courcelles, or other such localities where these mollusks are reared. The "pen," in the exact sense of the word as we use it in France, is unknown in the United States; for the ponds or reservoirs for oysters, formed in certain places by closing the mouths of small creeks, with sluice-dams, can hardly be so called. Establishments of this kind are, moreover, very rare, and I had not an opportunity of visiting one.

American ostriculture, more simple than ours in all its details, consists in planting the mollusks on those parts of the coast where the submarine soil is best fitted by its nature to fatten them and promote their growth. The process is very much the same as that adopted at Saint Waast and Cancale; and in the United States the results are so satisfactory that it would be worse than useless to have recourse to more complicated methods, which, without increasing the profit, would add greatly to the expense.

The success of this branch of the oyster industry depends upon the hydrographical configuration of the locality chosen for planting the oysters, upon the nature of the submarine soil, and upon the saltness of the water.

The American oysters, like our own, do not prosper on every kind of soil indiscriminately. In pure sand they do not fatten, and grow very little; in mud they contract an unpleasant taste, and also run the risk of being smothered; but in mixed soils of sand and mud they develop to an astonishing degree, especially when the water is slightly salt.*

These artificial deposits, called oyster-beds, are necessarily formed in accordance with circumstances which vary with the locality. Sometimes ground is used which is constantly under water. Sometimes, on the contrary, as at Boston, Wellfleet, and New Haven, the beds are exposed for several hours each day, and only covered at high-tide.

The most favorable places are those situated in bays, creeks, and the mouths of rivers in which the tide rises, but the bottoms of which are not shifting; in estuaries or arms of the sea; in salt ponds; in short, in all places so sheltered that there is no fear that the waves of the ocean will wash away the deposits. The action of currents, if not too strong, is not considered injurious. The maximum depth at which the oysters are planted is from twelve to fifteen feet at low tide; but more commonly the beds are only four or five feet below the surface of the water, which is preferable, as the oysters can be taken up more readily.

The most important plantations are in the vicinity of the large centers of population; but with the facilities for transportation which exist in the United States they are found on all parts of the coast.†

Whatever may be the locality chosen by the planters, they can in no case pursue their industry on the natural banks of oysters,‡ the common property of the people, or in any way interfere with the free exercise of navigation. These conditions complied with, every facility is generally afforded them by law; but in some States, before commencing operations, a license must be obtained from the civil authorities of the maritime district in which they are to be located.

The limits of plantations are marked by slender poles inserted in the

* Oysters planted in tidal rivers, or in ponds of brackish water, fatten and grow very rapidly, but are characterized by a more insipid taste than those cultivated in purely salt water.

† In the vicinity of New York the principal plantations are upon the shores of Staten Island, particularly at Prince Bay, in the East River; in the Harlem River and Shrewsbury inlet, &c. At New Haven they are numerous in the bay, and at the mouth of the Quinipiac. At Boston the most celebrated are established upon the projecting shores of Bird Island and Hog Island, as well as in certain parts of the Saint Charles and Mystic Rivers.

‡ By a natural bank, we mean a conglomeration of mollusca presenting a character of continuity, constituting what is usually called an oyster-bed. The natural bank may be single or formed of several small banks, separated by greater or less spaces, but always sufficiently connected to be considered parts of one whole. As to places where, through accidental circumstances, isolated oysters have developed, they are not classed among the natural beds, since, if this were the case, the largest part of the submarine soil of the coast would be under interdiction and oyster culture would be impossible. However protective the American laws may be in what concerns public property, they are careful not to interfere with private enterprise by a too rigorous interpretation of the term *public property*.

soil so long that the extremities, garnished with small branches, are two feet at least above the level of the highest tide. Similar poles divide the entire ground into squares of from twelve to fifteen yards at the side. These divisions, obligatory in most of the States, serve to indicate the exact position of the plantations, facilitate their surveillance by the police or coast-guard, and accelerate the labor of gathering. The poles are so flexible that they do not endanger vessels which may accidentally run against them.

The oysters are planted annually, from the 1st of March until the 1st of May, when the work generally ends. The vessels which bring them from the Chesapeake, the Delaware, or any other place of production, are, for the most part, schooners of 100 or 150 tons burden, which carry from 3,000 to 6,000 bushels of mollusks. When they reach their destination the oysters are delivered to the planters, who carry them to the beds, and distribute them as regularly as possible. The latter operation is of great importance, since if planted too closely together the mollusks will interfere with each other. The planting is done in the following manner: The men intrusted with the work load the oysters into long flat-boats, and carry them at high tide to the plantations. They station the boat over the center of each of the squares mentioned above in turn, and by means of a large shovel, or pitch-fork having twelve teeth, throw the oysters around them by a circular movement, very much like that of the farmer in sowing wheat. This is probably the origin of the term "planting" or "sowing" oysters. When the cargo of oysters is exhausted, the mollusks are regularly distributed at the bottom of the sea, in order that they may not injure each other. This part of the work, which is accomplished by rakes, is much more easily effected on ground which is sometimes exposed by the receding tide than in places always covered by the water.*

As I have already said, the oysters fatten and greatly increase in size in good plantations, and even change considerably in taste. No longer impeded in their development, the shells become more regular, spread, and have a more rounded form. In places where they are always covered by water, and there is no fear of their being frozen, they are frequently allowed to grow for several years, in order to obtain very large specimens. In localities, on the contrary, where the severity of winter would be sure to destroy them, on the exposed ground where they are cultivated, they are allowed to remain only during the warm season, and are taken up before cold weather commences. In any case they remain at least three months on the ground before they are used, otherwise the benefit of culture would be lost. About fifty bushels of mol-

* The position of the oyster upon the ground is of no importance, provided the deeper valve is uppermost. I have observed several times in the bay of New Haven a curious phenomenon. When the oyster happened to rest upon this valve, the growth was affected in such a manner that the edges of the shell turned upward toward the surface of the water, as if the animal thus endeavored to obviate the danger arising from its abnormal position.

lusks are generally sown upon each of the square divisions of the plantation. When the harvest season approaches the oysters are collected daily at low tide when the bed is exposed, or otherwise by rakes.

There is a very prevalent opinion in the United States and in England that oysters may be fattened by pouring Indian meal into the water which covers them. It is said that certain planters in New Jersey adopt this method in small ponds; but it is very probable the meal has no effect whatever upon the oysters, their stomachs being too delicate to digest such nourishment. Many persons reject this opinion as a mere prejudice without foundation.

The culture of oysters in the United States is a source of certain revenue, since it is an industry in which failure is unknown; and the survey of those parts of the coast where they can best be established is now so complete, that every probability of success is secured to the planter. A few years ago the profit upon capital engaged amounted to 50 per cent.; but as consumption became more extended, and the number of people employed in the commerce increased, profits, although still large, were reduced to a more ordinary rate. The war which desolated the country also interfered with the fisheries, since they were forbidden on a part of the coast of Virginia by the Federal authorities, lest the fishermen might establish communication with the enemy.

The effect produced upon navigation by the culture of oysters is very important. According to the information furnished me, the plantations of the bay of New York and of that vicinity employ one hundred vessels, and those of Boston and Cape Cod from thirty-five to forty. Before the war, from one hundred and fifty to two hundred schooners were employed during six months in the year, either in transporting oysters for plantations or in supplying the merchants of Fair Haven during the winter.

LAWS CONCERNING OYSTER-PLANTATIONS.

The oyster-planters are subject to laws peculiar to the different States, but which in every case are sufficiently stringent to protect the industry from the depredations of evil-disposed persons. This is very necessary, for as the plantations are for the most part in isolated places, sometimes at a distance from the shore, only very rigorous legislation can insure their safety. Misdemeanors are tried by the public officers, such as constables, sheriffs, harbor-masters, police, and coast-guards, and any person cognizant of an offense is requested to report the same to the authorities.

The following are some of the principal laws in force in the Northern States:

Maine.—Persons wishing to cultivate oysters on the banks of rivers, bays, or creeks belonging to the State must first obtain a permit from the local authorities. The only exception is in favor of plantations situated in the interior of bays and gulfs. In no case must navigation be impeded.

Massachusetts.—In Massachusetts the mayor and selectmen of each maritime locality may grant a written permit, to any inhabitant of the place, to plant oysters and to cultivate them, at any time during the year, in the waters of their district, provided the natural banks are respected. This permit, which is good for twenty years, indicates exactly the limits and character of the ground, and must be registered by the county clerk before it can be used. The magistrate who has granted it receives $2 as his fee, and the clerk 50 cents. This proceeding insures to the planter, and to his heirs in case of his death, the right to the ground conceded, and he can prosecute any one who trespasses upon it; while the offender is also punished by the law with a fine of $20 for each trespass.

Rhode Island.—In the Providence River the commissioners of the shell-fisheries can, upon their own responsibility, rent, for the good of the State, to any citizen of the State, any ground covered by water where there are no natural banks, for the establishment of plantations. These grants, given for five years, have a tax imposed upon them which is to be paid into the general treasury of the State.

When a citizen applies for a permit, the commissioners, before granting it, must give public notice of the day, the hour, and the place where the matter will be arranged. This notice, containing an exact description of the ground solicited, is published, at the expense of the solicitor, in one of the daily papers of Providence, at least two weeks before the day of settlement, in order that the transaction may be generally known, and the citizens have an opportunity of bringing before the commissioners any objections they may have to the issuing of the permit.

In no case can more than one acre be assigned to any one person, and only one acre a head to members of a company. The ground granted for the formation of oyster-beds cannot be rerented during the continuation of the grant.

A double copy is made of the lease, one for the solicitor, the other for the general treasurer, and if the commissioners consider it worth while, before signing it, a sketch may be made of the reservation granted.

The boundaries of plantations thus assigned must be determined exactly by landmarks on the adjacent shore, and by poles or boughs placed about eleven yards from each other, in the water; being so arranged as not to interfere with navigation. The landmarks, and poles or boughs, are renewed whenever the commissioners consider it necessary, and these officers of the government are also authorized to appoint a special guard, provided with a boat, for the protection of the plantations of Providence River known under the name of the Great Bed.

When the conditions specified in the leases are not complied with, or when the rent is not paid regularly, the grant may be revoked.

The regulations forbid the taking of oysters upon the plantations before the rising and after the setting of the sun, under a penalty of $20 and the confiscation of the boat.

Whoever robs a plantation of oysters is liable to a fine of from $20 to $100, and, in default of payment, may be imprisoned for a term not exceeding a year.

When a planter is found guilty of having taken oysters from a neighboring plantation his grant is withdrawn, and all the products confiscated to the State, while he is also subject to the ordinary punishment for theft. The right of fishing for oysters in waters belonging to the State is withdrawn for three years from persons twice convicted of transgressing the laws concerning plantations.

Connecticut.—In Connecticut each district has the right, in a special meeting of the inhabitants, to nominate a committee of five members at the most, who shall designate the places in the navigable waters where oysters may be cultivated without infringing upon the rights of citizens, and without detriment to navigation. Persons wishing to establish a plantation must address a written petition to the committee, clearly indicating the parts of the sea or river which they wish to occupy. If nothing asked for in this petition is contrary to the public interest, the committee may issue a grant, defining the situation and the limits of the plantation, and the time it may be held.

The extent of ground occupied by any one person must not exceed two acres, and before taking effect the grant must be registered by the clerk of the district. Plantations must be surrounded by poles, two feet at least above the highest water mark.

The owner of land on which there is a small creek or estuary may, with the permission of the selectmen, close it with a sluice-dike, in order to form a depot for oysters, where they may be fattened. He must present his request to the selectmen of the district, and if, in their opinion, the dam will not interfere with the privileges of the public, or be an obstacle to navigation, these officers will represent the case at the next annual meeting, and, if approved, the party interested may construct the dam in question.

Any person convicted of taking oysters from a plantation without permission, or of removing or injuring in any way the boundary-marks, is punished, for the first offense, by a fine not exceeding $7, and an imprisonment of not more than thirty days; for the second offense, by a fine of from $7 to $10, and an imprisonment of from one to three months; and for every subsequent repetition of the offense, by a fine of $50, and imprisonment for six months. The guilty party is also liable to punishment by the State authorities.

Any one who establishes a plantation upon a bank of natural oysters, without permission, is liable to a fine of from $5 to $50, one-half of which goes to the treasurer of the district in which the offense was committed, and the other half to the informant.

New York.—In the State of New York, all land-holders on the banks of the Harlem River, have the right to plant oysters in the bed of the river, in front of their property, provided that a sign-board, with the name of the owner plainly inscribed upon it, marks the spot as private property. If this condition is fulfilled, no one but the proprietor or his agents can take the oysters from the plantation, under a penalty of $50, in addition to the value of the oysters stolen.

In Jamaica Bay, Queens County, land-owners on the shores of the bay and its tributaries, may plant oysters in front of their property, starting from the line of low tide and extending the beds about 66 feet. No person, or association of persons, is allowed to occupy more than a quarter of a mile along the shore. In this locality robbery of the plantations is punished by a fine of $25.

New Jersey.—In certain parts of this State the proprietors of tidal ground, in which are ponds, creeks, coves, &c., of salt water, which are not required for any public purpose, may use these for the culture or preservation of oysters by inclosing them with a dam.

Persons who, without permission, take oysters from the plantations, are punished with a fine of $20, without taking into account the action the owner may take for his damaged property.

Delaware.—According to the legislation of this State any citizen can establish in public waters a plantation, not exceeding one acre in extent, provided it is not on a natural bank of oysters, and that it does not interfere with navigation. It is necessary to inclose the plantation with poles or stakes, and to mark the ownership distinctly; and then any person who commits a depredation upon it is punished by a fine of $20. A person not a citizen of the State cannot, under any pretext whatever, deposit oysters in the bays, creeks, or rivers, under a penalty of $20 and confiscation of the mollusks.

Maryland.—Every citizen of Maryland may appropriate in the rivers, creeks, bays, &c., of the State, an extent of maritime ground, not exceeding one acre, for depositing and cultivating oysters, either for his own personal use, or for commercial purposes; provided he opposes no obstacle to navigation, and does not interfere with the rights of land-owners on the shore. A written description of the plantation and its limits, given under oath, must be registered by the clerk of the district.

In all cases the land-owners on the shore have a right of priority over one acre of ground, extending from the ordinary low-water mark. The plantations should be, as nearly as possible, rectangular.

Landholders having upon their property creeks or inlets, with mouths not over 100 yards wide, may use them for oyster plantations.

CHAPTER THIRD.

THE OYSTER-BUSINESS IN SEVERAL CITIES OF THE UNITED STATES.

A complete work upon the American oyster-fisheries ought, properly, to include all the localities in which they are carried on to any extent; but the length of time such an extended exposition of the subject would require, owing to the difficulty of obtaining precise information, as well as the constant repetition of similar statements, would make the subject very tedious to the reader. I have therefore preferred to confine my remarks to those cities of the Northern States in which this industry has reached its greatest importance, as a sufficiently approximate estimate can thus be obtained of its valuable addition to the resources of public alimentation. These cities, which I have had occasion to mention several times in the course of this treatise, are New York, Fair Haven, Boston, and Baltimore. They alone monopolize, in consumption and transportation into the interior, more than half the entire commerce in oysters of the entire United States.

New York.—New York, the rich and populous commercial metropolis of the United States, contains to-day more than a million of inhabitants, including the city of Brooklyn, which may be considered only one of its suburbs. Nowhere in America is the consumption of oysters so great as in this city. As I have already stated, the Merchants' Magazine estimated it at 6,950,000 bushels annually; that is to say, 19,000 bushels a day, on an average.

The culture of the oyster is carried on to a great extent in the vicinity of New York, partly on account of the excellent grounds afforded by the bay and neighboring waters, and partly from the necessity the dealers experience of having large depots for these mollusks near at hand, to supply the daily needs of the inhabitants.

The most celebrated plantations are situated, on the one hand, on the shores of Staten Island and New Jersey, and, on the other, on the coast of Long Island and in the arm of the sea known as East River, in which there are innumerable small bays and creeks in a most favorable condition for such purposes.

The two most important markets for the wholesale trade in these mollusks are Catharine Market, on the East River, and another at the foot of Spring street, on the Hudson River. As to the retail sales, they are made in all the markets of the city indiscriminately, in the oyster-houses, and in markets intended especially for the sale of fish.

The establishments at Catharine Market and at the foot of Spring street are floating houses, constructed on rafts, generally one story, but sometimes two, in height, and ornamented more or less elaborately. These houses are generally moored together, and kept in communication with the wharf by means of a swing bridge, which rises and falls with the tide. They are usually about 15 yards long by 10 wide, and are divided into three distinct compartments.

1. The part entered from the bridge, which constitutes the only room in the house.

2. That which I will call the cellar, which is under water, and extends from the platform of the room to the bottom of the raft.

3d. The attic, which is formed at the top of the house by a ceiling about two yards and a half above the floor of the room.

These establishments, called oyster-boats in New York, are eleven in number at Catharine Market, and twenty-three in number at the foot of Spring street. They are generally furnished with two doors, one communicating with the wharf, the other opposite the first, and opening upon a small platform at the back of the house. This arrangement is for the convenience of the fishermen, who are thus enabled to discharge their cargoes immediately into the oyster-boat, labor as well as time being thus saved.

These floating houses possess one great advantage, which is, that the oysters can be preserved in them alive for several days during the winter season, however low the temperature may be; and also in summer during the greatest heat, since the part under water is always cool.

The oysters, or clams, placed in baskets containing about a bushel, are stored in the cellar and attic of the oyster-boat. In the room are placed only specimens of the different qualities for sale, from which samples purchasers make their choice. Here, too, all the packing which the necessities of the trade require is done.

Although there are always a great many oysters in these establishments, they never remain more than a few days, and arrangements are made with the plantations for constant and regular supplies. The number of boats of all kinds employed by the merchants and the planters of the bay, including those engaged in fishing for the oysters and clams, is estimated at 15,000.

Oyster-boats are obliged to pay rent for the place they occupy along the wharves.

The principal places for the retail sale of the mollusk are Fulton Market and Washington Market.

Fulton Market, on the East River, from which it is separated only by the width of the wharf, is a large, ungainly establishment, where all the various branches of the trade in comestibles are united. There is some regularity in the disposition of stalls, but nothing else that can compare with the well-ordered arrangements of the large markets of Paris, or other cities of France. The Americans are a free and easy people, but their love of liberty sometimes degenerates into lawlessness.

There are several persons in Fulton Market engaged in selling shell-fish, who, notwithstanding their contracted quarters, keep a kind of restaurant, which it is very interesting to visit about noon, when merchants and workmen come from all quarters for their dinner. They are popular establishments in every sense of the word, and oysters, cooked in various ways, constitute almost the entire repast.

In front of the counters of these traders are large sheet-iron furnaces, usually rectangular, about six feet long, six feet high, and three feet wide. The upper part serving as a receptable for smoke is terminated by a pipe, which communicates with the outer air. The lower part, lined with bricks, holds a large quantity of coal, by means of which a hot fire is sustained.

Upon the fire, and touching it, a gridiron is placed, and on this the mollusks are cooked, particularly the roasted oysters, for which Americans have a special predilection.

I do not intend to enter into details in regard to the preparations sold at these restaurants, but I must say a word about the roasted oyster, as it is peculiar to the United States.

The mollusks used for this purpose are of large size, and generally come from New Jersey or the East River. They are placed upon the gridiron, the deeper valve below, and when sufficiently cooked in their own juice they are withdrawn from the fire and served to the customers. Large oysters prepared in this way are excellent, especially when seasoned with a little pepper and a few drops of lemon-juice.

There is no better way to obtain an idea of the habits of the American people than to visit their restaurants, where at the same table are found promiscuously representatives from all classes of society. There is a number of them at Fulton Market, and their business is very profitable, some of them selling as many as 10,000 shell-fish a day in the winter season. At Washington Market the stalls are not as comfortable as those in Fulton Market, and although the trade in oysters is considerable there are no restaurants, for the name can hardly be applied to the small establishments where soup is sold.

The mollusks are sold in the market both with and without the shells, and a certain number of men are employed by all the dealers to open the shells and take out the oysters. Each man has before him a kind of small anvil several inches long, and upon this he breaks the edge of the shell with the assistance of a flat piece of iron called a knife, one end of which serves as a hammer; he then turns the instrument round in his hand and inserts the other end, formed into a blade, between the valves, takes out the oyster with it, and throws it into a dish half full of water The work proceeds in this way very rapidly, and the men earn from $8 to $10 a week, according to their dexterity. Some earn as high as $15, but these are generally men in whom the proprietors place great confidence, and who are also intrusted with the sale of the mollusks.

New Haven and Fair Haven.—New Haven, the capital of Connecticut, ranks next to Boston in importance, in the oyster-trade. The business is divided into two distinct branches, the culture of oysters and the various occupations connected with their transportation tothe towns of the interior.

The principal plantations are situated in the bay. Commencing at a short distance from the head of the great pier, they extend over a distance of about three miles, almost without interruption; on the one hand to the southern part of the sandy point, and on the other to Morris Creek, always leaving free the channels of navigation leading to the harbor.

The maritime ground on which they are established is partially exposed at low tide. In some cases, however, the plantations are constantly submerged, and are at a depth varying from one to six feet, when the water is lowest. The soil is formed of sand and mud, mingled with sea-weed, and the stratum of mud, upon which the oysters rest, is about three inches thick.

The spectacle presented on entering the harbor is most curious. As far as the eye can see, the bay is covered with myriads of branches, waving in the wind, or swayed by the force of the currents. It looks as if a forest were submerged, the tops of the trees only rising above the surface of the water.*

At certain distances on the plantations, large boats are anchored or moored to posts, having a small house built upon them for the accommodation of the men appointed to watch the grounds. They are four in number. The wages of these guardians of the property amount to about $30 a month, and are paid by the association of planters. This system of surveillance is indispensable, since most of the plantations are at a distance from the harbor, and might be invaded with impunity, especially at night.

The oysters cultivated in the bay remain, for the most part, upon the ground until autumn, when the work of transporting them proceeds on a grand scale. They are also consumed at that time in great numbers by the planters, so that when frost commences there is not a single one left upon the banks. This course is necessitated by the severity of the winter weather, and also by the little depth at which the oysters are cultivated.†

About five hundred men are employed in planting oysters in the spring, and in gathering them in the proper season to supply the necessities of commerce.

As the fishermen must visit the banks at all states of the tide, they have boats of very peculiar construction, called "sharps," which draw only a few inches of water, and yet are very swift. Entirely flat on the bottom, the prow is sharply pointed and the stern greatly inclined. They have a rudder and can carry a sail. These sails are extremely simple, consisting of one or two triangular pieces fastened to a mast, the top of which is somewhat flexible and terminates in a point. Light poles, arranged as with the shoulder-of-mutton sail, serve to extend the sails of the "sharp," so that they are entirely flat. The result is that when the boat, sailing too near the wind, is thrown upon its side, the wind glides over the sail, and the boat rights itself. This system of

*As in most places where oysters are cultivated, the plantations here, also, are indicated by poles or branches, dividing the ground into regular portions. Although very slight, these poles are fastened so firmly in the ground that they cannot be readily displaced; and they are so flexible that they are not easily broken. When I visited the plantations, the boat which carried me was in full sail, and pressed upon them, first on one side, then on the other, and yet not one was injured. The boat, I ought to say, however, was managed with great skill in passing these obstacles.

†Although many of these oysters come from a warm climate, they could probably be preserved during the winter in the bay of New Haven, if they were planted at a greater depth.

arranging the sails seems the best suited to the purpose, and has been generally adopted.

The "sharps" generally hold from seventy to eighty bushels of oysters.*

The New Haven banks have a very high reputation, and the number of bushels planted annually is estimated at 250,000.

The establishments engaged in the transportation business are mostly at Fair Haven, a charming village, beautifully situated.† Divided into two parts by the Quinipiac River, they have been connected by means of a viaduct or railroad bridge.‡

The establishments of the dealers are on both sides of the river, and many of them are built partly in the water, in order that the fishermen may discharge their cargoes with greater ease.

The operation of taking the oysters from the shell is performed exclusivély by women, chiefly Irish, and the process is very nearly the same as in New York. Seated before a stand, loaded with a quantity of oysters, each one is supplied with a small hammer, with which she breaks the edge of the shells upon a blade of iron inserted in the stand. She then opens the oysters with a thin knife and throws the fish into a wooden pail placed at her right side. These women receive 8 cents a gallon, including the juice. They can earn at this price, if skillful, $2 a day in the winter season, when the work lasts throughout the day; but ordinarily they do not make more than a dollar and a half. About seven or eight hundred women earn their living in this way and some of the dealers employ sixty of them at a time.

As soon as a woman has finished a measure, the inspector of the establishment sets it down to her account, and empties it immediately into a tin trough, pierced with holes and placed under the spigot of a water-tank. The oysters are then well washed, in a full stream of water, and moved about with the hands, in order that any small pieces of the shell may be carried off by the current. They are then thrown into a cask.

The dealers send raw oysters away in small wooden barrels, called kegs, or in tin cans, containing about a quarter of a gallon.

During the winter, wooden barrels are considered a sufficient protection; but in warm weather, and when the mollusks are to be sent to a distance, tin boxes are used exclusively.

The work of packing is accomplished in the same building where the

*These boats, which are quite graceful in form, might be used with advantage in France, in bays, rivers, ponds, &c., where the water is not rough.

†Some of these establishments are at Oyster Point, on the western part of the bay.

‡At Fair Haven the Quinipiac is about a mile and a half wide, and is protected from the winds on the south and east by a chain of wooded hills, lying parallel with its course. It forms a beautiful smooth sheet of water, until its entrance into the bay, where the currents are very strong, but not sufficiently so to disturb the plantations established in the bed of the river. Some of the dealers, before using the oysters, deposit them for two or three days in the Quinipiac, the saltish water giving the flesh a better appearance.

oysters are shelled, or in one near at hand; and whatever may be the receptacle used, it must contain only a quarter of its capacity of juice.*

A tinner is employed in each establishment to close the cases, by soldering a small round piece of tin over the opening. The cases are then placed in a refrigerator, where they remain until sent to the railroad.

When dispatched to distant cities, those of the West for instance, the cases are inclosed in a box of pine wood containing about a dozen. These are tightly packed, and a space is left in the middle of the box for the reception of a piece of ice, which preserves the oysters until they reach their destination.†

The number of barrels and boxes or cases required annually, at Fair Haven, is so great that two large manufactories have been established for the manufacture of these articles, and they employ about one hundred and fifty persons. That for the making of kegs uses steam as a motive-power. Everything in the establishment is done by machinery. One machine cuts out the staves, a second the bottom; others pierce the holes, and form the plugs. The kegs at wholesale bring the following prices: Kegs containing a gallon, $1.08 a dozen; kegs containing a half-gallon, 94 cents a dozen.‡ Tin cases are worth $5.50 a hundred.

Oysters without the shell are divided into two classes—those of large size selling for twenty cents a gallon more than the others. They sell at the rate of $3 for half a dozen cases, each of which contains from seventy to one hundred mollusks.

In 1858 the number of oysters used by the establishments of Fair Haven amounted to 2,000,000 bushels.

It has long been known that few occupations in America are more profitable than the packing and transportation of oysters. In 1856, the Journal of Commerce reported that a single house at Fair Haven had made $100,000 in the last four years. In that very year the Levi Rowe house, which has agencies at Buffalo, Detroit, Cleveland, &c., alone transported 150,000 gallons. Twenty vessels were in its employ, and from seventy-five to one hundred young women were engaged in its workshops during the winter. Twenty-five or thirty houses engross the largest share of the business, some of them transporting as many as 1,500 bushels mollusks a day.

The oysters planted in the bay of New Haven and in the Quinipiac are all disposed of before winter, and during that season the establishments of Fair Haven are regularly provided with mollusks from the

*In the State of New York, dealers found guilty of selling oysters in barrels or boxes containing more than a quarter of their capacity of liquor, are liable to a fine of $20.

†When sent only a short distance the dealers adopt a more economical method. The oysters, mingled with pieces of ice, are put into a kind of scuttle-cask, provided with a cover, and thus are sent to Hartford, Syracuse, Utica, and to places even more distant.

‡The kegs are made to contain two gallons, one, three-fourths, one-half, or one-fourth of a gallon, according to size.

Chesapeake and the Delaware. On the arrival of the schooners which bring them, they are either landed in the store-houses immediately, or remain in the hold of the vessels, until negotiations concerning them are complete.

A few years ago the commerce of New Haven was much more important than at present, especially with the West. It has in part been supplanted in the market of Saint Louis by that of Baltimore, which has greater facilities of communications with that city.

In 1857 from two hundred to two hundred and fifty schooners were employed, for six months in the year, in supplying the establishments of Connecticut; now the number does not exceed one hundred.

Boston.—Massachusetts, although one of the smallest States, is, nevertheless, one of the most influential. Through its commerce, the practical intelligence and enterprising spirit of its inhabitants, &c., it takes the lead in all the industrial movements of the country, and it is unrivaled in the importance of its literary and scientific institutions. Situated upon the Atlantic Coast, in a most favorable position for maritime interests in general, both its great and its small fisheries have enjoyed remarkable prosperity. The shores of Nantucket, of Cape Cod, of Plymouth, and of Cape Ann nourish enormous quantities of lobsters, and abound with edible bivalves, while immense shoals of migratory fish, varying with the season, such as cod, flounders, mackerel, shad, and herring, every year bring wealth to its hardy fishermen.

Of the whole tonnage of American fisheries in general, Massachusetts counts more than half. Boston, the capital of the State, naturally enters largely into this industrial and maritime movement; and to speak of the oyster-fisheries alone, this city plays the same part in supplying the Northern States as Baltimore and Fair Haven do for the Central and the Western. Built upon ground which is almost an island, at the head of a bay, and protected from the open sea by a chain of small islands, it is almost entirely surrounded with vast sheets of salt water, in which are found united the best conditions for the culture of the oyster according to the American method. Four rivers, of which the most important are the Charles and the Mystic, empty into the bay, and increase facilities for the fisheries.*

Ten principal merchants conduct the different branches of the oyster commerce. One of them, Mr. Higgins, senior, furnished me with much of the information which I received, and supplied me with most of the mollusks which I sent to France. At once dealer, planter, and proprietor of an oyster-house, no one could be better fitted to furnish me accurate information as to all the details of the business. His establishment, like those of his fellow-merchants, is situated upon the wharf

*The oyster-plantations are numerous in the bay, upon the shores of Bird Island and Hog Island. They are also to be found in the Saint Charles and the Mystic Rivers; but as they only partially supply the demands of commerce, the deficiency is made up by the plantations of Cape Cod, from which the markets of Boston are mostly provisioned. The quantity of oysters planted in the different localities in the spring amounts to about one hundred thousand bushels.

of the City Wharf, a part of the harbor specially reserved as a depot for fishing-boats. It is a building consisting of but one room, about twelve yards wide and ten deep, and the interior arranged with reference to the utmost economy of space. All round the apartment is a horizontal stand, breast-high, and almost two yards wide, on which the oysters are placed. At regular intervals a small square of wood, about an inch thick, is nailed to the stand, which separates the places of the workmen, and also serves as a convenient support for opening the oysters. The men stand side by side, but not so close as to interfere with each other's movements. They use a peculiar knife, consisting of a thin blade of steel, with a very sharp point and a round wooden handle. When a workman opens an oyster he takes it in his left hand, places it upon the small square of wood, the part opposite to the hinge facing him, pierces the edge of the shell with the sharp point of the knife, so that he can introduce the blade between the valves, then cuts the muscle, takes out the flesh, and throws it into a tin measure at his side.

A skillful workman can open eighteen oysters in a minute. I have nowhere seen work executed so rapidly; and as the edge of the shell is not broken, there is very little *débris* mingled with the oysters. As the supplies of oysters diminish upon the stand they are renewed by persons detailed for the purpose. As to the shells, each man throws them into a cask placed at his right hand, which, when filled, he carries to the door of the apartment, and empties on the public road.

Wages are 10 cents a gallon for the oysters without the shells. In winter, skillful workmen can earn as much as $3 a day when the oysters are of medium size; the small ones require much more time.* Six or seven hundred men are employed annually, and most of them are also engaged upon the plantations of the bay.

The work of packing, of closing the barrels and tin cases, and of re-packing in boxes, with a receptacle for ice, &c., is carried on in every respect as at Fair Haven.†

Mr. Higgins keeps the oysters until the time for packing in double cases of zinc, containing from 50 to 60 gallons, and pieces of ice are mixed with them. In winter the establishments for transportation are supplied as at Fair Haven.

Baltimore.—Baltimore is the most important of all the cities engaged in the oyster-trade, as far as regards interior and foreign transportation. In fact, no other city of the Union is as advantageously situated for the business. In consequence of its position, on a navigable river

*The principal markets are in the cities of Massachusetts, New Hampshire, Vermont, and Canada, especially Quebec and Montreal.

†For short distances, during the warm season, it is customary to use tin vessels somewhat like our milk-cans. The oysters are placed in these, mixed with pieces of ice, which keep them fresh until they reach their destination. The merchants of Boston are in constant communication with the merchants of the neighboring cities, from whom they receive daily cans marked with the names and address of their owners, and they are immediately returned, filled with oysters. When they arrive the oysters are again put upon ice, and must be consumed within three days.

emptying into Chesapeake Bay, the expense of receiving the oysters is not great, and they can be easily dispatched to their various destinations, by means of the railroads which diverge in various directions from the city.

For about thirty years, Annapolis, the capital of Maryland, has been the principal market from which the cities of the West have been supplied with this article of food which every year has become more popular. Yet, strange to say, it is only within the last few years that public attention has been turned to the commerce, or any mention made of it in the statistics of the State. The only satisfactory document I could procure upon the subject dates only back to 1856, when a summary article appeared in the Baltimore American.

During the civil war all business matters were more or less deranged, so that the information contained in this treatise relates only to the condition of the oyster fisheries or trade as it was two years ago. The facts given are, for the most part, taken from an excellent publication printed in New York, called the "Merchants' and Commercial Review."

Besides the oysters consumed in the city, the transportation-houses send into the interior oysters in the natural state, without shells, or in cans, employing exactly the same processes as have been already described.*

Oysters in the shell, as well as out of the shell, are sent to the West and Northwest. Canned and pickled oysters go for the most part in the same direction; while the others are sent to California, Australia, the Antilles, and to a few markets in Europe, where the first of these preparations are highly esteemed.

The city of Saint Louis, Mo., is the center of the western commerce for transportation into the interior.

According to the official documents of the State of Maryland, for 1840, the oysters consumed by the trade at that time amounted to 710,000 bushels.

During the years 1856 and 1857, September to May, inclusive, the statistics of the oyster-trade were as follows:

Oysters in the shell:

	Bushels.
To Cincinnati and Chicago	400,000
To other cities	400,000
Consumption in Baltimore	150,000
Total	950,000

*The oysters required by the trade are obtained directly from the banks, or from plantations on the shores of Maryland and Virginia. Within the last few years they have been brought in great numbers from the vicinity of Norfolk, and these are very highly esteemed both for their size and their quality. The most important plantations in Maryland are in the counties of Saint Mary's, Dorchester, Talbot, and Somerset: in Virginia, in the counties of Northampton, Accomack, York, Gloucester, Norfolk, Lancaster, and Middlesex.

Oysters out of the shell, raw or canned:

	Bushels.
To California	200,000
To Saint Louis	150,000
To other cities	310,000
To foreign ports	50,000
Total	1,660,000

The season from 1859 to 1860 was an excellent one for the business, which began and continued with great activity. In the month of September the demand for raw oysters, put up in ice, was very great, as the oysters were superior to those of preceding years, particularly those of large size, taken from banks far out in the bay.* The price of the oysters continued good, and the principal merchants were busy night and day. As to the canned article, prepared for foreign exportation, it was also in great demand, and sold at a reasonable price, although oysters in the shell had advanced in price. During this season, the oysters consumed by the trade amounted to 25,000 bushels a day.

One-half of the principal transportation dealers were specially occupied with the sale of raw oysters and the other with that of the canned. The number of vessels employed in supplying the market of Baltimore was estimated at from 800 to 1,200.†

In the season of 1860 and 1861, notwithstanding the general prostrate condition of commerce, the oyster dealers did a good business, especially during the first months. From the 1st of September to the 15th of June, 3,000,000 of bushels were consumed; that is to say, 10,000 bushels a day on the average. About two-thirds were sent to the West, in a raw condition, packed in ice.

The commercial statistics of that season were as follows:

Number of the principal houses of transportation	30
Quantity of oysters sold in the market of Baltimore, (bushels)	3,000,000
Amount of the reselling of the oysters at $1.35 a bushel	$1,050,000
Number of vessels employed in the transportation	500
Number of persons employed in the various labors connected with the transportation trade	3,000
Capital engaged	$1,800,000
Commercial value of the canned oysters	$3,000,000

To avoid repetition, I will not speak of the manner in which the various operations of the transportation trade are conducted, since it is much the same as at Fair Haven. The oysters are generally opened by colored persons, of both sexes; while the white workmen are employed

*These were taken from the great banks of the Chesapeake Bay, which, as they are worked less than the others, yield oysters of larger size.

†Some of the boats used in the bay for transporting oysters to Baltimore are called "*pungies.*" They are a kind of schooner peculiar to the Chesapeake, moving with great rapidity, and holding from 300 to 600 bushels of oysters.

in putting them in boxes, in canning them, repacking them, &c. It is a custom in Baltimore to pack cases of raw oysters in boxes three feet and a half long by seventeen inches in width and only eight in depth. The cases are handled with great ease, and a space is left vacant in the middle for ice.

Mr. Maltby, a dealer who has made a fortune in the oyster-trade, informed me that, during the warm season, the boxes were placed in ice-wagons, so arranged that a current of cold air might pass continually over them.

The packing of raw oysters, taken from the shell and canned, forms one of the most lucrative industries of Baltimore. No other branch of commerce has a more substantial basis, since the demand for the article is constant, and the sales are ordinarily for cash. The importance of the business, upon which I cannot dwell too strongly, is one of the most convincing proofs of the influence that ostriculture, conducted on a grand scale, may have upon the wealth of a nation. Two or three thousand sailors man the boats, which provide the establishments with oysters; two thousand persons of both sexes are employed in opening the oysters; two hundred men in packing and closing the cans and in making the outside boxes; while three hundred tinners are required for the manufacture of the cans. It is probable that the value of the tin and solder used annually amounts to $150,000, while the number of feet of pine wood used for boxes must be nearly a million.

CHAPTER FOURTH.

GENERAL VIEWS UPON THE NATURAL HISTORY OF THE MARKET-CLAMS.

Soft clam (*Mya arenaria.*)—The soft clam is, next to the oyster, the most important bivalve of the American coast, whether we view it as a means of public sustenance, or as an addition to the fishing industry of the country. Its great abundance on the coasts where it is found, the good market it commands, the ease with which it can be obtained from the banks at low tide, all render it a most valuable source of sustenance for the poorer classes.*

Its principal characteristics are the following: the shell is oval, equivalve, almost equilateral, thin, open at both ends, and especially at the posterior part, which can never be closed on account of the conformation of the valves. The exterior surface is rugose, and marked in places by the raised lines of growth. Its general color is a chalky white, sometimes a blue black, more or less deep. The left valve has a cardinal tooth, as broad as it is long. There are two muscular impressions, and the ligament which unites the two valves is internal. In specimens of large size the siphons are nearly two inches long.

* In some places this mollusk has retained its ancient Indian name of *Maninose*.

As I have said in the introduction, soft clams form upon the coast of New England immense banks, upon which constant demands are made by the people, without any apparent diminution in the products. The places where the mollusks are found in the greatest abundance are the emergent sloping beaches of the counties of Barnstable and Essex, in Massachusetts. Farther south they are more rare, and if the information given me is correct, they are not found below the latitude of the mouth of the Delaware. They are so numerous in Boston Harbor, that I have myself seen more than a hundred of different sizes taken from a single square foot of ground, on the shores of Governor's Island.

The soil which suits them best is sandy, with a large proportion of mud, in which they can bury themselves to a greater or less depth, according to the season. In pure sand, or in too compact gravel, they do not develop as well, and attain a size of only about two inches and a half in length; while in mud they generally grow full three inches and a half long. Dr. Gould had a specimen which measured five inches and a half in length.

The color and thickness of the shells vary greatly, according to the surroundings of the animal. In sand, they are almost white. If gravel predominates, they are more yellowish; while in mud, on the contrary, they take a bluish tint, more or less deep.

Soft clams are, in the full acceptation of the word, inhabitants of the beach, living as *Solens*, *Tellinas*, and *Donaces*, in banks which are uncovered at low tide. In certain localities they are found only a few feet from the point reached by the waves at the highest tide. The consequence is, that during the great heat of summer they are exposed for a part of the day to a very high temperature. During the winter, when the shores of New England are often covered with ice for several weeks, the fishermen say that the clams leave the higher banks, and move nearer the sea. I was not in possession of the data by which I could refute this statement, but I am inclined to think that the clams, instead of changing their locality, only bury themselves more deeply in the sand during the continuance of the cold weather. A fact strongly confirmatory of this is, that they can be obtained during the winter season, if the ice is broken. Whatever may be the truth in regard to their moving away in cold weather, it is certain that they can bear a very low temperature, since Professor Agassiz has frequently found in the shells of these mollusks icicles, which did not seem to incommode them in the least.

The spawning season occurs, according to the fishermen, during the months of June and July. How much time they require to attain full size is not known, the American naturalists not having studied the subject. Judging from the almost imperceptible difference there is between specimens differing considerably in age, their development must be very slow.

Clam-beds are generally found in sheltered parts of the coast, or at least in places where the action of the waves is not sufficiently strong to change the character of the banks. This fact I observed several times at Nahant, the summer residence of a portion of the wealthy inhabitants of Boston. On all the eastern shore of this quasi-island, washed by the open sea, not a single soft-clam is to be found; while on the western, where the water is comparatively calm, they exist in great numbers. They are taken by means of a spade, at low-tide, when the banks are left uncovered. Their hiding-place is betrayed by a number of small holes, through which they eject a stream of water when the sand is pressed down upon them, or shaken by the spade. This habit has won for them a very descriptive, although not very poetical name. On some parts of Long Island Sound hogs go down upon the banks at low water to hunt for clams, of which they are very fond. They manifest great sagacity in finding them, and know exactly when to leave, so as not to be caught by the returning tide.

The consumption of these mollusks is considerable during every season, but especially in summer, along the entire coast of the Northern States, from New York to Maine; but nowhere is it so great as at Boston.

In most places regular fishermen sell the clams in their natural condition; but in some localities, like New York, they are generally taken from the shell and sent to market in packages of twenty-five, which are sold, on an average, at 75 cents a hundred.

The merchants mix pieces of ice with the clams in summer to keep them fresh; in winter, of course, this precaution is unnecessary.

The extent of the fisheries throughout the year depends upon the rate of consumption.

The people of the United States use clams in a variety of culinary preparations, the most popular of which is, undoubtedly, a kind of soup especially esteemed in Boston.*

*In Rhode Island and Massachusetts clams serve as a pretext for fêtes of a very peculiar kind, called *clam-bakes*. The following description is taken from a work on natural history published in the United States:

"The clam-bakes which take place every year near Bristol, as well as in several other localities of Rhode Island and Massachusetts, have their origin in an old Indian custom.

"The aborigines of these States were accustomed to assemble in great numbers every year for a feast consisting of clams and green corn cooked together with sea-weed. The modern clam-bake is an improvement on the old one. A circular hearth or bed is first made in the sand, with large flat stones, upon which a fire is kept up until they are red hot. A layer of sea-weed is then placed upon them, and upon the sea-weed a layer of clams about three inches thick covered by more sea-weed; then follows a layer of green corn in the husk, intermixed with potatoes and other vegetables; then a layer of poultry cooked and seasoned; then more sea-weed; then fish and lobsters, again covered by sea-weed. This arrangement is continued according to the number of persons to take part in the feast, and when the pile is complete it is covered with a linen cloth to prevent the steam from escaping. When the whole is cooked each one helps himself without ceremony. These feasts are delicious beyond description, and it is said no one is ever made ill by them. In former times the most renowned warriors came from afar to take part in them, and now they are attended by persons of the highest social standing, sometimes to the number of several hundreds.

Whatever may be the value of soft clams as a means of sustenance for the people along the coasts, they are still more important to the fisheries of the country. The Americans have for a long time been aware of the marked predilection which many fish, particularly those of the cod species, manifest for the flesh of clams, under whatever form presented to them. Before this fact was proved by experiment the seamen of the banks of Newfoundland and Saint George had frequently observed that cod-fish relied to a great degree for their nourishment upon bivalves similar to the coast clam, called in natural history *Mya truncata*, and which is frequently found in the stomachs of these fish.

Clams are used for bait, either alive or salted, according as the fishery is on the coast or out at sea. In the first instance they are enveloped in pieces of net, and kept in the wells with which the coasting-vessels are generally provided. When they do not possess this convenience, they can still be preserved for several days by keeping them in a cool place. In the second instance, after they are taken from the shell, they are salted and then carefully packed in barrels, and are sold to the owners of vessels engaged in the cod-fisheries off the banks of Newfoundland and Sable Island.

Dr. Gould estimated that in 1840, 40,000 bushels of clams were consumed in the preparation of salt bait, in addition to large quantities used in a natural condition by the coast fisheries.

Salted clams are also used with success in the mackerel-fisheries, in which they are employed like the roe of the animal to attract the fish.

Round clam (*Venus mercenaria.*)*—The round clam is a species of edible Venus, almost as abundant upon the coast as the *Mya arenaria*, and rivals that mollusk as an article of food, although it is of far less importance as bait for the fisheries.

In some places it has retained its ancient name of quahog, by which it was known to the aborigines of North America. The Indians manufactured out of the violet part of the shell colored beads called *wampum*, which served them as money. The mollusks which they used came for the most part from Long Island, called, in the picturesque language of the Mohicans, "the Island of Shells."

The round clam has a regular, thick shell, very convex, with crenulated margins, and three cardinal teeth in each valve. The exterior surface presents numerous concentric lines, and a few more prominent ones. The part near the umbones is always more or less worn. The ligament, of a brown color, is large and very apparent; the lunule is oval; the exterior surface is ordinarily of a dirty white color, and sometimes bluish, according to the nature of the ground inhabited by the animal. There are two muscular impressions, and the interior edges of the valves are

*The "round clam," or simply "clam," as it is called along the coast of the Middle and Southern States, differs in several important characters, especially the armature of the hinge, from the typical species of *Venus*, and is therefore now generally regarded as the representative of a distinct genus, and accordingly called *Mercenaria violacea*.

of a violet color, more or less deep in proportion to the age of the animal. These mollusks, when fully grown, are commonly three inches and a half long, two inches and a half wide, and three inches thick.

The *Venus notata* is a species of clam very nearly allied to the one just mentioned, and is probably only one of its varieties.

Round clams exist in great abundance on the American coast, from Cape Cod almost to the extremity of Florida.* They are generally found on the shores of gulfs, of bays, and of the mouths of large rivers, which are less exposed to the action of the waves than the open coast. Their beds are at a depth varying from 6 to 25 feet below the surface of the water at low tide. Like all the mollusks of that family, they prefer a large proportion of mud with the sand in which they live. They bury themselves only a few inches deep, with the siphons directed upward. During my stay on Long Island, I frequently saw clams caught, the shells of which were covered with sea-weed, a convincing proof of the shallow depth at which they are buried in the soil.

Clams are caught by means of the tongs and the rake, the fishermen stationing their boats over the beds at the proper state of the tide. The tongs in use is exactly like that employed in taking oysters. As to the rake it is entirely of iron, about two feet wide, with semicircular teeth, the curvature of which answers the same purpose as the net-pouch in the ordinary rake. The teeth are separated about a quarter of an inch, and are about two feet long. The rake has a light pole for a handle, from 20 to 25 feet in length, according to the depth of the water over the bottom to be explored.

I would repeat here what I before said in connection with the taking of oysters, that these instruments are exceedingly well adapted for use upon small beds. They not only do not destroy a large number of mollusks to no purpose, as is the case with heavier implements, but, on account of the space between the teeth, small specimens are rarely taken, and the banks are consequently not depopulated.

I have imported from the United States models of the tongs and the rake for the fishery-bureau, since I am satisfied that if they were brought into common use upon our shores they would be of great service to our fishermen. Besides, I have no doubt that, with their aid, beds of mollusks, hitherto unknown, may be found in bays of the ocean or in the Mediterranean. It must be admitted that our present knowledge of the extent of our wealth in shell-fish is still very imperfect, on account of the restraints imposed by the ancient regulations which yet control the ordinary fisheries. The use of the instruments in question does not, however, interfere with the multiplication of fish in the water

*Clams are nowhere so abundant as in Long Island Sound; in the great bay south of this island; in the bay off Sandy Hook; upon the shores of Jersey, and at the mouth of the Delaware. They are also taken in great quantities in Chesapeake Bay, and in Albemarle and Pamlico Sounds.

when employed to explore the bottom of the sea, if the statements of the American fishermen are to be relied upon.

Round clams are the object of an especial industry designed to improve them and to promote the rapidity of their growth. Like the "païres doubles" [*Venus verrucosa*] or clams of the Mediterranean, they are never as delicate in flavor as when freshly caught. Still, in many places depots are formed for these mollusks in sheltered coves or creeks, in order to be ready to supply the exigencies of commerce.*

The fishermen generally supply the dealer directly from the banks, taking care to proportion the supply, as nearly as possible, to the demand. Clams are so hardy, however, that they will at any season live for several days out of the water if placed in the shade. In cool weather they will survive for as many as fifteen days, and may be sent by rail to distant localities in the interior of the continent.

In summer, the consumption of clams in the cities of New York† and Philadelphia is very considerable, much greater than that of the *Mya arenaria*. Like the latter, sold in their natural condition, or out of the shell, they furnish many excellent dishes, the most esteemed of which is clam chowder. Many persons eat the smaller specimens raw, and when flavored with a few drops of lemon-juice they seem to me as palatable as the clovisses [*Tapes virginea* and *Tapes decussata*,] and the païres doubles, [*Venus verrucosa*,] which are the especial favorites of the people of Marseilles.

The acclimation of round clams upon the shores of France offers, I believe, as many chances of success as that of the oysters from Virginia, of which the specimens I brought to France, numbering five or six thousand, are now living on our coast, without appearing to suffer in the least from the change of their native beds. It may be laid down as a principle, that wherever the "païres doubles" [*Venus verrucosa*], the cockles [*Cardium edule*], or the "palourds" or hen-clams [*Tapes decussata*] are found, the *Venus mercenaria* will be equally sure to prosper; success will be only a question of time.

RECOMMENDATIONS FOR INTRODUCTION.

Before closing this exposition of the shell-fisheries of the United States, I must insist upon the utility of propagating the *Mya arenaria* on our sea-coasts. Since my return from the United States, M. Fournier, commissioner of maritime inscription at Dunkirk, has furnished me with some valuable information regarding the same species found in the northern seas, bearing upon this question. This bivalve is

*At New London the ship-merchants build, in addition to their establishments, upon piles at the edge of the sea, special structures for the preservation of round clams. These consist sometimes of floating tanks, which contain several thousands; sometimes of wooden paddocks or pens, shaded from the sun and placed between the piles in such a way as to be covered by the tide several hours every day. The mollusks live for a long time in these reservations, provided too many are not crowded into them.

† At the Washington and Fulton markets, in New York, clams sell for $3.50 a thousand.

found in abundance on the shores of Dunkirk, especially in the fish preserves. To determine the question whether it and those of America were the same, M. Burkardt and myself endeavored to import some from the United States, but without success. I sent for several dozen of them by the captain of one of the steamers which ply between Havre and Dunkirk.

The specimens sent me on the 30th of June, 1863, were of all sizes, and one of them measured a little over three inches in length by two in width. I recognized at a glance the *soft clams* of New England. There were the shells separated at the ends, with the same twisted conformation, through the upper opening of which the animal projected a long muscular siphon, which it could contract so as to draw it entirely within the valves; the same form and size of the cardinal tooth, the exterior color of the shells, of a dun white, in some parts bluish; in short, these shell-fish were, in every respect, identical with those of the United States. Carrying my examination still further, I ate the Myas of Dunkirk in a raw condition, as well as cooked in various ways, and found them excellent. As they came from a basin where the sea-water was not sufficiently renewed, they were somewhat less delicate than those of the banks in the bay of Boston; but if transplanted into a more favorable medium, they would undoubtedly rival the latter.

The importance of the fact that the soft clam of North America lives in the latitude of Dunkirk is evident, as it shows the possibility, I may say the certainty, of realizing Professor Agassiz's programme. Once propagated in several localities on the coast, this mollusk will furnish a bait without rival for the coast fisheries; and when salted, it might be used for the cod-fishery of Iceland and Newfoundland. We know that at certain periods of the year the fishermen along the coast find it difficult to obtain bait; for instance, the fishermen of Havre, who, at the season of fishing for "gross-yeux," sometimes pay five centimes apiece for small cuttle-fishes, and cannot always obtain enough even at that price. The *Mya arenaria* would supply this want.

To plant the exposed sands of Britain and Normandy with these shell-fish would be truly a benefit to the maritime population. If not found there, it is probably owing to the shifting nature of the banks on the shores of Dunkirk, and also the rapidity of the currents. In short, the hydrographic conditions are such that, left to themselves, the *Mya arenaria* is not able to traverse the spaces which separate it from other portions of the coast, where, if transplanted by the hand of man, it would thrive wonderfully well.

The experiment might at least be tried; nor would it cost much, as, the locality once chosen, it would require only a few days to transport a sufficient number of mollusks. One of the steamers guarding the fisheries of the first maritime district might be employed for the purpose.

APPENDIX B.

THE RIVER FISHERIES.

XVII.—THE PROPAGATION AND DISTRIBUTION OF THE SHAD.

A—OPERATIONS IN THE DISTRIBUTION OF SHAD IN 1874.

BY JAMES W. MILNER.

DISTRIBUTION FROM COEYMANS, N. Y.

The work of shad-distribution began the last week of June; the delay in the control of available funds preventing any possibility of propagation in the Potomac or rivers to the southward.

The services of experts were obtained at once for the season, and four traveling parties organized at Coeymans, N. Y., the station of the New York State commissioners.

The first shipment was made from this point on the 24th of June. Between this date and July 9, seven shipments were made to streams in the States of Ohio, Indiana, Illinois, and Texas. In all four hundred thousand shad were placed in tributaries of the great lakes, the Mississippi, and in the Brazos and Colorado Rivers of Texas.

DISTRIBUTION FROM SOUTH HADLEY FALLS, MASS.

The work of the New York commissioners ceased about the 3d of July, and the traveling parties moved to South Hadley Falls, Mass., the station of the Connecticut commissioners. Mr. Monroe A. Green had the direction of the work at its commencement here and during my absence of a fortnight in Texas and elsewhere.

Part of the plan at this station was to move a portion of the shad into the Connecticut above the fish-way. The generally accepted fact in the habits of anadromous fishes that they are disposed to return to almost the exact locality where they passed their embryonic and earlier stages of growth indicated a necessity for establishing a colony above the Holyoke dam.

There is a large amount of evidence to establish the fact of this habit in the salmon and alewife, and many fresh-water fishes seem to have as strong an instinct for locality as have the birds and mammals. It is tolerably evident that the shad possesses the same disposition to find its way back to familiar waters.

Observation of the shad brought to the large markets shows considerable difference in the physiognomy and general contour of those from different rivers. The suggestion is natural that they are distinct and separate colonies of the same species, and thus slight characteristics are perpetuated because they breed in-and-in and do not mix with those of other rivers. If they have the instinct of locality to the degree that the salmon and alewife have, there would be likely to be little disposition in the shad of the Lower Connecticut to ascend the Holyoke dam. The Holyoke dam was erected in 1849. The present colony of shad in the Connecticut River can therefore have little of either inherited or developed instinct to extend their migrations above the foot of the dam.

As yet, no fish-way has proved to any large extent successful for shad. Their exceeding timidity is supposed to be the chief reason why they will not enter a fish-way. Even if this be the reason, no thorough test can be made until a colony has been established above the dam, because of the evidence there exists that they have no disposition to ascend higher than their familiar spawning-ground.

The proof of the success of a fish-way as a means of ascent for the shad to the upper waters of the rivers of the United States was regarded as a matter of considerable importance. A test at this well-constructed fish-way will probably afford all the evidence as to their desirability and their merits in deserving outlay where their purpose is principally for the ascent of shad. About 565,000 were placed above the dam, about one-half million being moved above Bellows Falls, in the State of Vermont. From this station, over two millions of young shad were sent to rivers in New England, the tributaries of the great lakes, Lake Champlain, and the Mississippi.

The German government during 1871 sent out Dr. Otto Finsch to examine into the fisheries and food-fishes of our waters, with reference, if possible, to a better development of the resources of their own waters. On his return he had strongly recommended the shad as above all other fishes the most important acquisition to Germany. This country is traversed by long rivers like the Rhine, the Weser, the Elbe, the Oder, and the Vistula. He was desirous, as a first experiment, that they should be introduced into the Weser.

The North German Lloyd Steamship Company, through their agents, Messrs. Oelrichs & Company, offered to transport the fish and attendants to Bremen, and return the attendants to New York, without charge. The friendly action of the German government in 1873 in their gift of 250,000 salmon-eggs prompted a ready compliance to this generous proposal, and 100,000 fish in charge of Fred Mather and A. A. Anderson were sent from Holyoke, Mass., and left on board of the steamer Donau, for Bremen, on the 5th of August. The steamer provided for the welfare of the fish a large clean tank containing an ample supply of Croton water. A convenient compartment on the deck contained the cans of fish swung in such a way that they were not endangered by the movements of the vessel.

Mr. Mather reports that continual care was given them and they remained in vigorous condition until the sixth day out, when they began to suffer.* A fog settling down over the surface of the sea increased the

*See Mather's report.

temperature until the mercury stood at 73° in the atmosphere. This seemed to lessen the vitality of the fish very fast, and at ten days out from land and within three days of the end of the voyage the last fish was dead.

An apparatus was devised by Mr. Mather with the intention of taking a quantity of partly-developed eggs, which would hatch when a few days out from land, and thereby limit the period of time the living fish would have to remain in the cans.

This apparatus was a large can, with a capacity of about twenty-five gallons; within it a cylinder having a wire-cloth bottom and a tight lid was adjusted, and within the cylinder the eggs were to be put. The cylinder had four arms soldered to it near the top, and the same number near the bottom. The ends of these arms had a solid rubber ball inserted. The ends of the arms with the rubber surface rested against the inside of the can, the friction sustaining the cylinder at any height in the can desired.

The plan was to fill the can to a convenient height with water, and it was thought the jolting of the railway-trains and possibly the roll of the steamer would be sufficient to give the eggs the necessary motion.

When leaving the river a quantity of eggs was put into the cylinder, but the wire-cloth used proved to be too coarse, and by the time the two miles between the river and the depot had been traversed the eggs had all worked through the meshes of the wire-cloth and were in the can below. It was, of course, useless to take the can farther.

It is due to those who had the experiment in charge to say that they were called on for the undertaking suddenly and unexpectedly, and that no time for experiment was afforded them before the start.

Omitting the shipment to Europe, I am able to report a very general success in the transfers of live shad.

The longest trip, that to Texas, suffered a loss in the quantity started with of 15 per cent. In most of the shipments the loss was very slight, not more than one or two per cent. A slightly larger loss was reported once or twice by men who had had little experience.

A very general appreciation of the effort was displayed in the regions benefited, and considerable enthusiasm shown wherever the people were at all informed in the matter of fish culture.

Tables are herewith appended showing the distribution of shad in 1874.

Record of distribution of young shad made from June 25, 1874, to August 15, 1874, by United States Commission Fish and Fisheries, under direction of James W. Milner.

Date of transfer.	Place whence taken.	Period of journey.	Number of fish.		Introduction of fish.			Transfer in charge of—
			Originally taken.	Actually planted.	Place.	Stream.	Tributary of—	
		Hours.						
June 25	Cooymans, N. Y	27	Loss scarcely perceptible	60,000	Eagleville, Ohio	Grand River	Lake Erie	Chase and Mather.
June 26	......do	28	......do	60,000	Tremont, Ohio	Sandusky River	....do	H. W. Welsher.
June 31	......do	34	......do	75,000	Logansport, Ind	Eel River	Wabash River	Mather and Vealey.
July 3	......do	132	23,000	20,000	Hempstead, Tex	Brazos River		Milner, Mason, and Clark.
July 4	......do	149	47,000	40,000	Austin, Tex	Colorado River		Do.
July 9	......do	44	Loss imperceptible	70,000	Rockford, Ill	Rock River	Mississippi River	Welsher and Chase.
July 9	......do	32½	......do	75,000	Bellefontaine, Ohio	Miami River	Ohio River	Mather and Vealey.
July 15	South Hadley Falls, Mass	5	......do	215,000	Bellows Falls, Vt	Connecticut River		Do.
July 27	......do	5¼	......do	140,000	....do	....do		Chase and Brooks.
Aug. 1	......do	5	......do	120,000	....do	....do		Mather and Vealey.
Aug. 8	......do	1	......do	60,000	Smith's Ferry, Mass	....do		H. J. Brooks.
Aug. 20	......do	5½	......do	30,000	Bellows Falls, Vt	....do		Do.
July 18	......do	24½	......do	65,000	Monroeville, Ohio	Huron River	Lake Erie	H. W. Welsher.
July 18	......do	23	......do	65,000	Elyria, Ohio	Black River	....do	Oren M. Chase.
July 22	......do	36	......do	80,000	Indianapolis, Ind	White River	Ohio River	Mason and Clark.
July 22	......do	5	......do	110,000	Putnam, Conn	Thames River		Mather and Vealey.
	......do	8	......do	20,000	Noank, Conn			Do.
July 25	......do	15	......do	100,000	Waterville, Me	Kennebec River		Mason and Clark.
July 28	......do	23	......do	100,000	Mattawamkeag, Me.	Penobscot River		Welsher and Griswold.
Aug. 14	......do	25	......do	100,000	....do	....do		H. J. Brooks.
July 28	......do	10	......do	150,000	Vergennes, Vt	Otter Creek	Lake Champlain	Chase and Brooks.
	......do	6	......do	35,000	———, R. I	Blackstone River		Ellis.
July 30	......do	33	......do	80,000	Elkhart, Ind	Saint Joseph River	Lake Michigan	Frank N. Clark.
	......do	51	......do	60,000	Ottumwa, Iowa	Des Moines River	Mississippi River	Mather and Vealey.
	......do	60	......do	40,000	Des Moines, Iowa	....do	....do	Do.
July 31	......do	38½	85,000	80,000	Columbus, Ind	Wabash River	Ohio River	H. J. Brooks.
Aug. 1	......do	27	Loss imperceptible	80,000	Detroit, Mich	Detroit River	Lake Erie	Chase and Griswold.
Aug. 3	......do	7¼	......do	100,000	New Milford, Conn	Housatonic River		Frank N. Clark.
Aug. 5	......do	60	......do	100,000	Saint Paul, Minn	Mississippi River		Chase and Vealey.
Aug. 6	......do	31½	......do	80,000	Corunna, Mich	Shiawassee River	Lake Huron	Frank N. Clark.
Aug. 10	......do	2	......do	80,000	Westfield, Mass	Westfield River	Connecticut River	Charles D. Griswold.
Aug. 13	......do	2¼	......do	210,000	....do	....do	....do	Frederick A. Smith.
Aug. 11	......do	11	......do	120,000	Winooski, Vt	Winooski River	Lake Champlain	Brooks and Griswold.
Aug. 12	......do	12½	......do	80,000	Georgia, Vt	Lamoille River	....do	Do.
	......do	12	......do	80,000	Swanton, Vt	Missisquoi River	....do	Do.
Aug. 15	......do	8½	......do	50,000	Noank, Conn			Charles D. Griswold.
				3,031,000				

B—REPORT ON SHAD-HATCHING IN NEW JERSEY.

BY G. A. ANDERSON.

I have the honor to submit the following report of shad-hatching operations on the Delaware for the year 1874, compiled from memoranda left by the late Dr. J. H. Slack, deputy commissioner.

In response to your telegram of June 23, Dr. Slack took the evening train to New York, and on the 24th called on you and received instructions. He left New York in the afternoon and reached Point Pleasant, Pa., (where the work was to be done,) on the 25th. His messenger from Troutdale met him with apparatus and the work was at once begun.

Owing to the very great drought prevailing at the time, the water in the river was very low, and the run of shad was small.

Dr. Slack remained at his post until the afternoon of July 2, when he returned to Troutdale, and on the following day was prostrated by a sudden attack of pleuro-pneumonia from which he never rallied, and which terminated fatally on the 27th of August. There is no doubt that exposure on the river at night, in the prosecution of his work, induced the disorder.

After Dr. Slack went away, the work was carried on by his assistant, William H. Swartz, who continued it until the 13th July, when he was ordered to cease operations. The number of spawn taken appears by the abstract hereto attached. It is proper to say that the water in the river was lower than had been known for many years, and that this interfered materially with the work. There appeared to be at all times a scarcity of male fish, and this fact prevented his increasing the number of spawn reported. It is probable that had Dr. Slack lived to continue the work this difficulty would have been overcome by keeping alive a few hours some of the males taken through the day.* An account of expenditures will be forwarded herewith. In conlusion, I will say that the importance of the work you have undertaken is beginning to be understood and appreciated by our people, and it is hoped you may be able to continue it.

All of which is respectfully submitted.

*Attempts to keep males confined for a few hours have usually resulted in their death.

Abstract showing spawn of shad taken by and under direction of the late Dr. J. H. Slack, deputy United States commissioner of fish and fisheries, on the Delaware River, at Point Pleasant, Pa., commencing June 25 and ending July 12, 1874.

	Time.	Air.	Water.	Spawn taken.
June 25, 1874	8 p. m.	77	74	35,000
June 26, 1874	10 p. m.	77	72½	75,000
June 27, 1874	8.30 p. m.	....	....	85,000
June 28, 1874	8.30 p. m.	83	72½	(Sunday.)
June 29, 1874	1.30 p. m.	97½	75	60,000
June 30, 1874	p. m.	83	76	No males taken.
July 1, 1874	9 a. m.	80	74	90,000
July 2, 1874*	5 p. m.	85	81	No spawn.
July 3, 1874	8 p. m.	72½	79	20,000
July 4, 1874	4 p. m.	84	79	20,000
July 5, 1874	7 p. m.	70½	74	65,000
July 6, 1874	5 p. m.	77	79	40,000
July 7, 1874	6 p. m.	73	78½	No spawn.
July 8, 1874	7 p. m.	80	80	No spawn.
July 9, 1874	6 p. m.	82	81	No males.
July 10, 1874	5 p. m.	83	80	No fishing.
July 11, 1874	5 p. m.	72	79	No spawn.
July 12, 1874†	5 p. m.	75	74	40,000
Total	....	....	....	530,000

* Record from July 2, kept by W. H. Swartz. † Ordered to stop by telegram from Dr. Slack.

Prof. SPENCER F. BAIRD,
United States Commissioner of Fish and Fisheries.
BLOOMSBURY, *October* 24, 1874.

C—VOYAGE TO BREMERHAVEN, GERMANY, WITH SHAD.

By FRED MATHER.

On the morning of Tuesday, August 4, 1874, I left Holyoke, Mass., for New York to make preparations to receive the fish on board the steamer Donau, advertised to sail the next day. At midnight the fish arrived at the Grand Central depot, in charge of two men of the commission. There were ten cans, each containing 10,000 fry, hatched the morning before. The cans were ordinary milk-cans, capable of holding twelve gallons; two extra cans for water, and a double set of siphons, strainer-tubes, and dippers were also brought. An express-wagon conveyed them to the steamer's wharf at Hoboken, where they were taken on board the ship. On the morning of the 5th I was joined by Mr. A. Anderson, who was selected to assist in taking care of the fish on the passage. The cans were placed in a room 15 feet by 8. This room was a passage-way, between the gangways of the lower or cabin deck; it had also a stair leading to the upper deck; a door at each gangway and at the top of the stairs, which when closed made it a tight room. The steamer had two tanks filled with Croton water, expressly for our use; these were in the lower hold, and were of cast iron, lined with cement.

Mr. Anderson and myself divided our watches into six hours each, and gave the fish fresh water every hour for the first six days, and every half-hour the four remaining ones that they lived. Our manner of giving it was this: about two gallons would be drawn from each can, and a dipper-full added each hour. In addition, on each watch the cans were drawn down half way, and the water aerated by pouring from one pail to another, and then replaced.

To keep the water in the cans sweet and wholesome, the dead were drawn off every morning; this was accomplished by swirling the water with a dipper, which caused all dead fish to collect in the center of the can; a siphon was then filled with water, and kept closed until it rested on this mass, when it was allowed to flow until all dead fish and sediment were removed.

The following is a table of temperatures and casualties:

Date.	Temperature in cans.				Remarks.	Loss.
	6 a. m.	Noon.	6 p. m.	Mid-night.		
	°	°	°	°		
Aug. 5	70	68	66	66	Gave water every hour	500
6	66	66	67	64		200
7	64	62	63	64	Emptied each can and cleaned it	1,000
8	64	62	64	64		20
9	62	62	64	64		100
10	64	65	67	73	Fog at night and hot	3,000
11	69	66	64	64	Gave water every half-hour as the fish were getting weak	500
12	62	64	64	63		1,200
13	63	62	62	62	Tried to feed them	5,000
14	64	59	60	61	All dead at noon but 1,000, which died at night	

The fish, in my opinion, died from starvation; hatched on the morning of the 4th, they were probably looking for food about the third or fourth day after, but appeared strong until the morning of the 12th, when we first noticed signs of weakness by a slow motion, and many alive resting on the bottom of the can.

On the morning of the 13th I procured a piece of raw beef, and washed it in water. I could see many particles in it, and it would have been good food for any of the salmonidæ, but the shad did not appear to notice it. I very much doubt, if the fish had been turned into a river full of their natural food at this time, that they would have lived, for they were past the point of reviving. It is doubtful if the Croton water that we had on board the ship contained the minute forms of animal life upon which the shad-fry feed. It was confined in tanks below three decks in the dark.

We now know the extreme-limit of their endurance without food. They have been taken from the Hudson River to California in seven days, and have lived and will probably breed. Ours died of exhaustion in a trifle over ten days.

From this, and the reports in the "Forest and Stream," of the experiments by Comdr. L. A. Beardslee, at Noank, I do not regard the transportation of shad-fry as at all practicable on a journey occupying over eight days, unless we can discover some method of feeding them. This seems at present difficult, and I have hope of a better result from taking the eggs and hatching the fry upon the passage. This seems to me to be the most practicable and easiest method; and in the connection I would refer to the hatching-can which I invented and have given to your commission. This was done too late for trial this season, and although intended for use on railroad-cars may be of service on shipboard.

The deputy commissioner, Mr. J. W. Milner, who had the charge of the shad-distribution, intended to have this can tried on our voyage, and when the fish were put up he had several thousand eggs put in the can; but on arriving at the railroad-station it was found that the wire cloth was of too large mesh; and that from the jolting of the wagon in which the can was brought to the depot the eggs had passed through to the bottom of the outer can.

If, by experiment, we find that we can hatch the eggs at sea, and, by the use of water at a temperature of 60° to 62°, delay the hatching until the fifth or sixth day out, then we may reasonably hope for success. The passage from New York to Bremerhaven occupied twelve days, and as two days should be allowed for distribution from that port, it will be a comparatively easy matter to get them through in eight days after hatching.

D—LIVING SHAD ON THEIR WAY TO THE WESER.*

Translated by H. Jacobson.

As has previously been mentioned, the German Fishing Society at Berlin was notified in June by Mr. Roosevelt, the commissioner of fisheries for the State of New York, that a number of live shad would be sent, which, however, never arrived in Germany, as, on account of the unusual heat, all the fish had died before they reached New York. Although we must acknowledge the earnest endeavors of Mr. Roosevelt, this first attempt must be conceded to have been a failure; and it is chiefly owing to the great interest which Prof. Spencer F. Baird, United States Commissioner of Fish and Fisheries, has taken in this matter, that another attempt has been made during this year. The circumstance that this year the migration-period of the shad in the Connecticut River, which generally lasts from April until the middle of July, was prolonged till near the end of July, made another attempt possible. With his peculiar energy Professor Baird knew how to make use of this circumstance, and in spite of the short time, made all the necessary arrangements in a manner which augured well for the success of the undertaking.

As early as the 7th August, Dr. Finsch received a cable telegram from Messrs. Oelrichs & Co., agents of the North German Lloyd in New York, announcing the shipping of a large quantity of live shad by

* From the "Weser-Zeitung," August 28, 1874.

the steamer Donau, Captain Neinaber, which left New York on the 5th August. The German Fishing Society thereupon intrusted Dr. Finsch, its corresponding member, with the care of placing the fish in the Weser, who was in this matter most willingly assisted by the practical advice of Mr. C. Schieber, the experienced fishing superintendent of the city of Hameln, who, fully appreciating the importance of the undertaking, personally placed himself at Dr. Finsch's disposal. Although no detailed information had been received from America regarding the number and age of the fish, or the manner of transporting them, all the necessary preparations were made for receiving the rare finny guests, the first which had ever crossed the ocean to be domiciled with us. All the details must of course depend on the condition of the fish at their arrival; and, in order to be informed of this in good time, Dr. Finsch asked Messrs. Keller, Wallis & Postlethwaite, agents of the Lloyd in Southampton, to telegraph immediately on the arrival of the fish regarding their condition. These gentlemen sent a telegram on the 15th, which arrived here on the 16th, saying that unfortunately the whole number of 100,000 fish had died on the day previous. A letter from Professor Baird, which Consul Schwab, in New York, had dispatched by the Prussian closed mail, announced the same day the arrival of Messrs. Frederic Mather and A. A. Anderson, in whose charge the fish had been placed. Dr. Finsch therefore went to Bremerhaven on the 17th August, and got from the above-mentioned gentlemen all the desired information and all the details, from which it is evident, beyond a doubt, that, in spite of the failure of this first attempt, the successful transportation of young shad is possible.

To understand the whole matter, we must speak of the particular difficulties attending the transportation of fish of the *Alosa* kind in a live state, which are much greater than with any representative of the *Salmonidæ*. Mr. Schieber was not able to keep our European *Alosa*, the *Alosa vulgaris*, alive more than twelve hours; and the American representative of this family, the shad, (*Alosa præstabilis*,) seems to be more tender, for, as Mr. Mather assured us, the attempt to put the mature shad in a vessel would prove fatal. The idea of transporting grown or half-grown shad can therefore not be entertained, just as little as that of spawn, as in this respect likewise the *Alosa* is subject to conditions of life differing entirely from those of the salmon. While in some varieties of these last-mentioned fish the eggs frequently require weeks for their development, which, moreover, can be retarded artificially by lowering the temperature—a circumstances of the utmost importance for transportation—this cannot be done with shad-eggs. These develop as early as the third or fourth day, and perish if the temperature is less than 72° to 80°, (Fahrenheit.) Another circumstance which facilitates the transportation of young salmon is this, that they keep the umbilical bag, which gives food to the young during the first period of their existence, from one to six weeks, while in the young shad this bag is very small and is lost on the fourth day. In spite of all these peculiar difficulties, the transportation of young shad has been successfully carried on in America. Seth Green made a successful introduction of shad into California in 1871, and later Livingston Stone in 1873. The first grown shad was during this year caught in the Sacramento River, and the lucky fisherman received the State premium of $25 for it.

As the American pisciculturists are well acquainted with the difficulties attending the transportation of young shad, it was to be expected that Professor Baird would commission competent and experienced men to convey the first shad to Germany, and Messrs. Mather and Anderson have certainly done everything in their power to justify the confidence placed in them. It must here be mentioned that both these gentlemen are experienced pisciculturists, the former possessing a piscicultural establishment of his own for brook-trout, (*Salmo fontinalis*,) near Honeoye Falls, on the Honeoye Creek, a tributary of the Genesee River, fourteen miles south of Rochester, in the State of New York; while Mr. Anderson is successfully raising black bass (*Grystes nigricans*) and salmon-trout (*Salmo confinis*) at Groton, near New London, Conn. Both these gentlemen are several months during the year engaged by the United States Department of Fisheries to transplant young fish, and possess an experience of many years, especially regarding the transportation of shad.

Mr. William Clift, in July, 1872, succeeded in transporting a large number of shad to the Platte River, in Colorado, and, though of course losing quite a number, in planting the majority near Denver; and Mr. Mather, before undertaking the journey to Germany, had just returned from Des Moines, Iowa, where he had planted 90,000 shad for stocking the Mississippi. During the railroad journey of seventy-two hours, only 200 out of this large number had died. Both these gentlemen received their commission by letter from Professor Baird, and had just enough time to hasten to New York to receive the fish at the Grand Central depot and to take them over to Hoboken on board the Donau by express.

These fish came from the piscicultural establishment for raising shad which the State of Massachusetts established some years ago near Holyoke, on the Connecticut River, and which has been instrumental in re-stocking that river with shad in the most astonishing manner. This requires no expensive buildings, but only very simple appliances, which consist in 200 wooden boxes, 2 feet long and 1½ feet broad, open at the top and having a wire-net at the bottom, being placed in the river. These boxes receive the impregnated eggs and protect the young fish till they lose their umbilical bag. The shad-raising establishments of the State of New York, on the Hudson, ten miles below Albany, and that on the Potomac near Washington, are similarly organized. The young fish scarcely two to three hours old were shipped by railroad from Holyoke on the 4th August, at 2.30 p. m., and arrived in New York at midnight, *via* Hartford and New Haven Railroad, in a healthy condition, in the same milk-cans in which they were to continue their journey across the ocean. These cans, which in America are very generally used for transporting milk on a large scale, are made of tin, round and about 2½ feet high, have been successfully employed in transporting fish. Such a can holds 10 gallons and affords ample room for 10,000 young fish, which will seem quite plausible if we inform the reader that the young shad on emerging from the eggs scarcely measure more than ⅜ of an inch in length. The whole number of fish, 100,000, could therefore easily be distributed in 12 cans, which, through the kindness of Captain Neinaber, had an excellent place on board the steamer where they were protected both against too violent movements and against the influence of the weather, as fresh air could constantly be admitted by means of a door, which could be closed when the temperature was too low. There was likewise a sufficient quantity of fresh water, which was brought by a small steamer from Croton River, and which filled two iron tanks, cemented on the inside, holding 1,500 gallons of water, destined for the exclusive use of the fish. The Croton water-works furnishes 60,000,000 gallons per day of water for the city of New York.

It must be said that both Messrs. Oelrichs & Co. and Captain Neinaber, with a zeal worthy of the cause, willingly did everything in their power to assist the fish-commissioners in their difficult task, and we express the sentiments of the American gentlemen, if we herewith publicly express their thanks to the above-mentioned representatives of the Lloyd.

As soon as the fish had been placed on board the Donau, which left Hoboken on the 5th August, Messrs. Mather and Anderson took them in charge. Their care for them consisted in the first place in filling in fresh water and introducing oxygen into the stale water. In transporting large fish this is done by means of bellows connected with the tank, and the so-called Freiburg transportation-kegs are built on this plan. Experience, however, has taught the Americans, who are well acquainted with this method, that it cannot be applied to young fish, and the only effectual remedy so far is the filling up of fresh water. This, of course, requires incessant activity by day and by night. Messrs. Mather and Anderson therefore relieved each other every six hours with a seaman-like regularity, which did not even suffer any interruption by slight attacks of sea-sickness. The business of filling up the water was attended to with the same regularity. By means of a tin cylinder and a rubber tube two gallons of water were carefully taken out every hour, and during the last part of the voyage even every half-hour. This water was supplied with new oxygen by pouring it continually from one vessel into another, the milky foam of the water indicating that the process had been finished. This water was then carefully filled in again by quarts, which for two gallons required several hours. Every three hours each can was up to one-third of its contents emptied by means of a siphon and filled with fresh water from the tanks. Dead fish had to be removed as soon as possible, and the temperature had to be kept quite even. On the third day of the voyage the fish lost their sacs, which could be seen by the difference of their movements. While before this they had quietly moved round in a circle, they now made rapid jerking movements from one side of the can to the other, as if they were in search of food. Two days after losing their sacs, 9th August, the fish were thriving; but from this time they gradually fell off, their bodies became thinner, more thread-like and transparent, whereby the large head seemingly increased in size. On the 13th August the young fish were very much exhausted, their movements grew slow, and the gentlemen prepared themselves for a total loss, which took place during the night from the 13th to the 14th August, in the English Channel, a short time before the arrival of the vessel in Southampton, after the little fish had been kept alive two hundred and fifty hours in all. According to Mr. Mather's diary the daily list of losses was as follows: 5th August, no losses; 6th August, 200 lost; 7th, 1,000; 8th, 20; 9th, 100; 10th, 3,000; 11th, 500; 12th, 1,200; 13th, 5,000; the 14th, all the remainder, almost 90,000. It need not be said how painful it was for the two American gentlemen, when they had to throw overboard the object of their incessant care during ten days; for this deprived them of the great triumph of having been the first to transport live fish across the ocean, the prize for which they had gone to so much trouble. But in spite of their failure these gentlemen may feel proud of the result of their undertaking, for while young shad had hitherto only been transported alive one hundred and eighty-four and a half hours, they succeeded in keeping them alive two hundred and fifty hours. The practical experience gained is likewise of great importance, and every pisciculturist will agree with us in assuming that the possibility of success can no longer be considered doubtful. Messrs. Mather and Anderson shared this view, and we rejoice to hear that so experienced a pisciculturist as Mr. Schieber, of Hameln, entirely agrees with them. Mather and Anderson felt convinced that nothing but want of food was the cause of the total loss; but unfortunately they had to see the fish die without being able to save them, as so far but very little is known regarding the food of young shad. Very small, almost microscopic animals will certainly form their food during the first days, but it proved impossible to supply their place by meat; and blood, which has in similar cases been successfully employed, was of no use. It is well known that the grown shad lives on various crustaceans, and that, like the salmon, it takes no food during the period of its migration in fresh water, but as regards the food of the young shad, we are so far entirely in the dark. Messrs. Mather and Anderson are going to make extensive experiments during next year, and will doubtless be in every possible way assisted by Professor Baird in his influential position as United States Commissioner of Fish and Fisheries, as the introduction of the shad into Europe is one of the pet plans of this eminent naturalist. To his energy and influence we owe in the first place this attempt, the expenses of which, as far as the fish and their attendants are concerned, were borne by the United States Fishery Commission, while the directors of the North-German Lloyd afforded a free passage, in order to give also some German support to an undertaking which promises to prove of incalculable benefit to our country.*

Convinced that the interest in this important matter will not decrease in America, we hope to be able to meet the two experienced pisciculturists, Mather and Anderson, again next year on the Weser, and wish them a final success in their endeavor to transport live young shad across the ocean.

E—SHAD HATCHING AND DISTRIBUTING OPERATIONS OF 1875.

1.—THE NEUSE RIVER STATION.

The shad work of 1875 began on the Neuse River of North Carolina about the 1st day of April. A few days were spent in a reconnaissance of the river, in order to find the best point for a hatching-station, and the fishing was delayed a number of days by the very high stage of water. Between the 9th and the 12th, the river rose 26 inches; after this date it began to fall. On the 13th of April, a camp was established a few miles below Kinston. Seine hauling began on the 14th. The water continued to fall until the 23d, falling in all 5 feet and 1¼ inches, an average of 5.5 inches a day; but owing to the continual rains in the region of the upper waters, the fall was very irregular, and varied from ⅜ of an inch to as much as 13½ inches in one day.

On the 23d, the gauge showed a rise at 6 p. m. of ½ inch, and the water continued to rise from 2½ to 7½ inches a day until the 27th, when it had gone up 23 inches. The morning of the 28th it had fallen 1½ inches, and continued to fall, in all 30½ inches, until the end of the month. The fall on the 29th was 15 inches. May 1 it again began to rise, and on May 5 had risen 23 inches, when it began to fall, and on the 7th had again fallen 12 inches. The camp was broken up on the 10th, and no records kept after the 7th. The extent of oscillation in the twenty-nine days of observation was about 5.7 feet. The variations of temperature were in the air between 32° and 80°; in the water 53° and 65°.

The fisheries were watched continually, and the examination of over 600 shad failed to find any ripe ones, with the exception of 14 males, soon after the camp was established. No eggs were obtained. Short excursions to different fisheries a few miles farther down the river were attended with no better success. The camp moved from this point to the Potomac.

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* This effort on Professor Baird's part was mainly prompted by his desire to make a suitable return for the liberality of the German government in presenting the United States Fish Commission with 250,000 impregnated eggs of the salmon of the Rhine.

2.—THE PAMUNKEY RIVER STATION.

In the mean time, a reconnaissance was made of the James, York, and Pamunkey Rivers, Virginia, and a point on the latter near the historic White House, was selected for the hatching-station. Mr. Fred Mather was appointed to take charge of this, and arrived on the 11th of May, and continued until the 20th, taking a few shad-spawn, which did not seem to be healthy, and from which no fish resulted.

3.—THE POTOMAC RIVER STATIONS.

The work on the Potomac began on the 14th of May. Previous to this time, a general reconnaissance of the fisheries had been made on the steamer Triana, and points determined upon for the hatching-stations.*

The first station, placed in charge of Mr. Jonathan Mason, was established at Free Stone Point, Va., the property of Mr. J. W. Fairfax. Mr. J. D. Faunce had the fishery, and was quite willing and obliging in all our relations with him, affording the fishes from each haul, and furnishing assistance when it was needed. Ripe fish were obtained from the time we arrived here until the fishing stopped.

The temperature of the river, owing to the cold season, was quite low and at first the development of the eggs was very slow. On the 15th, the temperature did not rise above 64°, and this was the highest water temperature until the 20th, when a gradual rise began. The young fish also seemed to suffer a degree of torpidity in the cold waters. The first fish were turned loose on the 21st, five days after the eggs were impregnated. The seine in use at this station was a large one, and the large expenses attending the fishing with the poor returns did not permit its continuance later than the 21st.

There were hatched altogether at this station and turned into the river 1,156,750 shad. Mr. Mason's camp was removed to Moxley Point, Md., at J. D. Skidmore's fishery on the 25th.

In the mean time, on the 18th of May, a station was established at the end of Long Bridge, opposite Washington, D. C., and put into the hands of Mr. H. W. Welsher. This was continued until June 5, and 1,072,800 shad were turned into the river at this point.

While this station was in progress, Mr. Welsher also carried on operations at Ferry Landing, Va., near Mount Vernon. This station produced the largest results of any one established on the river, as it was begun on May 21 and closed on May 29, and in only nine days 1,473,500 young shad were turned into the waters.

The Moxley Point (Md.) station continued from May 26 to June 7, and 1,182,500 shad were turned into the water.

The entire number hatched and put into the Potomac River was 4,885,550.†

The spawning-season in the river continues longer than the large seines find it profitable to fish. The height of the spawning-season begins about the 22d of May and lasts during the first week of June.

* See report on the Triana trip on subsequent page. † See tables on subsequent page.

The earliest spawners may be taken during the latter half of April. At this time, ripe males are abundant and become rather scarce late in the season. The large seines "cut out" at the fisheries about the 14th of June, and the fishing is continued by the small seines, pound-nets, and drift-nets until late in the summer.

4.—THE DISTRIBUTION OF SHAD FROM THE HUDSON RIVER.

The different camps were broken up entirely about June 7, and by the 10th the men were all off to the Hudson. From this point, the first shipment was made on the 11th of June, Messrs. Frank N. Clark and H. E. Quinn starting on the 11th for the White River of Indiana with 100,000 shad.

Shipments were made from here to the White, the Muskingum, the Scioto, the Des Moines, and to the Colorado of Texas; in all about four hundred and twenty-five thousand shad were distributed from this point.*

5.—THE CONNECTICUT RIVER STATION.

On the 1st of July, the parties moved to Holyoke, and shipments were begun to the South and West. The fishery below Holyoke was visited, and a couple of seine-hauls made for the purpose of judging of its advantages as a hatching-station. A small catch was obtained, and the fact of the availability of another hatching-location pretty well established, if it ever should be found necessary to use a second one.

Commissioner Brackett, of Massachusetts, and Commissioner Hudson, of Connecticut, came to Holyoke, and with them the general plan of the work was discussed.

It was decided that one-half of all fishes hatched should be returned to the Connecticut; and the proposal on the part of the United States was made to place one-fourth of the fish above the dam, in order that a colony might become established there which would be likely to have the desire for returning to this portion of the river when they had become mature fishes. A few shad of 8 to 12 inches in length, taken in the fishway, were thought to be from the stock placed above the dam at Bellows Falls, Vt., during the two previous years.

There were distributed in waters of New England, other than the Connecticut, 320,000 shad; distributed in waters of the United States in the Mississippi Valley and tributary to the Gulf of Mexico, 590,000; carried to the Upper Connecticut, 1,205,000; hatched and put in below the dam, 4,500,000; sent to Germany, 400,000—about 7,000,000 in all.

Two hundred thousand were sent from the Delaware, one-half to the Stanton River, headwaters of the Roanoke, and one-half to the Pearl River of Mississippi and Louisiana. The total of fish hatched and turned into the waters of the rivers which afforded the ripe fish and eggs and those sent away to distant waters was 12,500,000.

*See Tables.

6.—EXPERIMENTS WITH A VIEW TO TRANSPORTING SHAD TO GERMANY.

The failure of the German expedition the previous year induced a careful series of experiments with reference to the conditions most favorable to sustaining shad-eggs or embryo-fish for a prolonged period in transportation-vessels. The experiments made at Noank, Conn., the previous summer, proved that there would be no hope in attempting to inure the shad to sea-water so as to depend on fresh supplies of water from the ocean after the steamer was under way.

The first experiment begun this year was at Washington, D. C. Mr. Fred Mather, who was one of the attendants on the shipment of shad in the first German trip, was given charge of the work. He devised a can holding about eight gallons, and having the form of a cylinder for about two-thirds of its upper portion; below this, the remaining third had the form of a funnel. This was hung in gimbals, as it was intended it should be on shipboard. The water-supply entered at the bottom coming from a reservoir at a higher level, and flowed upward through a screen of wire-cloth, which rested upon the line at the bottom of the cylinder and top of the funnel. Upon this were placed about 20,000 shad-eggs.

For a day or two, they seemed to survive well, but soon an increasing mortality was evident, and after four days the last one was dead. Mr. Mather left Washington on June 11, and went to Point Pleasant, Pa., on the Delaware River, and began an experiment with a similar though smaller apparatus, and with little success.

An apparatus differing in being entirely of a funnel form and having only the inlet-tube covered with wire-cloth,* was the suggestion of Mr. Mather's assistant, Mr. Charles Bell.† This worked admirably, and young shad were produced seemingly with all the success and facility of the floating shad-boxes.

In the meanwhile an experiment was begun by Mr. H. W. Welsher, at the New York shad-hatching station on the Hudson River. His attempt was to retard the development of the eggs in a case of flannel-screens, upon which they were placed. The screens, fitted with light covers of the same material, slid into the case like drawers, one above the other, in a series of ten or twelve. One of the sides of the case was fitted on hinges as a door. Lumps of ice were placed in the upper screen, the drippings from which supplied the necessary moisture to the eggs. The temperature was moderated by means of the door. The development of the eggs was retarded by a low temperature, so as to hatch after six days and even ten, and seemed, when put into the water, just before the release of the fish, to be in a healthy condition, and the fish when hatched seemed vigorous.

Mr. Monroe A. Green was associated with Mr. Welsher just before it was decided to make the attempt of a trip to Germany; the announcement of their readiness to attempt the work arriving in advance of that from Mr. Mather, who was at the time experimenting on the Delaware.

* See Apparatus for hatching shad-ova while enrouté to new waters. † Since deceased.

Mr. Green now arranged a can made in similar form to that which Mr. Bell had devised, but instead of agitating the water and eggs by an inflow of water he applied a current of air from an air force-pump, the bubbles and force of the air rising from the bottom of the can carrying upward a current of water and the eggs, which slowly fell back toward the bottom, to again be carried upward by the in-rushing air.

The purpose of the can was to receive the eggs when they had undergone their slow development in the screens to the point when they were nearly ready to break the shell and release the young shad into the water.

Mr. Welsher and Mr. Green were quite confident of the efficiency of their apparatus, and expected to make a success of the trip.

7.—THE TRIP TO GERMANY.

On the nights of the 15th and 16th July, Mr. Green took a large quantity of shad-eggs at the station at South Hadley Falls, Mass., on the Connecticut River. Those chosen for the voyage were very carefully selected, all light eggs floating to the surface were allowed to float out of the pan, and the manipulation in the impregnation of the eggs was very carefully managed, and the ripe fish critically examined before eggs or milt were taken.

About 400,000 impregnated eggs were placed in the cases; large boxes were obtained in which the cases of eggs were packed. The method of packing was to lay a bottom thickness of four or five inches of turners' shavings, upon which the case rested. The same thickness was tamped in around the side, and over the top was put a heavy layer of the shavings and lumps of ice.

The boxes were put into the baggage-car on the morning of the 17th and arrived at New York on same day. They were moved to the steamer Donau in a light-spring wagon, and put on board about 1 p. m.

The place afforded by the officers of the steamer was the middle hatchway, which had been fitted up between decks into a commodious room. Timber-posts had been put in strengthening the hatch-cover overhead, and nine of the cans arranged by Mr. Green, each of about ten gallons' capacity, were suspended by chains. A rubber hose led from each of these to an air-chamber, into which the air was forced by an air force-pump, and through the hose distributed to each of the cans.

The cases of eggs were placed on the floor and the ice kept near by in a small ice-chest.

The steamer left on the 17th. After getting under way, Mr. Welsher and Mr. Green opened the cases of eggs, and, to their dismay, perceived that they had been injured during the transportation from the Connecticut River to the steamer.

No development seemed to take place at all in the eggs, and no fish were hatched. The jolting of the baggage-car between Holyoke, Mass., and New York had evidently entirely destroyed the vitality of the eggs.

The following tables exhibit the physical observations, the number of fish taken, and the number of fish put into the river at the different stations.

Record of shad-hatching operations conducted at Camp Milner, near Kinston, N. C., on the Neuse River, from April 12, 1875, to May 8, 1875, on account of United States Commission of Fish and Fisheries, by Welsher, Mason, and Quinn.*

Date.	Hour.	Temperature of— Air.	Temperature of— Surface-water.	Wind. Direction.	Wind. Intensity.	Condition of— Sky.	Condition of— Water.	Rise and fall of river.	Seine hauled.	Fish taken. Males.	Fish taken. Females.	Ripe fish. Males.	Ripe fish. Females.	Eggs obtained.	Remarks.
		°	°												
Apr. 14	6 a. m.	45	59	W. by S.	Fresh	Clear	Clearing	4¼ inches fall	30 times from 8.30 a. m. to 6 p. m.	6	4	6	....	None	Mr. Tilghman's seine in use.
14	12 m	60	59	N.	...do	Light clouds	...do	1½ inches fall							
14	6 p. m.	58½	59¼	S.	Calm	...do	...do	3½ inches fall							
15	6 a. m.	44¾	57¼	S. E.	...do	...do	...do	3 inches fall	6.30 a. m. to 6.00 p. m.	8	5	8	....	...do	A few drops of rain at 11.30 a. m.
15	12 m	63	59½	N. W.	Fresh	Few clouds	...do	1¾ inches fall							
15	6 p. m.	58½	60	S. by W.	Calm	Clear	...do	1 inch fall							
16	6 a. m.	54½	59	S. by W.	...do	Light clouds	...do	1¼ inches fall	7.00 a. m. to 6.30 p. m.	4	10	....	....	...do	
16	12 m	71	59	S.	Fresh	Few clouds	Roily	1½ inches fall							
16	6 p. m.	59	58½	S. W.	Gale	Clear	...do	Standstill							
17	6 a. m.	35	58	N. by E.	Light	...do	...do	1 inch fall	7.00 a. m. to 4.00 p. m.	7	5	....	....	...do	Seine hauled 5 times at night.
17	12 m	62	57	N. W.	Fresh	...do	...do	1½ inches fall		6	5				
17	6 p. m.	44	56	N. W.	...do	...do	...do	½ inch fall							
18	6 a. m.	32	55	S. W.	Light	...do	Clearing	...do	10.00 a. m. to 12.30 p. m.	2	2	....	....	...do	Ground covered with snow.
18	12 m	38	54	W.	Fresh	Cloudy	...do	¼ inch fall							
18	6 p. m.	35	55	W.	...do	...do	...do	Standstill							
19	6 a. m.	23	53	S. E.	Light	Clear	...do	¼ inch fall	9.00 a. m. to 7.30 p. m.	12	17	....	....	...do	Sprinkle of rain at 8.30 a. m. The second seine, Mr. Simmons', commences fishing.
19	12 m	46	54	W.	Fresh	...do	...do	¾ inch fall							
19	6 p. m.	50	55	S. E.	Light	...do	...do	1½ inches fall							
20	6 a. m.	52	54	S. W.	...do	Cloudy	...do	4 inches fall	7.00 a. m. to 6.30 p. m.	34	17	....	....	...do	
20	12 m	68	55	W.	Fresh	...do	...do	3¼ inches fall							
20	6 p. m.	66	56	N. E.	Light	...do	...do	...do							
21	6 a. m.	44	54	N. E.	Fresh	Raining	Roily	7 inches fall	7.00 a. m. to 6.30 p. m.	8	4	....	....	...do	Hauled in the night.
21	12 m	38	54	N. E.	...do	...do	...do	3¼ inches fall		37	16				
21	6 p. m.	41½	54	....	Calm	Cloudy	...do	3 inches fall							
22	6 a. m.	35	53	N. E.	Gentle	...do	...do	6 inches fall	6.00 a. m. to 7.00 p. m.	27	31	....	....	...do	2 seines hauled.
22	12 m	53¼	54	N.	...do	Clear	...do	2 inches fall							
22	6 p. m.	50	54	....	Calm	...do	...do	1¼ inches fall							
23	6 a. m.	41¼	53	E.	Gentle	Cloudy	...do	3½ inches fall	7.00 a. m. to 6.00 p. m.	14	6	....	....	...do	
23	12 m	50	53	E.	Fresh	...do	...do	1 inch fall							
23	6 p. m.	50	53	N. E.	Gentle	...do	...do	½ inch rise							
24	6 a. m.	41	53	....	Calm	Clear	Muddy	1 inch rise	7.00 a. m. to 7.00 p. m.	15	10	....	....	...do	Hauled at night.
24	12 m	63	54	W.	Fresh	...do	...do	3 inches rise							
24	6 p. m.	53	54	W.	Gale	Cloudy	...do	2 inches rise							
25	6 a. m.	41½	53	N. W.	Strong	Clear	...do	4 inches rise	....	....	....	....	....	...do	Sunday; did not fish.
25	12 m	51	53	N. W.	Gentle	...do	Roily	2 inches rise							
25	6 p. m.	48	53	....	Calm	Cloudy	...do	1¼ inches rise							

	26	6 a. m.	39¼	54	.....	...do	Clear	...do	3¼ inches rise							
	26	12 m	64¼	55½	S. W.	Gentle	...do	...do	2 inches rise.	7.30 a. m. to 6.30 p. m.	20	15	...	...	.....	
	26	6 p. m.	60	55½	N.	Fresh	Cloudy	...do	1 inch rise							
	27	6 a. m.	60	57	N. E.	Gentle	...do	...do	2 inches rise							
	27	12 m	68	58	E.	Fresh	Rained	...do	¼ inch rise	6.00 a. m. to 6.30 p. m.	5	13	...	...	.....	
	27	6 p. m.	66	59	S. E.	...do	Cloudy	...do	Standstill							
	28	6 a. m.	67	59	.....	Calm	...do	...do	1½ inches fall							
	28	12 m	55¼	58	N. W.	Fresh	...do	...do	2 inches fall	6.00 a. m. to 6.00 p. m.	4	7	...	...	.....	Thunder-storm 10 a. m
	28	6 p. m.	55	58	N.	...do	Clear	...do	3 inches fall							
	29	6 a. m.	45	58	.....	Calm	...do	...do	7 inches fall							
	29	12 m	69	59	S. E.	Light	...do	...do	4 inches fall	4.30 a. m. to 5.00 p. m.	2	2	...	...	.....	2 seines hauled.
	29	6 p. m.	64	59	S.	Strong	...do	...do	...do							
	30	6 a. m.	58	60	S.	Calm	...do	...do	6 inches fall							
	30	12 m	80	61⅓	W.	Strong	...do	...do	2 inches fall	7.00 a. m. to 5.00 p. m	9	11	...	...	.....	
	30	6 p. m.	77	63	S. W.	Gentle	...do	...do	1 inch fall							
May	1	6 a. m.	65	63	S.	...do	Hazy	...do	1 inch rise							
	1	12 m	74	63	S.	Strong	...do	...do	1½ inches rise	6.00 a. m. to 12 m	3	3	...	...	.....	
	1	6 p. m.	70	64	S.	...do	Cloudy	...do	2 inches rise							
	2	6 a. m.	64	64	S. W.	Gentle	Clear	Muddy.	3 inches rise							
	2	12 m	68	64	N. W.	...do	...do	...do	2 inches rise	.....	...	...	...	...	.....	Severe thunder-storm in the night.
	2	6 p. m.	63	65	N. W.	Calm	...do	...do	3 inches rise							
	3	6 a. m.	48	65	.....	...do	...do	...do	3½ inches rise							
	3	12 m	62	65	S. E.	Gentle	...do	...do	1½ inches rise	9.00 a. m. to 7.00 p. m	11	7	...	...	.....	
	3	6 p. m.	61	65	S. E.	Strong	Hazy	...do	1 inch rise							
	4	6 a. m.	61	65	S.	Gentle	Raining	...do	2¼ inches rise							
	4	12 m	66	65	N. W.	Fresh	Hazy	...do	1 inch rise	7.00 a. m. to 6.00 p. m	13	10	...	...	.....	51 shad examined at More's fishery; none ripe.
	4	6 p. m.	60	65	W.	Gentle	Cloudy	...do	...do							
	5	6 a. m.	44	64	N. E.	...do	Clear	...do	Standstill							
	5	12 m	70	65	S. E.	...do	...do	Roily	¼ inch fall	......do	3	4	...	...	.....	
	5	6 p. m.	58½	65	S.	Fresh	Cloudy	...do	...do							
	6	6 a. m.	57	65	S.	Gentle	...do	...do	2¼ inches fall							
	6	12 m	74½	65	S. W.	...do	...do	...do	1½ inch fall	6.00 a. m. to 5.00 p. m	4	4	...	...	.....	
	6	6 p. m.	66	65	.....	Calm	Clear	...do	2 inches fall							
	7	6 a. m.	53	65	W.	Gentle	...do	Clearing	3 inches fall							
	7	12 m	70	65	W.	...do	...do	...do	1¼ inch fall	6.00 a. m. to 6.00 p. m	3	6	...	...	.....	
	7	6 p. m.	61	65	N. E.	...do	...do	...do	1 inch fall							
Totals											257	214	14	...	.....	Number of shad examined, 522.

* No ripe fish obtained at this station.

Record of shad-hatching operations conducted at West Island, near Fish Haul, Va., on the Pamunkey River, from May 11, 1875, to May 20, 1875, on account of United States Commission of Fish and Fisheries, by Fred Mather.

Date.	Hour.	Temperature of— Air.	Temperature of— Surface-water.	Wind. Direction.	Wind. Intensity.	Condition of— Sky.	Condition of— Water.	Fish taken.* Males.	Fish taken.* Females.	Ripe fish. Males.	Ripe fish. Females.	Eggs obtained.	Loss, number.	Remarks.
		°	°											
May 11	5.00 p. m	62	68	....	....	....	Roily	23	9	20	...	....	....	Seine 800 yards long.
12	5.30 a. m	60	68	....	....	....	....	10	11	...	...	10,000	8,000	
13†	7.00 a. m	......	......	....	....	....	....	20	24	...	...	....	....	
13	7.30 p. m	......	......	....	....	....	....	24	18	...	...	....	....	
14	8.00 a. m	......	......	....	....	....	....	10	11	...	...	....	....	
15	9.30 a. m	62	65	S. W.	Fresh	Cloudy	....	1	...	...	...	....	....	
15	12 m	76	69	W.	Strong	....	....	....	...	...	...	....	....	Did not fish. The waves washed over box of eggs taken on the 12th. Fishermen left until Tuesday night. They say the season is over. Took 90,000 eggs from gill-nets; all bad.
15	7.00 p. m	74	70	N. W.	Violent	....	....	....	...	...	...	....	....	
16‡	....	......	......	....	....	....	....	....	...	...	...	....	....	
18	11.00 p. m	......	......	N.	Light	Clear	....	4	7	...	...	....	....	
19	12.30 a. m	......	......	....	Calm	do	....	3	1	...	...	....	....	
19	2.00 p. m	......	......	W.	Light	Light clouds	....	2	4	...	...	....	....	
20§	3.00 p. m	......	......	W.	do	do	....	5	1	...	...	....	....	
Totals								102	86	20	...	10,000	8,000	

* Seine hauled once at each flood-tide.
† Thermometer broken.
‡ Thermometer lost overboard.
§ The fishing with seine stopped. The gill-nets still take a very few fish.

Record of shad-hatching operations conducted at Free Stone Point, Va., on the Potomac River, from May 15, 1875, to May 25, 1875, on account of United States Commission of Fish and Fisheries, by Jonathan Mason.

Date.	Hour.	Temperature of—		Wind.		Condition of—		Tide.		Seine hauled.	Fish taken, males and females.	Ripe fish, females.	Eggs obtained.	Period of hatching.	Young shad turned loose.	Remarks.
		Air.	Surface-water.	Direction.	Intensity.	Sky.	Water.	High-water.	Low-water.							
		°	°													
May 15	6 a. m.	58	56	N. E.	Gentle	Clear	Roily	4.00 a. m.		11.00 a. m.	170	4				Eggs all dead.
15	12 m	80	60	N.	..do	..do	..do		11.30 a. m.	5.00 p. m.	175	4	125,000	4 days		
15	6 p. m.	63	64	W.	Strong	Cloudy	..do	4.00 p. m.	11.10 p. m.	11.30 p. m.	100	2	50,000	3 d. 18 h.		Thunder-storm 3 p. m.
16	6 a. m.	50	55	N.	..do	Clear	..do	5.20 a. m.		No haul						Seine "mudded".
16	12 m	60	59	N.	Gentle	..do	..do		12.15 p. m.	..do						
16	6 p. m.	58	64	N.	..do	..do	..do	6.00 p. m.		11.30 p. m.	170	3	75,000	3 d. 22 h.		
17	6 a. m.	52	56	N. W.	..do	..do	..do	6.30 a. m.		No haul						
17	12 m	60	61	N. W.	..do	..do	..do		12.30 p. m.	1.30 p. m.	140	4	110,000	3 d. 15 h.		
17	6 p. m.	57	64	N. N. W.	..do	..do	..do	6.15 p. m.		7.00 p. m.	237	12	298,000	3 d. 15 h.		
18	6 a. m.	52	58	S. S. W.	Fresh	..do	..do	6.25 a. m.	12.05 a. m.	1.00 a. m.	40	2	52,000	3 d. 12 h.		
18	12 m	63	62	S. W.	..do	Cloudy	..do		12.15 p. m.	1.00 p. m.	87					
18	6 p. m.	55	64	S.	Calm	Hazy	..do	6.50 p. m.		7.00 p. m.	184	10	205,000	3 d. 12 h.		
19	6 a. m.	48	58	S.	..do	Clear	..do	6.15 a. m.	12.50 a. m.	No haul						
19	12 m	72	64	S. W.	Gentle	..do	..do		12.00 m.	1.15 p. m.	180	4	85,000	3 d. 6 h.		
19	6 p. m.	68	64	S. W.	..do	Hazy	..do	6.10 p. m.		7.30 p. m.	149	8	205,000	3 d. 6 h.		
20	6 a. m.	52	59	S.	Strong	..do	..do	6.10 a. m.	12.15 a. m.	1.00 a. m.	48					Blowing hard.
20	12 m	80	65	S.	..do	..do	..do		11.50 a. m.	2.00 p. m.	126					Seine "mudded" and fish all dead.
20	6 p. m.	81	68	S.	..do	..do	..do	6.00 p. m.		8.30 p. m.	130	1	25,000	3 days		
21	6 a. m.	56	62	S. W.	Light	..do	..do	6.10 a. m.	12.15 a. m.	2.00 a. m.	32				103,500	
21	12 m	78	72	S. E.	..do	..do	..do		12.15 p. m.	2.30 p. m.	40					4 ripe fish; eggs all dead.
21	6 p. m.	65	76	S. E.	..do	..do	..do	6.20 p. m.		9.00 p. m.	101	6	125,000			
22	6 a. m.	62	68	S. W.	..do	..do	..do	6.20 a. m.	12.25 a. m.	2.30 a. m.	20				45,000	Seine "cut out".
22	12 m	78	72	S.	Gentle	..do	Clear		12.00 m.						70,000	Thunder-shower 3 p. m.
22	6 p. m.	68	75	S. W.	..do	..do	..do	6.00 p. m.							100,000	
23	6 a. m.	63	69	S. E.	..do	..do	..do	6.10 a. m.	12.15 a. m.						250,000	Seine "cut out".
23	12 m	84	79	S. E.	Light	..do	..do		11.50 a. m.						47,000	
23	6 p. m.	82	78	S. E.	Strong	..do	..do	6.00 p. m.							175,000	
24	6 a. m.	70	72	S. E.	Gentle	Cloudy	..do	6.20 a. m.	12.10 a. m.						75,000	
24	12 m	80	78	S. E.	Light	..do	..do		12.00						170,000	Shower at 2.30.
24	6 p. m.	69	75	E.	..do		..do	6.10 p. m.							21,250	
25	6 a. m.	66	71	E.	..do	Rainy	..do	6.00 a. m.	12.10 a. m.						100,000	Rained all night.
25	12 m	81	75	S. E.	..do	Cloudy	..do		12.00 m.							
Totals											2,029	60	1,355,000		1,156,750	

Record of shad-hatching operations conducted at Jackson City, Va., on the Potomac River, from May 18, 1875, *to June* 5, 1875, *on account of United States Commission of Fisheries, by H. W. Welsher.*

Date.	Hour.	Temperature of—		Wind.		Condition of—		Tide.		Seine hauled.	Fish taken.		Ripe fish.		Eggs obtained.	Period of hatching.	Young shad turned loose.
		Air.	Surface-water.	Direction.	Intensity.	Sky.	Water.	High-water.	Low-water.		Males.	Females.	Males.	Females.			
		°	°														
May 18	6 a. m..	......	60	W.	Gentle..	Clear ...	Roily ...	6.24 a. m	....	6 times on each ebb-tide.							
18	12 m....	......	61	W.	...do	...do ...	...do	....	1.13 p. m	...do	6	20	.....	.....	....	....	....
18	6 p. m..	......	61	W.	...do	..do ...	...do	6.44 p. m	....	...do							
19	6 a. m..	......	61	W.	..do ...	Clouds..	...do	7.03 a. m	1.33 a. m.	...do							
19	12 m....	......	62	W.	Gale ..	Rain...	...do	....	1.51 p. m.	...do	16	42	.....	.....	....	....	....
19	6 p. m..	......	62	W.	Gentle..	Clear ...	...do	7.22 p. m	....	...do							
20	6 a. m..	......	63	N. W.	Strong..	...do ...	...do	7.41 a. m.	2.11 a. m	...do							
20	12 m....	......	64	N. W.	Gentle..	..do ...	.. do	....	2.30 p. m	...do	10	30	2	1	12,000	3½ days ...	....
20	6 p. m..	......	64	N. W.	Strong..	Hazy ...	...do ...	8.01 p. m	....	...do							
21	6 a. m..	67	64	N. W.	Calm ...	..do ..	Clear ...	8.21 a. m	2.50 a. m	...do							
21	12 m....	79	69	S. E.	Gentle..	...do ...	...do	....	3.10 p. m	...do	11	25	1	1	15,000	3½ days ...	....
21	6 p. m..	76	71	S.	...do	...do ...	...do	8.40 p. m	....	...do							
22	6 a. m..	72	66	......	Calm ...	.. do ...	...do ...	9.00 a. m.	3.30 a. m.	...do							
22	12 m....	76	75	S. E.	Gentle..	...do	Roily ...	....	....	...do	8	3	1	3	60,000	3 days	....
22	6 p. m..	72	70	W.	...do	...do ...	...do	9.21 p. m	4.00 p. m.	...do							
23	6 a. m..	76	77	......	Calm....	..do ...	Clear ...	9.43 a. m.	4.10 a. m.	...do							
23	12 m....	78	75	......	...do	Clear ...	.. do	....	....	...do	10	20	1	1	15,000	3 days	....
23	6 p. m..	80	76	......	...do ...	..do ...	...do ...	10.06 p. m	4.32 p. m.	...do							
24	6 a. m..	67	70	S.	Gentle..	Hazy ...	...do	....	4.55 a. m.	...do							
24	12 m....	77	74	S. E.	...do	..do ...	...do	10.20 a. m	....	...do	7	18	2	4	70,000	....	....
24	6 p. m..	71	73	S. E.	...do	Rain...	Roily ...	10.52 p. m	5.20 p. m.	...do							
25	6 a. m..	68	71	E. N. E.	...do	..do ...	...do	....	5.41 a. m.	...do							
25	12 m....	72	74	......	Calm ..	Hazy ...	...do	11.14 a. m.	....	...do	7	21	1	2	40,000	3 days	....
25	6 p. m..	74	75	E.	Gentle..	...do	Clear ...	11.39 p. m.	6.13 p. m	...do							
26	6 a. m..	68	72	N.	...do	...do	Roily ...	....	6.28 a. m	.. do							
26	12 m....	82	72	N.	Strong..	...do	...do	12.03 p. m	....	...do	2	4	.....	.....	....	....	....
26	6 p. m..	79	76	N. E.	Gentle..	...do	...do	....	6.52 p. m	...do							
27	6 a. m..	72	78	N. E.	...do	...do	...do	12.28 a. m	7.17 a. m	6 hauls...........	4	6	1	1	20,000	65 hours ..	....
27	12 m....	69	79	E.	...do	...do ...	...do	12.54 p. m	....	....	.....	.....	.....	.....	....	....	....
27	6 p. m..	66	75	E.	...do	...do ...	...do	....	7.44 p. m	7 hauls 8 p. m.....	3	7	1	2	*50,000	...do	....
28	6 a. m..	68	72	W.	...do	...do ...	...do	1.22 a. m.	8.11 a. m	5 hauls 7.30 a. m ..	2	3	.....	.....	....	....	....
28	12 m...	73	78	S. S. W.	...do	...do	Clear ...	1.50 p. m	....	....	.....	.....	.....	.....	....	....	....
28	6 p. m..	64	74	S.	...do	..do	...do	....	8.39 p. m	7 hauls 9.30 p. m ..	6	14	3	7	†150,000	....	....
29	6 a. m..	60	72	S.	...do	Clear ...	...do	2.21 a. m	9.10 a. m	4 hauls 8.45 a. m ..	1	3	1	1	‡10,000	70 hours ..	....
29	12 m....	77	79	S.	...do	..do	...do	2.52 p. m	....	....	.....	.....	.....	.....	....	....	....
29	6 p. m..	72	76	N. W.	Gale	Cloudy..	Roily ...	....	9.41 p. m	6 hauls 10.45 p. m	4	20	[illegible]	8	150,000	3 days	....

30	6 a. m..	63	66	N.N.W.	Strong..	Clear ...	...do	3.23 a. m		4 hauls 10.45 a. m .	3	13		2	(§)		
30	12 m....	77	80	N.	...do	.. do	...do	3.51 p. m.	10.12 a. m.								
30	6 p. m..	74	76		Calm ...	...do	...do		10.40 p. m.	6 hauls 11 p. m....	6	39	1	2	30, 000	3 days	
31	6 a. m..	59	69	N.	Gentle..	...do	Clear ...	4.20 a. m		5 hauls 11.45 a. m .	2	5					
31	12 m....	74	78	N.	Calm ...	...do	...do	4.48 p. m	11.09 a. m								
31	6 p. m..	71	76		...do	...do	...do		11.37 p. m	6 hauls 12 p. m....	6	33	2	6	150, 000		
June 1	6 a. m..	67	72		...do	...do	...do	5.15 a. m			3	5					
1	12 m....	83	75	S.	Gentle..	...do	...do		12.04 p. m	5 hauls 12 m							
1	6 p. m..	70	75	S. S. E.	Strong..	...do	...do	5.42 p. m		5 hauls 12 m......	6	19	2	4	100, 000		
2	6 a. m..	62	70	S.	Gentle..	Hazy ...	...do	6.09 a. m.	12.31 a. m.		5	10					
2	12 m...	72	72	S.	...do	...do	...do		12.58 p. m	6 hauls 1.30 p. m ...							
2	6 p. m..	64	72	S.	...do	.. do	...do	6.36 p. m		6 hauls	2	5	2	3	75, 000		
3	6 a. m..	62	69	S. E.	...do ...	Cloudy..	...do ...	7.01 a. m	1.25 a. m.	6 hauls 2 a. m.....	5	12					
3	12 m...	69	71	S. E.	...do ...	Clear ...	...do ...		1.50 p. m.								
3	6 p. m..	68	70	S. E.	...do	...do	...do ...	7.29 p. m		6 hauls...........	8	25	4	6	125, 000		
4	6 a. m..	68	71		Calm ...	...do	...do ...	7.56 a. m	2.18 a. m.								
4	12 m....	79	80	E.	Gentle..	...do	...do		2.45 p. m.								
4	6 p. m..	78	78	E.	...do	...do	...do . ..	8.24 p. m		5 hauls 2.45 p. m ..	2	7					
5‖	6 a. m..	64	76		Calm ...	...do	...do		3.13 a. m		7	21	3	5	100, 000		
Totals											152	430	31	59	1, 192, 000		1, 072, 800

* Washed out of boxes by gale of 29th.

† Washed out by gale of 29th.

‡ Gale washed out 150,000 eggs with fish somewhat formed, and 200,000 young fish just from eggs brought from Ferry Landing, Va.

§ Eggs bad.

‖ Seine "cut out".

Record of shad-hatching operations conducted at Ferry Landing, Va., on the Potomac River, from May 21, 1875, to May 29, 1875, on account of United States Commission of Fish and Fisheries, by H. W. Welsher.

[Seine 1,200 fathoms long; hauled three times every 24 hours, once on the flood-tide, twice on the ebb-tide.]

Date.	Hour.	Temperature of surface-water.	Wind.		Condition of—		Tide.		Shad taken.*	Ripe fish.	Eggs obtained.	Young shad turned loose.	Remarks.
			Direction.	Intensity.	Sky.	Water.	High-water.	Low-water.		Females.			
		°											
May 21	6 a. m.	68	W.	Gentle	Clear	Clear	7.06 a. m	1.35 a. m.					
21	12 m	69	W.	do	do	do	...	1.55 p. m.	860	2	60,000	...	Eggs taken to Jackson City station.
21	6 p. m.	69	S. W.	do	do	do	7.25 p. m	...					
22	6 a. m.	70	S. E.	do	Cloudy	do	7.45 a. m	2.15 a. m.					
22	12 m	70	S.	Strong	Clear	do	...	...	801	3	90,000	...	
22	6 p. m.	70	...	Calm	do	do	8.06 p. m.	2.45 p. m.					
23	6 a. m.	70	W.	Strong	do	do	8.28 a. m.	2.55 a. m.					
23	12 m	71	W.	Gentle	do	do	...	...	569	5	130,000	...	
23	6 p. m.	71	...	Calm	do	do	8.51 p. m.	3.17 p. m.					
24	6 a. m.	72	S. W.	Gentle	Cloudy	do	...	3.40 a. m.					
24	12 m	72	S. W.	do	Clear	do	9.05 a. m.	...	384	6	185,000	...	240,000 eggs taken to Jackson City station, Virginia.
24	6 p. m.	72	S.	do	do	do	9.37 p. m.	4.05 p. m.					
25	6 a. m.	72	N. E.	Strong	do	do	9.59 a. m.	4.26 a. m.					
25	12 m	73	N.	do	do	do	...	...	383	10	260,000	...	
25	6 p. m.	72	...	Calm	do	do	10.24 p. m.	4.58 p. m.					
26	6 a. m.	72	S. E.	Gentle	Cloudy	do	10.58 a. m	5.13 a. m.					
26	12 m	73	S. E.	do	Rain	do	...	...	568	9	250,000	...	
26	6 p. m.	73	S. E.	do	do	do	11.13 p. m	5.37 p. m.					
27	6 a. m.	72	N.	do	Clear	do	...	6.02 a. m.					
27	12 m	73	N. E.	do	do	do	11.39 a. m.	...	695	8	200,000	...	
27	6 p. m.	74	...	Calm	do	do	...	6.29 p. m.					
28	6 a. m.	75	E.	Gentle	do	do	12.07 a. m.	6.56 a. m.					
28	12 m	76	S. E.	do	do	do	12.35 p. m.	...	514	14	300,000	...	
28	6 p. m.	76	S. E.	do	do	do	...	7.24 p. m.					
29	6 a. m.	76	S.	Strong	do	do	1.06 a. m.	7.55 a. m.	...	2	55,000	...	
Totals									4,774	59	1,530,000	1,473,500	

* Seine hauled once on the flood-tide, twice on the ebb-tide.

Record of shad-hatching operations conducted at Moxley Point, Md., on the Potomac River, from May 26, 1875, to June 7, 1875, on account of United States Commission of Fish and Fisheries, by Jonathan Mason.

Date.	Hour.	Temperature of— Air.	Surface-water.	Wind. Direction.	Intensity.	Condition of— Sky.	Water.	Tide. High-water.	Low-water.	Seine hauled.	Fish taken, males and females.	Ripe fish. Females.	Eggs obtained.	Young shad turned loose.	Remarks.
May 26	6 a. m	66	71	N.	Fresh	Hazy	Clear		5.28 a. m	11.00 a. m	3				Two seines used.
26	12 m	82	75	N.	..do	..do	..do	11.03 a. m.							
26	6 p. m	80	72	N.	Gentle	..do	..do		5.52 p. m.	2.00 p. m. to 7.00 p. m	84	8	200,000		
27	6 a. m	70	72	N.	Fresh	..do	..do	1.28 a. m.	6.17 a. m.	3.00 a. m. to 11.30 a. m	100	1			Eggs all dead.
27	12 m	78	77	E.	..do	Clear	..do	11.54 a. m.							
27	6 p. m	72	79	E.	..do	..do	..do		6.44 p. m	3.00 p. m. to 6.30 p. m	12	2	50,000		Eggs small and of glassy appearance.
28	6 a. m	67	69	E.	Light	..do	..do	12.22 a. m.	7.10 a. m.	3.00 a. m. to 8.00 a. m	150	5	100,000		Bad eggs.
28										7.00 p. m. to 8.30 p. m	2				
28	12 m	80	78	E.	Light	Clear	Clear	12.50 p. m.		11.30 a. m	6	1			Eggs all dead.
28	6 p. m	71	77	E.	..do	..do	..do		7.39 p. m.	4.00 p. m. to 9.00 p. m	112	19	465,000		
29	6 a. m	73	70	S.	..do	..do	..do	1.21 a. m.	8.10 a. m.	5.00 a. m. to 8.00 a. m	12				
29	12 m	84	78	S.	..do	..do	..do	1.52 p. m.							
29	6 p. m	75	78	N.	Fresh	Cloudy	Roily		8.41 p. m	5.00 p. m	114	12	290,000		Thunder-storm 5 p. m.
30	6 a. m	62	70	N.	Strong	Clear	..do	2.23 a. m.	9.12 a. m.	6.00 a. m. to 9.00 a. m	2				Gale of wind in the night.
30	12 m	74	78	N.	Fresh	..do	..do	2.51 p. m.							
30	6 p. m	74	74	N.	..do	..do	Clear		9.40 p. m.	5.00 p. m. to 10.00 p. m	132	13	275,000		
31	6 a. m	66	70	S.	Gentle	..do	..do	3.20 a. m.	10.09 a. m.					160,000	One seine "cut out" this morn'g.
31	12 m	80	79	N.	Light	..do	..do								
31	6 p. m.	76	78	S. E.	..do	..do	..do	3.48 p. m.	10.37 p. m.	8.00 p. m	113	6	125,000	25,000	
June 1	6 a. m	70	72	S. E.	Gentle	..do	..do	4.15 a. m.						50,000	
1	12 m	81	80	S. E.	..do	..do	..do		11.04 p. m.						
1	6 p. m.	75	81	S. E.	Fresh	Hazy	..do	4.42 p. m.		9.00 p. m	130	6	120,000	232,500	Wind blew very hard and washed some of the eggs out of the boxes.
2	6 a. m	71	73	S. E.	Gentle.	..do	..do	5.09 a. m	11.31 a. m.	9.00 a. m	8				
2	12 m	71	71	S.	..do	..do	..do		11.58 p. m.						
2	6 p. m	71	74	S.	Fresh	Cloudy	..do	5.36 p. m.		9.30 p. m	105	6	130,000		
3	6 a. m	63	70	S. E.	..do	..do	..do	6.01 a. m.	12.25 a. m						
3	12 m	71	71	S.	..do	..do	..do		12.50 p. m.					220,000	Slight rain at 5 a. m.
3	6 p. m	71	72	S. E.	..do	Hazy	..do	6.29 p. m.							
4	6 a. m	63	70	S. E.	Gentle	Clear	..do	6.56 a. m.	1.18 a. m						
4	12 m	78	81	N. E.	..do	..do	..do		1.45 p. m.					210,000	
4	6 p. m.	73	79	S. E.	Fresh	..do	..do	7.24 p. m.							
5	6 a. m.	69	71	S. E.	Gentle	..do	..do	7.51 a. m.	2.13 a. m.						
5	12 m	82	80	S. E.	Fresh	Cloudy	..do		2.39 p. m.					105,000	Thunder-storm; heavy wind from southwest at 5 p. m.
5	6 p. m	74	80	S.W.	..do	..do	..do	8.18 p. m.							
6	6 a. m	71	73	W.	Gentle	Hazy	..do	8.47 a. m.	3.06 a. m.						
6	12 m	80	82	W.	..do	Clear	..do		3.33 p. m.					70,000	
6	6 p. m	82	84		Calm	..do	..do	9.14 p. m.							
7	6 a. m.	72	74	S.	Fresh	Hazy	..do	9.42 a. m.	4.00 a. m.					110,000	
	Totals										1,085	79	1,755,000	1,182,500	

Record of shad-hatching operations conducted at South Hadley Falls, on the Connecticut River, from July 2, 1875, to July 30, 1875, on account of United States Commission of Fish and Fisheries, by C. C. Smith.

Date.	Hour.	Temperature of—		Wind.		Condition of—		Seine hauled.	Ripe fish.		Eggs obtained.	Remarks.
		Air.	Surface-water.	Direction.	Intensity.	Sky.	Water.		Males.	Fem's.		
		°	°									
July 2	6 p. m.	80	76	S.	Light	Clear	Clear	First haul	8	16		
2				S.	...do	...do	...do	Second haul	6	20	92,000	
2				S.	...do	...do	...do	Third haul	1	0		
3	6 a. m.	60	72	S.	...do	...do	...do	First haul	10	24		
3	12 m.	72	76	S.	...do	...do	...do	Second haul	9	20	800,000	Absorption of heat by rocks said to increase heat of water faster than air did.
3	6 p. m.	76	76	S.	...do	...do	...do	Third haul	9	10		
4	6 a. m.	76	76	S.				First haul	12	51		
4	12 m.	80	76	S.				Second haul	5	12	700,000	Spawn poor.
4	6 p. m.	79	76	S.	Strong	Cloudy	Clear	Third haul	.....	.....		
5	6 a. m.	76	78	S.	Light	...do		First haul	12	4		
5	12 m.	88	77	S.	...do	...do		Second haul	10	6	158,000	
5	6 p. m.	82	77	S.	...do	Hard shower 3 to 8 p. m.	Roily	Third haul	6	4		
6	6 a. m.	88	77	S.	...do	Cloudy	Clear	First haul	24	35		
6	12 m.	98	81	S.	...do	Clear	...do	Second haul	5	2	452,000	Lightning struck box.
6	6 p. m.	96	80	S.	Shifting	H'd sh'w'r 4 p. m.	Very roily	Third haul	4	1		
7	6 a. m.	82	77	S.	Light	Clear	...do	First haul	25	54		
7	12 m.	91	78	S.	...do	...do	...do	Second haul	4	0	652,000	
7	6 p. m.	90	78	S.	...do	...do	...do	Third haul	3	2		
8	6 a. m.	72	77	S.	...do	...do	...do	First haul	14	18		
8	12 m.	97	79	S.	...do	...do	...do	Second haul	2	24	430,000	Spawn of 8th injured by roily water.
8	6 p. m.	92	79	S.	...do	...do	...do	Third haul	2	0		
9	6 a. m.	69	78	S.	...do	...do	...do	First haul	14	8		
9	12 m.	82	79	S.	...do	...do	Clearing	Second haul	6	11	384,000	
9	6 p. m.	78	79	S.	...do	...do	...do	Third haul	2	5		
10	6 a. m.	67	77	S.	...do	...do	Clear	First haul	16	22		
10	12 m.	78	78	S.	...do	...do	...do	Second haul	9	18	550,000	
10	6 p. m.	76	78	S.	...do	...do	...do	Third haul	5	1		
11	6 a. m.	72	77	N. W.	Very high	...do	...do					
11	12 m.	86	78	N. W.	...do	...do	...do	None	.....	.....	.....	
11	6 p. m.	74	78	N. W.	...do	...do	...do					
12	6 a. m.	59	76	S.	Light	...do	...do	First haul	13	5		
12	12 m.	87	78	S.	...do	...do	...do	Second haul	1	4	236,000	
12	6 p. m.	80	73	S.	...do	...do	...do	Third haul	1	3		
13	6 a. m.	61	75	S.	...do	...do	...do	First haul	19	7		
13	12 m.	90	77	S.	...do	...do	...do	Second haul	4	10	335,000	
13	6 p. m.	72	78	S.	...do	Light shower		Third haul	1	0		
14	6 a. m.	77	76	N. W.	...do	Clear		First haul	9	18		
14	12 m.	79	71	N. W.	...do	...do		Second haul	5	8	276,000	
14	6 p. m.	70	79	N. W.	...do	...do		Third haul	2	4		

15	6 a. m.	80	79	S.	...do	...do	....	First haul.........	16	20		
15	12 m ...	99	79	S.	...do	...do	....	Second haul........	3	5	250,000	M. A. Green took spawn for German trip, selecting the best spawn, even throwing off light spawn from a good spawner.
15	6 p. m..	83	79	S.	...do	...do	....	Third haul.........	3	.....		
16	6 a. m.	70	79	N. W.	Moderate	Cloudy.........	....	First haul.........	11	*15		
16	12 m ...	72	78	N. W.	...do	Rainy.........	....	Second haul........	1	5	150,000	
16	6 p. m..	87	78	N. W.	...do	...do	....	....	.....	.....		
17	6 a. m.	65	76	N. W.	Light	Clear	....	First haul.........	5	11		
17	12 m ...	72	77	N. W.	...do	...do	....	Second haul........	†12	5	130,000	
17	6 p. m..	86	78	N. W.	...do	...do	....	....	.....	.....		
18	6 a. m.	62	76	N. E.	...do	Raining	....	First haul.........	4	21		
18	12 m ...	62	75	N. E.	...do	...do	....	Second haul........	.....	‡6	310,000	
18	6 p. m..	60	76	N. E.	...do	Clear	....	....	.....	.....		
19	6 a. m.	64	74	N. W.	...do	...do	Clear	First haul 8 p. m....	7	6		
19	12 m ..	85	75	N. W.	...do	...do	...do	Second haul........	.....	4	47,000	Only one good male.
19	6 p. m..	81	72	N. W.	...do	...do	...do	Third haul 10 30 p. m	.....	.....		
20	6 a. m..	55	72	S.	...do	Cloudy.........	...do	First haul.........	3	4		
20	12 m ...	80	75	S.	...do	...do	...do	Second haul........	1	8	93,000	
20	6 p. m..	72	73	S. W.	...do	...do	...do	Third haul.........	1	6		
21	6 a. m..	65	73	S. W.	...do	...do	...do	First haul.........	3	5		
21	12 m ...	89	76	S. W.	...do	....	...do	Second haul........	.....	.....	125,000	
21	6 p. m.	72	76	S.	Strong....	Shower	...do	Third haul.........	1	8		
22	6 a. m..	64	76	S.	Light	Clear	...do	First haul.........	2	4		
22	12 m ...	86	77	S.	...do	...do	...do	Second haul........	1	3	280,000	
22	6 p. m..	76	77	S.	...do	...do	...do	Third haul.........	4	12		
23	6 a. m.	76	76	N. E.	Moderate	Rain.........	Roily	First haul.........	3	13		
23	12 m ...	73	75	N. E.	...do	...do	...do	Second haul........	.....	.....	132,000	
23	6 p. m.	66	74	N. E.	...do	...do	...do	Third haul.........	.....	.....		
24	6 a. m..	68	72	N. W.	...do	....	Clear	First haul.........	1	8		
24	12 m ...	85	76	N. W.	...do	....	...do	Second haul........	.....	6	....	No good milt.
24	6 p. m..	71	76	N. W.	...do	....	...do	....	.....	.....		
25	6 a. m..	64	74	N. W.	Slight ...	Clear	...do	....	.....	.....		
25	12 m ...	98	75	N. W.	...do	....	....	....	.....	.....	....	
25	6 p. m..	82	76	N. W.	...do	Rain.........	....	....	.....	.....		
26	6 a. m..	64	76	S. E.	....	....	....	First haul.........	6	8		
26	12 m ...	88	76	S. E.	....	....	....	Second haul........	4	11	187,000	
26	6 p. m..	72	76	S. E.	....	....	....	Third haul.........	1	10		
27	6 a. m..	72	75	N. W.	....	Cloudy	....	First haul.........	.....	.....		
27	12 m ...	90	75	N. W.	....	...do	....	Second haul........	3	12	54,000	
27	6 p. m..	84	75	....	....	....	....	Third haul.........	4	2		
28	6 a. m..	66	76	N. E.	....	....	....	First haul.........	4	6		
28	12 m ...	85	78	....	....	....	....	Second haul........	2	8	70,000	
28	6 p. m.	72	79	....	....	....	....	....	.....	.....		
29	6 a. m.	69	76	S.	....	....	....	....	.....	.....		
29	12 m ...	81	76	S.	....	....	....	....	.....	.....		
29	6 p. m..	72	76	S. E.	....	Light rain	....	....	.....	.....		
30	6 a. m.	71	75	S.	....	Clear	....	....	.....	.....		
30	12 m ...	84	79	S.	....	....	....	....	.....	.....		
30	6 p. m..	76	76	....	....	....	....	....	.....	.....		
Totals									374	653	6,893,000	

* Extra good. † Not good. ‡ Spent.

XVIII.—*REPORT OF THE TRIANA TRIP.

BY J. W. MILNER.

DEAR SIR: I have the honor to report, with reference to the expedition among the fisheries of the Potomac and Patuxent Rivers, that we went on board the steam-tug Triana at 10 a. m. Tuesday, April 27. Our party consisted of Mr. T. B. Ferguson, commissioner of Maryland; Dr. W. B. Robertson and Mr. Alexander Moseley, commissioners of the State of Virginia; Dr. Pearson Chapman, of Baltimore, whose intimate knowledge of the fisheries of the Potomac afforded us valuable aid; and Mr. G. Brown Goode, of the Smithsonian Institution. The three latter gentlemen left the steamer on the second day out, at Quantico, Va.

We visited two localities on the Potomac River the first day; Gut Landing, Md., fished by W. M. Elliott, being the first. This gentleman complained severely of the decrease of fish, and attributed it largely to the drift-nets which have thronged the river for seasons past. He said that the season was unusual in the marked decrease of herring. We remained at this fishery an hour or more, conversing with the proprietor and examining the species of fishes taken in the net. Very many male Rock-fish (*Roccus lineatus*), measuring from 12 to 18 inches, were found to be ripe, but no ripe females were obtained.

We next proceeded to Chapman's Point Fishery, Md., where a seine haul was made during a rain-storm. Besides shad and the two kinds of herring, constituting the bulk of the food-fishes there, we found, in the net, Rock-fish, White perch (*Morone Americana*); Yellow perch (*Perca flavescens*); Sun-fish (*Pomotis aureus*); the Gizzard shad (*Dorosoma cepedianum*); the Catfish (*Amiurus albidus*); the Bull-head (*Amiurus atrarius*); the Mullet sucker (*Ptychostomus aureolus*); and in addition twelve species, of forms too small to be marketable, and of which we

*The work of shad-propagation for the Potomac, inaugurated in 1873, was only moderately successful that year, as the station at Jackson City, Va., was the only one employed. In view of the proposed increase in the number of hatching-stations, it became necessary to obtain a more intimate knowledge of the fishing-grounds, and by the kindness of the Secretary of the Navy the steam-tug Triana was placed at my disposal for a trip down the river under the direction of Mr. Milner. The commissioners of Virginia and Maryland were invited to be of the party, as being directly interested in the results; Dr. Pearson Chapman, of Baltimore, because of his knowledge of the fishery-interests of the river and their history; and Mr. G. Brown Goode, of the Smithsonian Institution, because of his familiarity with the species inhabiting the rivers and brackish waters of the Atlantic coast both south and north.—S. F. BAIRD.

obtained a supply of specimens and preserved them in alcohol. We were hospitably entertained for the night at Mr. Chapman's house.

We went again on board in the morning and proceeded down the river to Stony Point, Va., before landing. The large seine, belonging to the Gibson heirs, is worked here. This is over 1,600 fathoms, or 9,600 feet, in length, and the linear extent of seine and lines is nearly five miles. A steam-engine is employed at either end, one of fourteen horse-power and one of eight. But two hauls are made in twenty-four hours, one on each ebb of tide. The haul which should have come on shore while we were there was prevented by the stubborn churlishness of the captain of a little vessel, who anchored within the circuit of the seine while it was being laid down, and refused to move his vessel out of the way, though Gibson proposed to send his men on board to lift the anchor. Calculating the time lost by eighty men, the lost trip of the tug chartered for the season, and the sustenance of the men during the lost time, which is by no means the whole outlay, the amount would be about $83.

Mr. Ferguson and I crossed over to High Point, Va., one of the larger fisheries, where we found the ordinary 1,000 fathoms seine managed with one eight horse-power engine. Proceeding to the Occoquan-Bay side of the point, we examined the shores, hoping to find a locality, sheltered from the winds and sea, that might answer as a shad-hatching station. We found a cove, landlocked from all points save southwest. From this direction the wind had a sweep of the entire width of the Potomac for fifteen miles, and the bars near by, that might cut off the action of the waves, were not shoal enough to prevent a sea sufficient to affect our hatching-boxes.

We returned to the steamer with additions to our collections, and steamed for Quantico, Va. Mr. Goode, Mr. Moseley, and Dr. Chapman left us at this point. We came to anchor for the night off Blackistone Island.

On the morning of the 29th we were early under way, and entered Chesapeake Bay, keeping close along the west shore. The Maryland State steamer "Lela" was seen near the mouth. At Mr. Ferguson's request, the captain consented that we should obtain a pilot for the Patuxent from the oyster police boat, a short distance up the river.

We found the State oyster-boat at Drum Point, some distance up the Patuxent Bay, and took on board Captain Forrest, who was to pilot us to the head of navigation at Bristol, if the draught of our steamer would permit her to ascend so far.

At the lower end of the river, numerous oyster-dredging schooners were seen, occasionally of considerable size. They were all busily engaged, as it was near the end of the season. The law prohibiting taking oysters after April 30, the entire fleet had to make their cargoes by the next night, when they would all set sail for market.

As we got higher up the river, no dredgers were seen, the tongs-men in small boats replacing them on the oyster-beds. An eastern schooner was buying their cargoes at one point, and a large fleet of the "tongsmen" had gathered around her, some of them alongside, transferring their stock of oysters to her hold, and others lying anchored near by awaiting their turn.

Our pilot carried us through the narrow passage of the Benedict Shoals without stopping. The channel at this point has 13 feet of water, but is very narrow and flanked on each side by a shoal with only 7 feet soundings. Opposite Northampton we ran aground in the mud, but soon got off. The lead was thrown continually during the afternoon. The navigation was difficult for a steamer drawing nearly 10 feet, and we were aground several times, and at last gave up the attempt to reach Bristol, and tied up to a fishing-dock on the west shore known as "Half Pone."

Seine-fishing shores were seen at numerous points along the river, but we learned that fishing was stopped as soon as hot weather set in. No communication by railroad is available for the shores, and the use of ice for shipping by steamer has not been introduced.

The boat was lowered and Mr. Ferguson and I started for Bristol. The men raised a sail, as the wind was fair, but even with a small boat we soon ran aground. We reached Bristol after a half-hour's sail. Mr. Oren Chase, with an assistant, was there in charge of the Maryland shad-hatching station, just organized by Mr. Ferguson. About 50,000 shad-eggs were in the boxes, but the temperature was 48° and the eggs were in bad condition. A seine-haul was made before we left, but no ripe fish were taken. But little success was looked for until the water became warmer.

It was very dark, and blowing hard, when we started to return, and we were soon lost in the shoals and mud-lumps; and the men pulled back and forth for two hours before we reached the steamer. We were early on our way on the 30th, and passed the shoals quite successfully on our return, though we were aground once. We steamed into the Potomac and came to anchor for the night at Nanjemoy Stores.

At Freestone Landing, Va., May 1, a little after 8 a. m., Captain Cook, Dr. Robertson, Mr. Ferguson, Mr. Gee, and I landed at the fishery. On the southwest side of the peninsula on which the landing is we selected a site for a station. A cove formed by an arm of land extending into Powell's Creek was sheltered from nearly all directions; it was sufficiently near the fishery to take advantage of all the hauls, and the proprietors expressed their willingness to afford us spawners, as in fact did many of the fishery-proprietors at other points.

Another locality which would be quite favorable is the vicinity of Fort Washington, where the Piscataway Creek flows into the Potomac. Gunsen Cove and Doag Creek, on the Virginia side, also afford sheltered places for stations.

At Alexandria Dr. Robertson returned to Richmond by rail.

The Triana reached the navy-yard a little after 4 p. m., having been away about four days and six hours.

Throughout the Potomac waters, although examining the shad continually, no ripe ones were found. The Patuxent-shad eggs which had been obtained at Bristol were suffering from the low temperature of the water, and will fail to come to maturity; so that it is evident that it would be premature to begin shad-hatching operations at present, though a week may make a change in the aspect of things.

We gathered a good deal of valuable information with reference to the fisheries. A list of the fishing-shores, from Point Lookout northward, is given herewith, and the seines in operation this season.

The quantity of shad and alewives (herring, as they are called here, *Pomolobus pseudoharengus*), is said to be far below that of any preceding year. The larger seine-proprietors insist that they are losing money daily, which is probably the case as their outlay is very large.

The early abundance of fishes in the river is fresh in the memory of the older residents on the Potomac, and is but the repetition of the history of the early times on many of the Atlantic rivers.

Mr. Chapman recollects the time when the seine-hauls on the shore piled the herring up from the water's edge 12 or 15 feet landward. The men walked or waded knee-deep among them, thrusting in their arms to find and select out the shad, and allowed the herring to float off at high tide. In Mr. Chapman's words, "This reckless, destructive policy has brought its results, and this year the fishery-owners have to bewail the scarcity of herring," which they would be very glad to have in abundance.

In the *Gazetteer of Virginia, published in 1835, is the statement, referring to "the immense fisheries of the Potomac," that "the number of shad frequently obtained at a haul is 4,000 and upward, and of herrings from 100,000 to 300,000. In the spring of 1832 there were taken in one seine, at one draught, a few more than 950,000, accurately counted." * * * * "The lowest prices at which these fish sell when just taken are 25 cents per thousand for herrings, and $1.50 per hundred for shad, but they generally bring higher prices, often $1.50 per thousand for the former, and from $3 to $4 per hundred for the latter. In the height of the season, a single shad, weighing from 6 to 8 pounds, is sold in the markets of the District for 6 cents. Herrings, however, are sometimes taken so plentifully that they are given away or hauled on the land as manure for want of purchasers. Some idea may be formed of the importance of these fisheries from the following statement:

Number of fisheries on the Potomac, about	150
Number of laborers required at the landing..............	6,500
Number of vessels employed	450

*A New and Comprehensive Gazetteer of Virginia and the District of Columbia, containing, &c. * * * By Joseph Martin. To which is added, &c. * * * Charlottesville. Published by Joseph Martin. Moseley & Tompkins, Printers, 1835. p. 480.

Number of men to navigate these vessels	1,350
Number of shad taken in good season, which lasts only about six weeks	22,500,000
Number of herrings under similar circumstances	750,000,000
Quantity of salt required to cure the fish, bushels	995,000
Number of barrels to contain the fish	995,000

"The Potomac River can boast of the largest shad-fisheries in the United States. The advantages of the herring-fisheries she divides with some other rivers of the South, but it is equaled by none unless it be the Susquehanna."

The abundance of the rock-fish and its large size are also referred to. The record of a seine-haul is given at Sycamore Landing about 1827, where 450 were taken, averaging 60 pounds each.

The same writer refers also to the sturgeon abounding in the Potomac as far up as the foot of the first falls. A peculiar form of tackle thought to be used only on this river for taking sturgeon is described.

In Fleet's Journal, first printed in 1871, the following entry was made, under date of June 25, 1632: "We came to an anchor two leagues short of the falls, [falls of the Potomac.] This place without all question is the most pleasant and healthful place in all this country, and most convenient for habitation; the air temperate in summer, and not violent in winter. It abounds with all manner of fish. The Indian in one night commonly will catch thirty sturgeons in a place where the river is not twelve fathoms broad."

The statistics for the years 1874 and 1875 will afford an interesting comparison with the foregoing. The seine-fisheries of the Potomac, from Matthias Point northward, numbered about thirty-three seines during the shad-season of 1874. Since the time the Gazetteer was compiled, however, the drift-nets have come into the river and capture a great many shad which would otherwise find their way to the seines. A few pound-nets also have been established, and come in for a small share of the fish. Still, withal, the fishing enterprise must be considered as much diminished since the record given in the Gazetteer.

The nets in operation during shad-fishing of 1874 were at the following shores:

Virginia: Caywood's, Windmill Point, Tumps, Gum, Arkendale, Clifton, Freestone Point, Stony Point, High Point, White House, Ferry Landing, Jackson City.

Maryland: Maryland Point, Budd's Ferry, Stump Neck, Chapman's Point, Pamunkey, Gut Landing, Greenway, Bryant's Point, Moxley Point, Kent, Stick Landing.

The total for the Alexandria, Washington, and Georgetown markets for Potomac fish, as taken from the report of Mr. C. Ludington, inspector of marine products for the Washington board of health, is 1,051,587 shad; 15,006,940 herring; 340,387 hickory-jacks (*Pomolobus mediocris*); 616,791 bunches fish; and 1,650 sturgeon.

In 1875 there were seine-fisheries at—

Virginia: White Point; Caywood's or Foulk's Shore, fished by Joseph Caywood; Windmill Point, fished by Conrad Faunce; Tump's, by a man from Baltimore; Gum Bar, fished by Jerry Robbs; Arkendale, fished by Joseph Besley; Clifton, fished by Withers Waller & Montacure; Freestone Point, fished by Jacob Faunce; Deep Hole, fished by McCuing & Ticer; Sandy Point, fished by D. G. Henderson; High Point, fished by John Gibson heirs; Stony Point, fished by same; Ceate's Point, fished by Tucker & Hall; Cornfield or Barn Landing, fished by J. Haiser; Gunzton Hall or Tick Landing, fished by Jackson Haiser; Ferry Landing, (formerly owned by General Washington,) William Knight; Dangerfield Island, (a small seine;) Jackson City, fished by John Gibson heirs. Total, 18.

Maryland: Maryland Point, fished by Price Green; Budd's Ferry, by Cunningham; Stumpneck, by same; Rum Point, small seine; Chapman's Point, John H. Chapman, esq.; Pamunkey Point, S. H. Barrow; Government Landing, William H. Elliott; Green Ways, Moore, Smith & Co.; Bryan's Point, Conrad Faunce; Moxley's Point, J. H. Skidmore; Meadow Bars, a small seine; Tent Landing, James Guy; Sandy Bar, Jerry Robbs. Total, 13.

District of Columbia: Berry's Landing, McKewen; Stick Landing, Miller; Giesboro, Luckett. Total, 3.

Of pound-nets there were:

Nanjemoy Reach, 2 pound-nets, Rainer; season, two months in spring, three months in fall: 4 pound-nets, Lomax; season, two months in spring, three months in fall.

Curriomen, Va., 2 pound-nets, Reed; season, two months in spring, three months in fall.

Freestone Point, Va., 2 pound-nets, Stewart; season, two months; taken up before season was over.

Georgetown Channel, 1 pound-net, Frost; season, two months in spring.

Georgetown Channel, 1 pound-net, Jenkins; season, two months in spring.

Total, 12.

It is difficult to get at the number of drift-nets* and boats accurately. Many of them fish regularly and continually, and many others are very irregular and transient in their work, fishing when a little ready money is needed, when a few fish are wanted for the table, or from caprice.

On the 27th, between Washington and Pohick Bay, Mr. Goode counted 33 boats fishing. As it was during a continual cold rain it did not represent at all what would ordinarily have been engaged.

The total of the shad-season fishing on the Potomac for 1875 is 33 seines, 12 pound-nets, and a large number of drift or gill nets not counted.

* Mr. O. N. Bryan, of Charles County, Maryland, estimates the number of gill-net boats for the whole State of Maryland at 2,000.—(Marlboro Gazette, Port Tobacco, Md., November, 1875.)

The following comparative table of inspections for the Washington markets during the years 1873, 1874, and 1875, is taken from Mr. C. Ludington's comparative statement of the inspection of marine products for these years:

Comparative table of inspections of food-fishes in the Washington market for the years* 1873, 1874, *and* 1875.

Years.	Inspections.						Condemnations.				
	Shad.	Herring.	Tailors.	Bunches of fish.	Sturgeon.	Total pounds of fish.	Shad.	Herring.	Tailors.	Bunches of fish.	Sturgeon.
1873	852, 900	3, 789, 800	326, 200	553, 761	496	8, 548, 851	270	52, 600	.....	5, 153	...
1874	628, 637	6, 567, 240	89, 841	567, 291	919	10, 827, 967	149	140	158	6, 087	16
1875	464, 215	1, 674, 465	56, 430	557, 203	1, 204	7, 002, 049	60	2, 125	.....	8, 315	18

It is probable that the Potomac has the largest seines in use in the United States; the only ones at all approaching them in size are the large menhaden seines† of Long Island Sound and the Atlantic coasts of Massachusetts and New Jersey. The ordinary 1,000-fathom seines in use at the present time are very much the same in dimensions as those of former years; so that it is possible to obtain quite a correct comparative estimate of the fisheries of former times and the present.

A large number of the seines referred to above are of 1,000 fathoms length. The one at Stony Point, owned by the Gibson heirs, is 1,600 fathoms long,‡ and lines and seine together measure four and two-

*In explanation of the names and terms used in the table, the shad is the ordinary *Alosa sapidissima;* the herring, the Alewife of the north (*Pomolobus pseudoharengus*); the Tailor, sometimes called Hickory-shad (*Pomolobus mediocris*); the Sturgeon, the ordinary *Acipenser brevirostris;* the bunches of fish include white perch (*Morone Americana*); yellow perch (*Perca flavescens*); the bull-heads (*Amiurus atrarius*); the catfish (*Amiurus albidus*); the pickerel (*Esox reticulatus*); and several species of *Centrarchidæ, Catostomidæ*, &c.

† The menhaden seines in present use are generally "purse-seines."

‡ *Description of Stony Point Seine.*—Wings: 140 meshes deep, 3-inch meshes. Back, 100 fathoms long, 225 meshes deep, 2½-inch meshes. Entire length of seine, 1,600 fathoms. Lines: Land-end, 7 coils rope (150 fathoms to a coil.) Boat-end, 11 coils rope. An auxiliary line extends to the under side of the bag known as the "quarter-line." As the bag approaches shore it is from time to time drawn upon to relieve the strain upon the wings. No leads are used, the heavy bottom line (3-inch rope) keeping the net down sufficiently, and even this is sometimes supplied with block-runners to keep it from sinking into the mud. Cork line, 2-inch rope, 4 corks to a fathom on the wings; 6 corks to a fathom on the back. Boat, 65 feet long; 11 feet beam; round-bottomed; 30 oars.

Engine at land end, 8 horse-power; engine at boat end, 14 horse-power. The boat-line is shifted from time to time to sheaves set in the beach as the brails are drawn together, or the current drifts the seine down stream.

Men: Two seine captains, 5 assistants, 2 engineers, 4 net-menders, (white); 60 seine-haulers, 3 cooks, (negroes.)

One lighter scow, 30 tons burden. A tug, chartered for the season, tows two lighters and a schooner. A third lighter is necessary, as an empty one is left when the loaded one is taken away. The yearly expenditure is from $12,000 to $15,000 on this fishery.

thirds miles. In each haul of the seine over 1,200 acres of bottom are swept by the bottom line and the larger portion of the fishes in this area dragged on shore. Two hauls are made each day of twenty-four hours; one on each ebb-tide.

In 1873, while on a visit to some of the larger fisheries, I saw 2,316 shad and about 25,000 herring taken at one haul. I was told at the time that 4,000 shad were taken two years before.

Nearly all of the seine fishermen stated that this season they were losing more and more money the longer they fished. Instead of counting the shad by thousands, 200 was quite above the average haul for the large seines. It was apprehended that some of the proprietors would become bankrupt.

The decrease of fishing by seines is made evident by the desertion of many of the once most famous shores of the river. Opossum Nose, Cockwit Point, Marshall Hall, White House, Urban's, Scone's Gut, Smith's Point, Indian Head, Craney Island, and others, have been abandoned within fifteen years.

The abandonment of fishery-shores is to be attributed to the failures to make profitable captures for a period of years. These have arisen from a reduction of the numbers of the fishes, primarily; and, also, from variation in the run-ways of the fishes because of changes in the bed of the river (as at Craney Island) and of the obstacles to their ascent, principally the drift-nets and the pound-net leaders. The large rental which certain owners have demanded has also left certain shores idle.

The cause of the dearth of fish must be largely owing to over-fishing; the immense exhausting sweeps of the great seines; the continual drifting of the gill-nets, almost invisible to the fishes in the roily water, yet reaching across the channels often three-quarters of a mile and from the surface to the bed of the river; and of late years the pound-nets, fencing off long stretches of the run-ways of the fishes, until it is scarcely an exaggeration to say that not a gallon of the water of the river flows into Chesapeake Bay without being strained through the meshes of some net. The skim-nets used in the vicinity of the Great Falls are of small consequence in the reduction, as the total of their catch is inconsiderable.

It is the custom, without exception, in all fishing-localities to hear the different net interests attribute the decrease of fishes to the abuses of nets different from their own. The Potomac is not unlike other regions in this particular.

The drift-netters accuse the large seines, and the seine-owners inveigh against the drift-nets and pound-nets, and ask for laws and regulations to control and prohibit them.

A special point of complaint, is the incursion of "foreign fishermen" upon the fishing-grounds. During the last two seasons a considerable number of drift-netters have come upon the Potomac during the shad season, from Pennsylvania and farther north. The presence of these men seems to the resident fishermen and proprietors to be an intrusion and an outrage, and their strongest desire is for a law removing them.

On the sea-coast and the great lakes, fishermen migrate from point to point during the season wherever fish are to be found, regardless of boundary-lines within the United States, and no interference with them is thought of except with regard to shores held in deed or lease. On the Atlantic-coast rivers the disposition has been to reserve the waters more exclusively for the people of the State.

A strong feeling has at once arisen against the pound-nets. It is very curious to observe the entire coincidence there is in the history of the introduction of nets, and the rivalry of interest in different localities. From Lake Champlain, the several great lakes, and the larger rivers we have pretty complete reports of the history of their fisheries.

In all of these localities, in their first settlement, there is evidence of a seemingly inexhaustible abundance of the fishes; the nets necessary for the capture of large quantities being small and easily contrived. As the country became populated an increased demand for the fish grew up, and professional fishermen introduced large nets, and great quantities were taken and sold at low prices, and frequently used for manure. After a few years the supply became diminished, and resort was then had to legislation. The laws enacted were usually good ones, but were rarely enforced.

The history of Jefferson County, Lake Ontario, by F. B. Hough, M. D., affords an example of the rivalry of nets.

At Chaumont Bay the first net-fishing began in 1808. Scoop-nets or scaff-nets were first used. These were flat nets 12 feet square, stretched by two long bows, the ends of which were attached to the corners of the net, and, arched up high above it, crossed each other at the middle. At the point of intersection of the bows, the end of a pole was fastened and reached up to a long pole or sweep, which was balanced over a crotched stick either set into the bank, or a slight pier built out into the water. Later the same contrivance was used from the deck of a scow. The mode of fishing was to force the net down into the water until it lay upon the bottom, and when the fish swam over it to suddenly raise it, the balancing-pole relieving the fisherman from the weight of the net and fish. Mr. Hough, from records which he had seen, stated that as many as 300 fish were taken in a single night.

Seines were soon after introduced, from the Hudson River, and the fish being plentiful no opposition was made. They were from twenty to one hundred rods long. The products of a haul were said to be as high as 75 barrels of white-fish, and the average 6 or 7 barrels. With the multiplication of seines there was a sufficient reduction of the fish to arouse the animosity of the people against the gill-nets when they were introduced several years later. In time, however, they came to be an accepted thing, and when, about fourteen or fifteen years ago, pound-nets were introduced, the whole feeling of the people was brought to bear against them.

Throughout the great lakes, where the gill-net interest and pound-net interest are nearly divided, each inveighs against the other, and shows the advantages pertaining to its own system in relation to preserving the stock of fish in the waters, and in most instances (there have been favorable exceptions, however) a move for legislation for fishery laws, emanating from fishermen, will be found to bear unjustly on a certain class of nets, while the rival interest is not interfered with.

These facts are given to show that the complaints coming from the net interests are calculated to misguide, and that efficient, just, and enlightened legislation should base its conclusions on a more impartial, disinterested investigation of the matter.

There is little doubt that the great occasion for decrease in the Potomac is over-fishing, and in this all kinds of nets are more or less involved. Added to this, impurities carried into the river from drainage have some minor influence,* the disturbance of the fish, especially the shad from its well-known timidity, by the plashing of steamer-wheels; and the continual obstructions it encounters from the nets.

In those causes are the true reasons for decrease. The remedies are what shall influence these by way of restriction or prohibition. The latter has not usually worked to good advantage, as it has occasioned too strong an opposition and is rather un-American in spirit.

The true policy in a law would be to strike at abuses in all nets, and nothing can be more to the purpose in the protection of anadromous fishes, such as the salmon, shad, and alewife, than a "close-season" law prohibiting all fishing during a portion of each week—from Friday night to Monday morning, or such other time as may be considered necessary. Regulations of the length of nets and the size of mesh are also valuable measures.

The great reason for failure in the effect of fishery-laws has not been their character, but the fact that they were not enforced. This has been the almost universal history of the laws except in Canada, Scandinavia, and portions of Russia. It has been notably so throughout the United States.

A suggestion which has impressed me strongly with relation to the fisheries of the Potomac I hesitate to propose, as it is so opposed to the judgment of all who have taken fishery-laws under consideration, and among these I recognize many whose opinions I have reason to treat with great respect, as they have studied this question with earnestness and fairness, and have arrived at their conclusions from a considerable range of observation and thought.

The proposition I desire to make must be premised by the condition that suitable laws be enacted and efficient means be provided for their

*It is quite possible that the abundance of the shad in the Georgetown channel has been lessened because of the drainage from the gas-works at G street, although the amount of drainage into so large a stream as the Potomac is soon dissipated, and does not influence very far down the stream.

enforcement. How this may be done I will discuss further on. A careful consideration of the subject of the Potomac fisheries as we may anticipate it through years to come induces me to recommend that pound-nets be encouraged in preference to all others. There are a few important reasons why, under proper control, they will work more advantageously for the welfare of the fisheries than seines or gill-nets.

A purpose that must not be lost sight of in the ardor for the conservation of the stocks of fishes in the waters is the productiveness of the fisheries. They are one of the resources of income in the industries and productions of a State favored with a water area or coast, and should be made to produce to whatever extent they can without endangering future supplies.

In manufacturing industries and agriculture a great deal of attention is paid to the reduction of cost of production and improvement in machinery, and the same thing should be applied to the fisheries.

The pound-net, where it has been employed on the lakes in white-fish and lake-herring fisheries; on the coast in the scup, blue-fish, sea-bass, squeteague, and tautog fisheries; on the Atlantic rivers and bays in the salmon and the shad fisheries, more especially of the Connecticut River and Bay, has been found to cost very much less, in its current expenses, than the seine. The items in which it saves expenditure are its great reduction of the labor-force, its saving of the time lost between hauls by the seine, and the great saving of wear and tear that a stationary net has when compared with hauling seines.

The Stony Point seine investment* would establish at least 30 first-class pound-nets fully equipped for work, and instead of two steam-engines and crew of 75 men, 30 men would be an ample force to attend them and work fewer hours than the seine-crews have to. The twine of these large seines would not have to be thrown away, but would nearly all come into use in making up the pounds.

That many pound-nets properly placed and efficiently attended should certainly yield much more than the seine.†

The pound-net has also the advantage that the fish remain alive until it is desirable to take them out and move them to the market, and come upon the stalls in the freshest, best condition. In either seine or gill-net this is not the case.

Some advantage might also be claimed that the eggs of a spawning-fish would be preserved, and with the light specific gravity of the shad-

* I have estimated the investment for the steam-engines, the lines and twine of this seine at $25,000, which is well within the original cost; estimating a good ordinary pound-net at $800, 30 of them could be erected for this amount.

† The fishermen of the Potomac at present have but little confidence in the pound-net as a means of capture for the shad. In the bay and lower end of the Connecticut River they are constructed so as to capture shad very successfully; in fact, quite too much so in the estimation of the people of the upper portion of the river. There is no reason to believe the Potomac shad should differ from the Connecticut ones in the particular of entering a pound-net.

eggs, would float out of the net and have some chance for development and the production of young fish.

Another important advantage would be that as a stationary net the only portion of the bottom on which eggs might be deposited that would be disturbed, would be the 30 feet square of the bottom of the movable pot, and even this would be slight. A contrast very favorable to the pound-net is with the 1,200 or more acres swept by the seine referred to, twice in twenty-four hours, and the continual trailing of the drift-nets over miles of the bottom of the river.

The objections that have been advanced against the pound-nets on the lakes and sea-coast are the following: First, that by extending the leaders for long distances, often for miles, they fence off the run-ways of the fishes and guide entire shoals of fishes into the pot or trap portion; second, that by employing small meshes in the pot or trap, young and immature fishes are captured in large numbers, and the stock of fishes in the lakes thereby reduced uselessly and in an anticipatory manner, as the future stocks of fishes which depend on the progeny of these are of course prevented. These are the objections to pound-nets, and they are final and sufficient to condemn them for all waters if these features are necessarily attendant with their use.

The abuses, it will be seen, are the extension of the leader to unreasonable lengths, and the use of a mesh so small that immature fishes are destroyed in large numbers.

The Potomac has the advantage of the old pound-net regions in that the interest is as yet very small, and a good code of laws for their regulation can be enacted by the States interested without the opposition of a wealthy and determined body of net-proprietors, as has been the case on the sea-coast, Connecticut River, and the lakes. For the enforcement of laws after they have been established, no better system could be employed than that which controls the oyster-fisheries of Maryland. The extension of the duties of a fishing-police force, with properly-equipped vessels, to the oyster-dredgings, fisheries, and the nets, would place the whole matter under efficient control, and whatever regulations as to close-season, size of mesh, length of nets, and even number and character of fisheries, if there should be legislation in this particular, could be efficiently controlled.

I have to acknowledge my indebtedness to my companions during the trip for many suggestions and ideas developed in our conferences on board of the Triana.

Admiral Goldsborough, of the navy-yard, placed all facilities possible for the success of our trip, in equipping the steamer, and Captain Cook, commanding the Triana, rendered us every advantage possible to facilitate our inquiries.

I am, yours, respectfully,

JAMES W. MILNER.

Prof. S. F. Baird,

United States Commissioner of Fish and Fisheries.

XIX.—ON THE TRANSPORTATION OF SHAD FOR LONG DISTANCES.

A—EXPERIMENTS WITH A VIEW TO TRANSPORTING SHAD IN SEA-WATER.*

By James W. Milner.

In order to discover the best methods for transporting shad by sea-going steamers, a series of experiments was made at Noank, Conn., at the close of the spawning season.

Twelve glazed earthen-jars, with a capacity of little more than four gallons each, were provided to contain a certain number of shad, and a formula for the treatment of each jar written out.

The tests thought to be desirable were the endurance of young shad in sea-water, in mixtures of fresh water and sea-water, and in fresh water at different temperatures, and with fresh supplies at varying prolonged intervals.

The young fish used were the very last of the season's hatchings. The fish began to make their appearance freed from the eggs on the morning of the 14th of August. Early on the morning of the 15th, about 45,000 were put into five cans. The train left Holyoke, Mass., at 6.23 a. m. The water on the fish was 71°. Fresh-water supplies were given them at 7.30, at 9.30, and 11.30 a. m., and at 1.30, at 3.30, and 6 p. m.

On arriving at Noank, Conn., on Fisher's Island Sound, a small building was fitted with shelves, at a convenient height, and the twelve jars were arranged on two sides of the room. Jars Nos. 1, 2, 3, and 4 were to be devoted to experiments with definite mixtures of fresh and sea-water, the latter gradually increased; Nos. 5, 6, 7, and 8 to experiments on temperature; Nos. 9 and 10 to experiments as to the effect of ordinary changes of temperature; No. 11 to pure sea-water; and No. 12 to surface-water from the bay at low ebb of tide, in which was a mingling of the fresh water from the drainage of the land.

At 9 p. m. the series of experiments was begun, the jars having been supplied with a rather full quantity of fishes; by estimate, in accordance with our usual judgment from their thickness in the water, about 4,000 to each jar, Nos. 7, 8, 9, 10 having somewhat less. The temperature of the water in the jars was 70°. It required about one-half hour to apply the

* Having been called away from these experiments soon after inaugurating them, I have to thank Mr. C. D. Griswold, Commander L. A. Beardslee, United States Navy, and Mr. G. Brown Goode, for their interest in carrying them through to their results.—J. W. Milner.

varying treatment to the series of jars, but as it was always begun with No. 1, and carried through with the same order, the interval for each jar was always the same, and in recording, the hours of 9, 12, 3, and 6 were used for convenience sake, though strictly they would apply only to No. 1.

The purpose of the tests with 1, 2, 3, and 4 was to try if gradually increasing proportions of sea-water would enable the young shad to become accustomed in time to supplies of pure or nearly pure sea-water without diminishing their vigor and vitality.

No. 1, at 9 p. m. August 15, had 128 gills of fresh water at a temperature of 71° Fahrenheit. Two quarts of the water were drawn off, and this was replaced by two quarts of a mixture, 15 gills of which were fresh water and 1 gill was sea-water. Three hours later, at 12 midnight, two quarts were again removed from jar No. 1 and two quarts of a mixture of 14 gills fresh water and 2 gills sea-water poured in. At 3 a. m. of the 16th two quarts were again removed and a mixture supplied of 13 gills of fresh water and 3 of sea-water.

This supply of a mixture amounting to one-eighth the contents of the jar, with a continually increasing proportion of sea-water, was afforded every three hours. At the end of 45 hours the two quarts of supply, having the sea-water proportion increased one gill each time, would be all sea-water. After the 45 hours, at 6 p. m. on the 17th, or the fifteenth supply of water to the jar, two quarts of sea-water were afforded every 3 hours, a like quantity being at the same time removed. At this rate the water upon the fish at the end of 24 hours, or 9 p. m. of the 16th, would be about 25.6 per centum sea-water.

At the end of 48 hours, or 9 p. m. of the 17th, the jar would contain a mixture with 66.2 per centum sea-water. At the end of 72 hours, or 9 p. m. the 18th, the mixture would become 88½ per centum sea-water.

The temperature remained very even until noon of the 17th, when it fell to about 67°, 3° less than at 9 a. m. The 18th, at 6 p. m., it had again risen 4°.

The shad seemed to retain vigor and health until the 18th. They showed weakness in the morning, the per centum of sea-water having reached 80½, and at 6 p. m. they were all lying on the bottom of the jar, the per centum of sea-water being 86.8. A few of these were taken out and put into a glass jar which contained a mixture of one quart fresh water and one quart sea-water; in this the most of them revived and lived from 6 p. m. August 18 to 6 p. m. August 22—96 hours longer than those left in the jar.

In the jar No. 1 they were soon after all dead. They were about 102 hours old, and had been kept about 17 hours in the hatching boxes, about 16 hours in the cans, and 69 hours in the jars with the sea-water mixtures. Those revived in the glass jar were 198 hours or eight and one-fourth days from the egg at the time of death.

The treatment of No. 2 began at near the same hour as No. 1, the temperature being the same. In this jar the one-eighth supply of mixture every three hours had a more slowly-increasing proportion of sea water. The first supply at 9 p. m., August 15, was ½ gill of sea-water and 15½ gills of fresh water. At 12, midnight, the mixture was one gill of sea-water and 15 gills of fresh water, and at 3 a. m. of the 16th it was 1½ gills sea-water and 14½ gills fresh water. At this rate of increase the supplies would become all sea-water after 93 hours.

In this much more gradual increase of sea-water the young shad began to show weakness on the 19th, the contents of the jar having reached a per centum of about 75 sea-water. At 9 p. m. of that date, three hours after the first supply of all sea-water, they were observed to be dying. At this time the sea-water was 81 per centum of the whole contents. At 6 a. m. of the 20th, there were considered to be one-half of them dead, and on the 22d, at 9 a. m., the last of them died. The jar contained a solution of sea-water, 98.8 per centum sea-water and 1.2 fresh water.

The temperature had varied from 66° to 78°. The latter, occurring on the 20th, no doubt had some effect in reducing their vigor. They were, at the time the last of them succumbed, 189 hours from the egg, and had been in the jar 156 hours.

The increasing proportion of sea-water in the supplies to No. 3 was at the same rate as No. 2. It was continued until the mixture became half sea-water and half fresh, and the supplies from that time, the 17th at 6 p. m., forward, were in this proportion. The fish began dying at 9 a. m. of the 22d, the per centum of sea-water being 49.86, and at 3 a. m. of the 23d all were dead, the last ones being about 207 hours old, and having been in the jar 174 hours. The water had become 49.93 sea-water.

Jar No. 4 proved the most enduring of any of the experiments with sea-water. Beginning approximately at the same time, and with temperature the same as the others, in this jar the addition of sea-water to the supplies was at the same rate as in that of Nos. 2 and 3. The addition of ½ gill of sea-water at each interval of three hours to the mixture, with a corresponding decrease of fresh water, made the proportions of fresh and salt water in the supply, at the end of 30 hours, about one-third of the latter and two-thirds of the former. This proportion was thereafter retained. The fish began dying at 6 a. m. of the 23d, when the per centum of sea-water was 34.35. At 6 p. m. of the 23d about seven-eighths were dead, the water having attained a per centum of 34.36 sea-water. At 7 p. m. of the 25th the last one died having attained the age of 271 hours, and having been in the mixture about 238 hours. The sea-water had reached the percentage of 34.37.

These were all the experiments made with proportions of sea-water. Others were made with pure sea-water and with surface-water from the bay in which the fresh-water drainage had more or less diluted the salt.

A jar was filled with sea-water several times and a quantity of shad placed in it. They invariably died within three hours.

Jar No. 12 was filled with surface-water from the bay; the recent rains had diluted this to a considerable extent. The treatment of the jar was to afford a supply of this water every three hours. At 8 a. m. of the 16th they were put in the jar, and at noon of the 21st they were all dead, having been in the jar 124 hours.

An experiment was made by removing fish, nearly exhausted in sea-water, to fresh spring-water. The fish survived those left in the jar about 28 hours.

Nos. 5, 6, 7, 8, 9, and 10 were experiments to test the effect of different temperatures, and 70°, 65°, 60°, 55°, and 50° were prescribed for these jars. The temperatures were not, however, controlled with the facilities at hand. No. 5 was intended to retain a temperature of 65°, which it did quite regularly for about 175 hours. The last of the fish were dead at 3 a. m. of the 23d, being then 207 hours old and 174 hours in the jar.

The record for No. 6 was almost identical with No. 5.

No. 7, with a temperature of 64°, kept the fish alive until they were 225 hours old, 192 hours in the jar. This is the longest period of life among them; the No. 4 sea-water test, however, exceeded it some 13 hours. It had slightly fewer fish than Nos. 5 and 6, which was of course an advantage.

In Nos. 9 and 10 the water remained at the temperatures of the room without any care to decrease or regulate them in any way. The waters varied from 66° to 78°. The fish retained life 219 hours, 186 hours in the jar.

No. 8 it was intended to keep at 50°, but, instead, it remained for the most of the time at 64°. It was placed about the time the fish were six days old in the refrigerator, which reduced the temperature to 48°, at which the fish died rather rapidly. They were seven hours in the ice-chest, and were dead within three hours after the mercury stood at 50°.

It will be at once seen, by those who have followed the published experiences of men who have carried young shad long distances, that the longest periods recorded for transportation of shad by rail (as in Seth Green's trip with shad to California in 1871, 184 hours,) or by steamer (as in Mather's and Anderson's trip to Bremen, 240 hours,) are not much different from the longest period in which shad endured the treatment with sea-water, (as in No. 4, 238 hours,) or a low temperature, (as in No. 7, 192 hours.)

The movement of the car or steamer in producing a moderate agitation in the water is known by all who have carried shad to be a very large advantage in favor of the life of the fish. With this advantage the fishes in the jars would undoubtedly have prolonged their existence considerably, as the use of water from the same source continually is an advantage not at command when traveling, and the facilities for cleansing the jars and keeping the temperature regular are also much greater.

In the fresh-water temperature tests, the fish did not endure as long as in the sea-water test, No. 4.

There is ample evidence in the experiences in the treatment of shad that they are in need of food when about six or seven days old, and if not supplied will starve to death in from 70 to 80 hours, so that it is not possible to say that the presence of the sea-water in the last test killed the shad. No practicable methods for feeding embryo-shad and white-fish (*Coregonus albus*) have been discovered, though river-water seems to afford them some supplies of nourishment.* The intestines of many of the embryo-shad from the jars, when examined under the microscope, failed to discover any food.

The problem of the transportation of embryo-fishes like those of the shad and white-fish (*Coregonus albus*) long distances, which occupy a period of time longer than a week, requires study and experiment. The probability is that the great need is some method for feeding them *en route*.

To devise a method for feeding them will require the services of a microscopist familiar with the lower forms of invertebrates and the eggs and larvæ of higher groups, which are the principal minute organic forms available as food in the waters where the fish breed naturally. The only investigations which I am aware of are the observations of Mr. S. A. Briggs, of Chicago, published on page 57 of the report of 1872–3, and those observations just referred to in these experiments.

The experiment may also be carried out empirically by trying young fishes with the different forms of the groups just referred to. If food can be found among these forms, experiments as to the feasibility of breeding them *en route* will be in order. Many of them have been developed in numbers by naturalists for purposes of study, and with some it is very easily accomplished.

Another, and probably the most feasible method to obviate starvation, is, in the case of the shad, to retard the eggs by cold, and devise a process of hatching *en route*. If this can be accomplished so that the fish can emerge from the egg when six days out from land, they will be likely to arrive at their destination with vigor and strength.

These facts and experiences in regard to keeping shad alive seem to indicate that the application of sea-water with a very gradual increase and in small proportions has not a sensibly injurious effect. Where fresh water has been used, no greater periods of life have been attained when the fish were confined in small vessels. Still, the series of experiments indicates that in proportion as the quantity of sea-water increases the endurance of the fish diminishes; and, inversely, the less and more gradually the sea-water is applied, the longer the fish endure. A parallel instance would be that a little overplus of oxygen in the atmosphere

* See report of United States Commissioner of Fisheries, 1872–'73, p. 57; and fourth annual report of commissioners of New York, 1872, p. 20.

of a room exhilarates and even benefits a man, while a greater increase rapidly becomes injurious and fatal.

Pure sea-water, in repeated experiments, proved fatal in 3 hours. A rapid increase of the salt, in which the supplies became all sea-water in 45 hours, (jar No. 1,) and the contents of the jar became $80\frac{1}{3}$ per centum sea-water in 60 hours, the fish showed distress and weakness, and in 69 hours all were dead or dying at the bottom of the jar, the water having become 86.8 per centum sea-water.

In a more slowly increasing proportion, in which the supply became all sea-water in 93 hours, (jar No. 2,) after 96 hours the water having become $81\frac{1}{8}$ per centum sea-water, the fish began dying. After 156 hours all were dead, the sea-water being $.98\frac{6}{7}$ of the whole.

In a mixture where the supply was one-half sea-water after 45 hours, (jar No. 3,) and retained at that, the fish began dying when the water had become $49\frac{7}{8}$ sea-water, or in 156 hours. In 174 hours they were all dead, the mixture having become one-half (49.9 per centum) sea-water.

In the most slowly increasing proportion the supply became one-third sea-water after 30 hours, (jar No. 4,) and was retained at that. The fish did not begin dying until 177 hours, the contents of the jar being one-third sea-water. After 189 hours all were dead, the per centum of sea-water being 34.3.

There seems to be sufficient in the results of these experiments to deter any one from attempting to move shad across the ocean, depending upon the use of sea-water for large proportion of supplies; though small quantities could be cautiously used for improving the stale fresh water.

The temperature experiments were not very satisfactory, as the intended reductions were not readily reached and controlled with the appliances at hand. In the case of No. 8, it was produced by placing the jar in a refrigerator and reducing it very rapidly. The fish were already six days old, and probably somewhat reduced in strength. They succumbed at once to the rapid reduction of temperature, though to have completed the experiment an effort should have been made to revive them by gradually raising the temperature.

No. 7 had the advantage of having fewer fish in the jar, the advantage of a larger supply of water sustaining them beyond the expiration of 5 and 6, which had about the same temperature. The indications in the temperature tests are scarcely worth determining, as the devices and facilities for the necessary reductions of temperatures according to the plan laid down were not available, and the rapid reduction of No. 8 in the refrigerator would not afford a fair comparison of endurance of low temperatures with Nos. 5, 6, 7, 9, and 10.

The main purpose of the series of experiments, that of testing the value of sea-water, was well carried through, and I believe will be a final decision against its use, except perhaps in the slight quantity indicated.

Table showing comparative results of experiments in keeping embryo-shad alive in mixtures of fresh and sea water.

[Supply every three hours two quarts (one-eight contents of jar) of a mixture of fresh and sea water.]

Date, (to apply to all.)	Hour, (to apply to all.)	No. 1.—The proportion of sea-water in supply increased one gill each time until all sea-water.					No. 2.—The proportion of sea-water in supply increased one-half gill each time until all sea-water.					No. 3.—The proportion of sea-water in supply increased one-half gill each time until one-half sea-water, and retained at that.					No. 4.—The proportion of sea-water in supply increased one-half gill each time until one-third sea-water, and retained at that.				
		Temperature.	Per cent. sea-water.	Age, (in hours.)	Period in jar, (in hours.)	Remarks.	Temperature.	Per cent. sea-water.	Age, (in hours.)	Period in jar, (in hours.)	Remarks.	Temperature.	Per cent. sea-water.	Age, (in hours.)	Period in jar, (in hours.)	Remarks.	Temperature.	Per cent. sea-water.	Age, (in hours.)	Period in jar, (in hours.)	Remarks.
1874.		°					°					°					°				
Aug. 15	9 p. m.	71		33		Treatment begins	70		33		Treatment begins.	68		33		Treatment begins	69		33		Treatment begins.
*17	3 a. m.	69					69					68					69			30	Supply becomes ⅓ sea-water.
	6 p. m.	67			45	Supply becomes all sea-water.	68					66			45	Supply becomes ½ sea-water.	68				
18	9 a. m	67	80.34		60	Fish show weakness.	66														
	6 p. m	71	86.8	102	69	†Fish dying at bottom of jar.															
*19	6 p. m						69			93	Supply becomes all sea-water.	73									
	9 p. m							81.12		96	Fish begin dying.										
20	6 a. m						70	87.35		105	About one-half dead.	70					71				
	6 p. m						78					74					75				
*22	9 a. m						68	98.84	189	156	All die.		49.86		156	Fish begin dying.					
	6 p. m.																75				
23	3 a. m												49.93	207	174	All die.					
	6 a. m																	34.35		177	Fish begin dying.
	12 m.																	34.355		183	About one-half dead.
	6 p. m.																	34.36		189	Ab't seven-eighths dead.
25	7 p. m																	34.37	271	238	All die.

* Jars emptied and cleansed.

† A considerable number of these from the bottom of the jar (No. 1) were placed in a small two-quart jar containing a mixture one-half fresh and one half sea water, supplies of like character being afforded, and lived 96 hours longer than those in the jar.

B—EXPERIMENTS WITH A VIEW TO TRANSPORTING SHAD A FEW MONTHS OLD.

By Charles D. Griswold.

After returning from Noank, Conn., at the close of the experiments with embryo-shad, I began an experiment with fish of greater age and development. The shad were obtained from the Connecticut River with a fine-mesh seine. The experiments were made with a view of testing the endurance of fish of a larger growth than the newly-hatched embryos which we had before tried.

Great care was taken in their capture to prevent their injuring themselves before they were placed in the jars. They were dipped from the water, before the net was drawn entirely out, with a tin dipper and immediately put into pails of fresh water, with but few in each pail.

There was some difference observed in the color of the young shad, the pale, lighter-tinted ones proving generally the weaker, and enduring much less than the others.

The shad procured measured from 1½ inches to 4 inches in length; those of about 2½ inches being rather more numerous. They were taken in the evening, the net-hauls in the early part of the day taking nothing. They were kept in the transportation-cans, in stone jars, with and without gravel in the bottom, and with river and spring water.

The first experiment was made on September 5. The shad were put in a twelve-gallon tin can. Supplies of fresh water were afforded every two hours, the supply being about one-eighth the contents of the can or jar in which the fish were placed. The air temperature was 65° and the water (spring-water) 64° at the beginning of the experiment, and the variation from this was very slight. The last was dead after six hours.

The second experiment was made September 7. On this date two day-time hauls resulted in no captures. In the evening better success attended the effort. The shad were put into the twelve-gallon cans. The temperature of the water was 64°, the air 65°, at 5 p. m. At 11 p. m. the water showed a temperature of 60°, and in one hour afterward they were all dead, having lived seven hours.

The 8th of September shad were put into the cans at 6 p. m. The spring-water supplies were made less frequently. The temperature at 10 p. m. was for the air 66°, for the water 66°. At 1 a. m. the air was 55°, the water 60°. At 4 a. m., air 52°, water 59°, and the fish rapidly died. They lived ten hours.

On September 11 a number of shad were again taken and placed in a four-gallon stone jar. The temperature of the air was 66°, of the water 64°. They were supplied every two hours with river-water fresh from the river each time. The water grew colder in the night. Three died after seven hours, a few lived about thirteen, and one died after twenty-one hours.

On the 14th, a cloudy day, the smallest shad during the season were obtained. Their length varied from 1½ inches to 2 inches. A comparative experiment was made with spring and river water. Four shad were put into the jar with the river-water. The water of the river at the time of capture was 70°. A supply of one-eighth was afforded every two hours until the 17th, when the time was increased to three hours, but a larger supply of water afforded. The temperature remained quite even, the variation being between 67° and 70°.

Of the four fish put in the jar with the river-water, two died at 12 p. m., having lived about seven hours; the remaining two lived forty-nine hours.

In the spring-water test the fish were placed in the jar after the river-water fish had all died, or after sixty hours. Three had died in the can the first day. Two more died after one hundred and thirty-six hours. One of those remaining died after one hundred and fifty-seven hours, and one after one hundred and sixty-eight hours. The air-temperatures ranged from 62° to 70°, and the water from 64° to 67°.

The next capture of shad was made on the 17th of September, at 5 p. m. Four were put into a four-gallon jar, and three put into a three-gallon jar. The former were supplied with spring-water, the latter with river-water. After sixty-one hours one was dead in the spring-water and two in the river-water. The temperature at this time for air and water both had varied between 59° and 66°.

The subsequent variation was greater. The air ranged from 46° to 89° and the water from 50° to 65°. The high temperatures of the air were during short periods of the day, so that the water did not attain the high degrees of heat which the atmosphere did. The fluctuations in one day, however, amounted to from 50° to 65°. After 136 hours there had been one death more in each. After 160 hours there was another death in the spring-water, and one lived 253 hours, or 10 days and 13 hours.

An experiment was made in keeping five or six fish at a time in the hatching-boxes, where the current kept a good change of water continually. The fish lived from two to three days.

A dozen fish were put in a forty-gallon can, and the water was renewed from a hose continually. They varied in size from 2 to 3½ inches. The temperature remained quite evenly at 60°. A few lived three days.

On the 28th an experiment was made with shad, the water-supply being afforded every three hours. Nine fish were put into the forty-gallon can. The temperatures ranged from, for the air, 46° to 66°, and the water, 50° to 60°. Six fish died after 33 hours, one after 51 hours, one after 66 hours, and one after 87 hours.

The use of gravel in the bottom of the jars evidently provided food to some extent. Shad retained in a jar until quite weak worked busily awhile among it, and revived so as to outlive the others about 15 hours.

In the stomach of a shad about 2½ inches long I took fourteen small black flies. The contents of other stomachs were of a reddish hue.

These are the results of the series of experiments which, I think, show less advantage in an attempt to transport shad of these sizes, from 1½ to 4 inches, than in the little three-eighths-of-an-inch-long embryos. Besides the longer endurance of artificial confinement of the embroy-shad in a mass of thousands instead of four or five, as in these experiments, the larger shad have the disadvantage of not being obtainable in anything near the same numbers, and also that the proportion of fish to the quantity of water used in transportation must be very many times less. There may be something of value in the fact that our experience proved the glazed-stone jars better for the fishes than tin; and the observation that the lighter-tinted pale fishes invariably succumb first, proves that in each year's stock of shad there is a considerable variation of vigor and constitution in different individuals.

C—APPARATUS FOR HATCHING SHAD-OVA WHILE EN ROUTE TO NEW WATERS.

By Fred Mather.

Honeoye Falls, N. Y., *September* 16, 1875.

I send report of shad-hatching at Point Pleasant. I also send you a drawing of the improved hatcher.

I believe, notwithstanding that the second German expedition has failed, that I can get fry across, and that running water is superior to the use of an air-pump. I cannot conceive of a more perfect approach to the river-boxes than this can, and was glad to show you its perfect working at Holyoke this summer, (July 20 to 25.) Simple as it seems, it took some time to get it to its present perfection. The original idea as tried at the Smithsonian worked well on paper; but this one will bear trial and favorable comparison with anything of the kind.

Very truly, yours,

FRED MATHER.

Mr. James W. Milner,
Smithsonian Institution.

According to instructions, I went to Point Pleasant, Bucks County, Pennsylvania, to observe the development of shad-eggs in the hatching-can, which I suggested after my failure to transport live fish to Germany last year.

I had one made with a diameter of 15 inches, containing a screen or tray of 13 inches diameter; and after searching for something better for reservoirs, we obtained three oak whisky-barrels which had been used once, and, taking out one head, thoroughly charred the inside by burning straw in them; after this, they were soaked in water twenty-four hours, when they still had an odor of alcohol.

I had used whisky-barrels similarly treated for the transportation of fish, and once carried a quantity of adult grayling on a journey of thirty-four hours in them with but trifling loss, none of which seemed to be due to the slight trace of alcohol perceptible to the sense of smell.

Therefore, with a slight misgiving that so delicate a creature as an embryo shad might possibly be affected by the homœopathic amount of alcohol still present, I set up my apparatus on the shaded piazza of the hotel. One barrel was used for ice-water and the other two as reservoir and receiver.

The first trial was made with 3,000 eggs, which were taken from the fish at 10 p. m. June 20, and were put in the river-boxes, where the water was from 76° to 80°. On the following day, at 4 p. m., they were brought to the hotel, and the temperature gradually lowered to 68° by 8 p. m., when they were placed in the hatching-can, and the spigot set to flow twenty gallons per hour. The following table gives the temperatures and results:

Date.	6 a. m.	Noon.	6 p. m.	Midnight.	Mean.	Remarks.
	°	°	°	°	°	
June 20	....	....	....	80	80	
21	....	....	68	64	66	Water tastes of whisky.
22	62	72	74	74	70.5	Gave an entire change of water.
23	74	74	76	78	75.5	Fish visible in the eggs; motion at daybreak; fungus on dead eggs.
24	76	76	....	....	76	First fish hatched at 8 a. m.; 1,000 at noon; they appeared very weak, and there was no deposit of pigment in the eye; put them in box in the river and cleaned the barrels.
Average mean............					73.6	
Time 86 hours.						

In this experiment, nearly the same results were attained as in one that I conducted in the Smithsonian Institution some two weeks before, viz, the fish hatched, without any perceptible color in the eye, and had little vitality.

In the former trial referred to, this lack of vital power was attributed to the bad air in the basement where the hatcher was located, arising from the absorption of gases from a portion of a whale that had just arrived in bad condition. This theory, whether correct or not, was the only one that presented itself to account for the fact that the fish lived but a few hours after hatching, as it was the opinion of several experts that, as the flow of water was sufficient to supply all the oxygen required, and that a movement of the egg was not necessary, therefore when I attained the same result in the open air I concluded that a flavor of whisky in the water produced the same effects as the deleterious gases before referred to, or that a lack of motion was the cause.

To test the latter point, I had a new can made, with a diameter of six inches, and screen of five, which, with sixty gallons of water per hour flowing through it, gave a slight movement to the eggs. While this trial was in progress, the weather was very hot, at midday on several occasions reaching 96° in the shade, causing a great consumption of ice. The following table gives the results:

Date.	6 a. m.	Noon.	6 p. m.	Midnight.	Mean.	Remarks.
	°	°	°	°	°	
June 25	....	....	....	82	82	Eggs taken from fish 10 p. m. on the 25th; put 2,000 in hatcher at 10 a. m.; water in river 85°.
26	....	80	65	71	72	
27	70	66	60	64	65	Motion at daybreak.
28	63	63	....	....	63	Fish livelier than any former ones; still no color in the eyes; turned into the river at noon, 28th.
Average					70.5	
Time 92 hours.						

As the increase in vitality could only be attributed to the increased motion due to flowing three times the quantity of water through a screen of less diameter than on the former trials, it appeared evident that the failure of previous experiments was due to lack of motion, and as all water had to be dipped from the receiving-barrel standing on the floor into the reservoir-cask standing on the table, with a pail, that it would require too much labor for one man to handle double the quantity, and so would require at least four men to attend it, running night and day, and another objection was the limited capacity of this small can.

Here a valuable suggestion was made by my assistant, Mr. Charles Bell, and a hatcher was made after his plan, which did its work perfectly. (See illustration.) It was in the shape of a funnel, with a tube below like the others to connect the rubber supply-pipe. It had a depth of ten inches and a diameter of twelve at the top, to which was soldered a rim of wire-cloth one inch and a half high; outside of this rim was a flange with a tin rim, which had an outlet-pipe on one side.

Near the bottom, where the cone was two inches in diameter, a screen of fine brass wire was fastened. This passed all the water through a screen of two inches, on which an egg could not rest. They were sent up with a gentle motion in the center of the can, and separating equally in all directions toward the wire rim, through which the flow was so gentle that the eggs began to drop before they reached it, and, falling on the sloping sides, gently settled toward the center, to be again lifted before reaching the bottom.

We exchanged our whisky-barrels for old casks that had been used for catching rain-water, and moved from the hot piazza into the cellar, where the temperature of the air averaged about 70°, making the experiment without the use of ice, the temperature variation being very slight.

The following table exhibits the results:

Date.	6 a. m.	Noon.	6 p. m.	Midnight.	Mean.	Remarks.
	°	°	°	°	°	
July 1	......	......	......	......	......	Eggs from fish at 9 p. m.; put in hatcher at 10 a. m.; water in river 82°; found a flow of twenty gallons per hour sufficient.
2	......	66	65	64	65	
3	64	65	66	65	65	
4	65	66	66	68	66. 25	Eyes showed black at midnight; fish lively in egg.
5	68	68	68	70	68. 5	A few hatched at noon, and swimming at night.
6	68	70	72	......	70	About half hatched at noon; all hatched at 9 p. m.; very strong and lively; put them in the river next morning (7th).
Average mean					66. 95	
Time 120 hours (5 days).						

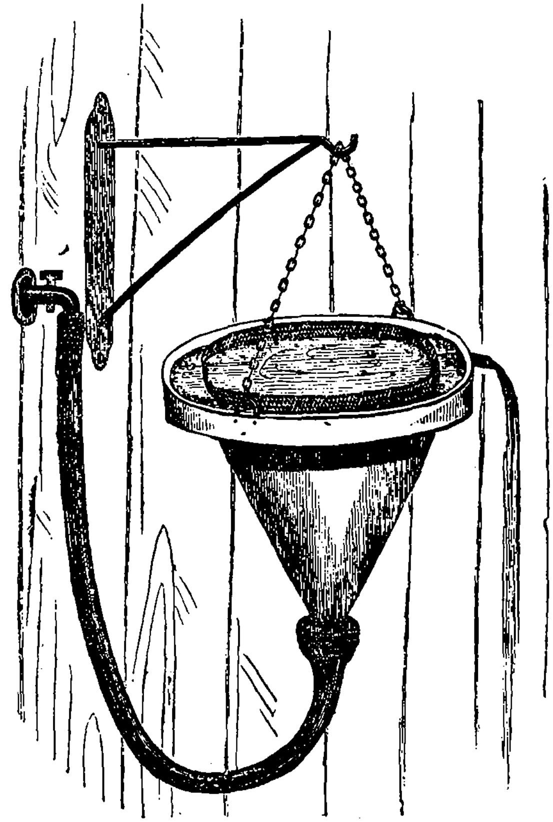
These trials have, I think, proved two things: first, that a flow of water that does not give motion to the egg sufficient to hold it in suspension will not hatch strong shad; and, secondly, that it is possible to hatch them in transit with a limited supply of water. The same water was used two to three days, and was well aërated in its fall from the hatcher into the barrel and by pouring from a pail from there into the reservoir.

As I found in my attempt to carry young shad already hatched to Germany for the Commission last year that the thermometer varied little from 62°, I think it possible that at that temperature the hatching will be delayed from six to seven days, and the fry delivered on the other side before they have suffered much, if any, from lack of food.

In order to test the endurance of shad-eggs, I made the following trial of 4,000 spawn with the same flow of water as before, using ice.

Date.	6 a. m.	Noon.	6 p. m.	Midnight.	Mean.	Remarks.
	°	°	°	°	°	
July 8	......	70	65	60	65	Spawn from fish at 9 p. m. 7th; water in river 82° at 8 a. m. 8th.
9	58	58	58	56	57. 5	
10	55	56	58	60	57. 25	Motion in morning.
11	58	56	54	54	55. 5	Eyes visible, but embryo small.
12	54	54	58	60	56. 5	No ice from noon till 6 p. m.; fish not lively.
13	58	59	60	62	59. 75	Am afraid that when hatched, they will not have vitality enough to live; let temperature go up to see if possible to revive them.
14	61	62	65	66	63. 5	All dead at 6 a. m.
Average mean					59. 52	
Time 7 days 9 hours.						

I do not consider the average mean temperature to be a fair test in this trial, as it was probably the *lowest* point that did the damage; and if the temperature of the river for the twelve hours they were in it had been figured in, the mean would have been much higher. As it is, the mean was only about 5½° below the former trial, which was so successful, and in my opinion a steady temperature of 59° to 60° would have given far different results.



Mather and Bell's apparatus.

The above tables are accurately copied from the record-sheet, and it is proper to add a word about the thermometers used. In the first two trials made upon the piazza, we had a small pocket-thermometer, only graduated to two degrees, and which registers two degrees higher than the one used in the cellar in the two last trials; but having no opportunity to correct the instruments, I give the record as it appeared at the time; but if the pocket-instrument was correct, then the records of the last two trials should read two degrees lower than shown in the tables.

In conclusion I will say, I believe that shad-fry can be taken across the Atlantic by hatching the eggs in transit in the can last described; and as the record of my trip last season showed the temperature of the water in the cans at sea without ice to be about 62°, that would seem, according to the above tables, to be about the proper point. It could probably be kept from 60° to 64° without the use of much, if any, ice, by opening or closing the hatches.

XX.—REPORT OF OPERATIONS IN CALIFORNIA IN 1873.

By Livingston Stone.

A—CLEAR LAKE.

1.—FIELD-WORK IN THE WINTER OF 1872-'73.

On the 1st of January, 1873, at which date my last report closes, I was at San Francisco, making observations in regard to the fish and fishing of the Sacramento, and intending, in a few days, to go to Oregon to look for a suitable location on the Columbia River for obtaining a supply of eggs of the salmon of that river.

A succession of storms on the Pacific coast deferred my departure from San Francisco for this purpose, and, while waiting for fair weather and an outward-bound steamer, advices were received by telegraph, stating that a large number of white-fish eggs were on their way to California from the great lakes.

At the same time, Mr. S. R. Throckmorton, the chairman of the California fish-commission, requested me to assist Mr. John G. Woodbury, then in the employ of the State commission, in selecting a favorable site for hatching the white-fish eggs on their arrival, and for depositing the young fish when hatched.

In compliance with the requirements of this new turn of affairs, I abandoned my plan of going to the Columbia, and, on the 10th of January, took the cars for Clear Lake, Lake County, California, one hundred and twenty miles north of San Francisco, having in view the objects just mentioned.

2.—CHARACTER OF CLEAR LAKE.

After two or three days spent in examination of various waters, it was decided, on the 15th of January, to locate the hatching-works for the white-fish eggs at Kelsey Mills.

These mills are situated on Kelsey Creek, a tributary of Clear Lake, and are three miles above Kelseyville, Lake County, and six miles from the outlet of Kelsey Creek into Clear Lake.

The water-supply was taken by a pipe from the flume of the mill, and was ample. The hatching-works were in every way satisfactory.

Owing to the difficulty of obtaining moss in the Eastern States in midwinter, the first lot of white-fish eggs forwarded from the East were packed in sponges.

This kind of packing, though suitable for short trips, was not adequate to the requirements of the long journey across the continent, and the eggs were all dead when they arrived at Clear Lake. A second lot, sent on afterward, to take the place of those which were lost, arrived in good condition, and from them 25,000 white-fish were hatched under the charge of Mr. J. G. Woodbury. About the time of the absorption of the yolk-sac, the young fish were placed in various portions of Clear Lake. This was the first introduction of the white-fish (*Coregonus albus*) into the waters of the Pacific slope.

While stopping at Clear Lake, I gathered the following items in regard to its waters and the fishes that inhabit them.

It is a singular fact, illustrating the inaptness with which names are often given to natural objects, that the water of Clear Lake is never clear. It is so cloudy, to use a mild word, that you cannot see three feet below the surface. The color of the water is a yellowish brown, varying indefinitely with the varying light. The water has an earthy taste, like swamp-water, and is suggestive of moss and water-plants. In fact, the bottom of the lake, except in deep places, is covered with a deep, dense moss, which sometimes rises to the surface, and often to such an extent in summer as to seriously obstruct the passage of boats through the water.

There are large soda-springs boiling up at various points in the bed of the lake, which discharge into it vast quantities of soda-water daily. A reddish-brown, frothy substance is produced in such abundance by the natural evaporation of the soda-water that the lake in places seems to be full of it.

In winter, the water is cool and not disagreeable, in spite of its earthy taste; but, in summer, it grows warm, the swampy flavor becomes intensified, the frothy substance from the soda-water increases, the plants and moss from the bottom float in great quantities in the water, and it becomes unfit to drink.

These conditions would seem to be unfavorable to fish-life in the lake; but, by another of those numerous contradictions for which California is noted, this lake seems to be particularly adapted to fish, and the water teems with them. In the spring, when they run up Kelsey Creek, Cold Creek, and other tributaries, to spawn, they swarm in these streams by millions, forming an almost solid mass, so that it is even difficult to cross the fords with a horse on account of them.

3.—LIST OF FISHES INHABITING THE LAKE.

The local names of the fish are as follows:

1. Perch.
2. Shapaulle.
3. Hitch.
4. Suckers.
5. Chy.
6. Roach.
7. Spotted sun-fish.
8. Mud-fish, (mud-suckers.)
9. Black-fish.
10. Trout.
11. Bull-heads.
12. Viviparous perch.

Perch, (Smithsonian Collection, No. 146.*)—The perch is very abundant, indeed. It resembles in color and shape the white perch of the Potomac, but is rather deeper and shorter. Those that I saw in February were about six inches long by three inches in depth. Their flesh is excellent, and they are highly prized as food both by white men and Indians. The perch spawn in May around the margin of the lake. Millions of young perch are seen in June.

Shapaulle, (Smithsonian collection, No. 152.)—This fish is a cyprinoid, and is the same as the Sacramento pike, or the California white-fish, of which several specimens have been forwarded to the Smithsonian Institution in my collections on the Sacramento and McCloud Rivers. It averages in weight about five or six pounds, though some have been caught as heavy as thirteen pounds. Their flesh is white, soft, and bony, and they are only a medium table-fish. I was told that they spawn in the sand and gravel in the creeks in May; but, from the fact that they are caught in great quantities during this month with the hook and line, I am inclined to think they spawn earlier, perhaps as soon as the beginning of March.

Hitch.—This is a small, light-colored, and slender fish, about a foot in length, and very full of bones. The whites do not consider them fit to eat. The Indians eat them, bones and all, and appear to like them. They run up the streams in the spring to spawn in countless numbers. It is not unusual to see one or two acres of ground covered with hitch, which the Indians have dried for food.

Suckers, (Smithsonian collection, No. 152.)—These resemble the common suckers of other localities. They are poor food, except the large red-finned suckers, which are esteemed tolerably good eating. They spawn on the sand-beaches of the lake and also in the tributary streams. They dig holes for their nests as large round as a bushel-basket and from six to twelve inches in depth. They run up the creeks in March, and probably spawn about that time.

Chy, (Indian name;) *silver sides*, common name; (Smithsonian collection, No. 148.)—This fish is quite small, and is said to be all bones. They run up the creeks to spawn in May and June in vast numbers. The Indians eat them, but they are not valued by the whites.

Roach, spotted sunfish.—These fish are edible, and are seen in vast quantities around the sand-beaches in May, when they probably spawn. They are not of much account.

Mud-fish, or *mud-sucker*.—This fish is a short, thick fish, of a bluish color. Its flesh is soft, and is of no value. It is supposed to spawn in May around the beaches and among the tules.

Black-fish.—I could not obtain a specimen of this fish to examine, but I heard different persons say that it was a very excellent fish for the table. Some ranked it next to the trout, while others placed it below

*The numbers attached to the names of the fishes refer to my catalogue of the specimens collected for the Smithsonian Institution.

the shapaulle. It grows to a considerable size, the full-grown fish weighing three or four pounds. It is not abundant as a rule, although large quantities of the black-fish collect in the tules in May, when many are killed with clubs. This is undoubtedly their spawning-season.

Salmon-trout, (Smithsonian collection, No. 151.)—This is the local name of a fine, large trout which inhabits the lake, and runs up the tributaries to spawn in the latter part of the winter. It is highly prized for the table. In summer, when the water is warm, the trout collect around the cold springs of the lake, and seem to live there exclusively; the water of the rest of the lake probably being too warm for them. The Indians fish them very regularly and steadily. These trout used to be very abundant in the lake, but the whites have pursued them so unrelentingly on their spawning-grounds that they are rapidly diminishing. It is difficult to find one now where hundreds used to come to spawn. Those that I saw in February, 1873, were about eighteen inches long, and averaged nearly two pounds in weight.

The common California trout is also abundant in the brooks and streams in the vicinity of Clear Lake, but cannot properly be called one of the fishes of the lake.

Bull-head.—I did not learn much about this fish, except that it likes the mud and is an inferior fish. It is not the bull-head, (*Pimelodus*,) or horn-pout, of the Eastern States.

Small perch, (see Nos. 244–250, Smithsonian collection;) (*viviparous perch*.)—This is a beautiful little fish, quite small, but very good eating. It is the same as the viviparous perch of the Sacramento, specimens of which are included in my Smithsonian collection of 1873. As its name implies, it brings forth its young alive. It is quite abundant in Clear Lake.

4.—THE CONDITION OF THE FISH IN CLEAR LAKE AT DIFFERENT SEASONS.

January.—In January, the lake rises somewhat, the tributary streams are full and high, and the trout of the lake run up the streams to spawn. A few suckers are also found in the creeks when they are roiled by the rains. It is said that black-fish are caught with the hook at this time, but I did not hear of any being taken during my stay in January. The Indians fish with a sweep-seine during this month, and catch various kinds of fish. They also catch the lake-trout with hook and line, and the perch with nets.

February.—In February, the shapaulle run up the streams, and are caught in considerable quantities. The lake-trout return to the lake. Black-fish are caught this month. The tributary streams are very high.

March.—Suckers and shapaulle abound in the creeks. The shapaulle bite somewhat in the lake. Black-fish are more abundant and more easily caught.

April.—Hitch, chy, shapaulle, and suckers abound in the creeks.

This is the best month for catching shapaulle. Perch, shapaulle, hitch, and chy are caught in the lake with hook and line this month. Black-fish are abundant.

May.—The first of May is about the best time for catching perch. In respect to the other fish, this month is very much like the last.

June.—The larger part of the fish which have gone up the creeks in such vast numbers have returned to the lake by this time. They have also left the sand-beaches and tules where they have been spawning, and have returned to deep water. Most kinds of the Clear Lake fish can be caught in the lake during this month with hook and line; more perch being caught, however, than any other species. The Indians go this month to the cold feeding-springs of the lake to catch trout with the nets.

July.—This month does not differ much from the last in respect to the fishing; but the water during this month becomes warm, and the fish get soft, and are not good.

August.—The lake is not fished much this month, the water being warm and the fish soft and inferior. The Indians, however, continue to fish for trout around the cold springs which feed the lake. There is one spring in particular fished by the Indians, two miles east of Morgan Young's, which is forty feet in diameter, and which boils up so that one cannot row a boat across it. This spring would make a small river if confined. It is thought that it furnishes the chief water-supply of the lake in the summer. It is, of course, cold all the year round.

A great number of dead black-fish are seen about the lake this month, and some dead perch and roach around the shores and among the tules, which, in many parts of the lake, line the edges densely to a depth of twenty or thirty feet.

September.—Fish and fishing are about the same as in August. The weather is a little warmer. No one fishes during this month except the Indians, who still keep after the trout. The water this month is in its worst condition. It is full of the frothy product of the soda-springs. A green scum covers a large part of the surface, and it is not only uncleanly to look at, but unfit to drink; and yet, strangely enough, this lake, which one would think uninhabitable by fish, fairly teems and swarms with them.

October.—In October the water begins to cool a little, but as yet there have been no rains, and there is no other improvement in the water except the cooling of it. There is no more fishing done this month than in September.

November.—The water is colder this month. The wind and rain clear off the stagnant scum which collects on the surface in the summer. The fish are better, but there is no fishing done.

December.—The lake is clear again on the surface, and begins to rise with the rains. The water continues to grow cooler, and the fish improve; but there is no fishing of any consequence done before the new year.

B—SACRAMENTO RIVER.

After leaving Clear Lake, I went to the Sacramento River to procure a collection of the fish caught at this season, (February.)

At Rio Vista and other points, I gathered the following fragmentary notes, which I present here as supplementary to my report on the fish of the Sacramento River for 1872.

1.—CHARACTER OF FISHING ON THE SACRAMENTO.

The fishing on the Sacramento River is done in three ways: 1. By drift-nets; 2. By fyke-nets; 3. By sweep-seines.

Drift-nets.—The drift-nets are used exclusively for catching salmon. They have an 8¼-inch mesh, are usually 40 meshes deep, and from 150 to 200 fathoms long. As nearly as I could learn, there were not far from a hundred salmon-nets in operation on the Sacramento River in 1872. At the meeting of the salmon-fishermen of the Sacramento that year, there were ninety-five boats represented.

These nets are worked by simply drifting them with the tide. The salmon, which, of course, are heading against the tide, are gilled in the meshes. The turn of the tide is the most favorable time for this sort of fishing.

The nets are frequently drifted a mile before being hauled in. The salmon-fishing is conducted entirely by white men; no Chinamen being allowed to participate in it. There is no law regulating the matter; but public opinion is so strong in relation to it, and there is such a prejudice against the Chinese, that any attempt, on their part, to engage in salmon-fishing would meet with a summary and probably fatal retaliation.

The number of fresh salmon shipped from Rio Vista to San Francisco in the year 1872 is as follows:

January	792	July	1,145
February	1,581	August	1,496
March	1,945	September	2,335
April	3,354	October	583
May	4,408	November	441
June	1,201	December	390

On one day in February, when I came down the Sacramento, there were put on board the steamer, at Courtland, 7 fresh salmon; at Rio Vista, 32 fresh salmon; at Sherman Island, 32 fresh salmon; at Collinsville, 123 fresh salmon.

The number of fresh fish (salmon and sturgeon) brought down the Sacramento River to San Francisco in 1872, by the steamers for the Central Pacific Railroad Company, is as follows:

January	5,514	August	15,677
February	5,799	September	14,706
March	11,394	October	3,082
April	15,563	November	2,367
May	27,394	December	3,716
June	5,561		
July	6,043	Total	105,796

The proportion of sturgeon and salmon in the various months are estimated as follows:

January: 10 per cent. salmon; 90 per cent. sturgeon.
February: 10 per cent. salmon; 90 per cent. sturgeon.
March: 50 per cent. salmon; 50 per cent. sturgeon.
April: mostly salmon.
May: all salmon.
June: all salmon.
July: all salmon.
August: all salmon.
September: all salmon.
October: 50 per cent. salmon; 50 per cent. sturgeon.
November: 50 per cent. salmon; 50 per cent. sturgeon.
December: 10 per cent. salmon; 90 per cent. sturgeon.

Besides the salmon above mentioned, a large number are taken by sailing-vessels and by the opposition-line of steamers and other conveyances to San Francisco and the larger towns.

The points from which salmon are shipped on the river-steamers are Sacramento City, Courtland, Emmatown, Rio Vista, Collinsville, Antioch, Benicia, Martinez.

In the spring of 1872; about 25,000 salted salmon came from the Sacramento River to San Francisco, and in the fall about 9,000.

The Rio Vista salmon-fishermen recommend the prohibition of fishing from June 1 to October 1 or from June 15 to October 15.

Fyke-net fishing.—The fyke-nets have a mesh of 2½ inches. There were, in the winter of 1872–'73, eighty-five fyke-nets on the Sacramento at Rio Vista. They are stationary of course, and are examined every twenty-four hours.

All the kinds of fish in the river are caught in these nets. Mr. John D. Ingersoll, a prominent fyke-fisherman of Rio Vista, informed me that the daily catch for twenty nets is now about seventy-five pounds of fish. They include: chubs,* (Nos. 210–216, Smithsonian collection;) perch, (Nos. 217–231, Smithsonian collection;) hardheads, (Nos. 231–236, Smithsonian collection;) Sacramento pike, (Nos. 237–243, Smithsonian collection;) viviparous perch, (Nos. 244–250, Smithsonian collection;) split-tails, (Nos. 251–262, Smithsonian collection;) suckers, (Nos. 263–264, Smithsonian collection;) herrings, (Nos. 265–270, Smithsonian collection;) sturgeons, (Nos. 271–273, Smithsonian collection;) crabs, (No. 275, Smithsonian col-

* Numbers referable to catalogue forwarded with specimens.

lection.) Of these varieties, the perch, pike, and sturgeon are the best food-fishes.

There has been a vast decrease in the returns of the fyke-nets during the last twenty years.

In 1872 and 1873, they used to catch 700 or 800 pounds a day in one fyke-net. An average of 250 pounds a day for one net, at Sacramento City, was usually expected in those times. The present catch of 75 pounds a day in 20 nets certainly presents an alarming contrast.

The fyke-net fishing is conducted wholly by white men, I believe; the Chinese fishermen being ruled out by the force of public sentiment. The fyke-nets are usually visited early in the morning of each day, and the catch is sent down to San Francisco by the noon-boat. The fyke-net fishing begins in November, and is continued till May. The best fishing is when a rise in the water drives the fish inshore where the fyke-nets are placed.

During the summer-months, the water is warm, the fish are poor, and the fishing is discontinued.

On the 27th of February, 1873, I went the rounds of Mr. Ingersoll's set of fyke-nets with him. We visited twenty nets; but, as some of them had not been examined for over twenty-four hours, the yield was supposed to be equivalent to one day's fishing for thirty nets. The nets had four hoops each, and 14-foot wings. We took about 120 pounds of fish in all. Hardheads were the most numerous, and the Sacramento pike next. Mr. Ingersoll said that perch used to rank second in abundance, the average for thirty nets being 200 or 300 pounds a day, but on this day the perch were quite insignificant in numbers. We found in the nets seven small viviparous perch and two small sturgeons. I learned also that minks, beavers, and otters are sometimes caught in the nets. In 1872, Mr. Ingersoll caught eight minks, two beavers, and one otter in his fyke-nets.

Sweep-seine fishing.—The sweep-seine fishing is given over to the Chinese, who are not allowed by public sentiment to engage in either of the other two kinds of fishing just described. What they are not permitted to do by the prohibited methods, they make ample amends for by their own methods. They are, I should say, the most persistent and industrious fishermen on the Sacramento. They fish all the year round; they use fine-mesh nets, with which they sweep every part of the river, especially the partially stagnant fresh-water lagoons, or "*slews*," as they are called in California, where the fish collect in myriads to spawn. With these nets, they catch vast quantities of fish of all sizes; and so destructive has their fishing been on the Sacramento that all the fish except salmon are disappearing from that river with unexampled rapidity. It is owing to this kind of fishing that the returns of the fyke-nets have diminished so alarmingly the last few years. The Chinese have been at it for seven or eight years; and, if they keep on three or four years more at this rate, the small fish of the Sacramento will be practically exterminated. I have no means of ascertaining with any exactness how many Chinese fishermen there were on the river, but there are a large number, and Mr. Ingersoll said that they were increasing every year. Most of their fish they send to the San Francisco market as soon as caught; but they also dry great quantities of them on bars and floors prepared for the purpose. These are partly eaten by themselves, and the balance are sent packed in barrels to the Chinese market in San Francisco. While at Rio Vista, in February, 1873, I visited a Chinese fishing-station on the Sacramento River. It was located about eighty rods above the Rio Vista steamboat-landing, and consisted of a nest of Chinese fishing-boats, numbering seven small boats and three large ones. There were also on the shore, just across the road, two old tumble-down buildings, with drying bars and floors near by, in the open air, where some of the fishermen lived, and attended to the drying of the fish. The small boats were common flat-bottomed dories, square at the stern, sharp at the bow, about fifteen feet long, and strongly built. The large boats were also strongly built, but narrow and pointed at both ends, and constructed after the Chinese fashion. Two of these large boats had one mast, and the other one had two masts, considerably raking, with Chinese sails, which were not like any sails used in this country. Nearly amidships, but a little nearer one end than the other, was a tent in which the Chinamen lived. There was also considerable space in the hold of this really Chinese junk, which added a good deal to their house-room. The whole air and look of these crafts was decidedly foreign, and I might say oriental. If I understand their method rightly, the small boats are to visit the "slews" and various fishing-points with, when they go out to draw the seine, and the large boats are really only movable dwelling and store houses, where they live and receive the fish that are brought in by the small boats, and which, of course, they move from place to place on the river as the exigencies of the changing fishing-seasons may require.

C—CALIFORNIA AQUARIUM-CAR.

After leaving the Sacramento River, I went to San Francisco, and immediately began making preparations for going East to procure a car-load of live fish, under the auspices of the California commissioners; but as the United States contributed toward defraying the expenses of this expedition, I will introduce the following account of it here. I left San Francisco on the 17th of March, 1873, and arrived in Boston on the 28th of March, having made a short stop at Sacramento to arrange for the transportation of the car, and also at Salt Lake City to provide for the reception and hatching of a consignment of shad and salmon which Professor Baird proposed to send to Great Salt Lake, Utah.

I quote the following account of the aquarium-car trip from my report to the California commission of that expedition:

"My plan of operations for the whole undertaking was, first, to collect the fish at some favorable point at the East, where they could be kept alive until everything was ready for the journey; secondly, to fit up a car with the apparatus most suitable for transporting living fish; and, thirdly, to take this car when loaded to California in the least possible time, and without any transfer of its contents. This plan was successfully carried into practice up to the time of the accident just beyond Omaha.

"The first installment of living fish intended for the California car arrived at Charlestown, N. H., the point of rendezvous, on the 7th of May. It consisted of eighty-two black bass, (*Grystes fasciatus;*) glass-eyed perch, (*Lucioperca;*) and bull-heads, (*Pimelodus;*) and about 300,000 eggs of the *Perca flavescens* and the *Lucioperca*.

"These fish were collected at Lake Champlain, and at the Missisquoi River in Vermont, and were taken a journey of thirty hours by rail, before reaching Charlestown. They, nevertheless, bore their trip admirably, and arrived at their destination in first-rate order.

"The next two weeks were spent in fitting up the car, which had arrived at Charlestown, N. H., and making other preparations for the difficult undertaking in prospect. Arrangements had been previously made, at the suggestion of Hon. Spencer F. Baird, United States Commissioner of Fisheries, with Mr. Monroe Green, at Castleton, on the Hudson, for a supply of young shad and fresh-water eels; and also, with Capt. Vinal Edwards, of Wood's Hole, Mass., for young lobsters and other salt-water fish. The eastern trout (*Salmo fontinalis*) were to be taken from the Cold Spring trout-ponds at Charlestown; the large lobsters were to come from Johnson & Young's establishment at Boston; and Mr. Myron Green was dispatched to the Raritan River for cat-fish.

"The equipment of the car having been completed, and everything being ready, the 3d day of June, 1873, was set for our departure. At midnight of June 2d, Mr. W. S. Perrin arrived from Boston with a special car, having on board the lobsters, oysters, small lobsters, salt-water eels, tautogs, and reserves of ocean-water. We began at daylight the next morning filling the tanks in the car and loading in the fish, and by 1 o'clock in the afternoon everything was ready, and at a quarter past 2 on Tuesday, June 3, the California aquarium-car started on its journey.

"The car was furnished by the Central Pacific Railroad Company, and was one of their fruit-cars, intended for quick trips across the continent. It was 27 feet long and 8 feet wide, and was provided with a Westinghouse air-brake and Miller platform, which enabled us to take it along with passenger-trains.

"At one end of the car was a stationary tank, built of 2-inch plank, lined with zinc, and occupying the whole width of the car and 8 feet of its length. This tank was 2 feet and 8 inches deep, and held, when full, about five tons of water. At the other end of the car was a large ice-box, the reserves of sea-water, six large cases of lobsters, and a barrel of oysters. In the center of the car, and occupying nearly all the room in it, were the other portable tanks for carrying the fish. Our beds were on the top of the large stationary tank, which, of course, was covered. The large tank was also arranged so that we could take on water on a large scale from the water-works at the railroad-stations *en route*. This proved to be a very great convenience, and was, in fact, indispensable.

"When we left Charlestown, N. H., the car contained upward of 60 black bass, from Lake Champlain, (*Grystes fasciatus*:) 11 glass-eyed perch, from Lake Champlain, (*Lucioperca, Americana*;) 110 yellow perch, from Missisquoi River, (*Perca flavescens*;) 80 young yellow perch, from Missisquoi River, (*Perca flavescens*;) 12 bull-heads, (horn-pouts,) from Missisquoi River, (*Pimelodus atrarius*;) 110 cat-fish, from Raritan River, (*Pimelodus*;) 20 tautogs, from near Martha's Vineyard, (*Tautoga Americana*;) 1,500 salt-water eels, from Martha's Vineyard, (*Anguilla bostoniensis*;) 1,000 young trout, from Charlestown, N. H., (*Salmo fontinalis*;) 162 lobsters, from Massachusetts Bay and Wood's Hole; 1 barrel of oysters, from Massachusetts Bay; supplies of minnows for feed-fish.

"The black bass, bull-heads, cat-fish, and part of the lobsters were *full-grown and heavy with spawn.*

"Besides the fish above enumerated, I took on at Albany 40,000 fresh-water eels from the Hudson, and arranged for 20,000 shad and shad-eggs (*Alosa præstabilis*) from the Hudson, to overtake us at Chicago.

"The receptacles for holding the fish consisted of 1 large stationary tank, 8 feet square and 2 feet 8 inches deep; 1 round wooden 70-gallon tank; 1 round 50-gallon tank; 3 round 30-gallon tanks; 3 conical-shaped 30-gallon tanks; 6 conical 10-gallon tin cans; 1 conical 15-gallon tin can; 3 round 9-gallon tin cans; 2 35-gallon casks; 6 large cases, containing the lobsters; the total capacity of the whole, excluding the lobster-cases, being about 16,000 pounds of water.

"Besides the vessels for holding the fish, the car contained the following articles: 1 large 120-gallon cask, filled with ocean-water; 1 60-gallon cask, filled with ocean-water; 1 large ice-box; ½ barrel of live moss; ½ barrel of water-plants; curd and meal for feed; 1 bushel of salt for killing parasites; the aerating-apparatus referred to; 1 alcohol-stove; 1 set carpenter's tools; 2 lanterns; 2 hammocks; 2 spring-beds; 2 mattresses and pillow; 2 sets bedclothes; 1 broom; 1 lot green sod; 2 thermometers; pipes, spouts, and siphons, for taking in and letting off water; 1 long-handled dip-net; 2 short-handled dip-nets; movable steps to door of car; sundry barrels, pails, dippers, &c.; maps, with stations marked where we knew the water to be good or bad; our trunks, valises, and private baggage.

"When the car left Charlestown, there were four of us in it: Mr. W. T. Perrin, of Grantville, Mass.; Mr. Myron Green, of Highgate, Vt.; Mr. Edward Osgood, of Charlestown, N. H.; and myself. We arrived at Albany at 11.30 p. m. the same evening, all the fish doing well, and the water in the tanks standing at 45° F. Here we took on the 40,000 eels mentioned above and half a ton of ice. We also left Mr. Myron Green here to go to the New York Shad-Hatching Works at Castleton, on the Hudson, and get a supply of young shad.

"On my urgent application to the New York Central Railroad authorities, that road took us with their passenger-train, which was due to leave Albany at 2.40 a. m. on the same night. We reached Suspension Bridge about noon, and left for Detroit with a passenger-train on the Great Western Railroad. We took on ice and water at Hamilton, Canada, and reached the boat at Detroit ferry about 11 p. m. the same day, Wednesday, June 4; all the fish being in good order, except the lobsters, which were dying in considerable numbers. The track on the ferry-boat being just filled by the train, without the aquarium-car, they left us east of the river all night, and, it being very warm, I spent the rest of the night till daylight looking up ice, of which I at last obtained about a ton and a half.

"Leaving Detroit that morning—Thursday, June 5—we proceeded directly to Niles, Mich., with a passenger-train, via the Michigan Central Railroad. We had now come all the way with passenger-trains, and had we known this beforehand we need not have lost any time in bringing on the shad; as it was, however, we expected to make slow time on freight-trains from Albany to Chicago, and I hence arranged to have the shad brought on by express from Albany two days after we left that point. These two days we had now on our hands, and it was very aggravating to be obliged to lose so much time when time was so precious. There was no help for it, however; and as I thought it would be better to wait part of the time on the road than to spend the whole of the two days in Chicago, I had the car dropped at Niles, Mich., and we remained there till 6.10 the next morning—Friday, June 6—when we went on to Chicago, after taking on ice and water, and catching some minnows to feed the large fish with. We entered Chicago about 10 o'clock on Friday morning, all the fish doing well except the lobsters and eels.

"The temperatures at which I aimed to keep the different varieties of fish were as follows:

	Degrees Fahrenheit.
"Cat-fish	50
"Fresh-water eels	45 to 50
"Tautogs	45
"Salt-water eels	45
"Black bass	42
"Yellow perch	42
"Bull-heads	42
"Glass-eyed perch	42
"Trout	38
"Lobsters	34 to 36
"Oysters	34 to 36

"From the experience which I have now had, however, I would advise a change with some of the fish, which would make the temperature as follows:

	Degrees Fahrenheit.
"Cat-fish	50
"Fresh-water eels	50
"Bull-heads	48
"Glass-eyed perch	48
"Yellow perch	45 to 48
"Black bass	42 to 45
"Salt-water eels	42 to 45
"Tautogs	40
"Trout	36 to 38
"Lobsters	34 to 36
"Oysters	34 to 36

"Mr. Myron Green rejoined us with the shad the next morning, Saturday, June 7th, and at 10.15 a. m. the same day, after having taken on three tons of ice and three tons of Lake Michigan water, we left Chicago for Omaha, via the Chicago and Northwestern Railroad.

"We took on water again at Cedar Rapids, Iowa, and arrived at Omaha at 11 o'clock on the morning of Sunday, June 8th. Through the courtesy of Mr. C. B. Havens, the train-dispatcher of the Union Pacific Railroad, who detailed an engine to take our car to the ice-house at the Union Pacific shops, we were enabled to take on a ton and a half of ice, and about 1 o'clock we started westward again. We were now on our sixth day out, and everything was promising well. All the dead eels had been removed, and we had 20,000 or 30,000 left. The mortality of the lobsters was on the decrease, and we still had over forty alive and in good condition. All the other fish were in splendid order. We had ice and water enough on board to take us, if necessary, to the Sierra Nevada—certainly with what supplies we could get in the Wahsatch Mountains, where the water is good. The circumstance of the fish having lived so well up to this time gave us a good deal of confidence, and we were encouraged to hope that they would continue to do well to the end of their journey.

"After leaving Omaha, we stowed away as well as we could the immense amount of ice we had on the car; and, having regulated the temperature of all the tanks, and aerated the water all round, we made our tea and were sitting down to dinner, when suddenly there came a terrible crash, and tanks, ice, and everything in the car seemed to strike us in every direction. We were, every one of us, at once wedged in by the heavy weights upon us, so that we could not move or stir. A moment after the car began to fill rapidly with water, the heavy weights upon us began to loosen, and, in some unaccountable way, we were washed out into the river. Swimming around our car, we climbed up on one end of it, which was still out of water, and looked around to see where we were.

We found our car detached from the train, and nearly all under water, both couplings having parted. The tender was out of sight, and the upper end of our car resting on it. The engine was three-fourths under water, and one man in the engine-cab crushed to death. Two men were floating down the swift current in a drowning condition, and the balance of the train still stood on the track, with the forward car within a very few inches of the water's edge. The Westinghouse air brake had saved the train. If we had been without it, the destruction would have been fearful.

"One look was sufficient to show that the contents of the aquarium-car were a total loss. No care or labor had been spared in bringing the fish to this point, and now, almost on the verge of success, everything was lost.

"I immediately telegraphed the state of affairs to Mr. S. R. Throckmorton, chairman of the California fish-commissioners, and to Hon. Spencer F. Baird, the head of the United States Fish-Commission at Washington. I received instructions, by telegraph, from Washington the next morning, to return east immediately, with my assistants, and take on a shipment of young shad to California under the auspices of the United States Fish-Commission."

D—OVERLAND JOURNEY WITH LIVE SHAD.

1.—PREPARATION FOR THE TRIP.

As soon as was practicable after the accident to the first California aquarium-car, I reported to Professor Baird at Washington, reaching that city on the morning of June 15th.

Having received here more explicit instructions in regard to the trip with shad, I made immediate preparations for undertaking this journey, and arrived at Castleton, on the Hudson, with my men, on the 25th day of June. The New York State shad-hatching works, under the immediate charge of Mr. Monroe Green, are located here, and it was at this point that I was to procure my consignment of shad for California.

2.—THE START.

At 6 o'clock in the afternoon of the same day, Wednesday, June 25, I left the shad-hatching camp, with 40,000 young shad. They were packed in eight 10-gallon cans, each can containing 5,000 fish. They had been just taken from the shad-hatching boxes in the river by Mr. Green, and appeared very healthy and lively; but they looked so frail and delicate that it seemed almost a hopeless task to undertake to carry them alive 3,000 miles, and deposit them in a river at the other extremity of the continent, and I certainly despaired of getting them there safely.

There were four of us in all at the start: Mr. H. W. Welsher; Mr. W. T. Perrin; Mr. Myron Green; and myself. Mr. Welsher accompanied us as far as Omaha, and the success of the expedition is largely owing to his skill and experience. The remaining three went through to California with the shad.

3.—THE APPARATUS.

Our outfit was very simple, consisting merely of the eight cans containing the fish, one similar can filled with water for a reserve, two or three pails and dippers, a thermometer, and the apparatus for changing the water. This apparatus and its use demand a few words of explanation.

The requirements demanded for keeping young shad alive in transit are radically different from those involved in carrying any other fish, I believe, that have yet been experimented with. They require changes of water, of course, like any other fish; but they always scatter indiscriminately through all portions of the water containing them, instead of dropping to the bottom of their can, and remaining quietly there, as is the custom with very young trout and salmon. In consequence of this, the water cannot be dipped out and thrown away to make room for fresh supplies without dipping out and throwing the fish away with it.

It becomes necessary, therefore, to separate the fish from the water before renewing it. To accomplish this, the apparatus in question is intended. It consists of a cylinder 2 inches in diameter, made of very fine copper-wire netting, and about as long as the can is deep. The bottom is closed with the same netting. The top is open. In connection with this is used a piece of ½-inch rubber tubing 6 feet long. To change the water, the wire cylinder is thrust into the can to any desirable depth; the water immediately enters the cylinder through the wire net-work, which also keeps the fish out. One end of the rubber hose is now dropped into the cylinder, the other end being placed in the pail or can intended for the waste water. The water being started in the hose by applying suction at the lower end in the pail, it acts at once as a siphon, and begins to draw the water out of the cylinder. As the fish cannot get into the cylinder, the water is drawn off without drawing off the fish. When a sufficient quantity has been removed, the cylinder and siphon are taken out, and the spare room in the can replaced by putting in fresh reserves of water very carefully with a dipper. Thus the changing of the water is safely accomplished. This very simple, ingenious, and effective method is the invention of Seth Green.

4.—THE CARE OF THE FISH.

The points about carrying living young shad safely are such as to make it very delicate and critical work. They are substantially as follows:

1. To make constant changes of water.
2. To keep the temperature of the water within specified limits.

3. To avoid sudden changes of temperature in the cans containing the fish.

4. To avoid any agitation of the water in the cans.

5. To furnish constant supplies of water containing minute natural food.

6. To guard vigilantly against the use of water in the least degree unwholesome.

Any failure to supply the above conditions will be immediately followed by fatal results.

Changes of water.—To make constant changes of water, experience has shown to be one of the important secrets about keeping the young fish in good condition. A change is usually made once in two hours. Any temporary neglect of this precaution soon shows its effect in the weakening of the fish, and prolonged neglect is fatal.

A spare can containing a reserve of fresh water is usually carried along with the other cans, and is filled as may be required at railroad-stations. The changes in the cans are made as just described under the head of apparatus for changing the water. In our case, the water was changed every two hours, night and day, for the first half of the trip, and almost every hour for the last half. As we had eight cans of fish, and were seven days and nights on the way, we made almost a thousand changes of water. The labor, of course, was almost incessant. It was like walking a thousand miles in a thousand hours.

Temperature of the water.—It has been ascertained that a lower degree of temperature than 62° Fahrenheit or a higher degree than 75° Fahrenheit is unfavorable to young shad. It becomes necessary therefore to keep the water in the cans between these two points, viz, 62° and 75°. This is done by cooling the water used for changing with ice when too warm, or heating it with artificial heat when too cold.

It is not usually a very difficult matter to obtain water of the right degree for changing with, because most trips with shad are made in warm weather, and in a warm climate, and the main difficulty is to get the water cool enough, which can easily be done with ice. On our overland journey, however, we passed through a very cold climate in crossing the high ridges of the continent. Indeed, at one point on the Rocky Mountains, it snowed in the day-time, although almost the 1st of July; and at these high altitudes the nights were always very cold. To keep the temperature of the water up to a safe point under these conditions, in a cold car, with no fire in it, and with reserves of water which themselves were cold, was no easy matter, as will appear in the account of the journey. Indeed, at one time there seemed to be no possible chance of saving the fish, though, through the untiring labor and perseverance of Mr. Perrin and Mr. Green, it was accomplished.

Sudden changes.—Sudden changes of temperature are very injurious, and often fatal, to shad. So important is the precaution thought to be of guarding against this danger that an alteration of more than two degrees in the cans when changing the water is avoided if possible. This end is accomplished by preparing the reserve water in a pail or can beforehand, and having it within two or three degrees of the temperature of the shad-water when the change is made. This can usually be done, but it adds very much to the labor and care. If we could simply have put a piece of ice in the shad-cans, or have poured in some warm water when it became necessary to depress or raise the temperature, the work of keeping it right would have been comparatively simple; but to be obliged to grade it by this slow process of preparing the water beforehand, and then to affect the temperature of the cans only two degrees at each change, was a complicated work, and required constant care and vigilance, as is evident from the consideration that if the temperature of the shad-cans took to rising or falling rapidly, it would get the advantage of us, so that we could not change the temperature fast enough, at the rate of two degrees at a time, to keep up with it, and to restrain it within the required limits.

Still another complication comes in passing through cold climates, which is that the character of hot water that is obtained cannot be tested, and it therefore cannot be safely used on the fish, even when reduced to the right temperature, and can only be employed as a warm bath to place the vessels containing the reserve water in. This is not all. The only way, at times, on the overland journey that we could get hot water was to heat bars of iron in the engine-furnace, and thrust them, when heated, into a vessel of water, the train, of course, being all the time in motion.

Under these circumstances, then, five steps became necessary in order to regulate the temperature of the shad-cans: (*a*) to heat the irons in the engine-furnace; (*b*) to heat water with these irons; (*c*) to warm the reserve water used for a change by placing a vessel of it in the water heated by the irons; (*d*) to make the change with the prepared reserve; (*e*) to continue altering the temperature in this way two degrees at a time until the desired point was reached.

To work all night at this, in a moving railway-car, in a cold climate, with the temperature of the water falling faster than you can possibly raise it two degrees at a time by the most active exertions, while all the time the lives of the fish and the success of the whole expedition are hanging in the balance, is no child's play. It was like the ancient punishment of being fastened to a pump up to one's chin in water which rose as fast as the most vigorous pumping could keep it down.

Agitation of the water.—Contrary to the requirements of young trout and salmon, agitation of the water, which is to the utmost degree beneficial to them, is equally injurious to shad. To avoid this injurious agitation, shad are carried in tall and (comparatively) slender cans, instead of in broad and shallow vessels. These cans, which have rather a narrow neck, are filled up to the narrowest point. By these precautions, the motion of the trains is almost entirely prevented from agitating the water. In putting in the fresh reserves, care is taken to place the water in gently, and never to pour it in hard, with the same object of avoiding a violent disturbance of the water. As our cans were properly made, having been prepared under the direction of Mr. James W. Milner, the very efficient assistant of Professor Baird, we had no trouble from the motion of the train agitating the water.

Supply of minute forms of life as food to the fish.—To furnish the fish with constant supplies of water containing minute natural food, is obviously necessary to do after the fish are two or three days old, and the yolk-sac absorbed; for then they are ready to feed. Nearly all creatures, as is well known, require, with great frequency when first born, supplies of nourishment to replace the waste produced by the vital processes; but with fish this is particularly true, and especially so with young shad.

To supply this nourishment is usually not difficult, all but very cold water containing more or less of it. The main precaution to be observed is to take on sufficient reserves of (relatively) warm water when opportunity offers. The warmer the water, other things being equal, the greater is the amount of nutriment in it. We had no particular trouble on our journey on this score.

Unwholesome water.—To avoid the use of water in the least degree unwholesome is a precaution the necessity for which is apparent. Unwholesome water will kill any fish even when not confined, and especially so highly-organized a fish as a young shad. And if this is important with fish in their free state, it is obvious how much more so it must be with fish confined by thousands in small cans, where all the conditions, to begin with, are unfavorable to life, and where only a slight addition to the increase of the evils of their situation is sufficient to turn the scale the wrong way and destroy them.

To guard against unwholesome water in traveling with live shad, various precautions are employed. Passengers and railroad-employés on the train are consulted as to the character of the water ahead. This usually helps somewhat in a great many cases; though great caution must be exercised in accepting the information so obtained. On arriving at any given water-station, further inquiries are made; and if all accounts agree that the water is lime or alkaline water, or otherwise unsuitable, it is given up; but if nothing is learned against it, it is then tasted, and, if this first tasting is favorable, a supply is taken on board. It is then more carefully and deliberately tasted, and, if traces of lime or alkali are discovered, it is thrown away; if not, a few fish are placed in a tumbler full of it, and their movements watched. If it is very unwholesome, they will show it at once by their actions. If they do not seem uneasy in it, the tumbler may be set aside for an hour or two, and if, at the end of that time, the fish appear to be doing well, it is considered safe to use the water. I may add here that it is surprising how sensitive and accurate one's taste will become after a few days' practice in detecting traces of lime or alkali in the water, The improvement in this respect during the journey in the case of our party astonished us. Our palates seemed to become as quick and positive in their actions as the most sensitive chemical tests. I believe at the end of the journey we could have detected almost the slightest traces of alkaline mixture in the water, by the taste.

It was always a matter of great anxiety with us, at every change of water, lest we should get unwholesome water into the cans, and so destroy in a moment the fruits of all our pains and care. It was particularly so at first before we had acquired confidence in our judgment of the qualities of different waters, and the thought that *one mistake in all the thousand changes of water to come would be fatal to the enterprise was appalling.* It seemed as if it would be a miracle if we should safely run the gauntlet of this thousand changes in passing through a country the water of which for two thousand miles held lime or alkali, and for a thousand miles was frequently so bad that cattle could not drink it.

We went through it all, however, safely; and, though we exercised all the caution we could bring to bear on the subject, I think we owed it as much to good luck as to our own care that we escaped the danger of using bad water.

I forwarded to you at Washington a list of the places *en route* where we found good water, so that hereafter, with this for a guide, there need not be much danger of going wrong.

5.—JOURNAL OF THE TRIP.

As before mentioned, we left the shad-hatching works at Castleton, on the Hudson, for the Castleton railroad-station at 6 o'clock on the afternoon of Wednesday, June 25, with forty thousand young shad packed in eight cans of water, each holding ten gallons.

On arriving at the Castleton station, we changed the water once, and left Castleton for Albany at 9.15 p. m., the water in the cans standing at 70°. At Albany, we made two changes, and took the westward-bound train for Sacramento at 11.30 p. m. We took on water at Utica, Syracuse, Rochester, Buffalo, Dunkirk, Erie, Painesville, Cleveland, Illyria, (well-water, doubtful,) Edgerton, Elkhart, South Bend, (lime-water, bad,) and Chicago, keeping the temperature of the cans very near to 70°, and arriving at Chicago on Friday morning, July 27, with the fish in good order. It was exceedingly hot at Chicago, the mercury standing at 100° in the shade, and it was only with the utmost difficulty; and by constant changes of water, that we succeeded in keeping the water down to a safe point. As it was, the heat made the temperature of the cans rise to 74°.

On leaving Chicago, the air grew cooler, and by night we had brought the temperature down to 68°; but approaching Omaha the next morning, it went up again to 70°; and while waiting at Omaha, which we reached on Saturday noon, July 26, it rose to 73°, though we tried hard to keep it down. Between Chicago and Omaha, we took on water at La Salle, Bellows station, Bureau, Tiskilwa, Rock Island, Davenport, Kellogg, Casey, and Avoca. Mr. Welsher left us at Omaha, and returned to Rochester.

We left Omaha on the Union Pacific road at 3 o'clock on Saturday, with the fish in excellent order. Through the courtesy of Mr. C. B. Havens, the Union Pacific train-dispatcher, I was permitted to stop the train at the Elkhorn River, where the aquarium-car accident happened, to take on a reserve of river-water at that point; the little experience I had had in it leading me to think that it would be good for the shad.

The country west of Omaha for fifteen hundred miles is, as is well known, very poorly supplied with good water. It therefore seemed necessary to have a larger reserve of water on board than the 10 gallons which served our purpose east of this point. I accordingly took on at Omaha a 30-gallon tank, which had oeen rescued from the aquarium-car wreck, which, with our pails and spare can, gave our reserves a capacity of 50 gallons.

On arriving at the Elkhorn River, the train stopped, and we took on a full reserve of 50 gallons of the river-water. The river was somewhat roily, and the temperature was 84° tō 85°, but the water tasted good and soft; and, by a singular coincidence, it proved to be the best for the shad that we found on the road.

The river that had swallowed up so unsparingly the car-load of California fish, thus contributed more than any other toward assisting the shad across safely to that State.

After taking on the Elkhorn water, we placed a few shad in two tumblers of it, and observed their movements. They seemed highly pleased and entirely at home in it. Being satisfied from their movements that the water was good, we immediately reduced its temperature with ice, and began making changes with it. The afternoon being very warm, however, we could not get the temperature below 72° till night. It grew cooler after dark, and by 1 o'clock, Sunday morning, we had the temperature of the cans down to 69° and 70°, the air in the car being at 69°. We took on ice Saturday night at Grand Island, Nebraska, one hundred and fifty-four miles beyond Omaha, and water at daylight on Sunday morning, at Big Springs, Nebraska, three hundred and sixty-one miles from Omaha. The water at Big Springs was clear and very good, with a temperature of 58°. The shad placed in a tumbler of it seemed to like it. At 10 o'clock on Sunday, June 29, the temperature of the cans was at 67° to 69°. We were now gradually climbing up the eastern slope of the continent. The air was cool and pleasant, and we had no difficulty in keeping the water at about 68° all day. At 6 o'clock p. m, on Sunday afternoon, we reached Laramie, Wyoming Territory, and took on 50 gallons of Laramie River water; temperature 62° and good water. We were now at an altitude of over 7,000 feet, and as soon as the sun set the air grew very cold. In spite of our best efforts, the water in the cans dropped to 65°. This I considered too rapid a decrease from the 72° of Saturday afternoon, so we built a fire in the stove of the express-car in which the cans of fish were carried, and heated our reserves, but only succeeded, with difficulty, in raising the temperature of the cans a degree or two, to 66° and 67°.

Monday morning, June 30, opened with a warm, bright sun, and the promise of a warm day, and we let the fire in the stove go down; but before noon it became very cold again, with a squall of snow at Bryan, Wyoming Territory. There was also snow on the side of the track. We built up another fire in the stove, and kept the water in the cans at 66°.

We arrived at Evanstown, Utah, about 2 o'clock p. m., on Monday, and took on a reserve of river-water. It was clear and comparatively good, with a temperature of 57°. As we descended Weber Cañon, toward Great Salt Lake, the weather grew warmer, and we descended to Ogden without mishap, reaching this point at half past five, Monday afternoon, with the fish all in first-rate order. Here I left 5,000 of the shad, as fresh and lively as when they were taken from the Hudson, in the care of Mr. Rockwood, of Salt Lake City, who deposited them in the Jordan River, a few miles above its outlet into Great Salt Lake. We also took on here 50 gallons of water from the Weber River, and started westward again on the Central Pacific Railroad, 15 minutes earlier than we arrived, according to the Central Pacific Railroad time, but really about two hours later.

Everything now looked exceedingly favorable and encouraging. We had passed through more than a thousand miles of the dangerous country without loss; the shad appeared as lively and healthy as when we started; we had 50 gallons of good water on board, and only four hundred and sixty miles to run to the beginning of good water again, at Humboldt, and only three hundred and fourteen miles more from there to Sacramento. We thought we had reason to feel encouraged. Our spirits rose accordingly. The terrible strain of the past five days of anxiety began to slacken. We did not know what was coming that very night, or we should not have felt so well over it, for the next night was the most alarming and critical of the whole journey.

The temperature of the cans was standing at 65°, or within 3° of the limit of danger; our reserves of water stood at 60°, or 2° below the limit. The night came on extremely cold; there was no stove or place for a fire in the car; and the temperature of the cans was falling every moment. In the day-time, hot water could have been obtained by telegraphing ahead; but at night this was quite impracticable. The situation was exceedingly alarming.

Through Mr. Perrin's foresight, however, at Ogden we made a favorable beginning of the night. While I was busy arranging for the transfer of the shad for Salt Lake, and attending to indispensable matters which absorbed all my time at the Ogden depot, Mr. Perrin, on discovering that there was no stove in the Central Pacific express-car, with admirable foresight went into the kitchen of the depot-restaurant, and procured permission to heat some water on the stove, by which we obtained eight gallons of hot water and got a good start.

I also took the first opportunity to go forward into the postal car and obtain permission to heat water on the mail-car stove during the night, The danger was now apparently averted, and, it being my night for sleep, I, having been up the greater part of the night previous, retired, leaving Mr. Green to remain on duty till midnight, and Mr. Perrin from midnight till daylight, when I was to go on again.

Mr. Perrin and Mr. Green deserve the entire credit of taking the shad through the critical night that followed, and for an account of it I will quote from Mr. Perrin's journal:

"As we left Ogden on Monday evening, it became evident that we should need hot water during the night; for the water which we took on at Ogden was, I think, about 60°, and the temperature of the air promised to be no higher, while it was necessary to keep the temperature of the cans above 62°. Accordingly, Mr. Stone made arrangements to heat water, if necessary, in the postal car, where there was a stove, but after he went back to the sleeping-car, the man in charge of the mail-car came to us and said that they were very busy and did not see how they could have a fire in the car. So Mr. Green went into the engine-cab and persuaded the engineer to heat some iron couplings in the furnace of the engine, and then to put them when red hot into our pails filled with water. This water was, of course, dirty and unfit for use in many other respects; so Mr. Green took the larger tin pail, and filled it with warm water, and set into it a smaller one with good water in it, but too cold In this way, he heated a sufficient quantity for immediate use. When he woke me up at 12 o'clock, the air in the car was cold, and growing colder, and it was apparent that work must be done to keep the temperature up to the right point. At the first stopping-place, I went forward to the engine, but found that at that place they changed engines and also engineers.

"The new engineer hardly understood the case, and was at first unwilling to do what I desired. The conductor, too, seemed averse to any delay, and was not very pliable; but after a statement of our necessities they both consented, and I was to go forward for hot water at the next stop. This I did, and obtained hot water heated in the way I have described. The engineer remarked that he could heat no more till he reached Toano, about 4 o'clock a. m., when he could give me all I wanted. But at 2.30 a. m. the temperature of the car was about 52°, and the water in the cans about 63°, and, of course, going down. I was getting a little nervous, for before 4 o'clock the water would surely get too cold unless something was done. The train stopped, and I ran forward, and after the engineer heard my case, he told me that they were going to stop for water in about 20 minutes, and then he would let me have another supply of warm water. About 3 a. m. the train stopped, and I went forward, and the engineer took out the hot irons and heated the water, and I was enabled to keep the water up to the right temperature until we reached Toano, where I got another supply. At Wells, I think it was, another engineer drew off boiling-hot water from the engine. This took some time, for the water ran very slowly, as it was mostly steam that came out. I could not have gotten enough hot water in this way had not the train made a stop of 15 or 20 minutes for breakfast.

"In this way I got through the night without letting the temperature fall below 62°; of course, it kept me almost constantly at work."

On Monday, at daylight, I joined the car again, and was quite appalled to hear of the dangers that had been passed the night before.

The water in the cans now stood at 63°; we were on a descending grade; the sun was quite warm; and by 10 o'clock, at Carlin, Nev., we had the water up to 66°. The sun and air grew warmer, and by noon the temperature in the cans rose to 70°. We had now descended 1,600 feet, and it was so warm that we began to use ice again to cool the water. I did not allow myself, however, to be deceived by appearances, but telegraphed ahead to Humboldt for hot water. I also telegraphed to Mr. Throckmorton, of the California fish-commission, for a supply of ice and river-water at Sacramento, on the arrival of the train.

We reached Humboldt at half past 6 the same day, Tuesday, July 1, and took on 8 gallons of hot water and 30 gallons of cold water. The water, which was from a spring, was very good indeed, and had a temperature of 65°. In three hours more, to our great consolation, we began climbing the Sierra Nevada, with all the bad water left behind us and only good water before us. We were also now only fourteen hours from Sacramento City. We had both hot water and ice on board, and the fish were in splendid condition. We therefore had great hopes of bringing them through safely.

The rest of the journey was comparatively free from anxiety or danger, or any marked events. About sunrise on the morning of Wednesday, July 2, our last day, we crossed the summit of the Sierra Nevada, and began descending the Pacific slope into California; the water in the cans now standing at 65° to 66°. At 9 o'clock we took on 20 gallons of good water, with a temperature of 60°, at Alta, Cal., and arrived at Sacramento City at half past 1 Wednesday afternoon, with the shad as fresh and lively as when they left the Hudson River a week before. It seemed like a miracle!

At Sacramento, we met Mr. Throckmorton, and took on the ice and water which he had provided at the depot.

At 20 minutes past 2 we took the California and Oregon cars up the Sacramento River, in company with Mr. John G. Woodbury, the California State fish-warden, and, after several changes of water and no mishaps, arrived at Tehama, Tehama County, California, about 9 o'clock in the evening. In a few minutes we were at the river-side, and just at 10 minutes past 9 on the evening of Wednesday, July 2, 1873, in the presence of Mr. Woodbury, Mr. Green, Mr. Perrin, and several others, citizens of Tehama, the 35,000 shad from the Hudson River, New York, were deposited safely and in good order in the Sacramento River, at Tehama, Cal.; and we turned away from the river toward our hotel, feeling as if a load of incalculable weight had been lifted from us. I ought to add here that, at Ogden and various other places on the road, we removed the sediment and dead fish from the water by placing the can-end of the rubber siphon close to the bottom of the cans, and starting the stream through the siphon without using the protecting cylinder. The live shad not resting on the bottom at all, this simple method will clean up every particle of impurity that has settled in the water without drawing off the live fish. This device serves a double purpose; for it not only removes all the dirt, but it draws off all the dead fish, where they can be seen and counted. In this way we arrived at a very near estimate of the loss *en route*, which we placed at about 400 fish, or only 1 per cent. of the whole.

In regard to Mr. Perrin and Mr. Green, and their work on the car, I must say that two better men for the undertaking could not have been found. Faithful, untiring, and nerved by the most resolute determination to succeed, they did all, and more than could be asked of them, and the extraordinary success of the expedition is, without doubt, greatly due to their efforts.

6.—EXPERIMENTS TO ASCERTAIN THE CHARACTER OF THE WATER.

The temperature of the water used in the experiments given below was approximated to that of the water in the cans at the time the experiments were tried.

Elkhorn River (Nebraska) water.—Soft, but roily. Saturday, June 28, put one shad in tumbler, containing three tablespoonfuls, at 4 p. m. He appeared to like it; was alive and doing well at midnight; showed signs of distress toward morning; at sunrise was just alive; at 7 a. m., on Sunday, was dead.

Big Spring (Nebraska) water.—Clear but a little hard. Put one shad in tumbler containing three tablespoonfuls of water; at 8 o'clock a. m., Sunday morning; showed signs of distress at noon; was alive at 2 p. m.; died soon after.

Laramie River (Wyoming Territory) water.—Not quite clear. Put several shad in a tumbler full, at 7 p. m., on Sunday; appeared to like it at first, but afterward to suffer some; at midnight were in considerable distress; at 1 a. m., Monday morning, they began to die; at 4 a. m., nearly all dead; at sunrise, all dead.

River-water, Evanstown, Utah.—Somewhat roily. Put two shad in a tumbler full, at 3 p. m., Monday, June 30; did well in it.

Humboldt Spring (Humboldt, Nev.,) water.—Put several shad in tumbler at 5 p. m., on Tuesday, July 1; seemed to like it; appeared well most of the night; in a good deal of distress at daylight; died in the forenoon.

7.—STATIONS AFFORDING SUPPLIES OF WATER.

West of Humboldt all the water is good, and it is not necessary to test it.

We took on water east of Omaha at Albany, Utica, Syracuse, Rochester, Buffalo, Dunkirk, Erie, Painesville, Cleveland, Illyria, (well-water, doubtful,) Edgerton, Elkhart, South Bend, (bad lime-water,) Chicago, (Rock Island Railroad depot,) La Salle, Bellows station, Bureau, (rain-water,) Tiskilwa, (spring-water,) Rock Island, (good,) Davenport, (from Mississippi River,) Kellogg, Casey, and Avoca.

West of Omaha, we took on water at Elkhorn River, 50 gallons, 84° F., roily;* Big Springs, 10 gallons, 58° F., clear; Laramie River, 50 gallons, 62° F., clear; Evanstown, (spring-water,) 10 gallons, 57° F., clear; Ogden, (Weber River,) 50 gallons, 60° F., roily; Humboldt station, (spring-water,) 50 gallons, 65° F., clear; Alta, 20 gallons, 60° F., clear; Sacramento, 20 gallons, warm, muddy.

8.—TEMPERATURE OF WATER IN THE CANS.

The temperature of the water in the cans was as follows: Hudson River water, 70°; Albany to Chicago, 70° to 74°; Chicago to Omaha, 74° to 68°; Omaha to Laramie, 73°, 67°; Laramie to Ogden, 67°, 65°, 67°, 66°; Ogden to Humboldt, 66°, 62°, 70°; Humboldt to Sacramento, 70°, 66°, 67°; Sacramento to Tehama, 67°, 70°; Sacramento River water at Tehama, 74°.

9.—CONCLUSION.

I will close this account of the overland journey with the shad by saying that, considering all the liabilities to accident and delays which are incident to railway-travel, especially when encumbered as we were with a dozen cans and pails, weighing in the aggregate half a ton, I think we were surprisingly fortunate in getting along as well as we did. We made numerous changes of cars and transfers of our freight from one train to another, often in the greatest confusion and hurry, with trunks flying about our heads and feet, and railroad-employés pushing and thrusting us and our cans out of their way. We were often ordered away by baggage-masters and express-agents, though we could not, with safety, leave our charge for a moment; and at times, especially at the junctions of the great lines of railways, where we were hardly left a place to stand, and where at the same time in all the confusion and crowding we felt obliged to take on water and even to change the water in the cans, it seemed as if some disaster must certainly come—either that the fish would be injured, or that the cans would be upset, or left behind, or that some of us would be left, or enter the wrong train, or something of the sort happen.

* I do not consider roily water at all objectionable, but the reverse. I think it much better to take on large reserves at a few places than small reserves at many places, because *every change of water involves a risk.*

Yet, though it seems almost incredible, not an accident, or delay, or drawback of any kind happened. We did not lose a fish from any contingencies of any sort, nor meet with a moment's delay, but entered Sacramento City with all our fish alive, just on the moment that we were due to reach it by the 11.30 p. m. train which we took from Albany on Wednesday the week before.

E—THE McCLOUD RIVER STATION.

The next evening, after depositing the shad at Tehama, I took the train for Redding, and the stage thence for the McCloud River, arriving at the river at daylight of the following day, July 5, 1874. My object in making this journey was to see in what condition our camp of last year on the McCloud might be, and to make some examinations of the river itself, with special reference to using the river-water this year for maturing the salmon-eggs for shipment. I confess I was somewhat surprised, considering the unsettled condition of the country and the presence of Indians, to find the house and belongings exactly as we had left them. Nothing had been molested, and nothing apparently touched, except some spare lumber which an agent of the California and Oregon Stage Company had borrowed in an emergency, and which was immediately settled for. An examination of the river seemed to indicate that water for the hatching-house could be obtained by carrying it in a ditch from a point about fifty rods above the site selected for the hatching-works.

These hasty examinations having been concluded, I went to Shasta City to engage the services of two fishermen who had assisted us the year before, and thence I proceeded to San Francisco. Having secured supplies and men for the season's campaign, I left this San Francisco city again for the McCloud River on the 5th of August, arriving at camp the next morning at daylight.

The year before, the idea of using the McCloud River water not having suggested itself, I had been obliged to locate the camp and hatching-works at a considerable distance from the river, in order to obtain brook-water for maturing the eggs. The inconvenience of this arrangement, which placed the fishing-grounds and the hatching-works a mile apart, is apparent. In fact, the constant necessity for crossing and carrying materials from one point to the other, frequently in a temperature of 110° in the shade, became so intolerable before the season was over, with its consequent labor, risk, and loss of time, that I had resolved if possible, the next season, to bring the camp, hatching-works, fishing-grounds, and stage-communication together at one place. This I was fortunately enabled to do by using the river-water for hatching at a point where the California and Oregon stage-road touches the west bank of the McCloud. The first plan for conveying the water from a higher part of the river to the hatching-works was not successful on account of there not being sufficient fall for a satisfactory hatching-apparatus, and for other reasons. This plan was therefore abandoned, and the attempt was made to raise water from the river by a wheel placed in the current. This method, which worked to our entire satisfaction, will be more particularly described hereafter.

Previous to my arrival, I had dispatched my foreman, Mr. Woodbury, together with Mr. Green and Mr. Anderson, to the McCloud, with instructions to move the camp and hatching-works to the river-bank, and to make preparations for using the river-water for hatching.

When I arrived, on the 6th day of August, I found things in a very satisfactory condition. The house had been moved in good order, and was now placed just at the water's edge a few rods from the junction of the stage-road with the river. The large hatching-tent had been erected, a considerable number of salmon had been caught and corraled, and everything promised well. I was soon after waited upon by a deputation of the McCloud tribe of Indians, who, at the time of their visit, expressed themselves friendly and well-disposed.

Our camp now consisted of John G. Woodbury, foreman; Myron Green, head-fisherman; Oliver Anderson, man of all work; George Allen, carpenter; Benjamin Eaton, steward; A. Leschinsky, fisherman; J. Leschinsky, fisherman; Livingston Stone, in charge; Indians, Lame Ben, Uncle John, One-eyed Jim, and others.

The eggs in the parent salmon at this time showed an advanced state of development, indicating that the spawning-season was not far distant. As there was a great deal yet to be done to get ready for the two million salmon-eggs which I hoped to take, no time was lost in pushing the preparatory work to completion; and we were so well prospered in our labors that by the evening of the 19th of August we had the water running through the hatching-troughs, and were ready for the first installment of eggs.

1.—CATCHING THE PARENT SALMON.

I will now leave the chronological order of events, and will speak of some of the branches of our work, beginning with the capture of the parent fishes and confining the parent salmon. I was very undecided whether to capture the salmon this year with a seine, or to construct a large trap in the river which would take advantage of their instinct to ascend the stream. As the result proved, I think it would have been easier and cheaper to build the trap, but I decided to use the seine, and continued to use it, and nothing else, through the season. My reasons for doing this were—

1. I had tried the seine-fishing, and knew it could be depended upon.

2. I had not tried a trap on any extensive scale, such as would be necessary in this instance, and was not certain that it could be relied upon.

3. The building of the trap would be an expensive undertaking, and the means at my command were such as rendered economy a primary consideration.

4. I had all the implements for seine-fishing on hand, and no expense for an outfit would be incurred in using the seine.

Had we been able to keep alive all the fish we caught till we had taken their eggs, the seining-method would have been the best and cheapest; but, as will be seen farther on, the parent salmon in our inclosures died so fast and in such numbers that I had to keep up the seine-fishing far beyond the expected time, which made it very expensive and probably less economical in the end than the trap-project would have been.

Our seine was a short one, of about 20 fathoms, and of a mesh small enough to catch half-pound grilse and trout. At the beginning of the fishing in July and first part of August, we caught a good many trout, but, in the latter part of the fishing in September, very rarely one. We drew the seine at first in still places, where the river had formed a large, broad, and deep basin, but we found subsequently that we caught more fish by carrying the seine up the river-channel a few rods, and sweeping the channel as well as the basin. In fact, our experience seemed to show that there were more salmon in the narrower channel above the deep holes than in the holes themselves. Later in the season, while the fish were spawning, we had the best success in the rapids below the holes, or, I should say, as near the rapids as we could go with the boats and seine; the rapids themselves being too swift water either to haul a seine or to row a boat in.

At times, the salmon caught would be mostly males; at other times, mostly females; and at other times, nearly all grilse, which seemed to indicate that there were separate runs of males and females and grilse, respectively. We usually began fishing at dark, and fished till midnight or daylight, according to circumstances. Mr. Myron Green had charge of the fishing most of the time, and performed his part very creditably and faithfully.

Table showing the character of the fishing at different intervals.

Date.	Number of fish caught.	Remarks.
Aug. 13	18	9 females.
14	80	60 females.
15	31	Chiefly females.
16	62	Chiefly females.
Sept. 3	120	Nearly all males and grilse.
4	32	Equal number of males and females.
5	60	Equal number of males and females.
6	10	
8	120	20 females; the rest males and grilse.
9	20 females	Many males and grilse besides.
10	20 females	Many males and grilse besides.
19	15 females	7 had spawned. 8 had eggs.
22	9 females	6 had eggs. 3 had spawned. Last day of fishing.

We caught about 1,000 salmon altogether during the summer's fishing.

The weight of the salmon caught (including grilse) varied from less than a half a pound to 29 pounds. The smallest and the largest were males. The largest male was caught on the 14th of September, and weighed 29 pounds. He measured 41 inches in length, and was 22 inches round just in front of the dorsal fin. (See No. 313 of my collection for the Smithsonian Institution.) We caught the smallest salmon, a grilse, of course, and a male, on the 16th of September. He was thin and worn, but full of very ripe milt. He weighed less than half a pound. (See No. 314*c*.) The largest female which was weighed was caught on the 28th of July. She weighed 22 pounds, (see No. 192*c*;) girth just in front of dorsal fin, 22½ inches. I think, however, that later in the season larger females were caught, which were not weighed. The smallest female was caught on the 17th of September, and weighed 6 pounds after being spawned; girth, 12½ inches. She yielded nearly 3,000 eggs. (See No. 315*c*.)

The first ripe male was caught on the 17th of August. The milt was ripe and good. He seemed to be in a healthy condition, but was dark and slimy. Weight, 26 pounds; girth, 23 inches. (See No. 280.)

The first female caught ripe in the net was taken on the night of the 29th of August. Two ripe ones were taken that night, but the weight was not observed. The two together yielded 13,000 eggs.

We found ripe females in the corrals three days before this. It might be inferred at first sight from this fact that confinement hastened the ripening of the spawn; but this does not necessarily follow, because the fish were, when caught, on their way to a higher point on the river, where the spawning-season naturally comes on earlier than it does lower down, so that the fish previously caught and now confined in the corrals were really earlier-spawning fish than those caught on the spot with ripe spawn in them.

The comparative weight of the spawn in the female fish, contrasted with the fish itself, may be inferred from the following specimen caught August 14:

Female salmon; spawn nearly ripe; weight, 19 pounds; length, 33½ inches; girth, 20½ inches; weight of spawn, 2¼ pounds. (See No. 206.)

On the 18th of August we caught with a hook a trout that had a very peculiar appearance, on account of the unmistakable marks of old age which it presented. It was very thin and lank. Its fins and tail were a good deal worn. Its eyes were sunken, and its whole appearence corresponded to that of an old dog or horse. It was the most aged-looking fish I ever saw.* (See No. 282.)

2.—CONFINING THE SALMON.

The corral.—The confinement of the parent salmon in suitable inclo-

* For a description of the appearance of the salmon of the McCloud River, and the changes which they undergo at the approach and during the progress of the spawning-season, see my report of operations on the McCloud River printed in the United States Fisheries Report for 1872.

sures, though it seems so simple a matter, was a very trying and difficult problem to solve, and gave us no end of trouble. To show the character of this difficulty, I will give my experience in the order in which it came.

We began building our inclosures by staking down a small circular fence of stakes in a shallow place in the river near the shore. The stakes were driven down one by one very firmly, and then firmly bound together and held in their place by withes. The main objection at first to this was that it was on too small a scale. We then built other inclosures on the same plan, but larger and deeper. This gave the fish more scope for jumping, and, although the top of the stakes was several feet above the surface of the water in the inclosure, the salmon easily jumped over them and escaped into the river. We then put a covering, or roof, over the corral on a level with the top of the fence. The salmon now, although they could not escape by jumping out, were no less persistent in their attempts to do so, and literally wore and lashed themselves to death in their frantic and ceaseless efforts to escape. I then built a large covered wooden box, 16 feet long and about 4 feet deep, and 5 feet broad, with wide seams between the boards to let the water through, and anchored it in the current. As the box when soaked sank nearly its depth in the water, the salmon had no chance to jump and lash themselves as in the staked inclosure, and we flattered ourselves we had found the solution of this troublesome problem of providing a suitable place of confinement; but what was our surprise and disappointment when, on examining the salmon in the box a few days after, we found them all dead. The close confinement of the box had really prevented them from injuring themselves as before by jumping, but at the same time had acted so unfavorably in other ways as to cause their death.

The prospect now looked very discouraging. We could catch salmon enough for our purpose, but we could not keep them alive. They were, in fact, dying as fast as we caught them. It now occurred to us that an open pond, supplied by a good stream of river-water, would obviate the difficulties presented, as then the fish, having nothing but dry land to jump on to, would give up jumping and remain quiet. I accordingly put on a force of Indians at once, and in a few days had a pond of considerable size ready, and supplied by a stream of water taken from the flume which conveyed the river-water from the wheel to the hatching-house. A large number of salmon were then put in here, and we felt decidedly encouraged. But now a new difficulty presented itself: the fish would not ripen in the pond. Whether it was that the roiling of the pond by their movements when frightened prevented the eggs and milt from maturing, or whether the friction produced by their incessant jumping is one of the necessary conditions of their ripening, I do not know, but it is certain that neither eggs nor milt matured in the pond, and I think we did not take a single ripe egg or any first-rate milt from one of the fish there confined. My next move was to build a close board floor over the staked inclosures in the river, almost touching the surface of the water. This prevented the fish from wearing themselves out by jumping, and did not seem to interfere with their ripening, but it did not keep them wholly from dying. At last I became convinced, and am still of the opinion, that the Sacramento spawning-salmon cannot be kept alive in any inclosure on a small scale. There seemed now to be but one alternative left, and that was to let those die that were confined, and to keep on fishing and catch what were needed as we went along. This we did; and fortunately there were so many fish running in the river that we were able, even after this, to obtain enough to furnish the requisite supply of eggs.

Our experience this year has shown one thing, and that is that if a seine is used exclusively in future for taking the parent salmon, the true way will be to begin fishing only just before the spawning-season commences, for all the spawn that we took from fish caught and confined at that time amounted to very few indeed, while, on the other hand, there was no difficulty in catching enough salmon after the season commenced to yield our quota of two million eggs.

The best way, however, for catching the salmon on the McCloud is, I think, to extend, if practicable, some impassable barrier across the river obliquely, say at an angle of 45° with the course of the current, and to have the upper end lead into a large inclosure, or pound, where the fish can be conveniently taken out for spawning.

This method, though involving a good deal of labor at first, will compel all the fish ascending the river to enter the pound, and will, of course, obviate the constant labor and expense of drawing the seine, which is no inconsiderable item when kept up for a long time.

The current and volume of the McCloud River are so formidable that it may be impossible to construct such a barrier; but if operations are continued on that river another year, I propose to make the attempt to dispense entirely with drawing the seine. The pound will, of course, be arranged so that the fish not required for our purposes can be allowed to pass up the river to spawn. This, in fact, would be necessary for another reason; for, if the salmon were entirely cut off from ascending the river, the Indians above us would be sure to make trouble.

Moving the parent salmon.—The moving of the living parent salmon across the river, being quite an important feature of our work, deserves a few words here.

The river at the place of crossing was about sixty yards wide, with swift water part of the way, and rapids just below. On account of the rapid current, no very heavy load could be towed across in safety. Our first plan for conveying the fish across was to bring them in a large box placed on the stern of the boat. This answered very well for a small quantity, but was on too small a scale for the carrying of large numbers. Our next plan was to tow them over in the seine, but this was not only laborious work, but it gave the fish a chance to injure themselves. The next plan, and the one we finally adopted, was as follows:

We took the large box containing about 2,000 gallons of water, which was first used to keep the parent salmon in, and afterward abandoned, and placed it close to the corral where the salmon were confined; we then lifted the salmon out from the inclosure with a net and deposited them in the box. The box was so large that it would always hold all we had to carry across, and a great many more. The salmon being all in, the cover was fastened down, and the box was ready for transporting. The 2,000 gallons of water in the box weighed about ten tons, so that towing it through the current with the boat was not to be thought of, and we had not a strong line long enough to reach across the river. We accordingly attached one end of what rope we had to the box, and made the other end fast to a rock as high up above the box on the same side of the river as it would reach. Then the box being ready, the boatman unfastened the upper end of the rope, and started across the river at the same time that others pushed the box out into the current. By quick rowing he could cross with the boat-end of the rope before the box had become unmanageable in the current. The boat-end of the rope was then made fast on this side of the river, and the box, with some help from the boat, gradually swung across to where it was wanted. This little maneuver, though so simple as to seem hardly worth mentioning, really had to be conducted quite dexterously to be successful in our rapid and dangerous river, and on that account assumed more importance than it may seem to possess.

3.—THE INDIAN SENTIMENT IN REGARD TO CATCHING THE SALMON.

Our attempt to locate a camp on the river-bank was received by the Indians with furious and threatening demonstrations. They had until this time succeeded in keeping white men from their river, with the exception of one settler, a Mr. Crooks, whom they murdered a few weeks after I arrived. Their success thus far in keeping white men off had given them a good deal of assurance, and they evidently entertained the belief that they should continue, like their ancestors before them, to keep the McCloud River from being desecrated by the presence of the white man. Their resentment was consequently very violent when they saw us bringing our house and tents and camp-belongings to the edge of the river, and taking possession of the land which they claimed as their own, and settling down on it. They assembled in force, with their bows and arrows, on the opposite bank of the river, and spent the whole day in resentful demonstrations, or, as Mr. Woodbury expressed it, in trying to drive us off. Had they thought they could succeed in driving us off with impunity to themselves, they undoubtedly would have done so, and have hesitated at nothing to accomplish their object; but the terrible punishments which they have suffered from the hands of the whites for past misdeeds are too vivid in their memories to allow them to attempt any open or punishable violence. So, at night, they went off, and seemed subsequently to accept in general the situation. Individuals frequently said to me afterward, however, that I was stealing their salmon and occupying their land; but it was more as a protest against existing facts than as an endeavor to make any change in the situation. Once, when I was walking alone in the woods on the other side of the river, an Indian with a very forbidding aspect met me, and said in the Indian dialect that he wanted to talk with me. I expressed my gratification at having an interview with him, and we sat down on the rocks, and the talk began. He was very much excited and very wrathful. He told me that this was his land, and that his fathers had always lived there, and that I had no right to be there. He said the salmon were his, too; that they belonged to his tribe, and that I was stealing his salmon. He ended by saying that the white men had lands and fish in other places, that the Indians did not go there and steal their lands and salmon, and that white men ought not to come here and take what belonged to the Indians. There is room enough in the world for the white men, he said, without taking this river from the Indians to live on.

I confess that his arguments seemed sound. The whole panorama of the Indian's wrongs and sufferings, as the history of this country portrays it, with the encroachments and injustice of the white man, and the gradual but certain disappearance of the red man before the advance of civilization, seemed to come up before my mind, and I felt that though I was the representative of a powerful and enlightened nation, I could not answer this poor, ignorant, indignant savage before me. I did not try to answer him, but I told him I was his friend; that I did not mean to take his land or his salmon; that I should go away in a few months; that I *only* wanted the spawn of the salmon; and that the Indians might have all the salmon as soon as I had taken the eggs. He was not satisfied or appeased, however, and left me in the same disappointed and indignant spirit with which he met me. This spirit continued to prevail among the tribe until we began to take spawn and to give them the salmon. Then, when they saw that they received only kind treatment from us always, and food and medicine occasionally, and that we gave them all the salmon to eat, securing only the spawn for ourselves, they seemed to see things in a new light. The public sentiment, I think, became entirely changed, and was pretty correctly expressed in what an Indian said to me, about that time: "I understand," said he, "you give Indian salmon; you only want spawn; that all right!"

I had one man in my employ who had fished on the McCloud the previous season for salmon on his own account; and, having taken some pains to clear away a fishing-ground for drawing the seine on the river-bank, he claimed the fishing as his private property. I allowed his claim at first, and paid him a considerable sum for the use of his ground, as he called it; but, after making inquiries, and taking legal advice upon the point, I made up my mind that if any one had rights on the river, it was the United States Government, to whom it belonged and whom I represented. The demands of the man having become exorbitant, and it being illegal for him to sell his salmon if he caught any, I told him that, after a certain time, I should fish there on my own responsibility without paying any toll. He was exasperated beyond measure at hearing this, and when he found that I was in earnest, and meant what I said, he became dangerous, and attempted violence, which would certainly have been followed by fatal results, if it had not been for the vigilance and presence of mind of Mr. Myron Green, who had charge of him for nearly three hours, part of which time he acted like a raving maniac. I fished there, however, as I had announced, and the man acquiesced at last, though under protest. A more thorough investigation of the facts showed conclusively that I was entirely correct in assuming the right to fish on the grounds in question; no one under the circumstances having *exclusive* rights to fish there.

This circumstance led me to think that it might be desirable for the United States to reserve to themselves the right to fish in a certain portion of the McCloud, so that, under no circumstances, could its representatives be prevented from obtaining spawning-fish for breeding-purposes.

4.—SPAWNING THE FISH.

The first spawn was taken on the 26th of August, neither the males nor females being very ripe. At first, we thought it required three men to spawn the fish: one at the head, one at the tail, and one to take the eggs. Afterward, we found that two could manage it; and Mr. Green finally brought the work down to its greatest simplicity by putting the salmon's head between his knees, holding the tail with one hand, and taking the spawn with the other. As we did not undertake to save the salmon alive, this one-man method proved perfectly satisfactory, except with very large fish, and, of course, saved employing so much extra labor.

At first, also, all the eggs that we took came from the salmon confined in the corral; but, as the season advanced, we took more and more in the net, till at last most of the eggs were taken from the fish as soon as they were caught in the seine. The parent salmon were then thrown on shore for the Indians, and, of course, not confined at all.

Below will be found a daily list of the eggs taken during the season.

Daily list of salmon-eggs taken at the United States salmon-breeding establishment. McCloud River, California, during the season of 1873.

Date.	Number of eggs taken daily.	Total number in troughs.
August 26	23,000	23,000
August 29	58,000	81,000
Date unrecorded	38,000	119,000
	45,000	164,000
	95,000	259,000
	60,000	319,000
	48,000	367,000
	80,000	447,000
	110,000	557,000
	93,000	650,000
September 6	30,000	680,000
September 7	120,000	800,000
September 8	140,000	940,000
September 9	55,000	995,000
September 10	195,000	1,190,000
September 11	70,000	1,260,000
September 12	100,000	1,360,000
September 13	100,000	1,460,000
September 14	40,000	1,500,000
September 15	100,000	1,600,000
September 16	110,000	1,710,000
September 17	60,000	1,770,000
September 19	70,000	1,840,000
September 21	130,000	1,970,000
September 22	30,000	2,000,000

5.—THE HATCHING-APPARATUS.

The water-supply.—In the season of 1872, I used water for hatching from a spring-brook which emptied into the McCloud a short distance above the site of our present camp, and which had its sources about a mile to the west of the river. This brook gave us no end of trouble on account o its unsuitableness to its purpose. Its average flow in the morning was a little over 1,000 gallons an hour, but at night, after a very hot day, it would shrink to 250 gallons. It would also heat up some days to a very dangerous temperature; then, again, the hogs, which run in the woods in a semi-wild state, would wallow in it and make it so roily that all attempts to filter it clean were fruitless; and, last but not least, there was present in the water all the time a vegetable growth, resembling our eastern *Conferva*, yet somewhat dissimilar to it, that no device of ours could cleanse the water of. It seemed to be ubiquitous, and gave a great deal of trouble.

These combined disadvantages of the water-supply of 1872 decided me to abandon it this season, and to look elsewhere for water. But here a new difficulty arose. There was no other spring or brook of any magnitude within several miles. To go that distance to locate would either destroy our stage-communication or take us away from the river. There was but one alternative left, and that was to take the water-supply from the McCloud. To accomplish this, a ditch was commenced from a point about fifty rods above the new hatching-house site, and was continued for about two hundred feet, when it was abandoned; the obstacles in the way of its successful prosecution making it practically useless.

We were now left without any water-supply whatever. There were salmon in abundance at our very feet, but no water to hatch the eggs with.

The wheel-pump.—In this emergency, the idea of raising the water from the river itself by a wheel was suggested, and immediately put into practice. From this time till it was finished, the wheel was the central object of interest at the camp. So much depended upon it and its successful working, and the project was so novel and unprecedented, that the progress of the work on it was watched with the greatest solicitude; and, at last, when it was completed, and actually revolved and lifted its 6,000 gallons of water an hour higher than our heads, and poured it down the flume into the hatching-troughs, our relief and enthusiasm were unbounded. I celebrated the occasion by raising at sunset a large American flag over the camp.

I consider this device for raising water for hatching-purposes one of considerable importance, as by this method a water-supply can be obtained on any similar salmon or trout stream when all other resources fail, and in regions where no other water-supply is available. On account, therefore, of its possible value to future operations, I will be more explicit in describing the wheel than might otherwise be thought appropriate. The wheel was placed in the rapids, just below the hatching-house, on our side of the river; the shore-pier resting on the river-bank. The other pier was built at the required distance out in the water, and was constructed by fastening heavy timbers together in the shape of a triangle, and filling the inclosed space with large rocks; the timbers forming the triangle being 12 feet long on the hypotenuse, and those on the sides being 8 feet long. The shaft was 11 feet long and 9 inches in diameter. The journals were 9 inches long and 7 inches in diameter. The journals were of pine and the boxes were of oak. The wheel was 12 feet in diameter, 8 feet wide, and had 16 paddles, each 15 inches wide. The buckets, containing between 4 and 5 gallons each, were arranged around the circumference of the wheel, on the shore-side of it, and were, of course, so constructed as to fill at every revolution, and discharge their contents just at the right moment.

A margin of several inches was allowed for raising and lowering the wheel in the water, so as to regulate its power at pleasure. The velocity of the current in which it was placed was such that, with my utmost exertions, I could just hold our fishing-boat against it with a good pair of oars.

At last, after many trials and discomfitures, and renewed efforts in constructing the wheel, it was finally pronounced complete, and our whole camp assembled to see it lowered into the water. To say that we were breathless with excitement was no exaggeration. Our suspense cannot be overdrawn. The situation, as it presented itself to our minds, was simply this: if the wheel worked well, our efforts to obtain salmon-eggs would be a success; if the wheel did not work, our whole expedition would be a failure. No wonder we watched the lowering of the wheel with absorbing interest. Our disappointment and dismay can hardly be exaggerated, then, when we perceived the wheel, having reached its resting-place, give a convulsive start, revolve perhaps a third of the way around its axis, utter a groan, and stop entirely. There was not power enough to lift the buckets of water. We then went to work to throw out a wing-dam on the river-side of the wheel, about 30 feet in length and at an angle of nearly 45° with the river-current. This was built by making fast one end of a large log to the outer pier and the other end to a point on the shore above by means of a cable, and filling in underneath the log with rocks and brush. To obtain the log was at first quite a problem, for the dam required one that our whole force could not move. We overcame this difficulty by going half a mile or so up the river and felling a large tree into the current. This as it lay in the river, we sawed into the requisite length, and then, with a good deal of labor and no little excitement and danger, towed down through the intervening rapids to the wheel. This dam increased the force of the water against the paddles very materially To gain still more power, we cleared out the channel below the wheel by exploding giant-powder in the obstructing rocks.

Everything being again ready, the wheel was once more lowered A more vigorous start, a somewhat longer revolution, another groan, and another entire stoppage was the result. Not a drop of water was raised up to the flume.

We were, however, very near the fulfillment of our hopes. We now had a bucket at every paddle, making sixteen in all. The wheel was required, therefore, to raise 16 buckets: 16 times 4½ gallons, or 72 gallons (720 pounds) at every revolution. There was evidently not power enough for that amount of work. So, to obviate this difficulty, we knocked off every other bucket, leaving eight only. The next time the wheel was lowered it creaked and groaned as the buckets filled, but revolved entirely around, and continued to do so without interruption, with a motion that seemed to our gratified eyes really majestic. Our watches showed that it made three revolutions a minute, raising 108 gallons in that time, or 6,480 gallons an hour. The problem of obtaining hatching-water was solved, and our minds were relieved of a great suspense and anxiety. The working of the wheel was from this time to the end a perfect success. The river was fed by the steadily-melting snows of Mount Shasta, so that it never fell, and, as no rains occur at that season in California, it never rose. The wheel revolved regularly, without interruption or change, until the eggs were matured and sent to their destinations.

The work that this simple contrivance accomplished really seems surprising. It raised 1,080 pounds 10 feet, or 10,800 foot-pounds every minute. This was 648,000 foot-pounds an hour, or 15,552,000 every day.

Our water-supply was now guaranteed, and the rest of the hatching-preparations were comparatively simple.

The flume.—They consisted of a flume from the wheel to the filtering-apparatus, the filtering-apparatus, and the hatching-troughs. The flume was a simple structure of wood, about fifty yards long, supported by trestle-work.

The filtering-boxes.—The filtering-boxes were made unusually large. This was rendered necessary by the spawning of the salmon in the river. In building and covering up their nests, they filled the water with particles of earth and vegetable growth, which, at that season, it required a great deal of filtering to keep out. I used three filtering-boxes, one large one, which first received the water, and two smaller ones, which received the water from the larger one. The larger box contained one screen of two thicknesses of mosquito-bar, and four screens of flannel, each measuring 3½ by 3 feet, yielding, in all, 63 square feet of filtering-surface. The smaller boxes contained one screen of three thicknesses of mosquito-bar, and seven flannel screens, having each about 2 square feet of filtering-surface.

The water of the McCloud River.—The water of the McCloud at the spawning-season is peculiar. It is not roily in the common sense of the word, or in the least approaching to being muddy; but the impurities in it, which have been stirred up from the bottom of the river by the working of the parent fish while spawning, can be distinctly seen, mechanically held in the water, which, with the exception of the presence of these foreign particles, seems very clear and pure. It has at this season more the appearance of water in which fine sand has been stirred up than what is generally considered turbid or roily water.

The distributing-spout.—The filtering-tanks conveyed the water into the distributing-spout, and the distributing-spout discharged it into the hatching-troughs.

The hatching-troughs.—The hatching-troughs were placed parallel with each other, and at right angles with the distributing-spout, as is the usual custom in hatching-houses. There were ten rows of troughs placed in pairs, with a passage-way between each pair, and in each row were three troughs, each sixteen feet long, placed end to end, one below the other, so as to give a fall from the first to the second, and from the second to the third, of a few inches. The troughs were on an average about breast-high, and were furnished with covers made by stretching white cotton cloth on a light frame of wood. Most of the eggs rested on the charcoal bottom of the troughs; but I used trays to a considerable extent formed of iron-wire netting, coated with asphaltum, and found them satisfactory for maturing eggs in for shipment, though I do not think fish hatched in the asphaltum troughs are as healthy as those hatched in charcoal troughs.

Seth Green's shad-box.—I also used, by way of experiment and with Seth Green's permission, half a dozen of his shad-hatching boxes, anchoring them in the river-current. They worked so well that I have no doubt that, in a river of a warm-winter temperature like that of the Sacramento, salmon-eggs could be hatched in them with perfectly satisfactory results, which adds another merit to this very simple but wonderfully effective invention. The only difficulty which we experienced with the boxes was the inconvenience of getting at them to pick out the dead eggs. On account of this inconvenience, I would prefer the stationary hatching-troughs if I had my choice, but should feel perfectly confident of hatching successfully any number of salmon-eggs with nothing but the shad-boxes.

The tent.—The whole hatching apparatus (excluding, of course, the flume and wheel) was covered in as before mentioned by a large and substantial tent 60 feet by 30 feet. The hatching-house, or, more properly speaking, hatching-tent, contained our work-bench and tools, and was the place where all the mechanical work was done.

6.—HATCHING THE EGGS.

Considering that the eggs were matured under so many entirely new conditions, and where eastern experience in hatching salmon-eggs furnished in many points no precedent for a guide, I think the hatching succeeded remarkably well.

There were losses, however, the causes of which may be classed chiefly under six heads:

1. Loss by suffocation.
2. Loss from direct rays of the sun.
3. Loss from diffused light of the sun.
4. Loss from inherent causes.
5. Loss from excessive agitation.
6. Loss from want of impregnation.

Death of eggs by suffocation.—The loss that resulted from this cause was very trifling. At the lower end of one of the lower troughs containing some of the most advanced eggs, one of the division-cleats separating the compartments had been made so high as to impede the circulation of the water just above it, in consequence of which some of the eggs in the water had an insufficient supply of air, and were suffocated. I may add here that I have noticed that a vast amount more of circulation in the hatching-water is demanded by trout and salmon eggs at a late period of their development than at the earlier stages. When these eggs are first taken, they can be literally piled together in heaps, in water having a very slight movement, without danger; but after the embryo has shown itself distinctly in the egg, great caution must be exercised in regard to crowding them or placing one tier above another, and an abundant circulation must be provided to prevent suffocation. In the case in question, the eggs were two tiers deep; the circulation about the eggs of the lower tier was insufficient, and loss ensued. The mischief, however, was almost immediately discovered, and the causes removed, so that the loss did not exceed 900 eggs.

Loss from direct rays of the sun.—The lower end of the hatching-troughs extended almost to the eastern end of the tent, so that the morning sun, unless the canvas covering of that end of the tent was carefully kept down, shone directly into the open end of the hatching-troughs. As the tent was made a thoroughfare by the Indians, and by our own household also, there was constant passing through it, and the folds of the canvas were sometimes left carelessly raised at night, so as to expose the eggs of the lowest compartments of the troughs to the direct rays of the early morning sun. The consequence, of course, was the loss of all the eggs so exposed. This accident happened with what might have justly been called an unpardonable frequency had we not all of us had our hands too full otherwise to look after this source of mischief. The mortality from this cause during the whole season, including both before and after we discovered the cause, amounted to perhaps 30,000 eggs.

Loss from the diffused light of the sun.—This was the main cause of mortality among the eggs this season; and it was all the more destructive because I was not aware before then that sunlight distributed and diffused through a barrier of canvas was fatal to the life of the eggs. This proved to be the fact, however. The fact was even worse than this; for the light, after passing through the canvas covering of the tent, and also through the cloth covering of the troughs, destroyed the eggs. This was so unexpected, and, I think, so unprecedented, that we were a long time discovering the cause of the trouble. Some simple experiments, however, revealed the fact that the diffused light of the tent was killing the eggs. The obvious remedy, of course, was covers. To provide board covers was out of the question; for it would take a week, certainly, and perhaps two weeks, to get the lumber; so I sent to the nearest town for some cotton cloth, and made covers from it by stretching the cloth on tight wooden frames. These were placed on the troughs. The sunlight had now the tent-canvas and the cloth covers to pass through, and I felt safe. But they were insufficient, and the cause being of so extended a nature, and being accompanied by consequences of a correspondingly extensive character, a great many eggs were lost. Even in the few troughs to which we could afford board covers, the diffused light through the cracks, reflected from the inner surface of the sides of the troughs, destroyed a considerable number of eggs.

It should not be inferred from this that the total number of eggs obtained in the end was reduced any by these losses. The effect of the losses was not to diminish the total number of eggs, but simply to make us more work; for the fact was that salmon-eggs were so abundant that any loss could be replaced at once, and was actually so replaced as fast as the loss occurred. By referring to the daily table of eggs taken, it will be seen how easily this was done. For instance, from the 10th day of September to the 13th, inclusive, we took 465,000, which was more than enough to cover all losses to the impregnated eggs from all causes combined.

Loss from inherent causes.—I include under this head losses that occurred with eggs that were already injured when they left the fish, and which could not live under any circumstances, as, for instance, eggs taken from dead fish, (chiefly by way of experiment,) and eggs already dead when in the fish. This loss—if to be deprived of anything which never had any value in the beginning may be considered a loss—may be set at 30,000.

Loss from excessive agitation.—This loss occurred, of course, in the earlier stages of the embryo; agitation, though very fatal at first, being harmless in the later stages of the eggs' development. The agitation was caused (*a*) by the action of the supply-stream on eggs placed too near the point where the stream falls into the hatching-troughs; (*b*) by carelessness of our Indian assistants in feathering the eggs when picking them over; (*c*) by the action of the river-current on the eggs which were placed in Seth Green's shad-hatching boxes.

The first two causes need no comment. In regard to the third, I will say that in experimenting with the shad-hatching boxes, we placed some of them at first in too active a current, which gave the eggs so much agitation that they became addled, and died. After a little experience, we learned what force of current they needed, and subsequently had capital success with them.

Mr. Woodbury informed me that after my departure he succeeded in finding just what degree of movement in the water was required for the salmon-eggs, so that his later experiments were attended with as good success as we met with in the hatching-troughs.

The losses from all causes of agitation combined I estimated at 100,000.

Loss from want of impregnation.—The mortality from other causes was not distinguishable from that resulting from want of impregnation, so that it is impossible to ascertain what the loss from this cause was this season. I should say, however, that the unimpregnated eggs numbered less than 100,000, or 5 per cent. of the whole. This would place the percentage of impregnated eggs at 95 per cent. I may add here that on account of the abundance of salmon-eggs on the one hand, and the scarcity of time on the other, it was often more of an object to save time than to get a very high rate of impregnation. For instance, supposing that, in taking 100,000 eggs, an hour should be consumed in taking pains to save 2 per cent. in the impregnation, the gain would be 2,000 eggs. The same amount of time spent in catching additional salmon and spawning them rapidly would have yielded, say 6 female salmon, or 30,000 eggs, of which 28,000 would be impregnated. This, it will be seen, is fourteen times the number gained in the same time by careful impregnation, which shows that the time spent in getting eggs is better rewarded than that consumed in laboring to obtain high percentages of impregnation.

To resume now the chronological order of events, I will repeat that by the 19th of August we turned the water through the hatching-house, and had the pleasure of seeing what I had long looked forward to, a successful hatching-apparatus in perfect working-order in the salmon-breeding regions of the Pacific slope. There seemed to be something in the very sound of the rippling and plashing water to exhilarate our spirits as it leaped through the troughs for the first time. I celebrated the day by collecting our whole force of whites and Indians at sunset and raising a large American flag over the camp.

We continued to catch more salmon and to build more corrals for them, and to extend the preparations for hatching the eggs. The female salmon now began to show every sign of being nearly ready to spawn, and we were daily expecting to find some ripe eggs. We remained, however, in this not unpleasant state of excitement and anticipation until the 26th of August, when we took the first ripe salmon-eggs of the season, numbering 23,000.

Now came a new and unexpected drawback. The salmon, confined in the corrals, had been literally wearing themselves out in their frantic endeavors to ascend the river. Every moment, day and night, impelled by their irrepressible instinct, they kept jumping and lashing themselves against the sides of the inclosures, and now, comparatively exhausted by their efforts and bruises, they were beginning to die from the effect of them. Fortunately, there were enough more in the river to get eggs from, for had we depended on our stock on hand when the first eggs were taken we should have obtained a very meager supply. As it was, I kept on fishing and replacing the dead salmon with live ones, so that we had no lack of eggs, and obtained in the end the full two millions, at which number I had set my limit.

Nothing further occurred to interrupt our steady progress. We continued to take eggs every twenty-four hours, both night and day, and the number in the troughs increased rapidly.

On the 10th of September, at noon, we had a million eggs laid down; on the 14th of September, at daylight, we had a million and a half; and on the 22d, at daylight, the quota of two millions was complete. On the 12th of September, the first eye-spots were visible in the eggs taken on the 26th of August, making sixteen days for the interval between the extrusion of the eggs and the appearance of the eye-spots, (the formation of the choroid pigment.) The water in the river had a temperature of 53° at sunrise when the first eggs were taken; but it always rose in the hatching-troughs during the day, sometimes to 58°, and sometimes as high as

64°, so that the exact average temperature of the water for the whole time cannot be stated.

On the 20th of September, I sent 300,000 eggs to the Atlantic coast; and on the 30th of September, I went east myself with 600,000 more, leaving the camp in charge of Mr. Woodbury.

On the 6th of October, Mr. Myron Green left camp with a third lot of a quarter of a million; and about a week later, Mr. Woodbury forwarded by express the balance of the eggs, amounting to another quarter of a million, or more.

7.—PACKING AND SHIPPING THE EGGS.

The taking of the eggs and the maturing of them for shipment was a marked success. Indeed, I have never seen a finer lot of salmon-eggs than we had in the hatching-troughs under the mammoth tent at the McCloud. Nothing could be wished for more happy and prosperous than our progress up to the point of shipping the eggs; but here came a formidable and threatening difficulty.

Between our camp and the waters which were awaiting the eggs, there lay a long stretch of three thousand miles of land, which must be crossed by the young embryos before they could be made available for the service for which they were intended. It was enough to make the most confident enthusiast falter.

We all looked forward to this dangerous journey of the eggs with dread. When we packed them in the moss, and screwed down the covers, it seemed like burying them alive; and when we saw the crates containing them loaded into the wagons, and sent off to the railroad-station, and thought of the almost interminable journey before them, and the ten thousand chances of injury that these frail creatures would be exposed to on the way, it seemed nothing less than infatuation to expect that they would survive them all and ever see the light again alive.

They must go, however, and we packed them as well as we could, and sent them off. The boxes in which they were packed were all two feet square and a foot deep. The eggs were packed as usual, with first a layer of moss at the bottom of the box, and then a layer of eggs, then another layer of moss, and so on to the top. Midway in the interior of each box, there was a thin wooden partition, to break the force of the superincumbent mass of moss and eggs. We packed about 75,000 in a box. When the box was filled, the cover was screwed down, and it was packed with another one of the same size in a crate, which was three inches and a half larger on all sides than the combined bulk of the two boxes inclosed; this intervening space being filled with hay to protect the eggs from sudden changes of temperature. On the top of the crates was a rack for ice. The nearest and only suitable moss that we could hear of was seventy miles away, at the sources of the Sacramento River. I accordingly dispatched Mr. Woodbury to Mount Shasta to procure a supply. He returned in a few days with thirty-five bushels of moss, all of which we used in packing.

The manner of the packing has been a matter of considerable criticism. On this point, I will only say that I had but one precedent to be guided by, viz, the shipment of salmon-eggs from the same place the last year. It was reported concerning this consignment that the eggs which did not hatch on the way arrived in excellent order. In a critical and difficult undertaking like this in question, there seemed to be no choice between adopting a method which had succeeded and others which had never been tried, so I adhered to the plan of the last year's shipment, and packed these eggs in precisely the same way.

8.—THE METHOD OF PACKING DISCUSSED.

To give the *pros* and *cons* of this method of packing would lead to a long discussion, which would, perhaps, be out of place here; so I will simply say that the packing was no hap-hazard affair, but the result of careful thought, and the exercise of as much foresight in regard to the journey as we could bring to bear upon the subject; and even now, after plenty of leisure for reflection, I do not know of any other practicable method of packing salmon-eggs which are to be sent this overland journey, without an attendant, which secures as many favorable combinations, or which is not open to quite as many objections, as the one adopted. Indeed, I think the results were a decided vindication of the merits of the packing. The first lot, forwarded in September, was undoubtedly destroyed by the heat; the second lot arrived in as good order as could be expected; the third lot was reported to arrive in excellent condition; and the fourth and last lot came the best of all. Of those sent to Great Salt Lake, distant a thousand miles, only 3 per cent. were lost. What more could be asked of the packing? A method that will carry salmon-eggs a thousand miles with a loss of only 3 per cent. cannot be a very bad one. Seth Green reports a loss on the 200,000 eggs consigned to him of only 11 per cent. both in transportation and in hatching. This certainly does not seem to reflect any discredit on the packing of the eggs; and when we remember that they came from a climate where the mercury stood at 110° in the shade, and that they were conveyed twenty-two miles in a wagon, to begin with, over a very rough mountain-road, and after that three thousand miles by rail, I think it is rather creditable to the packing than otherwise. I am open to conviction, however; and if there is any better way of packing the salmon-eggs for their overland journey, I should like to know it, and should be thankful for any light on the subject.

9.—COST OF THE EGGS.

The cost of getting the ova and preparing them for transportation was about $4,000. There were very nearly 1,500,000 impregnated eggs in good condition for shipment. This makes the cost of the eggs at the hatching-works $2.66 a thousand. I think in future, with the experience that has been acquired and with the work that has already been accomplished, that it is highly probable that the eggs can be got out at a still less expense; and I should not be surprised, in the event of the undertaking being repeated on the McCloud River another year, if 5,000,000 eggs could be secured at a cost of $5,000, gold, or at the rate of $1 a thousand.

10.—JOURNAL OF OVERLAND TRIP WITH SALMON-EGGS.

Below will be found an account of an overland trip with one lot of California-salmon eggs:

At 4 o'clock on Tuesday afternoon, September 30, 1873, all the eggs for one shipment, to the number of 600,000, having been packed in three large crates, we began moving them to the wagon which was to carry them to the railroad-station at Redding, Cal. The crates containing the eggs averaged in weight about 300 pounds apiece, and it was a difficult job, in the burning sun, to get them up the long, steep hill to the stage-road where the wagon was waiting. With the help of half a dozen Indians, it was accomplished at last, however, and at about 5 o'clock I started for Redding, distant twenty-two miles. So rough and difficult is the road that we did not reach our destination till 1 o'clock in the morning. I had previously arranged to have 200 pounds of ice provided at Redding, which I distributed on the crates.

The eggs were consigned as follows: To Seth Green, Rochester, N. Y., 3 boxes, 200,000; R. G. Pike, Middletown, Conn., 2 boxes, 150,000; F. W. Webber, Cold Spring trout-ponds, Charlestown, N. H., 1 box, 50,000; E. A. Brackett, Winchester, Mass., 1 box, 50,000; C. G. Atkins, Bucksport, Me., 1 box, 50,000.

The train left Redding at 3 o'clock a. m., on Wednesday, October 1, for Sacramento City, which I reached safely at 1 p. m., the crates apparently in good order. I left Sacramento on the Central Pacific Railroad on the train going east at 2 p. m. the same day; the eggs being in Wells & Fargo's express-car. The morning was warm; the night had been quite cool. The next morning, Thursday, October 2, I telegraphed for ice at Carlin, which was furnished when the train reached that point, and which I broke up and put on the crates.

On Friday morning, October 3, at 7 a. m., we reached Ogden, and the crates were transferred to the express-car of the Union Pacific Railroad train, which connects here with the Central Pacific Railroad. During the afternoon of Friday I opened one of the crates, and examined the top layer of eggs. They were in perfect order, and looked precisely as well as when they were first packed. I put on more ice and left them till morning. On Saturday morning, October 4, I got up early, and went to the express-car to examine the crates. The night had been cool, but the express-messenger had kept a hot coal-fire in the car and it was very hot. I procured a lot of ice at Cheyenne, Wyo., which I used at once, and telegraphed ahead to Laramie for more. The day was comfortably warm. No mishaps occurred except the heating-up of the car the night before.

On Sunday, October 5, at 1 p. m., we reached Omaha, crossed the Missouri River, and left Council Bluffs at 3 p. m., on the Chicago, Burlington and Quincy Railroad. That night was quite cool.

On Monday, October 6, at 3 p. m., we reached Chicago. The last night was cold and favorable for the eggs. Left Chicago on the Michigan Central at 5.15 p. m., with the eggs apparently in good order. Up to this time I had kept constantly replenishing the crates with ice.

On Tuesday morning, October 7, at 4 o'clock, we entered Canada on the Great Western Railroad, and the Union Pacific express-car, which still accompanied the train, was sealed up by the custom-house officers, so that I could not enter it till we left Suspension Bridge that afternoon at 2 o'clock. The crates had been well provided with ice, however, the night was frosty, and the day was cool, so I did not feel uneasy about the eggs. The car which contained them had a large amount of gold and silver coin and bullion in it, and the messengers had instructions to keep every one out of the car. Their instructions are so imperative in this particular that they will not even listen to any explanations. I had fortunately provided myself with a letter from Mr. Tracy, of Sacramento, one of the head managers of Wells & Fargo's express, and by means of it managed to get aboard the express-car and attend to the crates. Without the letter, there would have been no chance whatever of getting at the eggs. Even with such a letter a man insisting on entering the car runs a risk of being injured by the messenger's revolver. We arrived at Rochester about 5 p. m., Tuesday, October 7. Here I left the three boxes (a crate and a half) for Seth Green.

Tuesday night, at 2 a. m., the train reached Albany with the crates in good order. I went to bed supposing that the express-car would go on with the train to Boston, but in point of fact it is the custom to leave it at Albany.

On Wednesday morning, October 8, at about 8 o'clock, the train arrived at Boston. To my great surprise and dismay I could not find the salmon-eggs for Mr. Atkins and Mr. Brackett, and now learned for the first time that they had been left with the car at Albany. I was the more chagrined at this because I had been so very careful to keep with them. I might almost say I had hardly let them go out of my sight, and now at the end of this long and exceedingly anxious journey, just as I thought my care had been rewarded with success and was at an end, there came this disappointment and new anxiety. I could not get track of these eggs again or learn for some time what delayed them; and it was three days before Mr. Brackett got his and four days before Mr. Atkins received his. It was very provoking, when time was so precious, to reflect that the eggs were one-half as long going from Albany to Winchester, two hundred miles, as from our camp to Albany, three thousand two hundred miles. As the weather was very warm during these intervening days, it is surprising that the eggs were not entirely lost. Mr. Brackett, however, saved one-half of his, and Mr. Atkins one-tenth of his consignment. The eggs for Mr. Pike and for the Cold Spring trout-ponds were put off at Springfield, Mass. The latter arrived in good condition, but there was a large loss in the former lot. I learned subsequently from Seth Geen that his lot of 200,000 arrived in excellent order, and that only 11 per cent. of the eggs were lost, both in transportation and in hatching.

11.—DISTRIBUTION OF SALMON-EGGS.

The following table shows how the eggs were shipped and distributed.

First lot was shipped September 20, 1873	300,000
Second lot was shipped September 30, 1873	500,000
Third lot was shipped October 7, 1873	330,000
Fourth lot was shipped October 14, 1873	250,000
Fifth lot was shipped October 19, 1873	20,000
	1,400,000

The various shipments were distributed as follows:

First shipment, September 20, 1873:		
To J. H. Slack, Bloomsbury, N. J	150,000	
To James Duffy, Marietta, Pa	150,000	
Total		300,000
Second shipment, September 30, 1873:		
To Seth Green, Rochester, N. Y	200,000	
To R. G. Pike, Middletown, Conn	150,000	
To F. W. Webber, for United States Fishing-Commission, Cold Spring trout-ponds, Charlestown, N. H	50,000	
To E. A. Brackett, Winchester, Mass	50,000	
To Charles J. Atkins, Bucksport, Me	50,000	
Total		500,000
Third shipment, October 7, 1873:		
To A. P. Rockwood, Salt Lake City, Utah	40,000	
To George H. Jerome, Niles, Mich	120,000	
To James Duffy, Marietta, Pa	20,000	
To J. H. Slack, Bloomsbury, N. J	150,000	
Total		330,000
Fourth shipment, October 14, 1873:		
To J. H. Slack, Bloomsbury, N. J		250,000
Fifth shipment:		
To Dr. W. A. Newell, San Francisco, Cal		20,000
Total		1,400,000

F—CATALOGUE OF COLLECTIONS SENT TO THE SMITHSONIAN INSTITUTION IN 1873.

190. First male salmon taken; caught with a hook; weight, 8 pounds; girth, 14 inches; McCloud River, California, July 27, 1873.
191. Male salmon; weight, 5 pounds; girth, 13 inches; McCloud River, July 27, 1873.
192. Salmon caught in seine; weight, 22 pounds; girth, 22 inches; female; July 28, 1873.
193.
194.
195. Six small trout, McCloud River, California, August 6, 1873.
196. Two heads of small male salmon, McCloud River, August 6, 1873.
197. Female salmon; weight, 21 pounds; girth, 21 inches; caught with seine and kept some time in pen; fins and tail partly destroyed by fungus and abrasion; McCloud River, California, August 6, 1873.
198. Trout, McCloud River, August 8, 1873.
199.
200. Trout, McCloud River, August 8, 1873.
201. Jar of trout, McCloud River, August 7, 1873.
202. Four small trout, McCloud River, August 7, 1873.
203. Skin and head of female salmon; weight, 10 pounds; full of spawn, not separated, but nearly ripe; meat, dark salmon-color; skin now quite dark, slimy, and scales nearly absorbed; August 8, 1873.
204. Female salmon; weight, 12 pounds; girth, 17 inches; August 13, 1873; McCloud River.
205. Male salmon; weight, 4 pounds; girth, 11 inches; McCloud River, California, August 13, 1873.
206. Female salmon; very slimy and dark; weight, 19 pounds; girth, 20½ inches; length, 33½; spawn weighed 2¼ pounds and was nearly ripe; August 14, McCloud River, California, 1873.
207. Pyloric appendages and roe of 206.
208. Male salmon; weight, 6 pounds; girth, 13 inches; August 3, 1873, McCloud River, California.
209. Male salmon; weight, 5 pounds; girth, 12½ inches; McCloud River, California, July 29, 1873.
210. Female salmon; weight, 21 pounds; girth, 21 inches; McCloud River, California, August 6, 1873.
211. Male salmon; weight, 24 pounds; girth, 21 inches; McCloud River, California, July 30, 1873.
212. Female salmon; weight, 20 pounds; girth, 18 inches; McCloud River, California, July 25, 1873.
213.

277. Female salmon; weight, 10 pounds; girth, 19½ inches; full of eggs nearly ripe; McCloud River, California, August 15, 1873; very slimy, but not in bad condition.
278. Female salmon; weight, 8 pounds; girth, 14 inches; McCloud River, California, August 15, 1873; full of eggs nearly ripe.
279. Grilse; McCloud River, California, August 15, 1873.
280. Large male salmon; milt ripe and good; weight, 26 pounds; girth, 23 inches; McCloud River, California, August 17, 1873; in good condition, but dark and slimy; first ripe male taken.
281. Pyloric appendages of 280, (in jar.)
282. Trout, (see drawing;) probably an aged individual; fins and tail worn considerably; thin and slab-sided; weight, 4 pounds; girth, 11 inches; caught with a hook; McCloud River, California, August 18, 1873.
283. Lizard, (local name "salamander";) McCloud River, California, August 18, 1873.
284. Stomach of No. 282.
285. Male salmon, (see drawing;) weight, 28 pounds; girth, 23 inches; scales all absorbed; one of the largest caught this season; McCloud River, California, August 20, 1873.
286.
287.
288. Trout, Utah Lake.
289. Snub-nosed trout, San Andres Lake; spawning-season.
290. Fish from Utah Lake.
291. Fish from Utah Lake.
292. Trout from Utah Lake.
293. Trout from Utah Lake.
294. Fish from Utah Lake.
295. Trout from Utah Lake.
296. Trout from Utah Lake.
297. Trout from McCloud River, July, 1873.
298. Salmon-skin, McCloud River, August, 1873.
299. Trout, McCloud River, August, 1873.
300. Trout, McCloud River, August, 1873.
301. Split-tail, (herring,) same as Sacramento split-tail, McCloud River, August 23, 1873.
302. Grilse, McCloud, August 26, 1873.
303. Grilse, McCloud, August 26, 1873.
304. Male salmon; weight, 28 pounds; girth, 22 inches; McCloud River, September 1, 1873.
305. Male salmon; weight, 20 pounds; girth, 21 inches; McCloud River, September 2, 1873.
306. Jar of young trout and salmon, McCloud River, September 2, 1873.
307. Trout, McCloud River, California, September 3, 1873.
308. Trout, September 3, 1873, McCloud River.

309. Trout, McCloud River, California, September 3, 1873.
310. Head of male salmon, McCloud River, California.
311. Very small grilse, McCloud River, September 9, 1873.
312. Female-salmon skin after spawning, September 9, 1873.
313. Very large male salmon; weight, 29 pounds; girth, 22 inches; length, 3 feet 5 inches; McCloud River, California, September 14, 1873.
314. The smallest grilse caught this season, thin and worn, but full of milt and very ripe, McCloud River, California.
315. Smallest female caught this season; weight, after spawning, 6 pounds; girth, 12½ inches; contained about 2,500 eggs; McCloud River, California, September 17, 1873.
316. Salmon-trout, McCloud River, September 19, 1873.
317. Trout, McCloud River, California, September 19, 1873.
318. Trout, McCloud River, California, September 19, 1873.
319. Trout, McCloud River, California, September 21, 1873.
320. Trout-skin, McCloud River, California, September 22, 1873
321. Trout-skin, McCloud River, California, September 22, 1873.
322. Skin of female salmon; weight, 13 pounds; girth, 17 inches; McCloud River, California, September 26, 1873.
323. Skin of female salmon; weight, 13 pounds; girth, 17 inches; McCloud River, California, September 20, 1873.
324. Coarse tule matting, Clear Lake Indians, Lake County, California, February, 1873.
325. Fine tule matting, Clear Lake Indians, Lake County, California, February, 1873.
326. Material from which Indian baskets are made, Clear Lake, Lake County, California, February 10, 1873.
327. Trout, McCloud River, California, September, 1873.
328. Trout, McCloud River, California, September, 1873.
329. Trout, McCloud River, California, August, 1873.
330. Trout, McCloud River, California, August, 1873.
331. Trout, McCloud River, California, August, 1873.
332. Trout, McCloud River, California, August, 1873.
333. Trout-spawn, McCloud River, California, September, 1873.
334. Jar containing 56 small trout (or salmon) and three packages of pyloric appendages, McCloud River, California, August and September, 1873.
335. Jar containing small trout (or salmon) McCloud River, California, August and September, 1873.
336. Lizards, (local name "salamander,") McCloud River, California, August, 1873.
337. Unknown quadruped, McCloud River, California, August, 1873.
338. Bottle of exceptionally large salmon-eggs, McCloud River, California, September, 1873.
339. Jar containing three California lizards, also large salmon-eggs, McCloud River, California, September, 1873.

340. Sacramento salmon, artificially hatched at Cold Spring trout-ponds, Charlestown, N. H., December, 1873.
341. Hat (or basket) of McCloud Indians, McCloud River, California, September, 1873. (See 326.)
342. Spear-points, made of ankle-bone of deer, used by McCloud Indians for spearing salmon, October, 1873, McCloud River, Shasta County, California.
343. Indian girdle, badge of honor, McCloud Indians, McCloud River, California, September, 1873.
344. Indian rope, made from plant which grows on Little Sacramento River, McCloud Indians, California, September, 1873.
345. Hat, (or basket,) McCloud Indians, McCloud River, California, September, 1873. (See 326.)
346. Manzanita-berries, and flour made from berries by McCloud Indians, McCloud River, California, September, 1873.
347. Soaproot, used by McCloud River Indians for soap, and to make brushes, McCloud River, California, 1873.
348. Omitted.
349. Insect supposed to make noise at night, McCloud River, California, September 10, 1873. (Contributed by B. B. Redding.)
350. Moth from Summit station, Central Pacific Railroad, Sierra Nevada, California, December 22, 1873. (Contributed by B. B. Redding.)
351. Plume of the McCloud Indians, McCloud River, California, September, 1873.
352. Plume of McCloud Indians, McCloud River, California, September, 1873.
353. Plume worn by Indian Dick, who murdered Mr. Crooks, a white settler on the McCloud River, California, September 24, 1873.
354. Water-ouzel's nest, headwaters of Little Sacramento River, Siskiyou County, California, September, 1873.

G—A LIST OF M'CLOUD INDIAN WORDS SUPPLEMENTARY TO A LIST CONTAINED IN THE REPORT OF 1872.

BY LIVINGSTON STONE.

All-ale, Up, world of good spirits.
Ar-kal, Gone, used up.
Ar-nouka, I don't care to.
Attle-nas, Tattooing.
Bar-widder, Come and eat.
Barla, Irony, a joke (or) a falsehood.
-beeda, To be in want of.
Bew-wy, To be the matter with.
-bim, (an intensifier,) Very.
Boolock too mah, Not big enough.
Chaw-awl, Cooked, done.
Chee-oomay, To bury.
Che-hammis, Ax.
Chil-chilch, Bird,
Chilluk, Provoked.
Chinny, To take.
Chin-ou-le barda, I'll take it by and by.
Chippewinnem, Midnight.
Chocky, Near by.
Choo-hay, To gamble.
Chorck, Wooden.
Chuna, Dance.
Clarbooruck, Quartz.
Col, Lips.
Colcha, Pleasant weather.
Cou-yarda, It hurts me.
Dar-khal, Burned.
Darnal, Get out!
-de, (a pronoun referring to the speaker.)
Dee-ee, Yes, (very emphatic.)
Dōkhy, Chin.
Doompcha, To bathe.
Ello-de-hestarmin, Nothing is the matter with me.
Elponna, Come in.
E-wear, I don't know how.
Furbiss, New.
Hareimar, To carry away.
Harliss-penarda, I don't want to go.
Harpa, Father.
Harrardar, Good-by.
Hebarky, I guess so.
Hestarm, What's the matter?
He-wy-hy, More.
Hissarm, How much.
Hissart, How many.
Hornda, A long time; (also,) always.
Hoo-roo-chook, Needle.
Kaiser, Quick.
Kar, Cloudy.
Kar-har, A great wind.
Khark, Insane, crazy.
Kī-ra-ma, Finished.
Kellar, Straight.
Ken, Down.
Kent-parna, To rise up.
Kette-wintoon, Twenty; (*i. e.*, one Indian, all his fingers and toes.)
Khal-lokh, Plume.
Khee-yay, Uncle.
Khlark, Rattlesnake.
Klarmet, To give.
Klaw-ma, To kill.
Kleetich-liss-penarda, I don't want to work.
Koorcha, Pig.
Khlesh, Soul, spirit.
Kwee-yer, Sick.
Lén-darda, Long time ago.

Leepida, (used only with *mame; mame leepida*, I am thirsty.)
Lor-e-ke, Over that way.
Ma-art, Ear.
Man, Any one, (like the German.)
Markh-us, Leg.
Mī-ce, Foot.
-minner, Cannot.
Mooty, To understand.
Neechī, Nephew.
Nick-el, Skin.
Niss, Me, (objective case of *nett.*)
Now-owse, Cloth.
Nun-narma, True.
Oh-my, Enough.
Oo-koo, Yonder.
Oosa, Almost.
Oose-lénda, Day before yesterday.
Oose-poppil, Last year.
Oo-yool, Grapes.
Pahn-ce-tus, Handkerchief.
Park, Body.
Pee-ccha, To make.
Pī-ce, Manzanita.
Poilarn, Little while ago.
Pom missima, Winter.
Pom-kenta, Down, world of bad spirits.
Pooly, There.
Poo-re-war, Dark.
Poo-tar, Grandmother.
Poppil, Year.
Po-Po-oppil, This year.
Poppum-Po-poppil, Next year.
Sawny-winnem, Noon.
See-ee, Teeth.
See-okoos, To brush.
See-wy, Writing, letters, &c.
Shonn, Stone.
Shono, Nose.
Shoohoo, Dog.
Shookoo, Horse.
Soo-harna, Will you please?
Sukey, To stand.
Tabar, Gambling-stick.
Tar-kee, Hat.
Tay-ruch, Tanned buckskin.
Tee-chellis, Squirrel.
Tilteeta, To go visiting.
-tole, In, (or) on, (or) among; *e. g.*, *meetole*, in a tree.
Toon-makh, Bosom.
Toon-oo, Back.
Too-too, Mother.
Tu-lich, To swim.
Wawtcha, To cry.
Way-ee-worry, Come again.
Weh! Come here!
Werry-werry, Hurry up!
Wilner, To get up, (from bed.)
Win! Look!
Winne-harra, To go in search of.
Winnem, Middle.
Winne-squeea, I want to see.
Wittelly, Quickly.
Wohar, Cow.
Woor-ous, Fish-spawn.
Ya-mutta, Trail.
Yar-loo, Quit!
Yaw-lar, Snow.
Yay-lo-cou-da, Move away!
Yet-u-nas, Name.
Yilkh-mar, Heavy.
Yolie, Now.
Yolie-poppum, Pretty soon.
Yorkos, Gold.

XXI.—HATCHING AND DISTRIBUTION OF CALIFORNIA SALMON.

A—REPORT ON CALIFORNIA SALMON SPAWN HATCHED AND DISTRIBUTED.

BY J. H. SLACK, M. D.

SIR: The first consignment of spawn from California arrived on the evening of September 30, 1873. The weather for the previous few days had been warm, the thermometer ranging from 70° to 75° at noon. The spawn was contained in two packing-boxes inclosed in an open crate, the spaces between the boxes and crate being filled with hay. This hay was rotten, and the boxes exhaled a peculiar and, alas, too well-known odor, showing that a portion at least of the spawn was not only dead, but decomposed. The boxes were at once removed to the hatching-house and opened. Temperature of the air, 62°; interior of upper box, 74°; lower box, 84°. The temperature of the water being 50°, it was feared that if at once unpacked, the sudden change would be fatal. Water was therefore warmed to 70° and allowed slowly to percolate through the boxes, the temperature being gently lowered. About twelve hours elapsed before the temperature of 50° was obtained. The work of unpacking then commenced. Many of the spawn were completely rotten; others had burst, and long vermiform masses of albumen had been ejected; these, I afterward ascertained, were regarded by some as maggots. From the entire mass of spawn, said to number 150,000, only about 25,000 were saved, and about three days labor of two persons was required for the unpacking. The living spawn were all taken from the upper layers of the upper box; the entire contents of the lower box appeared putrid. However, they were emptied into a pond, and from careful examination of the water a few weeks subsequently, a number of living fishes were found. The good eggs were placed upon grilles, and in less than a week all were hatched. The mortality among the young was very slight.

The second lot of spawn arrived October 15, at 8 p. m., accompanied by Mr. Myron Green. On inspection, they appeared much shrunken, but otherwise in good order. Temperature of interior of boxes, 54°, 56°; air, 52°. A gentle current of water at 50° was allowed to pass through the boxes for fourteen hours; at the end of which period the eggs were found to be plump and the embryos lively. Two days were employed in unpacking them, and for a few days all seemed well, the percentage of loss being very small. But, to my surprise, on entering the hatching-house on the morning of October 21, an immense number were found to be dead. Every precaution had been taken, the water-supply was perfect, and the troughs had been carefully and tightly covered, yet for some days the loss was immense. However, in a few days the mortality ceased, and but little trouble was afterward experienced. This lot of eggs was said to number 175,000, of which it is estimated 130,000 were hatched.

The last lot, said to number 250,000, arrived October 23. These were treated similarly to the previous invoice, with the exception that, fearing they might have suffered from rough handling at the hands of my assistants, every egg was unpacked by my own hands. The result was very satisfactory, about 200,000 spawn being safely hatched. It was noticed that though the lots No. 1 and No. 2 were all hatched within a few days after their arrival, lot No. 3 did not commence to hatch until about two weeks after their arrival.

The after-treatment of the young fishes presented no peculiar points of interest. The loss of young was very small, and confined almost exclusively to the crooked fishes. A full set of specimens illustrative of the growth of these fishes will accompany this report.

The method of packing the spawn was probably the best that could have been devised under the circumstances. I would, however, propose that in the next shipm nt the eggs be laid between folds of mosquito-netting. This would greatly facilitate the operation of unpacking, which with the simple moss is very tedious and severe.

The following table will show at a glance the details of reception and number of fishes hatched:

Date.	No. spawn sent.	No. fishes hatched.	Percentage saved.	Temperature on arrival.
September 30	150, 000	25, 000	16. 6	74° @ 82°
October 15	175, 000	130, 000	74. 2	54° @ 56°
October 23	250, 000	200, 000	80. 0	52° @ 54°
Total	575, 000	355, 000	61. 7	....

By January 1, 1874, it was found that the number far exceeded the estimate which I had previously made, and that though ample accommodations for the hatching of fishes had been prepared, that the nursery-troughs were entirely too small for the proper rearing of them. An addition of 20 feet was therefore made to my hatching-house, at a cost of about $100. As this was done exclusively for the accommodation of the California salmon, it is hoped that the Government will be willing to defray at least a portion of this expense.

The following table will show, at a glance, the number of fishes distributed, and the streams in which they were placed:

Date.	Number placed.	Stream.	Main river.	State.	Placed by—
1873.					
Dec. 2	10,000	Yellow Breeches..	Susquehanna .	Pennsylvania.	Pennsylvania commissioners.
8	10,000	Conecogeague.....	Potomac	....do	Self, per Downs.
23	10,000	Mahontongo	Susquehanna .	....do	Pennsylvania commissioners.
1874.					
Jan. 1	10,000	Musconetkong	Delaware	New Jersey...	Self.
3	12,000	Pattenburg Creek.	Raritan	....do	Do.
10	10,000	Pohatkong........	Delaware	....do	Do.
14	13,000	Musconetkong	....do	....do	Do.
16	30,000	Cedar Creek	Potomac	Virginia	Self, per Downs.
23	30,000	South Side Club..	....	New York	Self.
26	25,000	Musconetkong	Delaware	New Jersey...	Do.
27	20,000	Bald Eagle.........	Susquehanna .	Pennsylvania .	Pennsylvania commissioners.
30	10,000	....	....do	....do	Do.
Feb. 6	30,000	Musconetkong	Delaware	New Jersey...	Self.
7	35,000	Pattenburg Creek	Raritan	....do	Do.
14	50,000	Musconetkong	Delaware	....do	Do.
16	50,000	Pond	....	....	On hand.
	355,000				

Recapitulation.

Given to Pennsylvania commissioners	50,000
Placed in tributaries of Potomac	40,000
Placed in Long Island streams	30,000
Placed in tributaries of Raritan	47,000
Placed in tributaries of Delaware	138,000
Still on hand in ponds	50,000
	355,000

In choosing locations for planting fishes the greatest care was exercised. Streams were selected as near as possible the spring-heads, and containing no other fishes. Most of these small streams having no names, the name of the nearest named stream is given in the table. The small streams selected were admirably suited for the purpose, the temperature ranging from 48° to 52°, and every stone and particle of aquatic plants being covered with minute insects or crustaceans, the latter, of which I send specimens, (*Gammarus?*), being very abundant.

On February 21 a careful examination was made of the Musconetkong. I found large numbers of salmon beneath projecting roots and rocks, especially at the points where small streams empty into the creek. The salmon were of comparatively enormous size, and might be readily divided, from their size, into three classes; the largest fish taken being over 2½ inches in length. It is very probable that these largest fishes are from spawn thrown out from the first invoice, as mentioned.

The rapid growth of these fishes is a strong argument in favor of turning them loose in the streams which they are destined to inhabit at an early age, in fact as soon as the yolk-sac is absorbed.

In conclusion, I would state that I consider this attempt at transporting the spawn and planting the young of the *Salmo quinnat* in our eastern waters a perfect success. With the exception of lot No. 1, which were literally cooked by the high temperature to which they were exposed, fully 75 per cent. were hatched and reared, a proportion rarely exceeded, if the truth be told, by our most successful fish-culturists, with spawn of their own impregnation. From experiments with various kinds of fishes, I would place their relative vitality as follows:

1st. *Salmo quinnat.*
2d. *Salmo confinis.*
3d. *Salmo salar.*
4th. *Salmo fontinalis.*

I might state that the number of fishes on hand was at first very much underestimated. As an example: one trough, containing 24 square feet of surface, was supposed to contain about 20,000 fishes. When placed in cans for transportation, the number was found to be more than double the estimate.

The method of counting was as follows: Fifty fishes were repeatedly counted and placed in a very small gauze net until the eye was familiar with their aggregate bulk; netfuls were then taken and counted; this was repeated until the number taken could be accurately estimated; in fact, it is believed that the total is rather below than above the true number.

All of which is respectfully submitted.

Prof. S. F. BAIRD,
United States Commissioner of Fish and Fisheries.

B—HATCHING AND DISTRIBUTION OF CALIFORNIA SALMON IN TRIBUTARIES OF GREAT SALT LAKE.

BY A. P. ROCKWOOD, *Superintendent of Fisheries in Utah Territory.*

SIR: I have this day received communication from Mr. Webber, superintendent of your fish-ponds in Charlestown, N. H., dated November 19, 1873. He purports to write at the request of Professor Baird, asking statistics in regard to salmon-eggs forwarded me from California. I received them at the junction of the Utah Central and Central Pacific Railways, on the 12th of October; placed them in my hatching-troughs the same evening; they were, generally, in good order. I found about twelve hundred bad eggs out of the forty thousand. Each day, for three weeks, the eggs were examined, and the bad ones thrown out, which amounted to about seventy-five per day on an average; on the third day I found two dead and the first fish hatched; on the seventh day several more were hatched; at the expiration of twenty days most of the hatching was through with. My hatching-troughs were only calculated for 30,000; the putting-in of 40,000 covered the nests so thick that the bottom could not be seen.

The umbilical sac was absorbed in from twenty to thirty days after hatching. The hatching-troughs and nursery-boxes were so crowded that I tried the experiment of removing some of them to the nursery-ponds before the umbilical sac was absorbed. My nursery-ponds are from 10 to 15 feet square, with an average depth of 12 inches of water, each fed by a spring at the head of respective ponds; the flow of water in each is from 25 to 30 gallons per minute, and about 3° colder than the water from which I removed them; for this, or for some other cause, they all settled to the bottom, and remained in an apparently dormant state for about an hour when they then began to revive, and in less than an hour they were all bright and active. Seeing this result, I immediately placed about four thousand more in the same pond, and about the same number in two more ponds that were in readiness. Very few that have been thus removed have died, whereas those that were left in the hatching-troughs have died in a much greater ratio. A portion of this mortality may be attributed to the fact that the cripples were left in the troughs as they lay near the bottom, and were not taken up in the dip-net used in removing.

I feed them on boiled grated liver. They are thriving well, and are much larger than the medium-sized ones of the same age referred to in "American Fish-Culture."

The young fry are now about thirty days old, and the umbilical sac is nearly all absorbed. The fry are from one to one and one-half inches long, and are not so full and plump as the fish of this age are represented to be in the work just referred to.

The shad-fry which I received from you about the 1st of August were placed in the Jordan River, about fifteen miles from the mouth. This river is the outlet of Mato Lake and empties into Salt Lake. I have not heard of any of them being seen since they were put in. I presume they will be like the "bread cast upon the waters to be gathered after many days."

Any suggestions or recommendations you will please furnish me will be thankfully received.

Please to make me a passing call at your convenience.

My respects to Professor Baird for the interest he has taken in fish-culture in Utah.

Mr. LIVINGSTON STONE,

Charlestown, N. H.

SALT LAKE CITY, UTAH TERRITORY, *December* 2, 1873.

XXII.—REPORT OF OPERATIONS DURING 1874 AT THE UNITED STATES SALMON-HATCHING ESTABLISHMENT ON THE M'CLOUD RIVER, CALIFORNIA.

BY LIVINGSTON STONE.

CHARLESTOWN, N. H., *April* 5, 1875.

HON. SPENCER F. BAIRD:

I beg leave to report as follows: I arrived at San Francisco with the second California aquarium-car on the 12th day of June, 1874, with the intention of resuming operations at the United States salmon-breeding station on the McCloud River, California, as soon as possible. Congress, however, did not pass the required appropriation for the purpose until the latter part of June. As soon as notice of this appropriation reached me, I proceeded to procure supplies, and on the morning of the 4th of July I left San Francisco, and arrived at the United States camp on the McCloud River on the morning of July 5. The rest of our force arrived on Tuesday, July 7. We then numbered nine white men in all: J. G. Woodbury, San Francisco, Cal., foreman; Richard D. Hubbard, Charlestown, N. H., assistant; E. C. Forbes, Clinton, Mass., assistant; Waldo F. Hubbard, Charlestown, N. H., assistant; Oliver A. Anderson, Red Bluff, Cal., assistant; Myron Green, Highgate, Vt., head fisherman; E. Conklin, New York City, photographer; Marshall L. Perrin, Grantville, Mass., secretary; Livingston Stone, United States Fish Commission, in charge.

Our force was occasionally increased by an additional man, but was not diminished till the first shipment of eggs was forwarded east. I brought up from San Francisco a Chinese cook, Ah Sing by name, and employed more or less Indians throughout the whole season, the largest number working on any one day being fourteen. At the close of the last season, 1873, it became necessary to remove the hatching-troughs and water-wheel to higher ground, to put them out of the way of the winter freshets, which sometimes raise the water fifteen feet above the summer level. The dwelling-house, although not above high-water mark, was firmly shored up with timbers. This we found standing and in good order. Our first work was to erect the hatching-tanks and replace the wheel. This being done, we proceeded to build an addition to the dwelling-house to accommodate the increased force of this year, and when this was finished we went to work on the hatching-apparatus and the fence across the river. The hatching-apparatus consisted of the troughs used last year, with some additional ones, in both of which were placed hatching-trays for the reception of the eggs. The trays employed were made of the usual wire-netting coated with asphaltum. At first, we employed trays ten inches wide by twenty inches in length, and very shallow, placing three tiers one above the other in each compartment of troughs. As the number of eggs increased, the moving of the trays every day for the purpose of inspecting the eggs became a great annoyance, and in place of the shallow trays we substituted deeper ones for the remainder of the eggs. The deeper trays answered their purpose to perfection. The water, entering from the bottom and finding its exit from above the eggs, necessarily permeated all of them continually. It also kept the eggs to a certain degree suspended in the water, so that the underlying tiers were partly relieved of the weight of those above them. At first, we placed the eggs in these trays eight layers deep; but as the season progressed, the deep trays worked so well that the layers were increased to twelve, and, as far as could be learned, without detriment to the eggs.

I am free to say that this combination of deep wire-netting trays with the Williamson plan of hatching-troughs is the best apparatus for maturing salmon-eggs for shipment that I have yet seen. It is simple, compact, and effective. By means of it, we hatched eighteen thousand eggs to the superficial foot of hatching-troughs without the least difficulty; so that in one length of our hatching-troughs, or eighty feet, we matured one million and a half of salmon-eggs.

The fence across the river, to which allusion has been made, was a peculiar feature of this year's operations. Last year, we depended wholly on the seine for securing parent fish. The largest number which could be secured in this way being inadequate to the supply of eggs which was desired this year, I adopted the method of building a salmon-proof fence and bridge across the McCloud River. This had a double effect. It enabled us to capture the salmon in the corrals, or traps, connected with the bridge, and also to stop all the salmon from ascending the river, in consequence of which vast numbers accumulated in the holes just below the bridge.

With the time and men at my command, the construction of the bridge and dam was an undertaking of no small magnitude. The point selected for the purpose was just below the hatching-tents, where the river begins to break over a series of rapids. It was necessary to do the work here, or at some similar place, in order to avoid the deep holes and irregularities of the river-bed, which prevailed everywhere in the channel. This necessity, however, involved the disadvantage of having very swift water to work in—so swift, indeed, that a boat could not be held for a moment along the whole line of the bridge without being made fast to the shore. This disadvantage was the more serious because the snow-water which forms the river is so cold that the men working in it, as they were obliged to, a great deal of the time up to their waists and often up to their necks, could not endure it long without severe suffering. Fortunately, I had with me a force of loyal and resolute men, who were daunted at nothing, and through their courage and resolution these and all other obstacles were overcome. The space to be bridged over was one hundred and five feet, or, with the corral-extension, one hundred and fifty feet. The line was made across the river at nearly right angles with the current. The water was from four to eight feet deep and running with tremendous force. The river-bed was of loose, detached rocks, varying from a pound to half a ton in weight. We began the work by felling logs in the woods, cutting them into twelve-feet lengths, and hewing off the ends square. Three of these lengths were then laid together horizontally and in the form of a triangle, and the ends firmly pinned together with wooden pins. Another similar triangle was then made and rested on the first, then another, and so on till the structure reached the required height to support the bridge at a suitable distance above the surface of the water. When this was finished, the men waded out with it, with great labor, to its place in the river, with one angle up stream, of course, and fastened it there with cables till it was banked up with rocks, and the hollow space inside was also filled with rocks. When it was done, we had a solid stone pier, resting on the bottom of the river, which the current was unable to move. Another similar pier was then built and placed, and then another and another, at suitable intervals, till the other side was reached The tops of the piers were then connected with logs, hewed square, and pinned to the piers with strong, wooden pins. This completed the bridge. When it is remembered that we had neither horses nor derricks, but relied entirely on our physical strength to do all the work, it will be seen that it was no trifling undertaking. Nothing was yet accomplished, however, in arresting the passage of the salmon, as the space below the bridge was, of course, except at the piers, entirely open to them. It, therefore, now remained to dam the rapid and powerful current, so that the salmon could not pass. After some deliberation, it was decided to make this dam of poles, about two inches in diameter, placed perpendicularly in the river, with the upper ends resting on the side of the bridge, and the lower ends against the bottom of the river. To facilitate the work of placing the poles, we concluded to make a regular fence of them, laying poles side by side, about one inch and a half apart, and inserting both ends of each pole into a strong cross-piece of hewed timber, running at right angles with the poles. This having been decided on, the next thing was to get the poles. We required a thousand. The nearest that could be found in any quantity were in a forest four miles off, over a rough mountain-trail. I immediately fitted out an expedition, with axes, blankets, and provisions for four days. The thermometer was ranging at that time between 100° and 110° in the shade. In the sun, it was hot enough to cook eggs. This made the work of lumbering rather severe; but at the end of the four days the expedition returned, having procured several hundred poles.

These they packed on their shoulders to the nearest point on the stage-road, whence they were brought to camp by the mule-teams returning from Oregon. I continued sending to this spot for poles until they reported the stock exhausted. We then scoured the woods in the immediate neighborhood of the camp, and gathered in all the scattering ones that could be found till these were gone. There were still many more needed, which were obtained from various quarters, and packed into camp on the shoulders of the men employed.

The poles having been secured, the fence forming the dam was constructed on shore in sections, which, when completed, were taken to the bridge, and dropped into the water at an angle of perhaps thirty degrees with the perpendicular of the bridge. The upper side of each section being now firmly spiked to the timbers of the bridge, the current, striking it at the angle mentioned, forced the bottom of the fence very tightly against the river-bed. All the sections being thus placed, rocks were then piled up around the bottom of the fence and thrust into any crevices which the salmon might get through, and, this work having been extended entirely across the river, the bridge and dam were rendered complete.

The next thing was to build the còrrals. These were constructed on the plan of the dam. Two of them, one opening into the other, formed an inclosure of about 50 by 20 feet. They were built on the east side of the river, and communicated, by a mouse-trap gate or opening, with the main stream, so that the salmon could run up into the corral, but could not return. The other corral was construcied on the same plan, about the middle of the river. As an illustraiion of the work performed on the bridge, I will say that two thousand 2-inch auger-holes were bored under the scorching sun, and no less than two hundred tons of rocks were used in the construction of the dam and corrals, all of which were taken, one by one, and put in their place by hand.

About four o'clock in the afternoon, a few days after the passage of the salmon was obstructed, and before the corrals were made, it was announced that the salmon were making their first assault upon the dam. The whole camp collected on the bridge to witness tie attack. It was a sight never to be forgotten. For several rods below the bridge the salmon formed one black, writhing mass of life. Piled together one above another, they charged in solid columns against the bridge and dam, which trembled and shook continually under their blows. Not daunted by their repeated failures, they led attack after attack upon the fence, one column succeeding as another fell back. Enouraged by their numbers, and urged on by their irrepressible instinct, tiey entirely disregarded the observers on the bridge, and struggled at their very best to pass the unwonted obstruction. Finding the fence impassable, many fell back a little and tried to jump the bridge. This several succeeded in doing, sometimes violently striking the men on the bridge in their leaps, and sometimes actually jumping between their feet.

For an hour and a half this fierce assault continued when, exhausted by their efforts and discouraged by many failures, they fell back to the deep hole just below the rapids, arrested, for the first time since the McCloud formed its channel, in their progress up the river. The Indians, who were watching their movements, were wild with excitement over this scene, which, even after a residence of centuries on the river, was new to them, and they begged for permission to spear the salmon. This, however, I did not give, as I felt obliged to save all the fish for their spawn.

The bridge and dam were completed, and the river rendered impassable to the salmon, on the 10th of August. From that time to the beginning of the spawning-season, all hands were busy about the preparations for taking and hatching the spawn, which were barely ready when it was announced that the first ripe salmon had been taken. This was the 26th day of August. From this time to the end of September, all hands were kept busy in gathering and taking care of the eggs and extending the preparations for receiving them.

From the end of September till the 18th of October, there was no work done in taking spawn, but the time was occupied in caring for what had been taken, and shipping the eggs to their eastern destinations.

Table of consignments of salmon-eggs, according to order of shipments.

1874.

FIRST SHIPMENT.

Sept. 25. Sent by Wells-Fargo's Express, in charge of Mr. E. Conklin, to—

A. P. Rockwood, Salt Lake City, Utah	150, 000
B. F. Shaw, Anamosa, Iowa	150, 000
David Day, Saint Paul, Minn	150, 000
George H. Jerome, Niles, Mich	300, 000
W. A. Newell, for New Zealand	25, 000
	775, 000

SECOND SHIPMENT.

Oct. 6. Sent by express, in charge of Mr. E. C. Forbes, to—

George H. Jerome, Niles, Mich	300, 000
Seth Green, Rochester, N. Y	150, 000
B. F. Shaw, Anamosa, Iowa	150, 000
David Day, Saint Paul, Minn., forward to Seth Green, Rochester, N. Y	125, 000
	725, 000

THIRD SHIPMENT.

Oct. 9. Sent by express, without an attendant, to—

W. W. Clark, Michigan	150, 000
George H. Jerome, Niles, Mich	150, 000
A. Palmer, Boscobel, Wis	80, 000
Seth Green, Rochester, N. Y	150, 000
	530, 000

FOURTH SHIPMENT.

Oct. 11. Sent by express, in charge of Mr. Clinton Johnson, to—

R. G. Pike, Middletown, Conn	150,000
Mrs. J. H. Slack, Bloomsbury, N. J	225,000
James Duffy, Marietta, Pa	150,000
Alexander Kent, Baltimore, Md	225,000
	750,000

FIFTH SHIPMENT.

Oct. 13. Sent by express, in charge of Mr. M. L. Perrin, to—

R. G. Pike, Middletown, Conn	150,000
James Duffy, Marietta, Pa	150,000
Alexander Kent, Baltimore, Md	150,000
J. B. Thompson, New Hope, Pa	150,000
Alfred A. Reed, Providence, R. I	100,000
Samuel Wilmot, Newcastle, Ontario, Canada	25,000
H. H. Thomas, Randolph, Cattaraugus County, N. Y., afterward forwarded to Seth Green	25,000
	750,000

SIXTH SHIPMENT.

Oct. 18. Sent by express, without an attendant, to—

E. M. Stillwell, Bangor, Me	150,000
E. A. Bracket, Winchester, Mass	200,000
Seth Green, Rochester, N. Y	150,000
William H. Cushman, Georgetown, Col	25,000
Jos. E. Andrews, Rockford, Ill	50,000
W. B. Robertson, Lynchburgh, Va	50,000
	625,000

SUMMARY.

First shipment	775,000
Second shipment	725,000
Third shipment	530,000
Fourth shipment	750,000
Fifth shipment	750,000
Sixth shipment	625,000
Total	4,155,000

Distribution of the eggs.

A. P. Rockwood, Salt Lake City, Utah	150,000
B. F. Shaw, Anamosa, Iowa	300,000
David Day, Saint Paul, Minn	150,000
George H. Jerome, Niles, Mich	750,000

Seth Green, Rochester, N. Y	575,000
R. G. Pike, Middletown, Conn	300,000
James Duffy, Marietta, Pa	300,000
Alexander Kent, Baltimore, Md	375,000
J. B. Thompson, New Hope, Penn	150,000
Alfred A. Reed, Providence, R. I	100,000
Samuel Wilmot, Newcastle, Ontario, Canada	25,000
H. H. Thomas, Randolph, N. Y	25,000
E. M. Stillwell, Bangor, Me	150,000
E. A. Bracket, Winchester, Mass	200,000
W. H. Cushman, Georgetown, Col	25,000
J. E. Andrews, Rockford, Ill	50,000
W. B. Robertson, Lynchburgh, Va	50,000
W. W. Clark, Niles, Mich	150,000
A. Palmer, Boscobel, Minn	80,000
Mrs. J. H. Slack	225,000
W. A. Newell, for New Zealand	25,000
Total number of eggs sent out of California	4,155,000
Hatched and placed in the McCloud River, California	850,000
Total number of impregnated eggs taken	5,005,000
Not impregnated, and lost from other causes	747,500
Total number of eggs taken	5,752,500

From the 18th of October till the camp was closed up, November 30, the time was taken up with hatching the eggs that were left, amounting to 850,000, and placing them in the McCloud River; in consideration of which, the California commissioners of fisheries contributed a thousand dollars toward the expenses of the campaign.

COST OF THE EGGS.

It is so difficult to separate the expenses of shipping the eggs from the general expenses of the season that the exact cost of the eggs when ready for consignment can only be approximated. The expenses of this season's operations were very much augmented by the addition of permanent improvements, as, for instance, a large tent and several hundred hatching-trays. These improvements ran up the expense of procuring the eggs this season to about $9,000, including the cost of hatching the eggs for the Sacramento, for which the California commissioners paid $1,000. There were five million impregnated eggs obtained, which makes the cost per thousand at the McCloud River, $1.80.

CAMP-BUILDINGS, ETC.

The general plan of the camp this year was the same as that of last, with some improvements and extensions added. The point lowest down on the river that we occupied was, as before, the lower fishing-ground. Here was the main fishery; the other, from its coming above the dam, being practically abandoned. There were here two or three corrals for salmon, and two or three little wooden structures forming a rude camp for the fishermen. Some distance above this point, and about a hundred yards from the house, were the bridge and upper corrals. The main corrals were on the opposite side of the river, and extended about 50 feet down to the farther end of the bridge. The bridge reached 106 feet across the river to the wheel which raised the water for the hatching-works. A flume connected the wheel with the filtering-tanks at the upper end of the hatching-tents. Next came the distributing-spout, and then the hatching-apparatus proper, which extended 80 feet farther to the end of the hatching-tents. Just at this point was a fishing-ground for trout and "Wyedar deckets;" and a little farther up the stream was a set of hatching-boxes, with wire sides and bottom, floating horizontally in the current. Only a few steps farther up the river came the house in which we lived. Behind was the United States flag on a 50-feet flag-staff, and a little farther on two smaller tents and a brush-camp. About ten rods up the river from this point was an inclosure, or pound, in which the young salmon for the State of California were put before they were old enough to wholly shift for themselves. This terminated our series of works in this direction.

It will be seen by comparison with last year's report, that the arrangement of the camp was similar to that of 1873; the river-corrals and bridge being new, however, as has been mentioned. The hatching-troughs were also extended 40 feet farther in length, involving the use of an additional tent 40 feet by 30 feet. This made the hatching-tents this year 100 feet long. The addition to the dwelling-house nearly doubled its size, making it 28 feet by 26 feet, and giving us three new rooms, one of which was employed for a bed-room, one for a store-room, and one for the photographer's use. The brush-camp north of the dwelling-house was quite a valuable addition of this year. It was very rudely built, after the fashion of the aborigines, but it was located in a shady spot, at the water's edge, and proved to be an extremely convenient place to transfer my office to during the warmer portions of the day, when my room in the house often became intolerably hot. The only other new feature at the station this year were the inclosures, or pounds, for receiving the young salmon intended for the McCloud River. These were built of rocks and covered with brush, and when the salmon were approaching the period of the absorption of the yolk-sac, they were transferred from the hatching-troughs to these corrals, where they had ample space to move about.

THE HATCHING-APPARATUS.

This was on a much larger scale as well as on a different plan from that of last year. The wheel and flume were the same, but owing to the greater pressure of water against the wheel caused by the erection of the dam, it raised three or four times as much water, or about twenty thousand gallons an hour. If necessary, the wheel could be made to pump up enough water to hatch a hundred million salmon-eggs. The filtering-tanks consisted this year of two tanks brought out in the second California aquarium-car. They were splendid tanks, made of eastern pine, iron-bound, and holding a thousand gallons each. The hatching-troughs this year were all made on the Williamson plan, which obliges the water to run from the bottom to the top of each compartment, as seen in the diagram. There were eight rows of hatching-troughs this year, each eighty feet long. In some of the troughs, the shallow trays were used three deep, with one layer of eggs in each tray. In others, one deep tray was substituted for the three tiers of shallow trays, and the eggs placed eight or ten layers deep instead of one. This new application of the Williamson troughs was suggested by my foreman, Mr. Woodbury, and is, I believe, the best and simplest method yet discovered for maturing salmon-eggs for shipment. By means of it, we could mature forty thousand eggs in each compartment, a quarter of a million in each trough, and one million and a quarter in each line of troughs. As there were eight lines of troughs laid down, our hatching-capacity this year was just ten millions; but it can be increased indefinitely. All the troughs were excluded from the light by covers formed by stretching black cloth over slight wooden frames. All the troughs, trays, covers, as well as the wheel, bridge, dam, and everything else about the place, were made by ourselves on the spot.

THE FISH AND THE FISHING.

The upper fishing-ground, being above the dam, was practically abandoned this year, and almost all the seining was done at the lower ground, where the fishing was good enough to satisfy any one. When the salmon had made an unsuccessful assault upon the dam, they fell back into the hole at the foot of the rapids, which formed the lower fishing-ground. Here they were practically in as secure confinement as if they had been caught and placed in a pound; for the dam prevented them from going up the stream, and their irrepressible instinct to ascend the river prevented them from going down. Every foot of this hole was swept by the seine. No better corral or inclosure for confining the fish could be constructed. Here they had their natural habitat and surroundings, the whole volume of the McCloud River for a water-supply, and nothing whatever to prevent them from keeping healthy and in first-rate condition. It was the best possible kind of a pound for them. Last year, they lashed themselves to pieces, trying to escape from the artificial pens. This year, they kept as fresh and well as could be wished. They accumulated in this hole by thousands. When any were wanted, it was only necessary to extend the net around them and haul them in. Once or twice no less than fifteen thousand pounds of salmon must have been inclosed in the net. They formed a solid mass reaching several yards from the shore, and filling the net two or three feet deep. If I should say twenty thousand pounds, I do not think it would be exaggerating. For some reason or other, my method of confining and capturing the salmon has been spoken of disparagingly; but if anything more simple, more natural, or more effective can be devised, or anything contrived on a larger scale, I can only say I should like to see it.

The seining for spawning-fish was usually done at night, and what fish were needed for the next day were thrown into small corrals intended for their temporary confinement. The spawning was done under a little brush-camp erected just where the seine is hauled ashore. The salmon were very abundant in the McCloud River this year, apparently more so than last year, although our conjectures on this point could not of course be verified. Young salmon a few inches long were very plentiful, as also were trout of all sizes. There was a large mixture of grilse among the older salmon. These were found very good eating, even up to the time of spawning. Occasionally, we captured a fresh river salmon, having a bright silvery surface, and scales looking exactly as if he had just left the sea. These fish were all very large, and all males. They were very rare, perhaps one in a thousand. One much-disputed point about the McCloud River salmon was settled this year by the presence of the dam. The vexed question has been whether the salmon ascending the McCloud River to spawn ever returned to the sea. Both sides of the question have been warmly advocated; the strongest point urged by the affirmative side being that the yearly run of salmon could not be kept up if all the spawning-fish died at the spawning-grounds, and none went to the sea to return the following year. Whatever may be the merits of the arguments advanced on either side, the fact has been proved this year that the spawning-salmon do not return to the sea. The proof is this: Our dam formed an impassable barrier to the return of the salmon which had ascended the river to spawn. Tens of thousands, not to say hundreds of thousands, which would perhaps be nearer the truth, passed the line of our barricade before it was completed. Not one of these salmon repassed that point on their return to the sea. If their habit had been to return seaward after spawning, they would have crowded up to the upper side of the barricade, as the ascending salmon did to the lower side of it two months previous; but, instead of this, not one was observed to even show the least disposition to pass it, although thousands floated down dead against the dam.

What, then, must be said of their disposition to return to the sea?

The only conclusion that we can come to is that they have no such disposition; that they are not accustomed to do so, and that they all die in the upper waters, which serve for their breeding-grounds; which last statement is confirmed by the fact that at the end of October a live salmon can hardly be found in the whole length of the McCloud River anywhere.

THE TAKING AND RIPENING OF THE EGGS.

The eggs were taken from the salmon, as before mentioned, close to the spot where the seine was hauled in, and where a small brush-camp was erected for the purpose. The spawning was usually done in the forenoon, and was performed very rapidly. The fish, when spawned, were usually given to the Indians, who were always in waiting, like fish-hawks around their prey, to receive them.

The Russian or dry method of taking the eggs was adopted exclusively this season, and the rate of impregnation obtained was very good. The largest number taken in any one day was 457,000. The first eggs were taken on the 31st of August, and the last on the 29th of September. The total number taken was 5,752,500. Below will be found the daily record of eggs taken.

Daily list of salmon-eggs, taken at the United States salmon-breeding establishment on the McCloud River, Redding, Cal., 1874.

Date.	Eggs taken each day.	Total.	Date.	Eggs taken each day.	Total.
1874.			1874.		
Aug. 31......	82,000	82,000	Sept. 15......	457,000	3,276,000
Sept. 1......	25,800	108,000	16......	390,000	3,666,000
2......	120,900	228,900	17......	364,000	4,030,000
3......	102,500	331,400	18......	252,000	4,282,000
4......		331,400	19......	290,000	4,572,000
5......	298,400	629,800	20......	217,000	4,789,000
6......	234,600	864,400	21......	126,000	4,915,000
7......		864,400	22......	172,000	5,087,000
8......	453,000	1,317,400	23......	126,000	5,213,000
9......	252,600	1,570,000	24......	126,000	5,339,500
10......	304,000	1,874,000	25......		5,339,500
11......	170,000	2,044,000	26......	210,000	5,549,500
12......	234,500	2,278,500	27......	126,000	5,675,500
13......	218,500	2,497,000	28......		5,675,500
14......	322,000	2,819,000	29......	77,000	5,752,500

After three or four million eggs had been placed in the troughs, the work of daily inspection became quite a task. I employed chiefly Indians to pick out the dead eggs, and they did it extremely well, their delicate fingers and native dexterity making them quite apt and expert for the work. The shallow trays did very well, although it was a great trouble to lift out the upper ones so constantly, in order to get at the lower ones. This was all obviated when we came to use the deep trays, in praise of which too much cannot be said. With these, it was only necessary, in picking out the white eggs, to raise the tray a little ways out of the water, and then gently immerse it again. The upward pressure of the water would throw the dead eggs to the surface, where they could be picked out without even the touch of a feather. With these trays the hands are never wet, the trays are never changed from their places, the eggs never flow over the top, and the feather becomes unnecessary. In addition to these advantages, all sediment accumulating about the eggs can be easily run off by gently moving the tray up and down a few times in the water. Besides the tray for hatching the eggs in the troughs, I used floating wire-boxes, placed in the river-current, with very good success. These, unlike the famous shad-hatching boxes, rested horizontally in the water. We had remarkably good luck this season; not a single mishap occurring to any of the vast number of eggs, either in the taking or the ripening of them.

PACKING THE EGGS.

The eggs were packed for shipment this year on the same general plan that was adopted last year. The packing-boxes were made two feet square and one foot deep. At the bottom of the box was placed a thick layer of moss, then came one thickness of mosquito-bar, then a layer of eggs, then mosquito-bar again, then other successive layers of moss, netting, eggs, netting, and so on to the middle of the box. Here a firm wooden partition was fastened in, and the packing renewed above the partition in the same manner as below. The cover was then screwed on the top and another box packed. When two boxes were ready, they were placed on wooden crates made large enough to allow a space of three inches on all sides of the boxes. This space was filled with hay to protect the eggs against changes of temperature. The cover being put on the crate and the marking done, the eggs were ready to ship.

This plan of packing, in spite of many severe criticisms that have been made upon it, seems to work remarkably well. Of those sent to Great Salt Lake in 1873, distant a thousand miles, only 3 per cent. were lost. Seth Green reports a loss on the 200,000 eggs consigned to him in 1873, of only 11 per cent. in both the transportation and hatching. Mr. James Thompson, of New Hope, Pa., writes as follows of the eggs sent him this season: "The 150,000 salmon-eggs shipped from California arrived in splendid order." The entire loss on this lot in transportation and hatching was only 6 per cent.

These facts seem to show that the packing is all right. The trouble with those who found fault with it is that they do not understand what it is that kills the eggs in the lots that do not go well. The mischief is not in the packing, but in the high temperature to which the eggs are exposed in transit. I will agree to take any of these lots of eggs to New York and back to California in this packing without serious loss, if I can have entire control of the temperature of the crates. But what can be expected of eggs that are packed in a hot climate, to begin with; are compelled to travel a whole day in a temperature often much above 100°, and then for several days either where the weather keeps them warm naturally or where the car containing them is artificially heated to an excessive degree, as is the case with the express-cars which convey them; and when, in addition to all this, they are delayed by negligent express-agents several days beyond the regular time? I challenge any one, whatever may be his ingenuity or skill, to pack salmon-eggs so that they will make the overland journey safely under these circumstances. If the eggs were not destroyed in any other way with those conditions, they would hatch out on the road from the heat, and so perish. I admit that sawdust would be much better than hay for the outside packing, but we should have to haul the sawdust sixty miles in order to get it at all. I propose, however, to use it next year, whatever may be the expense of procuring it.

It should be remembered that the following points must be combined in any method of packing the salmon-eggs that is adopted for the overland trip:

1. They should be compactly arranged, in order to reduce the express-charges, which are enormous at best.

2. The packages should be large and heavy, so that they cannot be knocked about the express-car.

3. The eggs and moss should be massed together in considerable quantities, to retain the moisture in the eggs, and also to be better protected from change of temperature.

4. The method that is adopted should be one that facilitates rapidity of packing, as the first boxes packed suffer while the others are being made ready.

5. General economy in regard to expense should be studied, as, with such a large number of eggs, even a small additional expense per thousand makes a large bill in the aggregate.

6. No method that I have been made aware of combines these advantages better than the one actually employed this season in packing the California eggs.

Many of the incidental causes of loss after the eggs left the McCloud River are shown in the appended report on the various consignments; as also in Mr. Perrin's account, just following, of his journey across the continent with various lots of salmon-eggs.

THE OVERLAND JOURNEY OF THE EGGS.

The very full account of my secretary, Mr. Marshall L. Perrin, of his journey with some of the California salmon-eggs, makes it unnecessary for me to present anything on this subject besides his report; which I give here with pleasure:

"*Report of Marshall L. Perrin, employed by Mr. Livingston Stone for the United States Fish Commission, to accompany the fourth lot of salmon-eggs transported from the United States salmon-breeding establishment upon the McCloud River, California, to various States on the eastern coast, during the season of* 1874.

"The fourth lot of salmon-eggs left McCloud River camp Tuesday afternoon, October 13, 1874. It consisted of seven crates, not of uniform size, but varying according to the number of eggs within, as follows, together with the names of the consignees, which were marked upon the respective crates:

"R. G. Pike, Middletown, Conn., 150,000 salmon-eggs.

"James Duffy, Marietta, Pa., 150,000 salmon-eggs.

"Alex. Kent, Baltimore, Md., 150,000 salmon-eggs.

"James B. Thompson, New Hope, Bucks County, Pa., 150,000 salmon-eggs.

"Alfred A. Reed, jr., Providence, R. I., 100,000 salmon-eggs.

"Samuel Wilmot, Newcastle, Ontario, Canada, 25,000 salmon-eggs.

"H. H. Thomas, Randolph, Cattaraugus County, N. Y., 25,000 salmon-eggs.

"In all, seven hundred and fifty thousand salmon-eggs. They were packed essentially the same as the former lots had been, in alternate layers, with moss gathered from Mount Shasta, and having mosquito-netting above and below each layer of eggs, so that they could be more easily gathered from out of the moss. Two boxes filled in this way, containing 75,000 eggs each, were placed in a crate slightly larger than the sum of the two boxes, and the space between the crates and the boxes was stuffed with straw. The boxes were bored on all sides with auger-holes, so that water poured from outside the crate upon the straw inside, and also water coming from the melting of ice, which was to be kept on the top of the crates, would enter the boxes and moisten the moss in which the eggs were placed.

"It was especially necessary to keep this lot of eggs cold, inasmuch as it was a later lot and the eggs were more nearly ready to hatch. Therefore I was to try to keep them as nearly torpid, and hence as cold, as possible, in order to prevent their breaking through the shell; in which case, of course, they would begin motion and animal life, and would need a medium of water, and inevitably perish for the want of it. Mr. Stone also wished me to try the experiment of packing hunks of ice, in place of the straw, inside of the crates, as soon as I should arrive with the eggs upon the Central Pacific Railroad to regions where ice was more abundant and obtainable, and keep it up for the rest of the journey.

"The crates were thoroughly soaked for a while before they were loaded upon the large team with which they were conveyed to Redding, 23 miles distant. We left camp at about 4 o'clock p. m., and reached Redding at about 2½ o'clock a. m. The load was very heavy and the road mountainous. During the trip it rained quite heavily, which gave the crates a further soaking with which to begin their long journey. At Redding were ready 250 pounds of ice, which had been ordered, and I put this in pieces upon the crates after they were loaded in the Wells, Fargo & Co.'s express-car. The train started at about half past 3 o'clock a. m., Wednesday morning, October 14. The morning was cold, and the forenoon cool, fortunately, for the car was quite small, and the crates had to be placed one upon another; consequently, ice could be upon only the upper ones, except so far as the under ones jutted out. Therefore I changed their positions twice, and often poured water over them on the way down to Sacramento, which we reached at 2 o'clock p. m., running into the city and not being left for connections at the junction.

"I found my time here (half an hour) very short in which to accomplish the necessary details, and so had to hurry in order to soak the crates with ice-water; to attend to transferring and icing them with 300 pounds of ice, for which I had telegraphed; to go to Wells, Fargo & Co.'s office to see the agent, Mr. Tracy, about expressing and rebilling the crates, and to obtain from him a letter for admittance to express-cars, which I never used; to buy pail, dipper, and thermometer, besides attending to my personal baggage, tickets, &c.

"The afternoon was hot; and when we left Sacramento the temperatures of the crates were varying from 60° to 63°; but they were loaded upon the coolest part of the car, and I iced them well during the afternoon and soaked them. Soon the temperatures were from 56° to 62°. At evening, the messenger telegraphed for ice at Summit, Cal., which we should reach in the night, and for a slight recompense he consented to be without a fire over night, though it was a cold night and he had started one. Upon arriving at Summit, he found that no ice (strangely) could be obtained there, and obtained a quantity at Boca, a station beyond. On the morning of Thursday, October 15, the temperatures were from 50° to 56°. I turned the crates upside down, which was done every day, so that the eggs should not settle down in one direction, causing in this way too much pressure upon them. We moved them to a rack in the car through which the water would run; and, while the travelers breakfasted at Humboldt, Nev., the engineer backed the train so that we could bring a hydrant-hose into the car and give the crates a thorough drenching. We also got about 400 pounds of ice from a trap-hole in the station-platform. At Humboldt the messengers changed.

"Having a good supply of ice, I commenced the experiment of taking out the straw with which the boxes of eggs and moss were packed into the crates, and substituting pieces of ice, pounded so as to fit its place, in the intervening space between the boxes and the crates. The temperatures at noon were 54° to 60°. At Carlin, Nev., 611 pounds of ice were procured and cut up for the purpose stated above. Finding some of the boxes had no holes in them, at Elko I got an auger and bored some. From Wells onward, the rest of the day, at every station, I obtained a pail of water, and, after cooling it with ice, poured it over the crates in turn. As was also one of my motives in giving them so much water at Humboldt and at Ogden the next morning, I wished to give them all the water possible this day, for the water, especially beyond Ogden through a long region of country, would be very doubtful in quality, and I should hesitate about using it.

"The temperatures that night when I left them were between 38° and 50°; and the next morning, Friday, October 16th, they were from 52° to 54°. Early in the forenoon we changed cars at Ogden, Utah, and while the other express was being transferred, I gave the crates a heavy soaking by means of a hose. No ice could be obtained at Ogden, but there was enough to last easily till reaching Evanston. On the whole I think it is better to procure ice at unimportant towns or stations *en route*, if possible, than at large cities and railroad junctions; for the quality of the ice is surely just as good, and other details, as necessary as they are numerous, will use the time at the large places. The trouble of transferring ice does not compare with that of procuring a new lot. Furthermore, the new messenger more willingly takes it from the previous messenger than when it is freshly imposed upon him, for certainly it is very disagreeable to them to have their car loaded with melting ice.

"The Wells-Fargo agent at Ogden informed me that Mr. Tracy, at Sacramento, had erroneously billed the crates, and they could not go over the routes which I said it was necessary for them to take beyond Omaha. He was in a hurry and unpleasant; as was also the messenger (from Ogden onward) at first, upon seeing seven big, heavy, dripping crates come into his car. It is not so great an evil that the crates of salmon-eggs come under the care of strangers as the fact that they are handled by constantly-changing strangers. There is a need of some one who will be a permanent friend to them, stand by them, and look out for their welfare in emergencies, and when the express messenger on one route or section changes for the uninitiated one who takes his place. There is, then, a need of some person who shall get this new messenger interested in the cause, and willing to put up with extra and unusual arrangements. The presence of a man in charge of the shipment is not merely better, but I think it is absolutely indispensable, judging from the dealings which I have had with express-messengers and railroad employés; who, when rightly dealt with, are a very obliging class of men. The gentlemanly and obliging manner in which I was treated during the whole trip deserves commendation.

"Toward noon, Friday, October 16, I got some ice at Evanston, Utah, and proceeded for the rest of the day to unpack straw from more crates, and put in the abundant ice and refilled the crates where the ice which I had previously put in had melted. The temperatures at noon were 53° to 56°; and at night were 42° to 50°. As I should have stated before, the way in which I took the temperatures, three times a day, was by thrusting a thermometer between the slats of the crates into the straw which surrounded the boxes. This, of course, does not precisely indicate the temperature of the eggs inside the boxes; they may be warmer or they may be cooler. If not attended to, and left to grow warm, the eggs must either increase in heat from the center outwards, or heat from the outside, the center remaining coolest. Now, when care is taken of the eggs, the stratum of cold, damp straw, in not allowing hot air from outside to touch the boxes, prevents the eggs from heating from the outside. Hence, when properly attended to, they will heat only from the center outward. This happens by the spoiling of the eggs in the middle; the fungus, attaching itself to the next egg, spreads outward after the manner of a warm, damp mold. This suggests two improvements: First, that the eggs might be packed in smaller boxes, so that the center eggs might not be so far away from the ice; and secondly, that some method might be devised for removing the decaying eggs during the journey. However, if the crates are attended to in a thorough manner, the present plan of packing does not much demand the proposed improvements; and as to removing the decayed eggs, the loss is not of a greater per cent. under the present system than would inevitably be caused by the disturbance produced by any method of removing the diseased eggs.

"Friday night was a very cold night, and the messenger seemed to be of that opinion the next morning, having walked back and forth, unable to sleep during the night, in the icy car, which they are not allowed to leave. Saturday morning, October 17, the crates were in temperature from 44° to 47°. They were turned over, and we moved them to the coolest part of the car, out of the sunlight. At Laramie, Wyoming, I procured a large quantity of ice, and watered the crates with ice-water, and repacked them with ice, as well as laid large pieces on the top of them.

"After having once removed the straw, it kept me almost constantly busy to keep the crates packed with ice. The intervening spaces between the boxes and the crates were very narrow, not large enough to admit pieces of ice larger than an apple, and the slats were too near together to crowd ice between them. To pack any side of a crate, therefore, it was necessary to tear off the slats of the crate each time, and nail them up again; which of course weakened the crates, and their structure would not allow any of the slats to be left off. This method of packing with ice consumes a large quantity of that article, and in the present case it was slow work to break it up into pieces of requisite size. Furthermore, the pieces were necessarily so small that they rapidly melted, and the finishing one round of filling the crates with ice was but the signal to begin again with the first on another round. Inasmuch as this method of packing with ice was a primitive experiment, and also not decided upon in time to construct the crates otherwise, many of these inconveniences were present in this case which need not be considered as necessarily accompanying the packing with ice. From the effects of my trial, I consider that the packing the crates with ice is a very plausible and practical method, and a decided improvement, if the crates are properly constructed, and if some one is constantly ready to renew the ice when it becomes melted to even a slight degree, so that a warm draught of air may not be allowed to strike the boxes at any point. The water from the melting ice permeates the boxes containing the moss and eggs, through the auger-holes, which is an additional item of advantage.

"The temperatures Saturday noon were 41° to 47°. When the express messengers changed at Cheyenne, Wyo., we conjectured that the wrong billing of the crates could be rectified at Omaha, but matters were worse from that point onward. The condition of things was as follows: There were seven crates; two of them (for Newcastle, Canada, and for Randolph, N. Y.,) I was to send from Chicago by northern routes direct to their destination; the others, for Marietta, Penn., New Hope, Penn., Baltimore, Md., Middletown, Conn., and Providence, R. I., I was to take with me over more southern routes from Chicago, and send the Baltimore and Marietta crates to Harrisburg, Penn., the New Hope crate from Philadelphia, and go on with the Middletown and Providence crates to New York, from whence I should send them to their respective cities. This was the only plan which could be carried out with success. Mr. Tracy, the Wells, Fargo & Co's. agent at Sacramento, billed some of the crates locally, *i. e.*, to be rebilled at every change of railroad or express company, and some he billed through to New York City. The billing, though he emphatically assured me it was right, was apparently indiscriminate. One of those which I wished to send from Chicago was locally, and one through billed; three of those which were to go over the southern routes were through, and two of them locally billed. Those through-billed must all go to New York City by northern routes, and then come around to Baltimore and their other destinations. This is because the southern routes from Chicago are run by the Adams Express Company, and the northern by the United States and American Express Companies; as the Adams runs only from Chicago, the other two receive the express at Omaha, and carry it by their own northern routes. I must, in some way, have all together with me, that I might attend to them. They could not all go by the northern routes, because the Baltimore, New Hope, and Marietta eggs would surely perish before getting to New York City over northern routes and around again to Maryland and Pennsylvania. There was only one way to do: they must all go the southern route from Chicago, billed or unbilled! The route from Omaha to Chicago was also quite doubtful. The United States and the American Express Companies both run into Omaha, and receive, from the Union Pacific, express alternately, one receiving the locally and the other the through-billed express."

"The temperatures of the crates Saturday evening were 42° to 50°. The night was going to be very cold and I had much ice in the car. The messenger was willing kindly to go without a fire for me, using my blankets in addition to his own. An accident late at night delayed us five and a half hours near Sidney, Neb., at which I had some thought of telegraphing to Mr. Tracy, at Sacramento. Sunday morning, October 18th, the temperatures of the crates were between 40° and 48°.

"The crates were now kept full of broken ice. As this broken ice rapidly melted, and the crates needed to be replenished often, I decided that should the crates be obliged to leave me in divisions, it would be much better for them to be packed with hay. The hay would keep them much cooler and more moist, and hold the moisture from the melting ice on the top; whereas, if no hay was around the boxes they would be directly exposed to the warm, dry air, unless the crates were kept constantly full of ice. Therefore, I procured 75 pounds of hay at Grand Island, Neb., together with 400 pounds of ice, and during the day packed up the crates with hay, which, of course, was dry, and watered them with ice-water at every station until they were very wet and cold. The temperatures Sunday noon were between 48° and 57°. An accident delayed us until we were almost seven hours late.

"Reaching Omaha the circumstances were anything but propitious for arranging matters. It was quite dark; it was Sunday night, consequently not many authorities could be found; the only agent who was at the station, having any power at all, was intoxicated. There is always hurry and confusion about the transfer across the Missouri, and especially as the train was so many hours late. It would be better to have the crates go to Chicago by the United States Express Company, as they were then more likely to go on well from Chicago. It being Sunday night, however, only the working employés were around, and their orders were such that I could get only the locally-billed to go by the United States Express, the others going by the American Express over another route. Therefore, at Chicago I must persuade the authorities of both express companies to give up their crates to the Adams Express, which runs over the southern routes from Chicago, by which the crates must be carried. While making the transfer across the Missouri River I found it could be possible to have all go to Chicago by the American Express. Hence, in Chicago I would have only one party to deal with; so all the crates unitedly, and myself, went to Chicago by that route. This outline of express troubles, filled in with a numerous amount of stubborn details and minutiæ, which were hard to overcome, caused me incessant anxiety concerning the preservation and final safety of the eggs; and, indeed, the express difficulties with this lot only began at Omaha, to continue onward to the end of the trip; but in this report it will be needless to particularize them.

"At Dunlap, Iowa, though very late, I procured 400 pounds of ice which I fixed over the crates; before which, however, I removed the slats from several crates and opened the boxes containing the eggs to examine them. They seemed to be in excellent order, at which I was very much encouraged. The temperature of the crates was warmer than usual, being 53° to 56°; but I was not afraid that it would rise, for the night was to be quite cool. The next morning, Monday, October 19, the temperatures were 50° to 50½. I obtained some ice at Clinton, Iowa, in the forenoon. The day was warm, and a good deal was used. At noon the temperatures were from 51° to 52°. Very fortunately, indeed, just before entering the city of Chicago, the superintendent of the American Express Company, (the company with which the crates then were,) came into the express-car. He was the person whom I could influence to the best advantage, and his was just the authority I was in need of.

It was through his intervention only that the agent at Chicago would be or was willing to do what I desired; and the eggs were not to be delayed longer than necessary. We rode with all the crates to the Michigan Central depot, where the two crates for Newcastle, Canada, and Randolph, N. Y., were left, and with plenty of ice. I saw the agent and left a note for the superintendent, and instructions were also given to all the messengers *en route*. The five remaining crates were carried to the office of the Adams Express, into whose hands they were really delivered and rightly bound. It was dark and cool, so they did not suffer by being on the sidewalk while waiting for the outward express. Leaving them in charge of a policeman, I telegraphed to the following four consignees of the salmon-eggs:—H. H. Thomas, Randolph, Cattaraugus County, N. Y.; Samuel Wilmot, Newcastle, Ontario, Canada; Alex. Kent, Baltimore, Md.; James Duffy, Marietta, Pa.;—stating that their crates of salmon-eggs were leaving Chicago that night by certain trains, which I specified.

"Soon the crates were loaded into the express-car at the depot of the Pittsburgh, Fort Wayne and Chicago Railroad; 400 pounds of ice were obtained, so that they kept finely through the night. The messenger made a great ado, and, though the night was not cold, he thought it dreadful to go without a fire. The eastern men on medium nights were much more appalled at going without a fire than were those upon the western roads, across the plains and mountains, during those intensely cold nights. Nevertheless, all hands went without a fire for me, and the crates were not in the presence of one during the journey across the continent. The temperatures of the crates at time of starting from Chicago were 46° to 50°. Being very tired I did not rise early the next morning, and the messenger neglected to get any ice at Crestline, Ohio, but it made not much difference, as there was enough to last to Alliance, Ohio, where I procured 250 pounds. The temperatures of the crates Tuesday morning, October 20, were 41° to 43°, and at noon were 42° to 47°. When not packed with ice it is much harder to keep them down to such an excellent degree of coldness, but I managed to attain this end by means of often wetting them with ice-water. In the afternoon I looked into the eggs again and they appeared very satisfactorily and well, showing a much less mortality than I had feared would take place through so many changes. Only a small per cent. appeared to have perished or to be unhealthy. The temperatures at night were 49° to 50°.

"Every change of cars had brought new troubles; and especially were large cities to be dreaded, because there would be so much more hurry and business going on. Therefore I was anxious riding into Pittsburgh. The train which connected at Pittsburgh for New York with our train never takes any express, and made very close connection, and it was impossible to arrange for the crates with that train. As it was, the express-men at Pittsburgh said they could not make special arrangements, the rules and customs were inflexible, and that crates bound for New

York (Middletown and Providence) must go the next morning, and the Marietta, New Hope, and Baltimore crates the next noon. It was then about 8½ o'clock in the evening. This proposed delay was out of the question, and must not be permitted, if I could possibly avoid it. As at Omaha, it was night, and only employés about. Finally I found one who appeared to have more authority than the others. He agreed that if the night-man should say it was practicable, he would authorize him to put a car of the New York Pacific Express upon the night-train at 2.50 a. m., though in doing so it would be stepping a good way beyond his official power.

"In this car the crates were put, and I procured two or three hundred pounds of ice and arranged the crates. There was no messenger to go with the car, and the strict rules of the express company require that in such case a car must be locked and sealed, therefore I was unable to take the temperatures the next day regularly. All the crates went together, as the agent at Pittsburgh telegraphed to Harrisburg to have the seal broken and the three crates for Baltimore, Marietta, and New Hope taken out, and also to have 400 pounds of ice ready. He also telegraphed to the agent at New York to forward the other two crates quickly upon their reception. After this I telegraphed to the following five consignees of salmon-eggs: James Duffy, Marietta, Penn.; Alex. Kent, Baltimore, Md.; James B. Thompson, New Hope, Bucks County, Penn.; Alfred A. Reed, jr., Providence, R. I.; and R. G. Pike, Middletown, Conn.; stating by what route and train their crates left Pittsburgh that night.

"At Harrisburg, which we reached at noon, the telegram had been received, and a team took the three crates to the office, where they would remain cooler than at the station waiting for their respective trains. The night and forenoon had been cool, and the crates had been by themselves in the closed car in an undisturbed atmosphere, with so much ice that they were very cold, being about 37°, and the ice had melted but little. Hence the ice ordered by the telegram was not needed, and I put most of it on the crates which were to leave me. Also, I gave explicit instructions about the care of these crates, and fastened upon them notes to the messengers in charge till at their destinations. These were the Marietta, New Hope, and Baltimore crates. The other two for Middletown and Providence were again shut up in the car and it was sealed until it should reach New York.

"We arrived in New York at about 7 o'clock p. m. The car had not come with us farther than Philadelphia; the train out of that city does not take express. This I did not know, but it was just as well, because in the cold closed car, alone, and with ice through the night, they would be in a better situation than if they had come to New York and waited till morning in the warmer office of the Adams Express. They came up from Philadelphia early the next morning.

"The admirable manner in which the crates of eggs kept, and the fine condition in which they remained during their 30 hours in the closed car is very noteworthy and suggestive. The ice melted but little; the moisture and water evaporated but slightly from the straw; there were no currents of warm or of dry air to strike the boxes; and the crates preserved a remarkably low degree of temperature, colder than I had known them to be at any other time, being 37° when I noted it at Harrisburg. I think they could have remained in such circumstances for a much longer time than they did, without needing much care, and have continued in excellent order. The methods and irregular times and intervals at which the salmon-eggs are taken from the parent-fish and matured, make the lots to be in different stages of advancement at a given time. If, however, some way could be devised so that several lots or a larger number of crates could make the trip at one time, it seems to me that it would be very proper to provide a car to run across the United States, containing only crates of salmon-eggs. It would not only make it decidedly more convenient to take care of the crates, but it would improve greatly the means for the preservation and safety of the eggs. Beside the advantages mentioned above, of the ice not melting, the moisture not evaporating, and the excellent degree of coldness preserved in an undisturbed atmosphere, others suggest themselves. Judging from the fact that the eggs at all other times are placed in running water, it seems probable that it would be well not only to keep them wet and in wet moss, during transportation, but also allow them more changes of water, by drenching and soaking, than can be done easily in express-cars. Many modes of watering and soaking could readily be devised; there would be place and room to harbor a large quantity of ice for use, to carry the requisite tools, and to have plenty of room to work in; the strong draughts of warm, dry air which rush in upon the crates from all the four doors of an express-car when opened at every station would be avoided; some refrigerating-apparatus might be prepared which would preserve a regularly low temperature; the eggs might be carried in such a way so that they could be picked over on the journey; for if better otherwise, they need not be packed in a portable manner, since not to be transferred so often; the eggs would be entirely freed from the jarring and banging which is injurious to them, and which they receive when changing cars; and the express difficulties and troubles arising from the billing, transferring, separating, and losing the crates would be entirely done away with. This special car, though not quite so necessary in this case, would be of the same nature, and have similar advantages, as those which, in the transportation of live fish and lobsters, the aquarium-car possesses over the inadequate facilities of the express-car.

"The sealed car, as I have said, reached New York Thursday morning, October 22, and the crates were carried to the Adams Express office, where more ice was immediately put upon them. I saw the Middletown crate off by the forenoon train from New York, and the Providence one by the boat; also I saw the messengers who were to accompany them, and instructed them, and ordered them to so instruct the messengers who should take their place, if there was a change before the crates reached their destinations.

"I learned afterward that the Providence crate was several days before reaching its destination, from New York, through some carelessness or oversight on the part of those having charge of the express between the two cities. Hence this crate of salmon-eggs suffered so much loss, some 30 per cent., I believe, that it was not as successful as the rest of the lot. This incites me to repeat that it seems, not only better, but very necessary to have some one accompanying the crates from the beginning to the end. There are many minute details also which will be overlooked, carelessly or otherwise, by the messengers; and it is so indispensable, in order to insure the healthiness of the eggs, that all these details should be performed, that if anything is to be done, the person accompanying the salmon-eggs must attend to it himself, or superintend it personally.

"Respectfully submitted.

"MARSHALL L. PERRIN."

LIFE IN CAMP.

Owing to the remoteness of the situation and the peculiar nature of our surroundings, a few words about our life in camp may possibly not be out of place.

The time passed very pleasantly with us all through the season. The work of the campaign was of course the main feature of the life here, and in this all seemed equally interested and bent on success. There was one peculiarity about the work: it was always driving us, even to working Sundays and nights, while we, on the other hand, were always looking forward to a time of comparative rest. This time of rest never came. At first we had to rush the work with all our might to get the house built and the two hatching-tents put up in season. Then came the cutting of the poles and felling of the logs for the bridge, and then the building of the bridge itself. No time was to be lost in this work, for the spawning-season was coming on rapidly, and, if the dam was not completed in good season, before the salmon stopped running, it would do no good. The bridge was no sooner finished than all hands had to go to work with a will on the hatching-trays and hatching-apparatus, in order to get them done in time for the eggs. This seemed almost an endless job, so many hundred wire trays had to be made and so much surface covered with asphaltum.

The hatching-apparatus was hardly ready when the eggs began to come on. Then the camp was busier than ever, and, when this work of ripening the eggs was at its height, the earlier lots had become ready for shipment.

Probably no one inexperienced in packing the eggs of fishes realizes how much work there is in packing a half a million eggs; but if he will undertake to pack 5,000, and then reflect that this must be repeated one hundred times to make a half a million, he will get some idea of it. In the first place, preparatory to the packing, the moss is to be obtained. Mr. Woodbury had charge of the expedition for the moss. They went sixty-five miles for it, and returned in twelve days with a hundred bushels. This moss had to be all carefully washed, picked over, and separated. Then the sixty packing-boxes were to be made, and thirty crates to send the eggs off in.

This preparatory work being done, and the time being come for making a shipment, all hands took hold of the work of placing the eggs in the boxes. We usually allowed two days to pack, box up, and mark a lot of 750,000, but on one occasion we packed the whole 750,000 in one day. Now that the fishing, spawning, ripening, and packing of the eggs was all going on at once, it can be easily seen that we had no time to rest. The first lull in our work came when the fishing was stopped and the seine hauled up for the season. This relieved the night-gang; and the reduction which had been caused, by various shipments, in the number of the eggs to be looked after, gave us a slight breathing-space, which I employed in making slight improvements about the ranch, such as putting an open fire-place in the house, for the nights had now become very cold, and in bringing up incidental work that had fallen behind in the hurry of the previous month. From this time, although the work did not drive us as it did in the summer, we had plenty to do. There were still two or three million eggs in the troughs, nearly a million of which were to be hatched for the McCloud River. The hatching-troughs, bridge, wheel, flume, dam, and tents were to be taken down and packed away, out of reach of the winter floods, and all the thousand little things to be attended to that are connected with the closing up of a place like this. Still, this work seemed light, compared to what we had been through. It was not a little ludicrous to reflect, afterwards, that when we considered our work all done, we had still *nearly a million of eggs to hatch*, a task that, under other circumstances, would seem quite formidable; but so strong was the contrast between it and the larger work which had been accomplished, that it seemed almost like nothing at all.

I have dwelt longer than perhaps appears to be necessary on the character of the work done at this station this season, because I am aware that to some it may appear quite incomprehensible what we had to do with so many men for so long a time. I can assure them, however, that there was enough to do every moment, and such things as idleness or loafing were not known in the camp. I think I ought to mention particularly here the services rendered by Richard and Waldo Hubbard, grandsons of Governor Hubbard, formerly United States Senator from New Hampshire. These two young men were always found equal to any occasion, whether it was to fell trees all day under the scorching California sun, or to work for hours immersed in the icy water of the

McCloud; they never once flinched at the severity of their work or hesitated to do anything that was required of them. Tall, stalwart, and muscular, they added a good deal to our reputation with the aborigines of the McCloud by throwing their champion wrestlers, while their strength, at the same time, when turned, as, indeed, it always was with undauntable resolution and energy, to the work of the camp, rendered their services invaluable.

By singling out these two, I do not mean to disparage the others, for all worked well, and the Hubbard boys typified rather than contrasted with the work that was done by all. As an illustration, I will quote the following paragraph from the Sacramanto Record of August 29, 1874:

"They (the party at the McCloud camp) have demonstrated that, for rapidity of action, endurance, hard labor, and practical accomplishments, their physical training is of a high order. Sleeping upon the rough planks of the living-room; draped in coarse woolen shirts and heavy pantaloons; with bare feet, or in jack-boots or moccasins; arms and breasts bared; tanned brown; muscles wrought up like iron, and all grim with the marks of labor, Mr. S.one has a party about him of both brain and muscle, proving that hard and serious labor can be evoked from students' arms, and that cultured intelligence and horny hands may meet in harmony. Look about the camp; every artificial thing is their handiwork; they are at once plumbers, fitters, carpenters, tailors, fishermen, geologists, chemists, artists, blacksmiths, lumbermen, loggers, and so on."

At the busiest part of the season the work was distributed somewhat as follows:

September 28.—Total number of hands employed, 24.

Picking over moss	4
In the hatching-house	7
In kitchen and about buildings	3
Hauling seine	5
Spawning salmon	3
In office and superintending	2
	24

The nature of our labors did not cut us off wholly from recreations, for which all found some time on summer evenings and on Sundays. There being no church within fifty miles, the time on Sundays was usually taken up with excursions to neighboring points of interest. Sometimes we went to Copper City, a settlement of two houses and five men, about fourteen miles from the McCloud River. Sometimes we went to the iron mountain, two miles distant, where a vast deposit of iron ore has been recently discovered. Sometimes we went up the river to hunt for game, or climbed the steep-pinnacled rocks of Mount Persephone, just opposite the camp. The summit of these extremely interesting limestone rocks we ascertained by the aneroid barometer to be 3,400 feet above the level of the sea, or 2,600 above the McCloud River.

In these limestone mountains we found two caves. One was an almost circular cavity in the side of the mountain, about 30 feet in diameter and 100 feet in length, with a floor nearly level, forming a magnificent chamber, with fresh green maiden's hair growing in large clusters downward from the roof. This cave is at an altitude of about 2,000 feet and is very difficult of access.

The other cave is similar and more easily reached, but has in addition a dark narrow passage-way leading through the interior of the mountain to a deep perpendicular abyss with re-entrant sides, from the bottom of which nothing, having once fallen in, could ever escape without wings or help from the outside. It is a place of such peculiar terror that I will describe our exploration of it. Having resolved to visit the cave, and having secured a guide in the person of Dr. Silverthorne, an old resident of this locality, we finished work at 5 o'clock on Saturday afternoon, and taking our blankets and necessary provisions, together with candles, lanterns, axes, ropes, &c., we proceeded to the foot of the mountain that evening, and, having cooked our supper, camped there over night. In the morning, after an early breakfast, we started for the cave.

Entering the main opening, we proceeded about 50 feet to a smaller opening in the right-hand wall of the cave and about ten feet from the floor. Climbing up into this we kept on through a narrow passage-way to a point about 30 feet from the entrance, where the passage dwindled into a small hole just large enough to admit a man's body. Here we all hesitated for an instant. Horrible visions of rattlesnakes and tarantulas and bottomless pits rose up before us and kept us back, but only for an instant. I happened to be the first through on the other side, and found this low archway led to another passage similar to the one we had left. On we went, turning several corners, but along a floor which kept nearly level until we came to a second archway, supported by round crystalline limestone pillars on either side. Here the level line of the floor became depressed to an angle of perhaps 30 degrees. The very blackness of darkness prevailed, which the candle we had with us seemed to only make visible. So intense was the darkness that the candle rays did not enable us to see six feet before us. Every one stopped involuntarily. No one wanted to begin the descent before us, and it is fortunate no one did, as the sequel will show. Presently some one proposed to throw a stone down the incline and listen to its descent. We did so. There was a breathless silence. The stone rolled along the incline, then bounded off and struck again far below, then again, and again, the sound reverberating as if it came from the depths of the earth. We were appalled. Two steps farther in the dark passage-way before us would have been instant death. Ropes were now brought and more lights, and before long we had a rope-ladder constructed, about 20 feet in length. It was lowered down the abyss, but did not reach the bottom. A strong line was fastened to it and it was again lowered. After paying out 30 feet of the rope the lower end of the ladder rested on something solid. A lantern attached to a 60-foot rope was then lowered down, and though its very feeble light was wholly inadequate to the requirements of the situation, we could see that there was a landing-place of some sort at the foot of the ladder, though whether it was at the edge of another abyss or not, or whether there was any substantial foothold there, could not be discovered. The place might be full of rattlesnakes or tarantulas, or it might be a bear-cave with other openings on its own level, for all we knew. I confess I had no disposition to swing off and slide down the dangling rope into the impenetrable darkness, without any assurance of foothold at the end of it. But not so with the brave fellows who were with me. They even contended among themselves as to who should be first to make the descent, and as soon as the word was given they sprang eagerly to the rope and swung themselves off without a faltering motion. Imagine a rope dangling loosely from a church-tower fifty feet in height, in the middle of a dark night, and a man without any special experience in that sort of thing swinging himself out on it for a descent, without knowing what was at the lower end of it. The case in question was worse if anything, for here there were all the grim surroundings and mysterious associations of a dark, forbidding, and unexplored cavern.

Dick (Richard Hubbard) begged earnestly to be the first to descend, but the lot had fallen to Green, (Myron Green,) and in a moment more he was seen on the rope dangling in mid-air, and in the next he became lost entirely to the sight of those above.

It seemed an age before he called out that he had reached the ladder. This hung so loosely that it was hardly better than the single rope, except that it gave a chance to rest. Another long silence, at the end of which he shouted that he had reached the bottom, when Dick sprang to the rope and swung off. Just at this moment the lantern which had been lowered to Green fell over and went out, and he was left in the impenetrable darkness. With perfect presence of mind, however, he felt for it, found it, and lighted it again, and reported a foothold at the bottom sufficiently large at least for a landing-place. Waldo Hubbard immediately followed Dick, and soon all three were at the bottom ready to proceed with further explorations. The opportunity was now afforded to the rest to make the descent, but no one came forward, and it soon became evident that Dick, Waldo, and Green would be the only ones that day to explore the abyss. This having been announced to those below, the exploration began, the result of which was as follows:

A chamber was found, 150 feet long and 40 feet wide, with a floor sloping slightly downward from the point of entrance. The chamber was, of course, the depth of the descent, or from 50 to 60 feet. Stalactites and stalagmites of beautiful crystalline structures, as is common in limestone formations, were found, and all the usual curiosities of a limestone cave; but what surprised all of us most was the discovery of several bones, partly coated with a limstone petrifaction. Whether they were human bones or otherwise we could not tell, but no one could help reflecting on the awful death that the creature, whether man or beast, to whom the bones belonged, must have endured, under the combined horrors of solitude, darkness, thirst, and starvation; nor could we help indulging in curious, though profitless, speculations as to the circumstances which led this hapless creature on to its terrible end. After spending about an hour and a half in exploring the cave, without finding an outlet, the explorers cut the letters U. S. F. C. in the rock, and filled a sack with the curiosities they had collected, which was fastened to the end of a rope, and pulled up by those outside. Then commenced the difficult and dangerous ascent. All three reached the top safely, though nearly exhausted; and, after retracing our steps to where we could once more see the welcome light of day, the party cheered the explorers, fired a salute, and returned to the camp.

The recreations in summer evenings usually consisted in boxing, wrestling, running, jumping, bathing, and target-shooting with rifles, revolvers, or Indian bows and arrows, and other similar outdoor amusements. Occasionally a gold-fever would strike the camp, and parties would hunt for gold around the house, but never with any paying returns, though considerable gold-dust was collected altogether.

Our table this year was well supplied. Possibly relying upon the general protection afforded by the presence of so many white men at our camp, one of the neighboring ranchmen did what had never been attempted before on the McCloud, namely, to drive a flock of sheep into the Indian country on the east side of the river. Hitherto this land had always been given up to the Indians for pasture for their horses, and when the sheep came, destroying every blade of grass, and leaving a desolate waste for their horses, the Indians resented it, as well they might. It certainly seemed cruel in the extreme, but, agreeably to the maxim that there is no great loss without some small gain, our camp was kept in capital mutton (it has not its superior in the world) from the sheep which brought such calamity upon the original owners of the soil. Besides the mutton, which was regarded as the principal luxury of our table, we had for fresh meats, venison, and occasionally, but not often, beef; and for cured meat, ham and bacon. Salmon and trout, of course, we had in abundance, and they were, each in its season, excellent. Of fresh vegetables, we had potatoes, onions, and tomatoes in abundance, with some turnips, green corn, and string beans. Baked beans were on the table at every meal.

The camp was kept well supplied with fruit, especially grapes, apples, and peaches, through the kindness of one of our neighbors, Mr. Clinton Johnson, who would take no return for his generous supplies, except an occasional present of salmon. The grapes in magnificent bunches were especially delicious.

Ah-Sin, our Chinaman, was a good cook, he made excellent bread, and always succeeded in giving us a very palatable meal.

The weather was of course pleasant till the end of the dry-season. Once we had a shower in the air, as it might be called, for it really did not wet the ground, and on a few days there were clouds in the sky; but with these exceptions the days were perfectly cloudless.

This summer was an unusually cool one, and there were but very few occasions when the weather was uncomfortably hot, although on one day the thermometer rose to 157° in the sand near the house; and we actually cooked an egg in the heated sand.

The nights were very cold, as is usual in this mountain region, the difference between the temperature at 3 p. m. and 7 a. m. of the same day usually being as much as 40°, and sometimes 50°; *e. g.*, July 9, July 20, September 3, as will be seen by the table of temperatures. (See p. .)

The heat of the sun in the middle of the day was, of course, severe, and extremely so on the exceptionally hot days. The wonder is that the young men from New England were able to endure it as they did.

The rainy season came on about the middle of October, two or three weeks earlier than was expected. From that time till our camp broke up, in the latter part of November, it rained, with an occasionally pleasant day now and then almost all the time. One morning early it snowed, though no snow remained on the ground; one of the rains was terrific.

It did not seem possible that the clouds could pour down such a deluge of water in so short a time. The rain fell in sheets and columns. The dry gulches about the camp became, in ten minutes, river channels, which would float a boat. The McCloud rose six inches in half an hour, and became apparently as turbid as the Sacramento. The gutters to the roof overflowed; the water poured down the chimney, and extinguished the fires; the swollen current of the river snapped the bridge in two in the middle, and carried one of the 20-ton stone piers a rod down the stream. It was literally a deluge while it lasted; then suddenly it stopped raining, the clouds vanished, the sun came out, and as lovely a day followed as ever was seen.

Two wind storms visited the McCloud Valley while we were there. The first lifted the large tent like a feather, and brought it to the ground with a collapse as sudden as it was unexpected to those working inside. The second was equally severe, and would have done the same mischief, had we not taken the precaution to wire the tent down with coarse iron wires.

Our quarters were tolerably comfortable. They consisted of a one-story building 24 feet by 26 feet, containing six rooms. They were the bunk-room, 12 feet square, containing 8 bunks, a fire-place, and nothing else; a store-room, 6 feet by 8 feet, where the supplies were kept, with the bunk for the Chinese cook; a front room, 12 feet by 14 feet, with four bunks; a kitchen, 12 feet by 6 feet; Mr. Woodbury's room, 6 feet by 12 feet, with two bunks; and my own room, of the same size, with one bunk.

These quarters would be considered rather small in New England for our large force, but in this climate people really live out of doors, and most of our Indians slept outside, either in the small tents or under the open sky.

Through the dry season we dined, and, indeed, had all our meals on the large piazza in front of the house, which was protected from the sun's rays by means of an awning. During the fishing season, the fishermen slept at the camp at the lower fishing ground.

Of the natural surroundings of our camp, an idea can be obtained from the following paragraph taken from an article by Mr. William M. Turner in the Overland Monthly of January, 1875:

"This stream has been selected with good judgment. Fed by the eternal streams of Shasta, some seventy miles from its mouth, its waters are icy cold, and, as yet, undisturbed by the miner's pick, as clear as the sunlight that pierces its azure pools and whirling eddies. No dams or other artificial obstacles obstruct its course, and it is now the most prolific and favorite spawning ground of the Pacific. A point on the river about twenty miles from Reading, the present terminus of the Oregon and California Railroad, and about three miles from its junction with the Pit River, one of the largest tributaries of the Sacramento, has been selected for the hatching works, and, among all the beautiful spots in California, none more lovely nor more grandly picturesque than this could have been chosen.

"The grade of the California stage-road curves over the hill a few hundred feet above the fishery, and from this point the view is magnificent. Eastward Mount Persephone, an immense wall of granite, shoots up athwart the sky, rising abruptly over 2,000 feet from the water's edge, seamed and scarred by the by-gone ages, and frowning down sullenly, as if jealous of the innovations below. Round the base of 'Big Mountain,' the beautiful river sweeps like a blue ribbon, flecked and sparkling here and there with bits of silver spray that bubble up from its ever-changing, restless current. Willows and water plants fringe the banks with their graceful drapery; wild flowers of brilliant hue light up the rugged hillsides; the bright, airy green of the manzanita shimmers on ridge and mountain crest; and the great moss-covered oaks, swinging their gnarled branches amid the music of the waters, lend a charm to the scene of peaceful beauty."

OUR NEIGHBORS.

Our neighbors were Mr. George Allen and wife, who kept the stage station a mile and a half west of the camp; the ferryman at Pitt River Crossing, four miles down the river, Mr. O'Conner, commonly called "Old Jack," who lived alone, four miles up the stage-road; Dr. Silverthorne, who lived with an Indian wife, seven miles from camp on

Cow Creek, and Mr. Campbell, eight miles up the river, who also has an Indian wife. We had no other white neighbors within twelve or fourteen miles.

We were surrounded by Indians, of course, this being an Indian country.

Conchoolooloo, the head-chief of the tribe, lived very near us on the bank of the river. "Jim Mitchell," the other chief, has a rancherie and "porum boss," (council-house or theatre,) in the forest a mile and a half from the camp.

There was a marked improvement this year in the disposition of the Indians towards our party. The first two years, 1872 and 1873, they regarded us with more or less dislike and suspicion. This year there was an entire change in them. They seemed to have learned that we were their friends, that we had a genuine consideration for their welfare and were opposed to anything like tyranny or oppression, and when I passed over to them the thousands of salmon which we caught and had used for spawning, their hearts were entirely won over, and I think that we now have as individuals the confidence and friendship of the tribe.

They express their sense of the difference between us whom they call "the far-off white men," and the whites they have been accustomed to, by a saying they often use: Chocky yapitoo *chipkalla;* kelail yapitoo *challa*. "The white men near here, *bad;* the far-off white men, *good.*"

At all events I thought I noticed this year an entire change for the better in their disposition toward us, though it should be remembered, that all the time in the depth of their hearts they wish that the whole race of white intruders were cleared out of the country, and if this much-desired consummation could be accomplished with impunity all personal considerations for us would be sacrificed to the common good.

Near our camp is the graveyard of their chiefs and magnates, where good Indians of the McCloud have been buried for centuries. The living members of the tribe are in constant fear lest we should dig up these graves for relics. This fear, caused without doubt by the casual remarks of our party on the subject, is well illustrated by the following unique petition brought to me one day, with great formality and seriousness. The Indian woman who brought it had employed some white friend to draw it up for her. It reads thus:

"SHASTA, *September* 11, 1874.

"This is to certify that Mrs. Matilda Charles Empire, one of the old settlers of Shasta County, is now on a pilgrimage to the graves of their ancestors, and she prays Commissioner Stone not to disturb any of her friends and relatives who have gone the way of all flesh, and thus they will ever pray; by

"Her husband,

"EMPIRE CHARLEY.
"MATILDA CHARLEY.

"Their sister,

KATE CHARLEY."

GAME.

The large game, I regret to say, is disappearing from this locality, owing, without doubt, to the approach of the railroad and the increasing facilities which it affords for hunting in this vicinity. I noticed a marked change even in the two years of my experience here. In 1872 it was a common thing to get a deer in the immediate vicinity of the camp: now it is a rare thing. During our stay on the McCloud fresh bear-tracks were continually seen, and several bears were killed: this year I have not heard of the killing of a single bear, and their tracks are not abundant. Only a few years ago grizzly bears used to occupy, almost undisturbed, a wild, rocky cañon not two miles from the site of our camp: now the grizzlies have all retired for several miles.

Smaller game, as quails and water-fowl, still remain, however; and there are minks and wild-cats enough left to make it very unsafe for poultry.

EXTRACTS FROM JOURNAL.

1874.

July 5.—Reached camp at 3½ a. m. All hands set to work on the fishing-ground.

July 6.—Made a corral for the cow. First haul of the seine. Visit from a Warm Spring Indian engaged in the Modoc war last year.

July 7.—Mr. Woodbury arrived with Ah Sin, the cook.

July 8.—Mr. Myron Green caught a salmon with a fly. Supplies arrived at noon. A busy afternoon.

July 9.—Visit from Conchoolooloo, the Indian chief. Mercury in thermometer, in the sun, 159°—in the sand near the house. Chinaman very sick.

July 10.—Mr. Woodbury killed a rattlesnake, making seven that have been killed in the neighborhood this summer. Launched the boat to-day. Target-shooting in the evening.

July 11.—The Chinaman went out in the boat and was carried over the rapids but not injured.

Sunday, July 12.—A party of us made the very steep ascent of the lower summit of Mount Persephone. Unpleasantness between the Chinaman and Indians. United States flag raised to-day.

July 13.—First photographs taken. All hands went to an Indian dance in the evening. Comet seen to-night for the last time in the evening here.

July 15.—Timber came to-day and we laid the floor of the new house.

July 16.—Bought cow and calf.

July 20.—Moved headquarters to-day to Brush Camp, out of doors. Felled several large trees for the bridge.

July 21.—Rattlesnake was killed opposite the house. Twenty minutes' exposure to the rays of the sun this afternoon cooked an egg.

July 22.—Blew up rocks in the river-channel, below the wheel, with giant powder.

July 23.—Thunder was heard to-day; there was a slight rain in the afternoon.

July 24.—Water from a strong sulphur-spring near by is used quite extensively in camp, and with beneficial results. The second pier in the bridge was placed to-day.

July 25.—After the day's work was done, a party started in search of a cave in Mount Persephone.

July 26.—A large limestone cave, forming a very handsome grotto, was found in the mountain. Two rattlesnakes were encountered.

July 27.—A little gold-digging was done to-day, and some gold found. A camping expedition was sent out to-day in search of poles.

July 30.—Camping expedition returned, having felled five hundred trees.

July 31.—Bridge across the McCloud was completed to-day. Quails very abundant around the house.

August 1.—A load of lumber having come yesterday, additional bunks were constructed, and other improvements were made.

August 2.—Nearly all the camp turned out to-day, it being Sunday, in search of another cave in the mountain, of which we had heard rumors. The cave was found after some difficulty, and extended through a long, winding passage-way, which ended in a chamber 50 feet high, 150 feet long, and 40 feet wide.

August 5.—An unusual number of Indians about the camp to-day. Took a photograph of Conchoolooloo, the chief of the tribe.

August 7.—Several minks were seen playing in the water, just in front of the house. One hundred and forty-seven salmon, weighing about a ton, were caught in one haul to-night.

August 10.—The dam across the McCloud River, obstructing the ascent of the salmon, was completed to-day.

August 13.—All hands at work to-day in the tent on the hatching-apparatus. The Indians fish a good deal in the river about this time, at night, diving, themselves, for the salmon with a hand-net, which they use in the water with wonderful skill.

August 16.—Made the ascent of the summit of Mount Persephone. Height found by aneroid barometer to be 4,100 feet above the level of the sea.

August 18.—An Indian woman came to the camp for protection, being pursued by an Indian, whose brother she had killed.

August 19.—The Indian in pursuit arrived in camp this morning, armed with a six-shooter. Danger of another murder. The Indian, after some flourishing of his revolver, was peremptorily ordered to leave the camp, which he did.

August 20.—Quails very abundant around the camp.

August 23.—Our poultry has been nearly all killed by minks and wild-cats.

August 25.—A thunder-shower at night.

August 26.—First ripe pair of salmon. About two hundred salmon caught at one haul of the seine.

August 27.—Water below the bridge is black with salmon, trying to pass it.

August 29.—Wild plums ripe and abundant.

August 30.—Another rattlesnake killed.

September 1.—A wind-storm blew down the large tent.

September 3.—Indians hold a large council in an immense underground council-house.

September 4.—The seine was caught on a rock in the rapids, and torn in pieces.

September 5.—A large salmon, fresh from the sea, was caught.

September 10.—Expedition for moss left to-day for Mount Shasta.

September 13.—A party of Indians, on a pilgrimage to the graves of their ancestors, arrived to-day, and presented a petition, requesting us not to disturb the bones of the buried forefathers.

September 15.—Large trout very abundant in the river, where the white salmon-eggs had been thrown.

September 19.—Water in the river getting too cold to bathe in, its temperature being at 50° in the morning.

September 20.—The eye-spots of the eggs taken the first part of this month are now very distinctly seen.

September 25.—The first shipment of the eggs was made to-day.

September 28.—Grand festival of the McCloud Indians at their underground council-house.

October 1.—Very violent and copious rain; the McCloud River rose a foot, and carried away a section of the bridge. Sent a second expedition after moss.

October 5.—Packed 750,000 eggs to-day.

October 6.—Sent second lot of salmon-eggs.

October 7.—Hear coyotes howling at night. Found some excellent raisins to-day, formed from grapes which had been accidentally left in the sun.

October 9.—Sent third lot of eggs by express.

October 10.—Another violent rain last night.

October 11.—Fourth lot of salmon-eggs sent off to-day.

October 12.—Very violent wind-storm this afternoon. The rainy season seems to have set in, although it is not expected till three weeks later.

October 13.—Fifth lot of eggs sent off.

Record of temperature at the United States fishery, McCloud River, California.

TEMPERATURE OF AIR.

Date.	6 a. m.	3 p. m., shade.	3 p. m., sun.	6 p. m.
1874.	°	°	°	°
July 8	55	100	126	75
9	54	106	*138-9	78
10	68	100	123	74
11	58	102	112	82
12	64	97	112	74
13	57	100	120	....
14	60	100	110	74
15	56	98	128	73
16	58	95	107	80
17	49	93	113	80
18	51½	91	113	74
19	....	96	115	70
20	48	98	120	72
21	60	101	130½	80
22	58	100	129	70½
23	58	72	†72	‡70
24	67	99	119	76
25	62	93	106	....
26	....	90	116	72
27	....	82	100	69
28	62	87	98	68
29	53	92	120	71½
30	63	94	114	72
31	51	§92	106	73
Aug. 1	50	90	112	73
2	48½	90	102	68
3	48½	89½	106	68
4	48½	87	96	76
5	52	....	....	67
6	47½	93	104	68
7	47½	98	102	72
8	50	88	100	73
9	50	90	110	66
10	50	91½	108	74
11	48	86	95	74
12	50	81	95	73
13	53	85	100	74
14	59	85	100	67½
15	48	84	98½	69
16	51	99	110½	74
17	50	94	118	74
18	52	96	117½	74
19	50	90	100	69½
20	46	84	105	69
21	43	87	103	69
22	43	88½	99	74
23	....	88	100	74
24	50	84	106	74½
25	52	93	114	79
26	58	95	115	78
27	56	93	102	74
28	58	97	116	74
29	52	95	115	....
30	....	....	....	....
31	44	93	115	74
Sept. 1	64	89	108	73
2	67	93	118	68
3	48	100	122	73
4	52	....	....	73
5	52	84	100	74
6	46	83	100	68
7	44	79	92	68
8	52	76	86	67

Date.	6 a. m.	3 p. m., shade.	3 p. m., sun.	6 p. m.
1874.	°	°	°	°
Sept. 9	37½	86	90	65
10	38	76	98	60
11	54	77	99	65
12	46	88	100	69
13	46	96	108	66½
14	64	98	116	66
15	46	92	112	78
16	65	93	113	65
17	30	90	100	70
18	64	90	110	70
19	48	92	108	68
20	68	90	110	68
21	48	86	104	66
22	43	84	100	67
23	43	80	101	68
24	44	84	104	64
25	45	....	....	50
29	....	90	110	58
30	49	82	Cloudy.	61½
Oct. 1	40	64	Rainy.	59
2	41	61	....	50
3	52	78	102½	59
4	50	81	100	60
5	55	80	96	58
6	48	79	99	56
7	50	96	110	60
8	53	94	115	68
9	54	80	91	64
10	50	78	92	60
11	52	83	100	60
12	51	72	96	53
13	....	....	....	66
14	47	82	100	63
15	65	86½	100	63
16	51	84	95	63
17	51	73	82	61
18	56	58	58	54
19	57	59	59	51
20	52	66	82	55
21	53	....	....	58
22	53	51	63	56
23	51	56	56	53
24	47	....	....	46
25	32	37	37	37
26	40	42	42	40
27	41	....	....	43
28	38	52	74	43
29	35	50	87½	43½
30	35	57	90	42
31	35	57	90	42
Nov. 1	....	....	....	45
2	35	....	....	48
3	38	....	....	53½
4	50	51	54	52
5	53	50	52	45
6	33	....	....	47
7	42	45	45	45
8	46	50½	51	51
9	50	54	54	52
10	50	53	53	53
11	53	58	62	50
12	52	....	....	49

* In sand, 157°.
‡ Thunder, with rain, all the afternoon.
† Cloudy.
§ 5 a. m.

Record of temperature of McCloud River at the United States fishery, California.

Date.	6 a.m.	12 m.	7 p.m.
	°	°	°
July 6	54	58	58
7	56	58	58
		3 p.m.	6 p.m.
8	56	60	58
9	56	60	58
10	56	60	58
11	56	62	60
12	57	62	61
13	56	62	....
14	56	62	61
15	56	61	61
16	56	61	61
17	56	61	60
18	58	60	59
19	....	60	50
20	56	60	58
21	55	62	60
22	56	62	60
23	56	58½	58
24	56	61	60
25	56	62	(*)
			7 p.m.
26	....	61	60
27	....	60	58
28	55	58½	57½
29	55	59½	58½
30	55	59	58
31	54	†59	58½
Aug. 1	54	60	58½
2	....	59½	58
3	54	59½	58
4	54½	....	57½
5	53½	58½	57½
6	53½	58½	57½
7	53½	58	57½
8	53½	58	57½
9	54	58	57
10	53½	58	57
11	53½	58	57
12	53	58	57
13	54	59	58
14	54	59	58
15	53½	58	57½
16	53	60	58
17	54	59	58
18	54	59½	58
19	54	59½	58
20	53½	58½	56
21	53	57½	57
22	52	57	56
23	....	58	57
24	53	58	57½
25	53½	58½	58
26	54	52	58
27	54	58½	58
28	54	60	58
29	54	59	....
30	....	....	....
31	52½	58½	58
Sept. 1	52½	57½	57½
2	53	58	56

Date.	6 a.m.	3 p.m.	7 p.m.
	°	°	°
Sept. 3	52	57	56
4	52	....	56
5	52	57	56
6	56	57	56
7	52½	57	56
8	52½	59	56½
9	51	55	55
10	49	54	54
11	49½	54	54
12	50	54	54
13	50	55	55
14	50	56	56
15	52	57	56
16	52	56	56
17	51	56	56
18	51½	56	56
19	50	56	56
20	52	56	56
21	57	56	54
22	50	53	54½
23	50	55	55
24	50	55	54
25	50	....	....
29	....	55	53
30	50	55	53½
Oct. 1	50	53	51½
2	49	54	50
3	50	53	52
4	50	55	54
5	50	54	53
6	51	55	53
7	50	55	53
8	50	54	53
9	51	54	53
10	51	55	54
11	51	55	53
12	50	54	51
13	48	53	51
14	48	53	52
15	49	51	51
16	48	54	52
17	48	51	51
18	49	50	49
19	49	51	50
20	48	49	49
21	58	49	50
22	48	50	49
23	49	50	49
24	48	....	49
25	44	43½	45
26	42	43	43
27	43	....	45
28	44	47½	47
29	44	47	47
30	44	46½	46
31	42	46	45
Nov. 1	....	....	46
2	42	....	45
3	44	....	47
4	47	48	47
5	48	48	48
6	....	....	47
7	44	45	45
8	44	47	46
9	47	49	47
10	48	48	48
11	49	50	50
12	49	....	....

* Thunder, with rain all the afternoon; rain during night.

† 5 a.m.

Temperature of water in hatching-troughs.

Date.	7 a. m.		3 p. m.		7 p. m.	
	Inlet.	Outlet.	Inlet.	Outlet.	Inlet.	Outlet.
	°	°	°	°	°	°
Sept. 10	49	48	54½	56	54	59
11	49	49	56	56½	54	54
12	49	49	56	56½	55	55
13	50	50	57	58	56	56
14	50	50	57	60	56	58
15	51	50	58	59	57	57½
16	52	52	56½	58	56	56
17	51	51	56½	57	56	56
18	51½	51½	56½	58	56	56
19	50	50	56	56½	56	56
20	52	52	56	56½	57	56
21	51	51	56	56	54	54
22	50	50	55	56	54½	55
23	50	50	55	56	55	55
24	50	50	54	55	54	54
25	50	50	....	....	....	....
29	....	....	54	55½	53	53
30	50	50	54	55	53	54
Oct. 1	50	50	53	54	52	53
2	49½	50	53	56	50	52
3	48	48	52	52	52	53
4	50	50	55	55	54	54
5	50	51	54	55	53	54
6	51	51	54	55	54	54
7	50	50	55	56	53	54
8	50	50	54	55	53	53
9	51	51	54	55	53	53
10	51	51	55	55½	54	54½
11	51	51	55	56	53	54
12	50	50	53	54	51	51
13	....	....	....	....	51	53
14	47	47	53	54	52	52
15	49	49	52	52	51	51
16	48	49	52	52	51	51
17	48	48	51	51	51	51
18	49	49	50	50	49	49
19	49	49	50	50	49½	49
20	48	48	49½	49½	49	49
21	48	48	....	....	50	50
22	49	49	50	50	49	49
23	49	49	50	50	49	49
24	48	48	....	....	49	49
25	44	44	43½	43½	45	45
26	42	42	43	43	43	43
27	43	43	....	....	45	45
28	44	44	47	47	47	47
29	44	44	46	46	45	45
30	44	44	47	47	46	46
31	42	42	40	40	45	45
Nov. 1	42	42	....	....	45	45
2	42	42	....	....	45	45
3	44	44	....	....	47	47
4	47	47	48	48	48	48
5	48	48	48	48	48	48

Temperature of the Sacramento River, taken at Tehama bridge, for the month of May, 1874, at 3 p. m.

Date.	Temperature of air.	Temperature of surface.	Temperature of bottom.	Date.	Temperature of air.	Temperature of surface.	Temperature of bottom.
	°	°	°		°	°	°
May 7	64	54	54	May 20	82	61	61
8	74	57	54	21	88	62	62
9	76	56	56	22	72	60	60
10	76	58	58	23	82	60	60
11	79	59	59	24	84	62	62
12	86	60	60	25	80	60	60
13	85	60	60	26	78	60	60
14	90	60	60	27	72	60	60
15	90	61	61	28	78	60	60
16	92	62	62	29	86	60	60
17	88	62	62	30	92	62	62
18	88	63	63	31	86	64	64
19	80	62	62				

Temperature of the Sacramento River, taken at Sacramento City, for the months of April and May, 1874, at 3 p. m.

Date.	Air in shade.	Air in sun.	Temperature of the surface.	Temperature of the bottom.	Date.	Air in shade.	Air in sun.	Temperature of the surface.	Temperature of the bottom.
	°	°	°	°		°	°	°	°
April 9	74	80	56	54	May 6	60	66	57	57
10	54	......	54	53	7	58	91	57	57
11	62	68	54	53	8	73	78	57	56½
12	56	58	53	52	9	73	77	57	57
13	60	......	53	52	10	75	97	58½	58
14	62	81	53	52	11	76	98	61	61
15	62	85	54	53	12	83	110	62	62
16	66	78	54	53	13	77	85	62	61
17	67	81	55	54	14	81	95	62	61
18	70	......	55	55	15	86	100	63	61
19	70	75	56	55	16	87	107	63½	62
20	66	74	57	57	17	87	90	63	62
21	68	84	57	57	18	84	94	63	62
22	70	84	57	57	19	76	85	62½	61
23	78	86	57	57	20	80	No sun.	63	61
24	74	78	58	57	21	82	85	63½	61
25	68	74	57	57	22	72	No sun.	62½	61
26	69	96	58	57	23	82	106	64	62
27	76	81	58	57	24	81	85	63½	62
28	78	98	59	58	25	82	88	63	61½
29	69	......	59	57	26	75	83	63¼	62
30	64	66	57	56	27	57	No sun.	63	63
May 1	65	87	57	56	28	73	88	64	62
2	75	78	56	55	29	78	91	64	63
3	76	97	57	56	30	83	102	64	63
4	64	70	57	56	31	77	83	64½	63
5	59	No sun.	57	56					

Catalogue of Collection to Smithsonian Institution, contributed in 1874.

356. Wyedardeeket. McCloud Camp. July 2, 1874.
357. Trout. McCloud Camp. July 15, 1874.
358. Wyedardeeket. July 8, 1874.
359. Catfish. Elkhorn River, Nebraska. June 8, 1874.
360. Wyedardeeket. McCloud Camp. July 5, 1874.

361. Trout. Lake Tahoe, California. June 11, 1874.
362. Wyedardeeket. McCloud Camp. July 1, 1874.
363. Wyedardeeket. McCloud Camp. July 4, 1874.
364.
365. Trout. McCloud Camp. July 10, 1874.
367. Trout. McCloud Camp. August, 1873.
368. Male salmon. McCloud Camp. July 12, 1874.
369. Wyedardeeket. McCloud Camp. July 2, 1874.
370. Fish. (sp?) San Francisco. June 20, 1874.
371. Trout. McCloud Camp. August, 1873.
372. Trout. McCloud Camp. August, 1873.
373. Trout. McCloud Camp. August, 1873.
374. Salmon. McCloud Camp. July 12, 1874.
375. Trout. Lake Tahoe. June 11, 1874.
376. Bass. Elkhorn River, Nebraska. June 8, 1874.
377. Catfish. Elkhorn River. June 8, 1874.
378. Female trout, caught with hook. McCloud Camp. July 16, 1874.
379. Female trout, caught with hook. McCloud Camp. July 16, 1874. Weight 1½ pounds, girth 9¾ inches.
380. Catfish. Elkhorn River. June 8, 1874.
381. Catfish. Elkhorn River. June 8, 1874.
382. Female salmon. McCloud River. July 14, 1874. Weight 13 pounds, girth 15 inches.
383. Wyedardeeket. United States Salmon Camp. Caught with hook. July 16, 1874.
384. Catfish. Elkhorn River.
385. Salmon milt. July 8, 1874. McCloud Camp.
386. Catfish. Elkhorn River, Nebraska. June 8, 1874.
387. Skin of female salmon, taken same day as 382. Eggs were much less developed than 382. Skin has a marked reddish tinge. Weight 22 pounds, girth 17 inches. McCloud River. July 14, 1874.
389. Trout. McCloud River. July 15, 1874.
390. Catfish. Elkhorn River, Nebraska. June 8, 1874.
391. Trout. McCloud Camp. July 15, 1874.
393. Bass. Elkhorn River, Nebraska. June 8, 1874.
394. Female trout. McCloud Camp. July 10, 1874.
395. Trout. McCloud Camp. July 10, 1874.
396. Bass. Elkhorn River, Nebraska. July 12, 1874.
397. Catfish. Elkhorn River. June 8, 1874.
398. Crawfish. Santa Barbara, Cal. June 19, 1874.
399. Trout. McCloud River, California. July 16, 1874.
401. Wyedardeeket. McCloud Camp. July 4, 1874.
402. Trout. Independence Lake, headwaters of little Truckee River. Spawn and milt, ripe. July 3, 1874.
403. Trout. Independence Lake. These fish were spawning; there was snow about the lakes.

404. Trout; male. McCloud River. Handsome fish; weight, 2 pounds; girth, 2½ inches. July 17, 1874.

405. Salmon; male. July 18, 1874. McCloud Camp. Length, 27 inches; girth, 14 inches; weight, 6 pounds.

406. Salmon; male. July 18, 1874. McCloud Camp. Length, 30 inches; girth, 16 inches; weight, 8 pounds.

407. Young grilse. McCloud Camp. July 18, 1874.

408. Grilse. July 18, 1874. Length, 20 inches; girth, 11 inches; weight, 2½ pounds.

409. Small trout. July 18, 1874. McCloud Camp.

410. Small trout. July 18, 1874. McCloud Camp.

411. Alcohol bottle of salmonidæ. McCloud Camp. July 18, 1874.

412–416. Heads of salmon, all male, taken August 1, 1874, and packed in strong salt brine.

417. Male salmon. McCloud River. August 28, 1874.

418. Female salmon. McCloud River. August 28, 1874.

419. Male salmon head, taken at spawning time, September 3. McCloud River.

420. Female salmon head, taken at spawning time, September 3. McCloud River.

421. Male salmon, taken after ripe season partly over. Girth, 1 foot 3 inches; weight, 10 pounds; length, 30 inches; dark-colored skin. September 4, 1874. McCloud River.

422. Female salmon, partly spawned, taken September 4. McCloud River fishery. Girth, 1 foot 5 inches; weight, 12 pounds; length, 13 inches; beautiful spotted tawny skin; and unusually long for the size.

423. Head of a *very large* male salmon. Girth, little over 2 feet; length, about 40 inches. Caught in McCloud River, September 5, 1874. Looked as if it had come directly from the sea, the scales not being yet absorbed into the skin, as is the common rule among other fish taken here.

424. Large male salmon, from the sea, with scales upon him. Girth, 1 foot 9 inches; length, 3 feet; weight, 19 pounds; eyes very small; silvery, very thin and greasy skin.

425. Young trout. McCloud River. September 22, 1874. Very handsome, and with silvery scales.

426. Young trout. McCloud River. September 24, 1874.

427. Very large, fierce male salmon. McCloud River. September 26, 1874. Girth, 23 inches; weight, 30 pounds; length 42 inches.

428. Young trout. McCloud River. September 27, 1874.

429. Young trout. McCloud River. September 27, 1874.

430. Young trout. McCloud River. September 25, 1874.

431. Young trout. McCloud River. September 25, 1874.

432. Young trout. McCloud River. September 25, 1874.

433. Young trout. McCloud River. September 25, 1874.

434–435. Wyedardeeket. McCloud River. September 18, 1874.

436. Specimens of young salmonidæ. McCloud River, California. From September 1 to October 1, 1874.

437. Jar of various specimens from McCloud River Camp. Lizards, Poison lizard, (local name,) tree-toad, beetle, snails.

438. Trout. Soda Creek, Siskiyou County, California. September 12, 1874. Contributed by R. D. Hubbard.

439. Wyedardeeket skin and head. McCloud River, California. Eggs very little developed.

440. Wyedardeeket. McCloud River, California. United States fishery. Very large for this locality.

441. Water ouzel. (Sourcinny, Indian name.) McCloud River. United States fishery, California. October 17, 1874.

SECOND CALIFORNIA AQUARIUM CAR.

Under the auspices of the California fish commission, I left Charlestown, N. H., on the 4th of June, 1874, with a car-load of living eastern fish, and arrived in California on the 12th of June, after a journey of eight days.

Below will be found a tabulated statement of the results of the expedition.

SECOND CALIFORNIA AQUARIUM CAR, 1874.

List of fishes which arrived alive at their destinations, and the waters into which they were introduced.

Numbers started with.	Where procured.	Numbers deposited.	Place of deposit.
FRESH-WATER FISH.			
75 full-grown black bass, (Micropterus salmoides.)	Lake Champlain, Vermont....	73	Napa Creek.
24 small black bass, (Micropterus salmoides.)	Saint Joseph's River, Michigan	12	Alameda Creek.
18 full-grown glass-eyed pike, (Stizostedion.)	Missisquoi River, Vermont ...	16	Sacramento River.
76 large Schuylkill catfish	Raritan River, New Jersey....	74	San Joaquin River.
Mississippi catfish	Elkhorn River, Nebraska	......	San Joaquin River.
71 horn-pouts, (Amiurus)................	Lake Champlain, Vermont....	70	Ponds or sloughs near Sacramento.
4 cans small silver-eels, (Anguilla)	Hudson River, New York.....	1 can.	Sacramento River.
450 small Penobscot salmon, (Salmo salar) .	Penobscot River, Maine.......	305	Sacramento River, near Reading.
6 full-grown rock bass	Missisquoi River, Vermont ...	4	Napa Creek.
SALT-WATER FISH.			
24 small tautogs, (Tautoga onitis)........	Wood's Hole, Massachusetts ..	23	Bay of San Francisco.
2 cans small salt-water eels, (Anguilla) .	New York Harbor	1 can.	Bay of San Francisco.
150 full-grown spawning lobsters.	Massachusetts Bay	2	Great Salt Lake.
		4	Bay of San Francisco.
1 barrel of oysters.....................	Massachusetts Bay	1 bbl.	Great Salt Lake.

Times of starting and arrival of the second aquarium car.

Car left Charlestown, N. H., June 4, 1874.

Reached Albany, N. Y., Thursday, June 4, at 12 p. m.

Reached Rochester, N. Y., Friday, June 5, at 10.30 a. m.

Reached Suspension Bridge, N. Y., Friday, June 5, at 2 p. m.
Reached Niles, Mich., Saturday, June 6, at 4.20 p. m.
Arrived at Chicago, Ill., Saturday, June 6, at 8.30 p. m.
Left Chicago, Ill., Sunday, June 7, at 10.15 a. m.
Left Cedar Rapids, Sunday, June 7, at 8 p. m.
Arrived at Omaha, Nebr., Monday, June 8, at 10.30 a. m.
Left Omaha, Nebr., Monday, June 8, at 1 p. m.
Arrived at Elkhorn River, Nebraska, Monday, June 8, at 2.30 p. m.
Arrived at Grand Island, Nebraska, Monday, June 8, at 9.15 p. m.
Arrived at Big Springs, Nebr., Tuesday, June 9, at 8.15 a. m.
Arrived at Sidney, Nebr., Tuesday, June 9, at 11.30 a. m.
Arrived at Laramie, Wyo., Tuesday, June 9, at 7.10 p. m.
Arrived at Green River, Wyo., Wednesday, June 10, at 8.30 a. m.
Arrived at Evanston, Utah, Wednesday, June 10, at 3.20 p. m.
Arrived at Ogden, Utah, Wednesday, June 10, at 6 p. m.
Arrived at Elko, Nev., Thursday, June 11, at 8.45 a. m.
Arrived at Carlin, Nev., Thursday, June 11, at 10.15 a. m.
Arrived at Humboldt, Nev., Thursday, June 11, at 6.15 p. m.
Arrived at Wadsworth, Nev., Thursday, June 11, at midnight.
Arrived at Truckee, Cal., Friday, June 12, at 4.55 a. m.
Arrived at Sacramento, Cal., Friday, June 12, at 1.30 p. m.
Arrived at San Francisco, Cal., Friday, June 12, at 8.15 p. m.

XXIII.—CORRESPONDENCE RELATING TO THE SAN JOAQUIN RIVER AND ITS FISHES.

SAN FRANCISCO, CAL., *April* 14, 1875.

DEAR SIR: Your letter 39449, addressed to Dr. Thomas M. Logan, has been handed to me.

I have made the request of Mr. S. S. Montague, chief engineer, and he has issued the orders for the temperature of the San Joaquin River to be taken at the railroad-crossing from this on. It will be taken and returned to you as it has been in the case of the Sacramento River.

I have not much information as to the run of salmon in the San Joaquin. Some salmon go up the San Joaquin, and, it is said, spawn in the headwaters of the main stream, and some in the Merced, near the Yosemite Valley. This is not from personal knowledge, but report.

Formerly there was considerable work done in the catching of salmon in the San Joaquin, but of late years it has been abandoned, as it has been partially in the Sacramento, above Sacramento City. The fishermen here have found by experience, what had been previously ascertained in Scotland, that the fish, after they come in from the ocean, remain for a time, and run back and forth from fresh and salt water, probably to get rid of parasites, and then start for the spawning-grounds; therefore, they fish for them with more profit in the vicinity of where the fresh and salt water meet, than they do above in the fresh water, where they do not remain, but continue as rapidly as possible on their journey to the spawning-grounds.

I suppose that the fish are still going up the San Joaquin to spawn, but, if taken at all, are only now taken by Indians on the Merced, the Chowchilla, the Fresno, and the other branches of the San Joaquin, and I have no doubt they continue to do so. Many branches of the San Joaquin take their rise in the highest mountains of the continent, and as the streams are unvexed by miners, they are admirably adapted for spawning purposes.

Our commission will probably, in another year, put some McCloud River salmon into the Kern River, which empties into Kern Lake and Buena Vista slough, and, so on, into Tulare Lake. We may also put some salmon into the main San Joaquin and its branches.

I will attempt to obtain positive and definite information as to the present condition of the salmon in the San Joaquin and its branches. I think that the evidence, when obtained, will show that the San Joaquin is very much warmer than the Sacramento, for if you will look at the map you will see that although it drains a higher range of mountains, yet, that it runs one hundred fifty and miles, at least, through the center of an almost tropical valley.

Very respectfully, &c.,

B. B. REDDING.

Prof. SPENCER F. BAIRD,
Smithsonian Institution, Washington, D. C.

P. S.—We hatched out about 20,000 white-fish of those you so kindly forwarded, and on the 28th ultimo I turned them out in Tulare Lake. I have no doubt they will thrive, as there is abundance of food. Tulare is a peculiar lake. On its entire eastern shore its bottom has a descent of only about a foot in a mile; it is quite deep on the western shore; the evaporation is so great on the eastern shore that the water becomes slightly alkaline, and is always warm, while in the center and on the western shore it is cold and pure. For two miles or more wide and thirty miles long, the water on the eastern shore is filled with minute animal life. Its fish are as yet, I believe, undescribed. I have seen a perch and some very coarse-scaled suckers (*Catostomus.*) There is a fine large white-fleshed fish, about 2 feet 6 inches long, which the people call "lake trout." It is not a "salmon." It is excellent food, quite abundant, and in constant demand. It looks to me to be a carp, and of finer flavor than any I ate in Europe.

B. B. R.

FRESNO, *April* 25, 1875.

DEAR SIR: In regard to catching fish and the different kinds that are in the San Joaquin River, as far as I have been able to find out, is as follows:

During the summer there is no fish of any consequence, except a large kind of what is called sucker, but in the fall the salmon and salmon-trout find their way up here in large quantities. Last fall I helped to spear quite a number, as that is about the only way of fishing in this part of the country; but below the San Joaquin bridge I understand they were trapped in a wire corral by ranchers and fed to hogs; they were so plentiful. Besides the two kinds mentioned there are small rock-bass, and I have seen something resembling black bass, but in rather scant numbers.

If I can furnish you with any more information on this subject, please let me know.

Yours,

WALTER NETHERCLIFT.

Mr. B. B. REDDING.

SAN FRANCISCO, CAL., *May* 11, 1875.

DEAR SIR: Your letter of April 29 just received. I am making inquiries and gathering information relative to the salmon in the San

Joaquin, and as the general result of this information, am satisfied they make their annual immigrations to the headwaters for spawning in large quantities. A few years since, they spawned near the Yosemite Valley. A dam built for mining purposes, some four or five years since, prevented them from reaching this spawning-ground. Last year the dam was removed and the fish have again free access to the headwaters of the Merced, but whether they have returned to their former spawning-grounds on this river, which is a branch of the San Joaquin, I have not learned. I will write to Millerton, near the headwaters of the San Joaquin, so as to have information as soon as they reach that point this spring, and I will again communicate with you.

I think it would be advisable for you to instruct Mr. Stone to send one or more of his assistants to the San Joaquin for the purpose of observing the salmon on their way to the spawning-ground and having some caught and forwarded to you. I think, from all I can learn, that they differ somewhat from the McCloud River salmon, and that they remain for weeks and months in the rivers, in a climate much warmer than Florida or Mississippi. In fact I have no doubt that you will find in the San Joaquin a salmon which might be successfully introduced into rivers emptying into the Gulf of Mexico.

I will try and procure for you some of the carp brought by Mr. Poppy from Hamburg, and which he is now successfully raising in Sonoma County, and sending to market here.

We have done nothing about introducing the Gourami from China. We find it very difficult to make business connection with people in China in relation to these matters. All Americans in business in that country appear to be entirely absorbed in other matters, and have no knowledge or take no interest in fish-culture, or of obtaining new varieties of fish.

I gave Mr. Stone a letter of introduction to United States Minister Avery, who formerly resided here. He is a man of culture, and alive to every interest that would benefit the United States or, especially, this State. When Mr. Stone shall have received a reply, I will then open a correspondence with Minister Avery and see what we can do in relation to this matter. By-the-bye, Ex-United States Minister F. F. Low informs me that there are in the rivers of China a much larger and finer-flavored shad* than that of the Atlantic States. It is largely consumed in China, and it is considered a great delicacy. He is convinced that it would be a valuable acquisition. I also learn that there is on the coast of Japan a shrimp, averaging from four to six inches long, and very delicate in flavor, but how we are to get either the shad from China or the shrimp from Japan here, I do not know.

I will send you by express soon a box containing two of the Idaho red-fish, which you will see are a new variety of lake-trout, or land-locked salmon, as yet undescribed.

* Probably the Sam lai (*Alosa Reevesii*, Rich.)

The gentleman from whom I procured them writes me that when alive in the water they are all of a beautiful vermilion, very nearly the color of gold-fish, and that they are considered excellent eating. I would be pleased, if after their receipt and examination, you will give me your views in relation to these fish. Unfortunately, instead of being placed in alcohol, they were packed in a box of salt, but still I think they are not so shrunk but that you can determine their class.

I trust that when your carp come from Germany we may receive a few for propagation. We have any quantity of lakes, surrounded by tule and other vegetable growth, admirably adapted to carp, filled now with only very poor and coarse suckers and chubs, except in the case of Tulare Lake, where there is a large, fine fish, locally called lake-trout, but which I believe to be of the carp kind. I will try and procure one of them and forward to you.

Very respectfully, &c.,

B. B. REDDING,
Secretary California Fish Commission.

Prof. S. F. BAIRD,
Smithsonian Institution, Washington, D. C.

SAN FRANCISCO, CAL., *August* 25, 1875.

SIR: I have received some further information relative to salmon in the San Joaquin River. Mr. O'Neil, who has charge of the railroad-bridge crossing the San Joaquin River, in latitude 36° 30′ north and longitude 120° west, writes me, on the 13th August, that the salmon have commenced running up and are passing by the bridge in quantities. He states that they do not appear to be any different from the Sacramento salmon.

The run of salmon in this river, at this particular season of the year, seems somewhat extraordinary, from the fact that it is in the midst of the summer, and to reach this point they have passed for one hundred and fifty miles through the San Joaquin Valley, where the temperature of the air at noon is, at this season of the year, never less than 80°, and is often as high as 110°.

The record of temperature of air and water is kept at that point and forwarded regularly to you. I find, on examination, that the mean from the 16th to the 31st, was, for the air, 104¾°, water at the surface, 80°, water at the bottom, 79°, mean of the depth of the river, 4 feet 7⅜ inches. The record, when received, will show that the mean of both air and water in July was higher.

It seems very extraordinary to me that there should be a run of salmon at this season of the year come in from the ocean for the purpose of spawning, and passing up a river for more than one hundred and fifty miles, where the temperature of the air and water are so high as these figures show. It but confirms Mr. Livingston Stone's theory, in his report to you, that somewhere in California the salmon are spawning about every month in the year, but until the receipt of this report from O'Neil, I did not suppose that there were any salmon that pass through the hottest portion of the State for the purpose of spawning during the hottest season of the year. It appears to me that these salmon might be introduced into any of the southern rivers of the United States and possibly into the Rio Grande.

Should I receive further information I will forward it to you.

I would like to know if you received the box, containing two red-fish, from Idaho, packed in salt and sent to your address, at the Smithsonian Institute.

Very respectfully, &c.,

B. B. REDDING.

Prof. S. F. BAIRD,

Smithsonian Institution, Washington, D. C.

XXIV.—THE ATLANTIC SALMON (SALMO SALAR).

A—REPORT ON THE COLLECTION AND DISTRIBUTION OF PENOBSCOT SALMON IN 1873-'74 AND 1874-'75.

By Charles G. Atkins.

1.—METHODS.

The modes employed in the collection of salmon-eggs at Bucksport in 1873 and 1874, and in their development and distribution, have been so closely like those of 1872-'73, fully described in the report for that season, that it will be simply necessary to specify the changes and new features introduced.

No changes were made in the mode of collecting breeding-fish from the weirs, save the larger use of boxes in bringing them together from the several weirs where they were caught to the boat wherein they were to be brought to Bucksport, and some improvement in the fittings of the transporting-boats and in the materials of the dipping-bags. The latter were at first made of cotton-duck, pierced by brass grommet-holes. Hemp was found to be superior to cotton, having greater flexibility, strength, and durability, but the brass grommets are still used.

At the pond, a much larger inclosure was made than in 1872, embracing about twelve acres at time of high water, and probably nine acres at low water, with an area of at least six acres 5 to 9 feet deep at the lowest stage. The 650 salmon inclosed in 1873 had therefore very nearly a square rod of deep water for each. For the brush-hedge, which proved so ineffectual in 1872, there was substituted a strong net, its top suspended on stakes and its lower edge held down by a heavy chain. Owing to the favorable natural contour of the pond, this large inclosure required a net only 640 feet long and about 18 feet deep. Within this inclosure, the arrangements for catching the salmon at the breeding-season were the same, with some extension, as before, and in 1874 nets were stretched along all the inclosed shores with the view of shutting them off from gravel to spawn on, that they might be more certain to enter the brook or the pounds and thus come within reach.

In the brook itself there was built a board sluice about 20 inches wide, rising and falling with the water, to lead the salmon directly from the outlet-gate to the pens at the spawning-shed. This contrivance, for which we are indebted to Mr. Alfred Swazey, effected a great saving in the labor of collecting the fish, and in the eggs, of which a good many were formerly lost here when the fish had access to the gravelly bottom of the brook.

The arrangement of the hatching-house and apparatus has remained as shown in the cuts of the previous report.

In the mode of packing eggs for transportation, some change has been made. The apparatus which received the preference the former season consisted of tin boxes 5 or 6 inches in diameter and the same in depth, in which the eggs were placed in alternate layers with damp meadow-moss, disks of mosquito-net or similar material being placed above and beneath each layer of eggs to separate them from the moss and facilitate unpacking, the tins to be inclosed in boxes of sawdust to protect against frost. These tins have latterly been superseded by wooden trays, which afford a more expeditious and economical mode of packing. The trays mostly used have been 3 inches deep, and in length and breadth either 24 inches by 18 or 18 by 12. The larger size was found to be objectionable because it afforded room for the eggs to get out of place by the sliding of the mass of eggs and moss from side to side, when, as is often the case in transport, the boxes are carelessly allowed to ride upon their sides. This was remedied by dividing the trays by a partition in the middle; and in the smaller trays no serious trouble of that sort was experienced. The depth adopted was found to be sufficient to admit three or four layers of eggs in moss, separated, as before, by mosquito-net. When filled, the trays were placed in stacks, four or five deep, and secured together by strips of wood tacked on the sides, making a rectangular package easily fitted with an outside case and an intermediate space for sawdust. This package, when all complete, ready for shipment, holds from 5,000 to 10,000 eggs per cubic foot, and is at once the cheapest and most compact consistent with the safety of the eggs.

2.—PURCHASE OF BREEDING-SALMON.

The run of salmon in the Penobscot in 1873 was better than average, though hardly so good as that of 1872. The weather prevailing in June was very favorable, and the catch of the weirs from which I was buying salmon was so large that the requisite number of breeders was secured in a very short time. The work of collection began June 7 and closed June 24; in the intervening sixteen working-days, 650 salmon were collected, being something over 40 per day. The best day's work was on the 16th, when 105 salmon were received and placed in the pond.

In 1874, however, the weather and the supply of salmon were both against us, and we were engaged from June 9 to July 21, including thirty-seven working-days, in collecting 601 salmon. In quality, however, the salmon of 1874 were superior to any received since the establishment was founded, being uncommonly stout and fat. This was more noticeable among those of the smaller class, which may be held to include all those under 15 pounds in weight. Among this class, the most common weights are, in ordinary seasons, 10 and 11 pounds, a few exceeding 12 or falling below 10 pounds. This year a very large number weighed 13 or 14 pounds apiece; while of 10-pound salmon and smaller there were far fewer than usual. This superiority in weight was also characteristic in a less degree of the salmon of 1873. The general average weight for three years was as follows:

Year.	Size of salmon.		
	When bought.	When used in spawning.	
	Weight.	Weight.	Length.
	Pounds.	*Pounds.*	*Inches.*
1872	12.3	....	....
1873	13.28	12.28	32.24
1874	14.03	12.73	32.19

The weight at time of purchase was estimated; in the fall, it was obtained by weighing. It will be seen that the results correspond.

The extension of the period of collecting salmon to so late a date as July 24 was not from choice but from necessity. It was thought that there was a larger proportion of males among the salmon in the later than in the earlier part of the season; and since, at the best, we should have a surplus of that sex, it was considered very undesirable to increase their proportion. The result of the examination at the spawning-season, however, dispelled all fears on that score. The ratio of male fish was no larger than usual. Thus we had—

	Males, per cent.	Females, per cent.
In 1872	36.6	63.4
In 1873	33.9	66.1
In 1874	34.2	65.8

The mortality of salmon during and after transportation has become less each season. This is to be attributed largely to improved apparatus and modes of handling and greater care and skill on the part of the fishermen. As in the first season, the deaths of salmon occurred almost wholly immediately on arrival at the pond or within ten days thereafter. There is no evidence that the extreme heat of the water in the pond has had an injurious effect, though the observations show a much higher temperature than has been considered compatible with the healthy existence of salmon. Between the 28th day of June and the 13th day of August, 1873, there were only five days when the water at the bottom of the pond stood below 70° Fahrenheit, and on one occasion, July 31, it rose as high as 76° Fahrenheit. Not only did no salmon die during this heated term, but at the succeeding spawning-season they came out in perfect condition, and yielded eggs of the highest degree of health and vigor.

The weather has been less favorable to spawning-operations than in 1872. There was less rain, and the water in the pond and brook was at a lower stage in 1873 and still lower in 1874. One of the results was that the salmon found the descent into the brook more difficult, and were more reluctant to try it. We were therefore compelled to resort more to pounds and seines for catching them. These were so far successful that a larger proportion of the salmon were caught than the first season. In 1873, the number unaccounted for was 111, quite a serious loss; but, in 1874, this number was reduced to 40, which is a very satisfactory result.

The process of spawning was conducted in the usual way, the dry method of impregnation being exclusively employed with the usual success. In 1873, a careful examination of the eggs showed the rate of impregnation to be 97 per cent. The following year the examination was less thorough, but indicated about the same rate. There was no material variation in the season. Spawning began in 1873 on the 27th of October, and in 1874 on the 31st of October. Each year the most of the eggs were taken before November 20, but small lots as late as the first week in December.

3.—DEVELOPMENT AND DISTRIBUTION.

In the winter of 1873 and 1874, the development of the eggs proceeded in a manner highly satisfactory. Up to the time of distribution, there were taken out, by count, 160,963 white eggs, or about 6½ per cent. of the entire stock. Since the unimpregnated eggs amounted to only 3 per cent., or 73,000, and some remained among those that were sent away, it is probable that about 100,000 of the white eggs had been impregnated. The cause of this death of impregnated eggs is not well understood. Rough handling will cause it, but when handled in the most careful manner there is still a percentage of white eggs. The shipment of the eggs was commenced February 11, and closed March 30. Including those retained at Bucksport to be hatched for the State of Maine, there were distributed 1,300,000 eggs on account of the United States Commission, and 991,675 on account of the several States interested, making a total of 2,291,675. If to this sum we add the total of the bad eggs rejected, 160,963, we find the original number to have been 2,453,638. At the time of taking them, however, they were estimated at only 2,321,934.

In 1874 and 1875, the eggs gave no sign of any defect until packing for shipment was begun. It was then discovered that they did not resist the action of the atmosphere as well as usual. In a few hours after being taken from the water, even though enveloped in very damp moss, the outer shell was found to have shrunken. Some of the recipients of the packages remarked that the eggs were shrunken like raisins. In many cases, even on short journeys, a good many of the eggs burst open prematurely, and even of those that held together many were so injured that they died before hatching or soon after.* Nearly all the lots of eggs that were sent away suffered severely, and in the end so many of the young fish perished that the number set free in the rivers was but 56 per cent. of the number of eggs taken. Those that remained in the house at Bucksport until hatched succeeded much better than those sent away. About 266,000 eggs were left there, and 234,000 healthy young fish obtained from them; and the loss would have been smaller still had not there been among the eggs a few thousand that had been packed for shipment and afterward returned to the troughs.

So generally were the eggs affected that the malady cannot be attributed to any local cause in the hatching-house. The cause must have been one that operated on all the eggs this season and not at all in other seasons. Our observations show that the water used in the hatching-house, in which all the eggs developed, was, in November of this year, in an unusually low and turbid condition,—turbid with microscopic vegetation and saturated with solutions from the muddy bottom and shores of the pond,—was, in short, entirely unlike the clear new water that the autumn rains usually bring in before the close of October. In the action of this water on the eggs, either after spawning or before it had left the ovaries of the mother fish, it seems most reasonable to look for an explanation of the imperfect condition of the shells.† In all other respects, so far as known, these eggs had the same treatment as those of other years when they turned out healthy.

Means were taken to guard against a similar misfortune the next season, by preparations for the development of the eggs in another place, commanding a supply of better water, should circumstances demand it; but fortunately the water was renewed by the wonted rains, and at the time of this writing it is late enough to say that the eggs and young fry of 1875 and 1876 were perfectly healthy.

The eggs taken in 1874 were estimated, when they were measured into the troughs, at 3,056,500; but the measurement at time of distribution showed 2,842,977 divided among the subscribers, and previous to that

* In examining some of these weak eggs that had been standing at rest, I discovered that the weakest place in the shell was in each case just over the eyes of the embryo, and at that point the shell gave way on application of pressure. I do not know how to explain this phenomenon, unless it be that the shell of the egg is in normal cases softened by some secretion of the embryo at the proper time for birth, and that in the defective specimens the secretion was simply exuded prematurely.

† It is to be noted that the parent fish showed no signs of disease at any time, being in the fall remarkably fine.

division there had been picked out 263,479 bad eggs, which would make the original number 3,106,456. I am inclined to think the former estimate is nearest to the truth; but as the latter has been used by all the recipients of eggs in estimating their balances, I have used it in the statement of hatching and distribution, to be given below.

4.—MARKING SALMON FOR FUTURE IDENTIFICATION.

At your suggestion, I undertook, in 1872, to mark the salmon that had been used as breeders and set free again in the river, so that something might be ascertained in relation to the length of their absence from the river, their rate of growth, &c.

The first mode adopted was the use of an aluminum tag about half an inch long and a quarter of an inch wide, stamped with a number which corresponded with a record showing the sex, length, and weight of the fish, and the date of liberation. This tag was at first attached to a rubber band that slipped on over the tail of the fish. This mode was quite defective, and led to no favorable results. Those bands that were loose probably slipped off, and those that were tight enough to stay on cut through the skin of the fish, and produced a wound that probably resulted in death. When the impracticability of this mode became manifest, it was abandoned, and the tag was attached to the rear margin of the first dorsal fin, where it would least interfere with the motion of the fish, and where the action of the latter in swimming would give it the least lateral motion, and it would therefore be least likely to wear out of its place. The attachment was by means of a piece of fine platinum wire passed through a hole in the tag, and by means of a needle through the edge of the fin, the ends being carefully twisted together and trimmed with scissors. This mode was exclusively employed in 1873, and was partially successful. The tags, to be sure, did not stay so long as was desired. Five or six months after the liberation of the salmon in the river, a good many specimens were taken with the tag still adherent, but of those that were taken a year and a half afterward not one was found with the tag on. Probably it was attacked by some destructive acid in the water and so softened that the wire on which it swung cut its way out and let it fall off. Some of the tags on salmon turned into the fresh pond were found after a while to be in a soft and brittle condition. The wire, however, remained in a good many cases, and the kind of wire and mode of attachment served to identify a number of salmon afterward caught as of the number marked and liberated in 1873.

The first marking was, as stated above, in 1872. In the spring of 1873, a reward was offered and thoroughly advertised among the fishermen, for the return of any tagged salmon, with statements of the time and place of capture. Not one was brought. In 1874, the offer was repeated, and was so far successful that twenty of the salmon turned out the preceding autumn were returned to me between the first of January and the first of June, mostly in April and May. These were, without exception, poorer than when turned out. They had evidently not been to their feeding-grounds, and had not even left the river. Twelve of them were caught above Bucksport, and nine of them at Veazie, above Bangor, 25 miles above Bucksport, at the head of the tide, and at the foot of the first dam, which alone, it seems, had prevented their ascending the river still higher. Only four out of the twenty had lost the tags, and these retained the wire. Of nine that were weighed, one had lost only eight ounces since November; the others had lost from one to two pounds. The males still retained the hook on the lower jaw, but it was smaller than in the autumn; the red spots on their sides, and the oculated spots on their backs were a good deal faded, but still distinctly visible; in their spermaries appeared to be the remains of last year's milt. The females were almost as bright and silvery as when in prime condition; in almost every case, they carried in their abdomens a few remaining eggs of the last litter, and in their ovaries appeared the germs of the next litter already well established, though exceedingly small. No food could be found in the stomachs of either sex.

In the autumn of 1874, no salmon were marked. In the spring of 1875, the offers of reward for the return of marked salmon were renewed. Any that could be returned at this time would have been absent for a year and a half. We were partially successful. Eight salmon were brought in and examined. They weighed from 16 to 24¼ pounds, and were from 34½ to 40½ inches long. There were four females, two males, and two not determined. All were in prime condition. One of the females was placed alive in the pond, and yielded in the fall about 11,500 eggs. As explained above, the tag itself had fallen off, so that we could not trace the individual salmon back to the record of liberation, but the wire was still there, and proved beyond doubt that these were the salmon liberated in November, 1873. In addition to these eight, there was a large male, weighing 24 pounds, found among the salmon in the pond at the spawning-season, making the whole number known to have been caught *nine*. There were reports of others having been taken and sent to market; and from the fact that a very close scrutiny was necessary to detect the presence of the wire, I am quite confident that a good many more were actually taken and escaped notice. However, enough were caught to establish the fact of their return this season, the second season since their liberation; and as none did return in prime condition or in breeding condition the first season, we may consider it pretty well established that the Penobscot salmon enter the river to breed only once in two years.

This experiment will be renewed with the substitution of a platinum tag for that of aluminum.

5.—SUMMARIES.

The following statement shows the number of salmon bought for breeding stock, and the number brought to hand in the spawning-season, for three years past:

Year.	Salmon bought.	Salmon brought to hand at spawning-season.		
		Males.	Females.	Total.
1872	692	130	225	355
1873	650	143	279	422
1874	601	178	343	521
Sums	1,943	451	847	1,298

The following exhibits the number of salmon-eggs taken, lost, and distributed at Bucksport, and the number of young set free as the result of their hatching, for three years:

Year.	Eggs taken.		Eggs lost by count.	Eggs distributed.	Young salmon set free.
	First estimate.*	Second estimate.*			
1872	1,560,044	....	....	1,241,800	876,000
1873	2,321,934	2,453,638	160,963	2,291,175	2,064,445
1874	3,056,500	3,106,479	263,479	2,842,977	1,726,668
Sums	6,938,478	....	....	6,375,952	4,667,113

* The first estimate was obtained by measurement of the eggs at the time they were taken and placed in the hatching-troughs. The second estimate is obtained by adding the number known to have been thrown out to the number distributed among the subscribers. The discrepancy between the two estimates is, in 1873, nearly 6 per cent. of the original estimate; in 1874, less than 2 per cent.

TABLE I.—*Statement of salmon bought alive at Bucksport in 1873.*

Date.	Hour.	Whence received.	No. of salmon.	Weight of salmon. Several weights.	Aggregate.	Average.	Daily summary. No. of salmon.	Weights. Aggregate.	Weights. Average.	Date.
1873.				*Pounds.*	*Lbs.*	*Lbs.*		*Lbs.*	*Lbs.*	1873.
June 7	p. m	J. W.	6	24, 12, 11, 11, 10, 9	77	12.83				
7	p. m	A. H. W.	17	24, 22, 20, 20, 18, 14, 14, 12, 12, 12, 11, 11, 11, 11, 10½, 10, 10	242½	14.25				
7	p. m	A.	4	20, 18, 11, 9	58	14.50	27	377½	15.98	June 7
9	a. m.......	J. W.	4	12½, 12, 11½, 10	46	11.50				
9	a. m.......	A. H. W.	5	20, 15, 14, 12, 11	72	14.40	9	118	13.11	June 9
10	a. m.......	J. A. W.	4	18, 15, 15, 12	60	15.00				
10	p. m	J. A. W.	4	19, 15, 14, 11	59	14.75	8	119	14.87	June 10
11	a. m.......	A. H. W.	13	22, 20, 18, 12½, 12½, 12, 12, 11, 11, 11, 11, 11, 11	175	13.46				
11	a. m.......	J. W.	6	18, 17, 15, 11½, 10, 6	77½	12.91				
11	a. m.......	A.	11	17, 16, 13, 13, 12, 12, 10, 10, 10, 10, 9	132	12.00	30	384½	12.82	June 11
12	a. m.......	J. A. W.	2	20, 12	32	16.00				
12	p. m	J. A. W.	3	19, 12, 10	41	13.66				
12	a. m.......	A.	6	16, 14, 10, 10, 10, 10	70	11.66				
12	a. m.......	A. H. W.	16	21, 20, 20, 19, 18, 15, 15, 12, 12, 12, 12, 11, 11, 11, 10, 10	229	14.31				
12	a. m.......	J. W.	9	17, 12, 12, 12, 12, 11½, 11, 11, 10	108½	12.06	36	480½	13.35	June 12
13	a. m.......	A.	11	22, 20, 19, 13, 13, 13, 12, 11, 10, 10, 9	152	13.82				
13	a. m.......	A. H. W.	8	22, 18, 12, 11½, 11½, 11, 10, 9½	105½	13.19				
13	a. m.......	J. W.	4	12½, 12, 11, 11	46½	11.62				
13	p. m	J. A. W.	2	22, 12	34	17.00	25	338	13.52	June 13
14	11 a. m	A.	9	22, 21, 15, 14, 12, 10, 10, 10, 9	123	13.66				
14	12 m	A. H. W.	14	22, 20, 15, 14, 12, 12, 11, 11, 11, 10, 10, 10, 10, 10	178	12.71				
14	12 m	J. W.	13	22, 21, 19½, 18½, 12, 12, 11½, 11, 11, 10½, 10, 8, 7	174	12.38				
14	6 p. m	J. A. W.	6	20, 13, 12, 12, 10, 10	77	12.83	42	552	13.14	June 14
16	8 a. m	J. A. W.	10	20, 18, 14, 14, 12, 12, 12, 10, 10, 9	131	13.10				
16	1 p. m	A.	36	23, 22, 21, 21, 20, 20, 20, 18, 18, 18, 14, 13, 13, 13, 13, 12, 12, 12, 12, 12, 12, 12, 12, 11, 11, 10½, 10, 10, 10, 9, 9, 8, 8, 8, 8, 7.	482½	13.40				
16	2 p. m	A. H. W.	25	21, 20, 20, 20, 18, 15, 13, 13, 12, 12, 12, 11, 11, 11, 11, 10, 10, 10, 10, 10, 10, 10, 9½, 9, 9	317½	12.70				
16	2 p. m	J. W.	21	22½, 22, 21, 20, 20, 20, 15, 14½, 13, 12½, 12½, 12½, 12½, 12, 11½, 11½, 11½, 11, 11, 10, 8	304½	14.50				
16	9.30 p. m..	J. A. W.	13	20, 20, 20, 14, 13, 12, 12, 11, 11, 10, 10, 10, 9	171	13.15	105	1,406½	13.39	June 16

TABLE I.—*Statement of salmon bought alive at Bucksport in 1873*—Continued.

Date.	Hour.	Whence received.	No. of salmon.	Weight of salmon. Several weights.	Weight of salmon. Aggregate.	Weight of salmon. Average.	Daily summary. No. of salmon.	Daily summary. Weights. Aggregate.	Daily summary. Weights. Average.	Daily summary. Date.
				Pounds.	*Lbs.*	*Lbs.*		*Lbs.*	*Lbs.*	
1873. June 17	6 a. m	J. A. W.	4	19, 16, 11, 10	56	14.00				1873.
17	2 30 p. m.	J. W.	19	19½, 15½, 14, 13, 13, 12½, 12½, 12½, 12, 12, 11½, 11½, 11½, 11½, 11, 11, 11, 10½, 10	236	12.42				
17	3 p. m	A. H. W.	18	21, 20, 20, 18, 15, 13, 12, 12, 12, 12, 11, 11, 11, 11, 10. 10, 10, 10	239	13.28				
17	3 p. m	A.	24	22, 18, 18, 18, 16, 14, 13, 13, 13, 12, 12, 12, 12, 12, 12, 11, 11, 11, 10, 10, 10, 10, 10, 10	310	12.92	65	841	12.94	June 17
18	5.30 a. m.	J. A. W.	6	17, 13, 12, 12, 10, 10	74	12.33				
18	3 p. m	A.	18	22, 21, 21, 20, 20, 20, 18, 15, 14, 14, 12, 12, 12, 12, 12, 11, 11, 10	277	15.39				
18	3 p. m	J. W.	12	21, 13½, 12½, 12½, 12½, 12, 12, 12, 11½, 11, 11, 8	149½	12.46				
18	3 p. m	A. H. W.	11	15, 13, 13, 13, 12½, 12, 12, 11, 11, 11, 11, 10	131½	11.95	47	632	13.45	June 18
19	a. m	J. A. W.	2	13, 12	25	12.50				
19	4 p. m	A. H. W.	10	21, 20, 15, 13, 12½, 10, 12, 11, 11, 10	137½	13.75				
19	4 p. m	J. W.	6	22, 13, 12½, 12, 11½, 10½	81½	13.58				
19	4.30 p. m.	A.	6	20, 20, 14, 14, 12, 11	91	15.16	24	335	13.96	June 19
20	5 p. m	A. H. W.	9	15, 13, 12½, 12, 12, 11, 10, 10, 10	105½	11.72				
20	5 p. m	J. W.	10	20, 14, 13½, 13, 12, 11½, 11, 11, 10, 9	125	12.50				
20	5 p. m	A.	18	18, 14, 12, 12, 12, 12, 12, 12, 11, 11, 11, 11, 11, 10, 10, 10, 10, 9	208	11.55	37	438½	11.85	June 20
21	6 a. m	J. A. W.	6	20, 18, 14, 14, 12, 12	90	15.00				
21	7 a. m	A. H. W.	25	21, 20, 18½, 15, 15, 14, 14, 13½, 13½, 12½, 12½, 12, 12, 12, 12, 12, 11½, 11½, 11½, 11½, 11½, 11, 11, 10, 10	329	13.16				
21	1.30 p. m.	J. A. W.	4	21, 20, 14, 14	69	17.25				
21	3 p. m	A.	21	22, 20, 20, 15, 12, 12, 12, 12, 12, 12, 12, 12, 11, 11, 11, 10, 10, 10, 10, 10, 10	266	12.66				
21	6 p. m	A. H. W.	15	20, 18, 13, 13, 13, 12½, 12, 12, 12, 12, 11½, 11½, 11½, 11, 10	193	12.87				
21	6 p. m	J. W.	16	24, 23, 15½, 14, 13½, 13½, 13, 13, 13, 12½, 12½, 12½, 11½, 11½, 10½, 10½	224	14.00	87	1,171	13.46	June 21
23	9 a. m	A. H. W.	22	20, 16, 15, 15, 14, 14, 13, 13, 13, 12½, 12, 12, 12, 12, 12, 11½, 11, 11, 11, 10, 10, 10	280	12.72				
23	9 a. m	J. W.	7	14, 13, 12½, 11½, 11, 11, 10	83	11.86				
23	10 a. m	A.	14	22, 18, 12, 12, 12, 12, 12, 12, 11, 11, 10, 10, 10, 10	174	12.43				
23	4 p. m	J. A. W.	2	20, 13	33	16.50	43	570	13.26	June 23
24	5 a. m	J. A. W.	11	22, 20, 19, 15, 13, 12, 12, 12, 12, 11, 10	158	14.36				
24	11 a. m	A. H. W.	37	22, 22, 22, 18, 18, 15, 15, 15, 13, 13, 13, 13, 12½, 12½, 12½, 12, 12, 12, 12, 12, 12, 12, 12, 12, 12, 11½, 11½, 11½, 11, 11, 11, 11, 11, 11, 10, 10, 10.	487	13.16				
24	11 a. m	J. W.	2	19, 14	33	16.50				
24	11 a. m	A.	15	18, 18, 15, 14, 13, 12, 12, 12, 11, 11, 11, 11, 10, 10, 10	188	12.53	65	866	13.32	June 24
				Total	......	......	650	8,629½	13.28	

TABLE II.—*Statement of salmon bought alive at Bucksport in 1874.*

Date.	Hour.	Whence received.	No. of salmon.	Weight of salmon. Several weights.	Aggregate.	Average.	Daily summary. No. of salmon.	Weights. Aggregate.	Weights. Average.	Date.
1874.				*Pounds.*	*Lbs.*	*Lbs.*		*Lbs.*	*Lbs.*	1874.
June 9	....	J. A. W.	6	26, 25, 14, 13, 13, 12½	103½	17.25	6	103½	17.25	June 9
10	p. m	A. H. W.	14	24, 21, 13, 12½, 12, 12, 12, 11½, 11, 11, 11, 10½, 10, 10	181½	12.96				
10	p. m	J. W.	6	24, 21, 16, 11½, 11½, 11	95	15.83				
10	p. m	J. A. W.	2	23, 13	36	18.00	22	312½	14.20	June 10
11	....	A.	10	22, 13, 12, 12, 12, 11, 11, 10, 10, 9	122	12.20				
11	....	A. H. W.	15	23, 20, 18, 13, 12½, 12, 12, 11½, 11, 11, 11, 11, 11, 10, 10	197	13.13				
11	....	J. W.	2	20, 11	31	15.50				
11	....	J. A. W.	5	15, 14, 13, 12½, 11	65½	13.10				
11	....	A. H. W.	5	20, 13, 12½, 12, 10	67½	13.50				
11	....	J. W.	14	23, 18, 15½, 14½, 14½, 14, 13½, 13, 12, 12, 11½, 11½, 11, 10	194	13.86	51	77	13.27	June 11
12	....	A. H. W.	5	25, 24, 13, 12½, 11	85½	17.10				
12	....	J. W.	3	20, 11½, 10½	42	14.00				
12	....	A.	8	17, 14, 14, 12, 12, 12, 11, 9	101	12.62	16	228½	14.28	June 12
13	a. m	A. H. W.	9	25, 24, 22, 13, 12½, 10½, 10, 10, 10	137	15.22				
13	a. m	J. W.	4	19½, 11½, 10½, 10	51½	12.87				
13	4 p. m	J. A. W.	2	12, 10½	22½	11.25				
13	7 p. m	A. H. W.	8	21, 14, 13, 12½, 11, 11, 10, 10	103½	12.94				
13	7 p. m	J. W.	12	24, 23, 22, 20, 12½, 11½, 11, 11, 11, 10½, 10, 10	177½	14.79				
13	7 p. m	A.	6	22, 21, 12, 12, 11, 10	88	14.67	41	580	14.15	June 13
15	5 a. m	J. A. W.	4	24, 21, 20, 14	79	19.75				
15	9.40 a. m..	A. H. W.	15	20, 16, 15, 15, 14, 13, 13, 12½, 12, 12, 12, 12, 11, 10½, 10	198	13.20				
15	9.40 a. m..	J. W.	6	13, 12½, 12, 11½, 11, 10½	70½	11.75				
15	10.10 a. m..	A.	6	22, 15, 14, 12, 11½, 11	85½	14.25	31	433	13.97	June 15
16	10.30 a. m..	A.	10	23, 22, 15, 14, 14, 13, 12, 12, 12, 11	148	14.80				
16	11 a. m	A. H. W.	7	25, 24, 23, 20, 12, 12, 11½	127½	18.21				
16	11 a. m	J. W.	3	23, 12½, 10	45½	15.17				
16	6 p. m	J. A. W.	7	25, 21, 20, 15, 12½, 12½, 10	116	16.57	27	437	16.19	June 16
17	11 a. m	A. H. W.	7	13, 12, 12, 12, 11½, 11, 10	81½	11.64				
17	11 a. m	J. W.	13	24, 20, 20, 15, 14, 13½, 13, 12½, 12½, 12, 12, 12, 11½	192	14.77				
17	12 m	A.	8	23, 20, 15, 14, 12, 12, 11, 9	116	14.50	28	389½	13.91	June 17

TABLE II.—*Statement of salmon bought alive at Bucksport in 1874*—Continued.

Date.	Hour.	Whence received.	No. of salmon.	Weight of salmon. Several weights.	Weight of salmon. Aggregate.	Weight of salmon. Average.	Daily summary. No. of salmon.	Daily summary. Weights. Aggregate.	Daily summary. Weights. Average.	Daily summary. Date.
1874.				*Pounds.*	*Lbs.*	*Lbs.*		*Lbs.*	*Lbs.*	1874.
June 18	12.30 p. m..	A.	12	23, 21, 20, 19, 13½, 12½, 12, 12, 11, 11, 11, 9	175	14.58				
18	1 p. m	A. H. W.	17	24, 24, 23, 20, 15, 14, 13, 13, 13, 13, 12½, 12½, 12, 12, 12, 11, 10	254	14.94				
18	1 p. m	J. W.	13	22, 21, 20, 20, 14, 13½, 12, 12, 12, 11½, 11, 11, 11	191	14.69				
18	8.30 p. m..	J. A. W.	4	23, 19, 12, 11	65	16.25				
18	8.30 p. m..	R. A.	1	18	18	18.00				
							47	703	14.95	June 18
20	....	J. A. W.	6	27, 24, 14, 12½, 12, 10	99½	16.58				
20	....	A. H. W.	13	24, 22, 21, 20, 18, 14, 12½, 12, 12, 11½, 11, 10, 10	198	15.23				
20	....	J. W.	8	27, 22, 21, 16, 14, 13½, 13, 11	137½	17.19				
20	....	A.	7	23, 21, 15, 14½, 12½, 11, 10	107	15.29				
							34	542	15.94	June 20
22	12 m	J. A. W.	6	12½, 12½, 11, 10, 10, 9	65	10.83				
22	3.30 p. m..	A. H. W.	5	12½, 12, 12, 12, 11	59½	11.90				
22	3 30 p. m..	J. W.	2	25, 13	38	19.00				
							13	162½	12.50	June 22
23	....	A. H. W.	4	20, 13, 10, 9	52	13.00				
23	....	J. W.	5	18, 16, 14½, 14½, 13	76	15.20				
23	....	A.	8	19, 15, 14, 14, 13, 13, 12, 11	111	13.87				
							17	239	14.06	June 23
24	....	J. A. W.	4	22, 13, 12, 9	56	14.00	4	56	14.00	June 24
25	7 a. m	A. H. W.	9	22, 20, 15, 14, 13, 12½, 12, 12, 11½	132	14.66				
25	7 a. m	J. W.	7	22, 19, 18, 15, 12½, 12, 11½	110	15.71				
25	2 p. m	J. A. W.	3	22, 19, 14	55	18.33				
							19	297	15.63	June 25
26	9 a. m	A.	10	16, 14½, 14, 13, 13, 12, 12, 11½, 11, 10	127	12.70				
26	3 p. m	J. A. W.	5	23, 21½, 14, 12, 11	81½	16.30				
							15	208½	13.90	June 26
27	9 a. m	A. H. W.	12	15, 14, 13, 13, 12, 12, 12, 12, 12, 11, 11, 9	146	12.17				
27	9 a. m	J. W.	6	22, 13½, 12, 11½, 11½, 10	80½	13.42				
							18	226½	12.58	June 27
29	7 a. m	J. A. W.	4	12½, 12½, 12, 10	47	11.75				
29	9.30 a. m..	A.	9	20, 15, 14, 13½, 12½, 12, 12, 11, 10	120	13.33				
29	9.30 a. m..	A. H. W.	12	20, 16, 15, 13, 13, 13, 12½, 12, 11, 11, 10, 10	156½	13.04				
29	9.30 a. m..	J. W.	9	23, 13, 13, 12½, 12½, 12½, 12, 11½, 11	121	13.44				
							34	444½	13.07	June 29
30	10 a. m	A. H. W.	4	19, 16, 16, 12	63	15.75				
30	10 a. m	J. W.	5	15½, 14, 13½, 12½, 11½	67	13.40				
							9	130	14.44	June 30

32 F

July 1	11 a. m	A.	8	19, 16, 15, 13, 12, 12, 11, 10	108	13.50				
1	11 a. m	A. H. W.	8	20, 20, 15, 13, 13, 12, 12, 11	116	14.50				
1	11 a. m	J. W.	6	23, 21½, 19, 13½, 12½, 11½	101	16.83				
1	5 p. m	J. A. W.	3	12½, 12, 10	34½	11.50	25	359½	14.38	July 1
2	11.30 a. m ..	A.	5	23, 20, 14, 12, 11	80	16.00	5	80	16.00	July 2
3	12 m	A.	8	18, 12½, 12, 12, 11, 11, 10½, 10	97	12.12				
3	12 m	J. W.	9	22, 13½, 12½, 12½, 12, 11½, 11½, 11, 8	114½	12.72				
3	12 m	A. H. W.	14	19, 16, 15, 14, 13½, 13, 13, 13, 13, 12½, 12, 12, 11, 11	188	13.43	31	399½	12.89	July 3
4	12 m	A. H. W.	5	22, 16, 14, 13, 12	77	15.40				
4	12 m	J. W.	5	23, 22, 15, 12½, 12	84½	16.90	10	161½	16.15	July 4
6	....	J. A. W.	2	12, 8	20	10.00				
6	....	A. H. W.	6	16, 13, 12½, 12, 11½, 11	76	12.66				
6	....	J. W.	6	13, 12½, 12½, 11½, 10, 10	69½	11.58	14	165½	11.82	July 6
7	3 p. m	A. H. W.	1	14	14	14.00				
7	3 p. m	J. W.	10	23, 14, 13½, 12½, 12½, 12, 12, 11½, 11, 11	133	13.30				
7	3 p. m	J. A. W.	1	12½	12½	12.50				
7	4 p. m	A.	6	14, 12, 12, 11½, 11, 10	70½	11.75	18	230	12.78	July 7
8	....	A. H. W.	9	22, 15, 14, 13, 13, 12, 12, 11, 11	123	13.66				
8	....	J. W.	8	13, 12½, 12½, 11, 11, 10½, 10½, 10	91	11.37	17	214	12.59	July 8
10	....	J. W.	3	20, 13, 11	44	14.66				
10	....	A. H. W.	4	22, 13, 12, 9	56	14.00				
10	....	A.	5	18, 13½, 11, 10½, 10	63	12.60	12	163	13.58	July 10
14	....	J. A. W.	4	23, 16, 12½, 11½	63	15.75				
14	....	A. H. W.	3	19, 18, 11	48	16.00	7	111	15.86	July 14
15	....	J. W.	3	22, 18, 11½	51½	17.16				
15	....	A.	9	12, 12, 12, 11, 11, 10, 10, 10, 9	97	10.77	12	148½	12.37	July 15
18	....	A. H. W.	5	19, 13, 12, 12, 11	67	13.40				
18	....	J. W.	4	12½, 12½, 12, 12	49	12.25				
18	....	A.	3	17½, 13, 11	41½	13.83	12	157½	13.12	July 18
21	....	A. H. W.	5	13, 12, 12, 11, 11	59	11.80				
21	....	J. W.	1	10½	10½	10.50	6	69½	11.58	July 21
				Total	....	....	601	8,429½	14.03	

TABLE III.—*Statement of salmon examined and eggs obtained in October, November, and December,* 1873.

Date.	Salmon caught.			Condition of females.				Eggs obtained.	
	Males.	Females.	Total.	Unripe.	Ripe.	Spent.	Total examined.	Weight.	Approximate number.
1873.								*Lbs. oz.*	
Oct. 20	4	5	9	......	......	......	......	....	....
21	4	8	12	......	......	......	......	....	....
27	......	......	......	8	5	......	13	4 14	41,000
28	1	4	5	......	4	......	4	17 0	45,300
29	1	3	4	......	3	......	3	9 3	27,000
30	5	9	14	......	9	......	9	35 2	101,500
31	15	20	35	1	19	......	20	59 9	174,400
Nov. 1	6	6	12	......	6	......	6	29 3	84,600
3	3	8	11	......	8	......	8	26 15½	80,600
4	0	8	8	......	8	......	8	30 8¼	84,200
5	0	7	7	......	7	......	7	19 5	56,700
6	1	8	9	......	8	......	8	25 13½	74,800
7	4	5	9	......	2	......	2	5 13	16,500
8	28	64	92	......	65	2	67	214 0¼	603,300
9	2	5	7	......	......	......	......	....	....
10	1	8	9	......	11	1	12	43 3	118,900
11	1	10	11	......	8	......	8	23 14	71,400
12	4	21	25	......	19	2	21	58 2	158,000
13	36	34	70	......	27	4	31	85 7½	243,200
14	5	9	14	......	14	3	17	39 14¼	109,000
15	1	6	7	......	4	1	5	13 6	37,800
17	......	......	......	......	......	......	......	2	400
18	5	7	12	......	5	2	7	17 7	46,000
19	10	9	19	......	2	......	2	8 12	24,700
20	1	4	5	......	10	......	10	24 0½	70,000
22	2	2	4	......	1	......	1	2 0	5,300
25	2	2	4	......	1	2	3	3 2	9,500
26	1	5	6	......	2	......	2	10 3½	28,000
Dec. 3	0	2	2	......	1	2	3	3 13	10,600
4	......	......	......	......	......	......	......	1½	234
Sums	143	279	422	9	249	19	277	820 15¼	2,321,934

TABLE IV.—*Statement of salmon examined and eggs obtained in October, November, and December*, 1874.

Date.	Salmon caught.			Condition of females.				Eggs obtained.	
	Males.	Females.	Total.	Unripe.	Ripe.	Spent.	Total examined.	Weight.	Approximate number.
1874.								*Lbs. oz.*	
Oct. 31	44	80	124	28	52	......	80	157 6	431,700
Nov. 2	37	51	88	9	42	......	51	128 3	342,000
3	8	18	26	1	17	......	18	64 4	170,000
4	32	42	74	......	42	......	42	122 8¼	351,000
5	7	12	19	......	12	......	12	145 1½	375,000
6	4	12	16	......	12	......	12	47 11	126,000
7	11	31	42	......	31	......	31	110 3	282,000
9	8	21	29	......	21	......	21	87 13	228,000
10	10	12	22	......	12	......	12	55 0¼	150,000
11	10	17	27	......	16	1	17	66 2¼	189,300
12	1	16	17	......	15	1	16	21 7	59,000
13	1	11	12	......	11	......	11	78 9	196,000
14	0	1	1	......	1	......	1	....	....
15	1	......	1	......	......	......	......	....	....
16	1	......	1	......	......	......	......	....	....
17	0	3	3	......	3	......	3	15 2	38,000
18	0	1	1	......	1	......	1	....	....
19	1	2	3	......	2	......	2	....	....
20	0	4	4	......	4	......	4	10 1	24,500
21	0	3	3	......	3	......	3	....	....
22	2	2	4	......	2	......	2	....	....
23	0	1	1	......	1	......	1	26 4	60,500
25	0	1	1	......	1	......	1	3 14	9,000
28	0	1	1	......	1	......	1	2 10	7,000
Dec. 1	0	1	1	......	......	......	......	....	....
2	......	......	......	......	1	......	1	4 6¼	12,000
8	......	......	......	......	......	......	......	2 0	5,500
Sums	178	343	521	38	303	2	343	1,147 10¼	3,056,500

Table V.—*Statement of measurement of salmon in October, November, and December, 1873.*

Date.	Measurement of males.								Measurement of females.												
	Number measured.	Weight in pounds.				Length in inches.				Number measured.	Weight before spawning, in pounds.*				Weight after spawning, in pounds.†				Length in inches.			
		Aggregate.	Average.	Heaviest.	Lightest.	Aggregate.	Average.	Longest.	Shortest.		Aggregate.	Average.	Heaviest.	Lightest.	Aggregate.	Average.	Heaviest.	Lightest.	Aggregate.	Average.	Longest.	Shortest.
1873.																						
Oct. 28	1	15¼	15.25	15¼	15¼	39	39.	39	39	5	63.3	12.66	17.7	9.4	147½	9.50	13½	7	162	32.4	35½	29½
29	1	6½	6.50	6½	6½	31½	31.5	31½	31½	3	35.7	11.97	18.6	8.2	26½	8.83	14	6	98	32.7	37	29½
30	4	52	13.	20½	9	126½	31.6	40½	31	11	134.1	12.19	19.4	9.	99	9.	14½	6½	358	32.5	38	30
31	21	287	13.67	21½	10	716	34.1	39½	31	20	257.1	12.81	19.2	8.7	198½	9.92	14½	7½	646½	32.3	37½	29
Nov. 1	6	77	12.83	15	10½	199	33.2	34½	32	8	110.5	13.81	21.4	10.5	87¼	10.91	16	9	260	32.5	37	29½
3	5	50½	10.10	12	8	160	32.	33½	29½	9	98.1	10.90	17.2	8.9	75½	8.39	12½	6½	283	31.4	36	29½
4	....	....	....	....	....	....	....	....	....	9	106.5	11.68	17.4	8.6	78½	8.72	12½	6½	282½	31.4	36	29½
5	....	....	....	....	....	....	....	....	....	7	72.9	10.41	11.9	8.9	54	7.71	8½	7	215½	30.8	32½	29
6	1	10½	10.50	10½	10½	33	33.	33	33	8	97.0	12.12	19.4	8.8	73	9.12	15	6½	257½	32.2	38	29½
7	2	21½	10.75	11½	10	64½	32.2	33½	31	2	21.3	10.65	10.7	10.6	15½	7.75	8	7½	61½	30.7	31½	30
8	27	316½	11.72	23	8	883½	32.	39¼	28½	66	*898.5	*13.61	22.2	‡7.2	684½	10.37	16½	6½	2,145½	32.5	38	29
10	4	47	11.75	20	8	133	33.2	40	30	12	119.7	9.97	14.8	‡5.9	88	7.33	10½	5	366	30.5	33½	28½
11	1	9½	9.5	9½	9½	32	32.	32	32	8	89.9	11.24	17.8	8.9	66	8.25	13½	6½	253½	31.7	37	29½
12	4	38½	9.62	11	8	127½	31.9	31	30½	21	238.1	11.34	19.1	‡7.9	180	8.57	14½	6	672	32.0	37	29½
13	30	380½	12.66	22½	8	997½	33.2	40½	29½	31	360.0	11.61	12.6	‡7.3	274½	8.85	14	6	969½	31.3	36½	28
14	....	....	....	....	....	....	....	....	....	17	174.8	10.28	12.6	‡8.1	142	8.35	10	7	514½	30.3	32	29
15	1	12½	12.5	12½	12½	33½	33.5	33½	33½	5	61.9	12.38	21.4	9.1	48½	9.70	15½	7	160½	32.1	37	28½
18	....	....	....	....	....	....	....	....	....	7	90.4	12.91	20.2	‡8.	73	10.43	15½	7	233	33.3	37	30
19	....	....	....	....	....	....	....	....	....	2	22.0	11.	11.5	10.5	15½	7.75	8	7½	62½	31.2	31½	31
20	....	....	....	....	....	....	....	....	....	10	111.5	11.15	‡14.9	9.	87½	8.75	13	7	318	31.8	37	29
22	....	....	....	....	....	....	....	....	....	1	9.	9.	9.0	9.	7	7.	7	7	30½	30.5	30½	30½
25	....	....	....	....	....	....	....	....	....	3	27.1	9.03	10.1	‡8.2	24	8.	8½	7½	93½	31.2	33	30
26	....	....	....	....	....	....	....	....	....	2	37.7	18.85	18.9	18.8	27½	13.75	14	13½	75	37.5	37½	37½
Dec. 3	....	....	....	....	....	....	....	....	....	3	25.8	8.60	11.4	‡6.3	22	7.33	8	6	89½	29.8	31	28
Sums	108	1,324¾	12.26	23	6½	3,578½	33.13	40½	28½	270	3,262.9	*12.08	22.2	‡5.9	†2,495¼	†9.24	16½	5	8,608	31.88	38	28

*On November 8, and on nearly every day from that date to the close of the season, there were among the females examined some that had dropped a portion of their eggs. These are included in the measurements, and of course somewhat reduce the aggregate and average weight before spawning for those dates and in the summary. The figures for all dates previous to November 8 represent the true gross weights for that period, and their average is found to be 12.14.

†The figures given as "Weight after spawning" represent the weight immediately after the first or main spawning. A very small quantity, averaging not far from 1¼ ounces of eggs, remained in the ovaries of each female, to be taken out at a subsequent manipulation. Strict accuracy requires, therefore, that an allowance should be made on this account. The total weight of these residual eggs during the season was about 30 pounds, which indicates a reduction of about 12 thousandths on all the figures in the columns of weight after spawning. This gives us a general average of 9.13 pounds instead of 9.24 pounds.

‡The females thus marked had dropped part of their eggs, and the figures given are therefore less than their true gross weights.

TABLE VI.—*Statement of the measurement of salmon in October, November, and December, 1874.*

Date.	Measurement of males.									Measurement of females.												
	Number measured.	Weight in pounds.				Length in inches.				Number measured.	Weight before spawning, in pounds.*				Weight after spawning, in pounds.				Length in inches.			
		Aggregate.	Average.	Heaviest.	Lightest.	Aggregate.	Average.	Longest.	Shortest.		Aggregate.	Average.	Heaviest.	Lightest.	Aggregate.	Average.	Heaviest.	Lightest.	Aggregate.	Average.	Longest.	Shortest.
1874.																						
Oct. 31	44	582½	13.24	26½	9	1,428½	32.5	41	29	52	679.2	13.06	21.7	9.1	525	10.09	16	7	1,648½	31.7	39	29
Nov. 2	37	501	13.54	22	9¼	1,216	32.9	40	29½	42	575.4	13.70	23.9	9.6	449	10.66	18	7¼	1,336	31.8	37	29
3	5	50½	10.10	12½	9	159½	31.9	34	31	17	199.4	11.73	20.3	8.4	146½	8.62	15½	6	538	31.6	37½	28½
4	32	372	11.62	24	9	1,042	32.6	41	30½	48	477.5	11.37	21.4	7.4	355	8.45	15½	5¼	1,300	30.9	37	28½
5	4	42½	10.62	12½	9½	128	32.	35	30	40	527.1	13.18	22.3	7.4	392	9.80	15½	5½	1,309½	32.7	38	29
6	4	51½	12.87	22	9½	133	33.2	39	31	12	167.1	13.92	22.1	9.9	123½	10.29	16½	7¼	390½	32.5	39	29
7	11	121½	11.05	18	8½	355½	32.3	38	30½	31	401.7	12.96	22.5	8.4	291½	9.40	16½	6	998	32.2	38	28½
9	8	100	12.50	21	9	270½	33.8	40	31	21	297.6	14.17	23.9	9.1	216½	10.31	18	7	684	32.6	38	29
10	8	75½	9.44	11	8	253½	31.7	33	31	18	207.5	11.53	19.7	8.2	152½	8.47	14½	6	572½	31.8	38	29
11	10	104½	10.45	11½	9½	325½	32.3	33½	30½	19	*241.6	*12.71	21.5	8.7	180½	9.53	15½	6¼	611½	31.6	38	29½
12	1	11	11.	11	11	33	33.	33	33	5	80.9	16.18	21.2	9.9	59½	11.90	15½	7	174	34.8	38	21
13	.....	.....	.....	.....	.....	.....	.....	.....	.....	21	285.8	13.61	20.6	6.6	208½	9.90	15	5	691	32.9	38	27½
17	3	30	10.	11½	7½	98½	32.8	34	32	5	51.4	10.48	12.2	7.7	38½	7.70	9	6½	154½	30.9	32½	29
20	1	6	6.	6	6	29½	29.5	29½	29½	4	49.	12.50	13.5	9.4	39½	9.87	13½	7¼	130½	32.6	37	30
23	2	29½	14.75	19	10½	71½	35.7	39	32½	10	118.7	11.87	18.6	7.3	92½	9.25	15	6	323	32.3	37	29½
25	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	16.4	16.40	16.4	16.4	12½	12.50	12½	12½	38	38.	38	38
28	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	15.1	15.10	15.1	15.1	12½	12.50	12½	12½	36	36.	36	36
Dec. 2	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	17.9	17.90	17.9	17.9	13½	13.50	13½	13½	37	37.	37	37
Sums	171	2,078	12.15	26½	6	5,544½	32.4	41½	29	342	4,409.3	12.89	23.9	6.6	†3,309	†9.67	18	5	10,972½	32.1	38	27½

* On November 11, and on nearly every day from that date to the close of the season, there were among the females examined some that had dropped a portion of their eggs; these are included in the measurement, and of course somewhat reduce the aggregate and average "weight before spawning" for those dates and in the summary. The figures for all dates previous to November 11 represent the true gross weights for that period, and their average is found to be 12.85 pounds.

† The weight of spawn taken from these fish after this weighing was, for the whole season, 40 pounds 8½ ounces. Deducting this, we have, for the corrected average weight after spawning, 9.56 pounds instead of 9.67 pounds.

TABLE VII.—*Statement of hatching and distribution of Penobscot salmon, winter and spring of 1874.*

State.	Place of hatching.	In charge of hatching.	Number of eggs received.			Number of young salmon distributed.	Waters stocked.	Tributaries in which young salmon were placed.	Locality.	Number of fish set free.
			Allotted by United States.	From other sources.	Total.					
								Baskahegan River	Eaton and Danforth	50,000
								Passadumkeag River	Passadumkeag	10,000
								Salmon Stream		25,000
Maine	Bucksport	C. G. Atkins	181,000		181,000	165,000	Penobscot River	Sebois Stream	Whitney Ridge	25,000
									Howland	25,000
								Pleasant River	Milo	15,000
									Brownville	15,000
	Sebec Lake	H. L. Leonard	50,000		50,000	45,000	do	Piscataquis River	Dover	25,000
								Ship Pond Stream		20,000
	Dobsis Stream	G. L. F. Ball	11,000	14,000	25,000	22,000	Saint Croix River	Dobsis Stream		22,000
	Pembroke	J. N. Whitman	10,000		10,000	8,613	Penmaquan River	Penmaquan Lake	Charlotte	8,613
	Waldoborough	F. M. Everleth		98,300	98,300	76,000	Medomak River		Waldoborough	38,000
							Saint George River		Warren	38,000
	Dixfield	H. O. Stanley		98,600	98,600	95,832	Androscoggin River	Swift River	Dixfield	30,000
								Self	do	65,832
New Hampshire	Meredith	W. W. Fletcher	50,000	211,500	261,500	250,000	Connecticut River	Headwaters	In New Hampshire	250,000
								White River	Royalton, Vt	15,000
								Lamoille River	Georgia, Vt	70,000
Vermont	Charlestown, N. H.	L. Stone	125,000	36,000	161,000	150,000	do	Dog River	Northfield, Vt	60,000
								Self	Charlestown, N. H	5,000
Massachusetts	Winchester	E. A. Brackett	100,000	178,500	278,500	270,000	do	Headwaters and tributaries.	In New Hampshire	270,000
							Blackstone River	Slatersville Branch	14 places	12,000
Rhode Island	Ponaganset	J. H. Barden	75,000	142,775	217,775	180,000	Paucatuck River		18 places	45,000
							Pawtuxet		28 places	123,000
								Passumpsic tributaries.	Wheelock, Vt	20,000
									Concord, Vt	10,000
									Barnet, Vt	60,000
									McIndoe's Falls	50,000
Connecticut	Westport	E. M. Lees	175,000	180,000	355,000	318,000	Connecticut River			50,000
									Newbury, Vt	50,000
									Bradford, Vt	8,000
								Saxton River	Rockingham	10,000
								Quobaug River	Palmer, Mass	60,000
							Delaware River	Delaware		12,000
								Musconetcong		65,000
New Jersey	Bloomsbury	Dr. J. H. Slack	200,000		200,000	168,000	Raritan River			31,000
							Hackensack River			10,000
							Passaic			50,000

Pennsylvania	Marietta	J. P. Creveling	150,000	....	150,000	137,000	Delaware River	Bushkill Creek	Northampton County	55,000
							Susquehanna River	Swatara Creek	Dauphin County	30,000
								Chiques-Salunga Creek.		25,000
								Donegal Creek		12,000
								Codorus Creek		15,000
Michigan	Pokagon	G. H. Jerom	153,000	32,000	185,000	164,000	Calumet River		Kensington, Ill	10,000
									Wildwood	8,000
									South Lawn	7,000
								Gun Lake	Barry County	8,000
								Metcalf Lake	Calhoun County	1,000
							Manistee River	Pine River		40,000
							Boardman River	Salmon Creek		40,000
							Muskegon River	Higgins Lake	Roscommon County	7,000
							Saint Mary's River			25,000
							Saint Joseph's River	Diamond Lake	Cass County	8,000
								Lime Lake	Branch County	3,000
								Salmon Lake	Berrien County	5,000
								Dowagiac Creek		2,000
Wisconsin	Waterville	H. F. Dousman	20,000	....	20,000	15,000	Rock River	Madison Lake		7,500
							Illinois River	Geneva Lake		7,500
Totals			1,360,000	991,675	2,291,175	2,064,445				2,064,445

TABLE VIII.—*Statement of hatching and distribution of Penobscot salmon, winter and spring of* 1875.

State.	Place of hatching.	In charge of hatching.	Number of eggs received.			Number of young fish distributed.	Waters stocked.	Tributaries where young fish were placed.	Locality.	Number of fish set free.
			Allotted by United States.	From other sources.	Total.					
Maine	Bucksport	C. G. Atkins	82,377	185,000	267,377	234,898	Penobscot River	Seboois River	Howland	30,000
								Madaceunk Stream		15,000
								Salmon Stream		5,000
								Mattawamkeag River	Bancroft	45,000
								....do	Danforth	45,000
								... do	Kingman	94,898
	Sebec Lake	H. L. Leonard		201,600	201,600	120,000	......do	Wilson Stream, Sebec Lake.		25,000
								Ship Pond Stream, Sebec Lake.		35,000
								Salmon Stream	Foxcroft	45,000
								Sebec Lake		15,000
	Dobsis Stream	G. L. F. Ball		25,000	25,000	20,000	Saint Croix River	Dobsis Stream		20,000
	Pembroke	J. N. Whitman	160,000		160,000	85,300	Pennamaquan River	Pennamaquan Lake	Charlotte	45,000
							Crocker's Lake		......do	5,000
							Denny's River		Meddybemps	5,000
									Dennysville	15,000
							Little River	Boyden's Lake	Perry	20,300
	Machias	Ellis Hanscomb		25,000	25,000	1,000	Machias River	Longfellow Stream	Machias	1,000
	Waldoborough	F. M. Everleth		50,000	50,000	5,000	Medomak River	Brook tributary to Medomak Pond.	North Waldoborough	5,000
	Dixfield	H. O. Stanley		48,000	48,000	43,000	Androscoggin River		Dixfield	43,000
	Norway	F. H. Holmes		50,000	50,000	47,870	Presumpscot River	Crooked River	Ryefield Bridge	40,000
							Androscoggin River	Little Androscoggin River.	Norway	7,870
Vermont	Charlestown, N. H.	L. Stone	368,000	48,000	416,000	191,000	Hudson River	Battenkill River	Manchester, Vt	47,500
							Lake Champlain	Lewis Creek	Ferrisburgh, Vt	48,500
							....do	Saranac River	West Plattsburgh, N. Y.	36,500
							....do	Salmon River	Peru, N. Y.	10,000
							....do	Chazy River	Ellenburgh, N. Y.	48,500
Massachusetts	Winchester	E. A. Brackett	120,000	225,000	345,000	245,000	Merrimack River	Pemigewassett River	Near Plymouth, N. H.	215,000
								Contoocook River		30,000
Rhode Island	Ponaganset	J. H. Barden	20,000	180,000	200,000	125,000	Blackstone River	Slatersville Branch	10 places	15,000
							Pawtuxet River		31 places	110,000
Connecticut River.	Westport	E. M. Lees	135,000	225,000	360,000	320,000	Connecticut River	Farmington River	New Hartford	200,000
							Housatonic River	Butter Brook	New Milford	50,000
							East River		Guilford	20,000
							Thames River	Shetucket	Willimantic	30,000
							Mill River		Southport	10,000
							Saugatuck River		Westport	10,000

New York	Caledonia	Seth Green	80,000	....	80,000	30,000	Lake Ontario	Allen's Creek	....	10,000
							Hudson River	Mohawk River	Rome	20,000
New Jersey	Bloomsbury	Mrs. J. H. Slack	80,000	....	80,000	79,000	Passaic River	Whippaug River	Morristown	1,000
								Rockaway River	Dover	1,000
							Raritan River	South Branch	South Branch	3,000
							Delaware River	Paulinskill River Musconetcong River Pohatcong River	....	74,000
Pennsylvania	New Hope	Jas. B. Thompson	10,000	....	10,000	....	....	....	....	
Maryland	Baltimore	Alex. Kent	80,000	....	80,000	72,800	Potomac River	North Branch	Fort Pendleton	16,000
								....	....	56,800
							Patuxent River	....	....	
							Gunpowder River	....	....	
							Susquehanna River	Deer Creek	....	
Michigan	Pekagon	G. H. Jerome	320,000	....	320,000	5,000	Saint Joseph River	Dowagiac River	....	5,000
Illinois	Elgin	W. A. Pratt	20,000	....	20,000	19,000	Illinois River	Fox River	Elgin	19,000
Wisconsin	Bescobel	A. Palmer	25,000	....	25,000	12,800	....	Elkhart Lake	Fond du Lac County	5,000
							....	Cedar Lake	do	1,500
							....	Devil's Lake	Sauk County	1,000
							....	Madison Lake	Madison	300
							....	Rock Lake	Jefferson County	5,000
Iowa	Anamosa	B. F. Shaw	80,000	....	80,000	70,000	Mississippi River	Dubuque Creek	Dubuque	3,000
								Cedar River	Cedar Bapids	4,000
								do	Waverley	25,000
								Turkey River	West Union	15,000
								Iowa River	Marshall	5,000
								Maquoketa River	Manchester	2,000
								do	Worthington	2,000
								Bear Creek	....	4,000
							Missouri River	....	Council Bluff	10,000
Totals	....	....	1,580,377	1,262,600	2,842,977	1,726,668	....	....	....	1,726,668

TABLE IX.—*Observations on temperature at Bucksport, from June 1, 1873, to May 31, 1875, inclusive.*

Date.	Temperature.						Wind.	Remarks.
	Air at H. H.		Water at pond.					
			Surface.		Bottom.			
	7 a. m.	1 p. m.	7 a. m.	1 p. m.	7 a. m.	1 p. m.		
1873.								
June 1	48	75	......	......	......	......	Westerly	Clear.
2	50	88	......	......	......	......	......do	Do.
3	46	60	......	......	......	......	Southwesterly	Do.
4	50	49	......	......	......	......	Southeast	Rain.
5	50	64	......	......	......	......	Southwest	Cloudy.
6	52	72	......	......	......	......	Easterly	Rain.
7	49	56	......	......	......	......	......do	Do.
8	55	66	......	......	......	......	Northerly	Clear.
9	52	68	......	......	......	......	......do	Do.
10	54	77	......	......	......	......	......do	Do.
11	51	68	......	......	......	......	Southerly	Rain a. m.; clear p. m.
12	62	68	......	......	......	......	Northerly	Clear.
13	58	70	......	......	......	......	Southwesterly	Do.
14	52	68	......	......	......	......	Westerly	Do.
15	52	66	......	......	......	......	Northerly	Do.
16	62	80	......	......	......	......	Southwest	Do.
17	65	66	......	......	......	......	Northerly	Do.
18	54	69	......	......	......	......	Northwest	Do.
19	58	77	......	......	......	......	Northerly	Do.
20	56	86	......	......	......	......	Westerly	Do.
21	58	77	68	70	68	68	......do	Partly clear.
22	57	71	66	70	66	68	Northerly	Clear.
23	54	80	67	70	66	66	Westerly	Do.
24	54	78	68	68	66	66	Southwest	Do.
25	62	83	69	72	67	67	......do	Do.
26	62	88	70	71	68	68	Southerly, light	Do.
27	66	86	71	72	69	68	Westerly, light	Do.
28	65	84	71	75	69	70	......do	Cloudy and showery.
29	70	84	73	74	70	71	Southwest, light	Clear.
30	60	70	72	72	70	70	Southerly, light	Cloudy; showery a. m.
Sums...	1684	2194	695	714	679	682		
Means..	56.13	73.13	69.5	71.4	67.9	68.2		

TABLE IX.—*Observations on temperature at Bucksport, &c.*—Continued.

Date.	Temperature. Air at H. H. 7 a. m.	Air at H. H. 1 p. m.	Water at pond. Surface. 7 a. m.	Water at pond. Surface. 1 p. m.	Water at pond. Bottom. 7 a. m.	Water at pond. Bottom. 1 p. m.	Wind.	Remarks.
1873. July 1	63	69	72	71	71	71	Southeast, light	Rain most of day.
2	63	89	70	78	70	71	Easterly a. m.; westerly p. m.	Cloudy a. m.; clear p. m.
3	66	86	72	73	70	71	Southeast a. m.; southwest p. m.	Do.
4	68	87	73	74	72	72	Southwest	Clear.
5	63	80	74	76	72	73	Southerly	Foggy in a. m.; partly clear p. m.
6	68	80	74	77	72	74	Northerly, strong breeze.	Clear.
7	58	77	73	78	72	75	Northerly, light	Do.
8	57	76	72	74	71	72	Southwest, strong	Partly clear; cloudy p. m.
9	60	82	72	74	71	72	Southerly, light	Cloudy a. m.; partly clear p. m.
10	70	82	73	74	71	72	.....do	Clear.
11	57	76	72	74	71	72	Southwest	Foggy a. m.; clear p. m.
12	59	74	72	73	70	72	Northerly, strong	Clear.
13	59	80	72	71	70	70	Southwest, fresh	Partly clear.
14	60	88	70	72	70	70	Southwest, light	Partly clear; showery p. m.
15	70	89	73	75	72	74	Northerly	Clear.
16	60	75	72	73	72	72	.....do	Do.
17	60	78	71	74	70	72	Northerly, light	Clear and cloudy p. m.
18	60	77	70	72	70	70	Easterly a. m.; southerly p. m.	Cloudy and partly clear.
19	55	52	69	69	69	68	Southeast	Rain all day.
20	58	78	67	70	67	68	Northerly, light	Mostly clear.
21	57	84	68	71	67	69	.....do	Cloudy part of day.
22	61	84	69	74	68	70	.....do	Clear.
23	66	92	71	77	69	70	Westerly	Do.
24	72	84	72	75	70	73	Northerly	Do.
25	68	81	73	72	72	70	Southerly, fresh	Partly clear.
26	68	82	73	73	71	71	Southerly, strong	Clear.
27	63	67	72	73	72	72	Southeast	Rain most of day.
28	68	84	73	80	72	73	Westerly	Clear.
29	61	72	74	74	73	73	Southerly, light	Foggy all day.
30	62	87	72	74	72	72	.....do	Foggy 9 a. m.; clear afterward.
31	70	90	75	80	74	76	Northerly	Clear.
Sums	1950	2482	2225	2295	2193	2220		
Means	62.9	80.06	71.77	74.03	70.74	71.61		

TABLE IX.—*Observations on temperature at Bucksport, &c.*—Continued.

Date.	Temperature.						Wind.	Remarks.
	Air at H. H.		Water at pond.					
			Surface.		Bottom.			
	7 a. m.	1 p. m.	7 a. m.	1 p. m.	7 a. m.	1 p. m.		
1873.								
Aug. 1	61	66	75	74	74	74	Southerly, light	Foggy.
2	71	83	73	77	73	74	Northeast a. m.; southwest p. m.	Cloudy a. m.; clear p. m.
3	62	86	73	75	72	74	Southerly	Clear; showery p. m.
4	65	76	74	75	73	74	Northerly, fresh	Clear.
5	57	73	74	75	73	74	Northerly, light	Do.
6	55	85	73	76	73	73	Southerly, light	Clear; cloudy p. m.
7	63	76	72	72	72	72	...do	Clear.
8	63	83	72	76	71	72	Northerly, light	Do.
9	62	84	72	74	72	73	Westerly, light	Do.
10	60	78	71	72	71	71	Northerly, light	Do.
11	57	75	70	72	70	71	...do	Do.
12	58	80	70	76	70	70	Northwest, light	Do.
13	52	80	70	71	69	68	Southerly, light	Do.
14	55	80	70	70	68	68	...do	Cloudy.
15	64	67	69	69	69	69	Easterly	Rain.
16	57	75	68	70	68	68	Southerly, fresh	Clear.
17	64	77	68	70	68	69	Northerly	Do.
18	57	82	69	70	69	68	Northwest	Do.
19	58	67	69	70	68	68	Easterly	Rain; cloudy p. m.
20	62	73	68	70	68	68	Easterly, light	Cloudy.
21	58	80	68	76	68	68	....	
22	58	72	68	68	68	68	Southerly, light	Cloudy.
23	59	84	68	70	68	68	Southwest, light	Clear; showery p. m.
24	56	60	66	66	66	66	Northeast, very strong	Cloudy.
25	52	65	60	62	58	61	Northerly, fresh	Clear.
26	52	66	62	63	62	62	Easterly, light	Mostly cloudy.
27	52	71	62	65	62	64	Northerly	Clear.
28	46	78	63	69	63	65	Northerly, light	Do.
29	49	82	64	66	63	63	Southwest, light	Do.
30	58	77	64	66	63	64	...do	Mostly clear.
31	63	80	66	70	64	66	Variable	Showery in p. m.
Sums...	1806	2361	2131	2195	2116	2133		
Means..	58.26	76.16	68.74	70.8	68.26	68.8		

TABLE IX.—*Observations on temperature at Bucksport, &c.*—Continued.

Date.	Temperature. Air at H. H. 7 a. m.	Air at H. H. 1 p. m.	Water at pond. Surface. 7 a. m.	Water at pond. Surface. 1 p. m.	Water at pond. Bottom. 7 a. m.	Water at pond. Bottom. 1 p. m.	Wind.	Remarks.
1873.								
Sept. 1	53	70	66	66	65	65	Southerly, light	Rain 4 p. m.
2	60	77	64	66	64	65	Variable	Showery.
3	56	70	64	66	61	64	Northerly, fresh	Clear.
4	51	59	64	64	63	63	Southerly, light	Rainy.
5	60	75	63	65	62	64	Southerly, fresh	Cloudy a. m.; clear p. m.
6	54	65	64	66	63	64	Northerly, fresh	Clear.
7	44	65	63	66	63	63	Southerly	Clear a. m.; cloudy p. m.
8	57	59	63	63	62	63	Southerly a. m.; northerly p. m.	Rainy a. m.; clear p. m.
9	43	66	62	62	62	63	Southerly, light	Clear.
10	46	67	62	63	60	62	......do	Do.
11	52	63	62	65	61	62	Southwest	Foggy a. m.; clear p. m.
12	51	69	62	64	62	62	Southerly, light	Do.
13	55	69	63	64	62	63	Southwest, fresh	Clear.
14	52	49	64	62	62	62	Northeast	Rainy.
15	40	58	60	64	60	61	Southerly, light	Clear.
16	57	57	60	60	59	59	Southerly, fresh	Cloudy; showery in p. m.
17	42	57	58	60	57	58	Northerly, light	Mostly clear.
18	37	64	58	58	58	57	Southerly, fresh	Mostly cloudy.
19	56	64	58	59	58	59	......do	Cloudy a. m.; rain at 4 p. m.
20	48	57	58	59	58	59	Northerly, fresh	Mostly clear.
21	45	58	57	58	57	57	......do	Clear.
22	37	61	56	58	57	57	Southerly, light	Do.
23	46	55	56	57	57	57	......do	Rainy.
24	52	57	57	57	57	57	......do	Rainy in a. m.; clear in p. m.
25	43	62	56	60	56	57	......do	Mostly clear.
26	52	69	57	59	57	57	Northerly, light	Do.
27	43	67	58	59	58	58	Southwest, light	Clear.
28	57	84	59	58	59	61	......do	Do.
29	58	70	59	62	59	61	Southwest, fresh	Foggy a. m.; clear p. m.
30	48	56	59	60	59	60	Northerly	Clear.
Sums	1495	1919	1812	1850	1802	1820		
Means	49.83	63.97	60.4	61.67	60.07	60.67		

TABLE IX.—*Observations on temperature at Bucksport, &c.*—Continued.

Date.	Temperature.						Wind.	Remarks.
	Air at H. H.		Water at pond.					
			Surface.		Bottom.			
	7 a. m.	1 p. m.	7 a. m.	1 p. m.	7 a. m.	1 p. m.		
1873.								
Oct. 1	31	52	58	59	57	57	Southerly, light	Clear.
2	37	58	57	59	57	57	Westerly, light	Do.
3	39	57	56	57	56	56	Southerly, light	Cloudy a. m.; clear p. m.
4	34	50	54	54	54	54	Southerly, fresh	Cloudy.
5	56	57	54	54	54	54	......do	Rainy.
6	57	69	54	56	54	55	Southwest, light	Cloudy a. m.; clear p. m.
7	41	44	56	55	54	55	Northeast, light	Rainy.
8	39	54	52	53	52	52	Northerly, fresh	Mostly clear.
9	39	52	46	52	51	52	......do	Clear.
10	36	60	51	57	50	52	Northerly, light	Do.
11	34	65	51	56	50	52	......do	Do.
12	49	64	53	57	52	54	......do	Wind southerly in p. m.
13	46	50	54	54	53	53	Northerly, fresh	Mostly clear.
14	40	58	52	54	52	53	Variable	Partly clear.
15	35	53	52	53	52	52	Northerly, light	Clear.
16	32	55	52	52	51	53	Southwest, fresh	Do.
17	42	49	52	52	51	52	Northeast, fresh	Do.
18	27	52	50	51	50	50	Southwest, fresh	Cloudy in a. m.; clear in p. m.
19	52	62	51	51	51	51	Southerly, light	Cloudy.
20	59	67	52	54	53	54	Southerly, fresh	Partly clear.
21	55	57	54	54	54	55	......do	Rainy.
22	38	54	54	56	54	54	Southerly, light	Clear.
23	46	54	54	56	54	54	......do	Do.
24	48	61	53	54	52	53	......do	Cloudy in a. m.; clear in p. m.
25	42	52	52	53	52	52	Northerly, light	Clear.
26	30	49	50	52	51	51	Variable	Mostly cloudy.
27	49	56	51	52	50	52	Southerly, fresh	Rainy.
28	33	53	50	51	50	49	Southerly, light	Mostly cloudy.
29	32	45	49	50	48	49	Southwest, fresh	Cloudy in a. m.; clear in p. m.
30	30	40	47	48	47	48	Northerly, light	Clear.
31	36	42	47	47	47	47	Easterly, light	Rainy.
Sums ...	1267	1691	1618	1663	1613	1632		
Means ..	40.87	54.54	52.19	53.65	52.03	52.65		

TABLE IX.—*Observations on temperature at Bucksport, &c.*—Continued.

Date.	Temperature.								Wind.	Remarks.
	Air at H. H.		Water at pond.				Water at H. H.			
			Surface.		Bottom.					
	7 a. m.	1 p. m.	7 a. m.	1 p. m.	7 a. m.	1 p. m.	7 a. m.	1 p. m.		
1873. Nov. 1	39	45	46	46	46	44	47	48	Westerly, light ...	Showery a. m.; clear p. m.
2	33	46	44	45	44	44	45	48	Southerly, light...	Clear.
3	46	48	44	44	44	44	45	48	Westerly, fresh...	Showery a. m.; clear p. m.
4	22	41	42	42	42	42	42	45	Westerly, light ...	Clear.
5	38	34	42	42	42	42	43	45	Northerly, fresh...	Do.
6	21	31	39	40	39	39	40	42	Northerly, light...	Do.
7	17	32	38	38	39	38	38	41	Westerly, light ...	Do.
8	38	40	38	38	38	38	40	40	Easterly, light	Rainy.
9	37	45	38	38	38	38	39	41	Northerly, light...	Mostly cloudy.
10	28	31	38	38	38	38	37	38	Northeast, fresh ..	Cloudy; snow p. m.
11	20	28	37	36	37	36	35	37	Northerly, light...	Clear.
12	28	36	34	35	36	36	36	37	Easterly, light	Snow a. m.; rain p. m.
13	31	37	32	34	36	36. 5	36	37	....do	Clear a. m.; cloudy p. m.
14	15	24	32	34	.....	......	35	36	Northerly, light...	Clear.
15	17	26	32	32	.....	......	34	36	Northwest, light ..	Do.
16	14	24	32	32	.....	......	35½	36	Easterly	Snow.
17	21	30	32	32	.....	......	34	35	Northeast	Cloudy.
18	31	38	32	32	.....	......	34½	35	Northeast, light...	Rainy.
19	26	32	32	......	.....	......	35	35	Northwest, light ..	Clear.
20	18	28	......	......	.....	......	35	36	Northerly, light...	Do.
21	12	27	......	......	.....	......	35½	37	Westerly, light....	Do.
22	14	31	......	......	.....	......	36	36	....do	Mostly clear.
23	5	23	......	......	.....	......	35	36	....do	Snow a. m.; clear p. m.
24	16	23	......	......	.....	......	35	35	Easterly, light ...	Snow.
25	20	30	......	......	.....	......	35½	36	....do	Cloudy.
26	17	22	......	......	.....	......	36	35	Northwest, light..	Clear.
27	—2. 5	22	......	......	.....	......	35	34	Southeast, light...	Cloudy a. m.; snow p. m.
28	2	20	......	......	.....	......	33	34	Northerly, light...	Clear.
29	—1	15	......	......	.....	......	33	33	....do	Do.
30	3	12	......	......	.....	......	33	33½	Northerly, fresh ..	Do.
Sums ...	625½	921	704	678	519	515¼	1113	1145½		
Means ..	20. 85	30. 7	37. 05	37. 66	39. 92	39. 65	37. 1	38. 18		

TABLE IX.—*Observations on temperature at Bucksport, &c.*—Continued.

Date.	Temperature.				Wind.	Remarks.
	Air at H. H.		Water at H. H.			
	7 a. m.	1 p. m.	7 a. m.	1 p. m.		
1873.						
Dec. 1	— 7	6	33	33½	Northerly, light	Clear.
2	— 22	8	33	33	Northeast, light	Cloudy; snow 5 p. m.
3	22	38	33	34	Easterly, light	Foggy.
4	42	44	34	34	Southerly, fresh	Fog, a. m.; rain in p. m.
5	33	37	34	34	Southerly, light	Mostly cloudy.
6	20	24	33½	34	Northerly, light	Clear.
7	12	23	33½	34	Northwest, light	Do.
8	6	26	34	34	Southwest, light	Do.
9	36	38	34½	34½	Southerly, fresh	Cloudy a. m.; rainy in p. m.
10	28	28	34	34	Northerly, fresh	Clear.
11	6	24	34	34	Southwest, light	Mostly cloudy; snow at 3 p. m.
12	30	34	35	35	......do	Cloudy.
13	26	22	34½	34	Northeast, light	Snowing all day.
14	15	22	33	34	Northerly, light	Clear.
15	12	13	34	34	Southwest, light	Do.
16	12	33	34	34	......do	Mostly clear.
17	4	30	34	34	Westerly, light	Do.
18	30	33	34	34	Calm	Foggy.
19	24	35	34	34	......do	Do.
20	23	29	34	34	Northeast, light	Snow.
21	4	17	33	33½	Northwest, light	Clear.
22	18	31	33	34	Westerly, light	Partly cloudy.
23	— 10	28	33	33	......do	Clear.
24	4	22	33	33	......do	Do.
25	27	31	33	33	Northerly, light	Cloudy a. m.; clear p. m.
26	5	16	33	33	......do	Cloudy.
27	12	18	33	33	Northeast, light	Cloudy, some snow.
28	18	20	33	32½	Northerly, fresh	Snow all day.
29	20	32	33	33½	Southwest, light	Cloudy with snow.
30	18	27	33	33	Westerly, light	Mostly clear.
31	13	31	33	33	Southerly, light	Clear a. m.; cloudy p. m.
Sums	481	820	1040	1044½		
Means	15.52	26.45	33.54	33.69		

TABLE IX.—*Observations on temperature at Bucksport, &c.*—Continued

Date.	Temperature.				Wind.	Remarks.
	Air at H. H.		Water at H. H.			
	7 a. m.	1 p. m.	7 a. m.	1 p. m.		
1874.						
Jan. 1	10	31	33	33½	Southerly, light	Mostly clear.
2	30½	35	33	33½	......do	Snow at 10 a. m.
3	17	34	33	33	......do	Foggy.
4	36	40	33	34	......do	Do.
5	45	32	34	34	Northerly, light	Cloudy a. m.; rain and snow p. m.
6	14	16	33	33	Northeast, light	Rain most of the day.
7	31	34	33	33	Southerly, light	Do.
8	41	50	33	34	Southerly, fresh	Rain all day.
9	30	39	33	34	Southwest, light	Clear.
10	30	38	33	34	Southerly, light	Clear a. m.; rainy p. m.
11	24	34	33	34	Southwest, light	Clear.
12	20	24	33	34	Northwest, light	Do.
13	6	16	33	33	......do	Do.
14	12	15	33	33	Northeast, light	Snow.
15	— 4	13	33	33½	Northerly, light	Clear.
16	3	9	33	33½	Northwest, light	Do.
17	0	16	33	33	......do	Do.
18	— 9	31	33	33	Southwest, light	Do.
19	34	40	33½	34	Southerly, light	Rain.
20	16	16	33	33	Northerly, fresh	Clear.
21	— 4	14	33	33	Easterly, light	Cloudy a. m.; snow p. m.
22	25	26	33½	34	Southerly, light	Foggy.
23	38	40	34	34	......do	Do.
24	19	24	33½	34	Northeast, light	Clear.
25	16	9	33½	33½	Northerly, fresh	Do.
26	—13	—13	33	33½	......do	Do.
27	—12	4	33½	34	Northeast, light	Snow.
28	6	14	33½	34	......do	Cloudy, with snow and rain.
29	8	20	33	34	Northwest, light	Clear in a. m.; cloudy and snow p. m.
30	2½	1	33½	34	Northerly, fresh	Clear.
31	—12	2	33½	33½	Northeast, light	Snow.
Sums...	460	701	1029	1041½		
Means..	14.84	22.71	33.19	33.59		

TABLE IX.—*Observations on temperature at Bucksport, &c.*—Continued.

Date.	Temperature.				Wind.	Remarks.
	Air at H. H.		Water at H. H.			
	7 a. m.	1 p. m.	7 a. m.	1 p. m.		
1874.						
Feb. 1	—7	2	34	34	Northerly, light	Clear.
2	—21	—2	33	33	......do	Do.
3	2½	16	33½	33	Northeast, light	Snowing all day.
4	22	28	33	33½	Northeast, fresh	Snowy a. m.; cloudy p. m
5	—1½	7	33	33	Northerly, light	Clear.
6	—6	9	32½	33	......do	Do.
7	—8	10	33	33	Westerly, light	Do.
8	3	19	33½	33	Northerly, fresh	Do.
9	6	30	33	33½	Northerly, light	Do.
10	8	30½	33	34	Northeast, light	Cloudy.
11	16	22	33	34	Northerly, fresh	Cloudy a. m.; clear p. m.
12	5	21	33½	34	Westerly, light	Clear.
13	—2	39	33	34	Southerly, light	Cloudy; rain at 5 p. m.
14	41	45	34	34	Westerly, light	Cloudy a. m.; clear p. m.
15	13	31	34	34½	Southerly, light	Clear.
16	24	33	33½	34	Variable	Cloudy; snow in a. m.
17	22	29	33½	34	Northwest, fresh	Clear.
18	9	23	33½	34	Northerly, fresh	Do.
19	0	34	33½	34½	Southerly, light	Clear a. m.
20	32	37	34	34½	......do	Rain a. m.; cloudy p. m.
21	24	38	34	34½	......do	Snow and rain.
22	31	34	34	34½	Northerly, light	Cloudy.
23	27	33	34	34	Southeast, light	Snow and rain.
24	22	28	34	34	Northwest, light	Clear in a. m.; cloudy in p. m.
25	—2	27	33½	34	Easterly, light	Cloudy.
26	12	27	33	34	Southwest, light	Mostly clear.
27	18	32	33½	34	Northerly, fresh	Partly clear.
28	5	22	33	34	Northerly, light	Clear.
Sums...	295	704½	936	947½		
Means..	10.54	25.16	33.43	33.83		

TABLE IX.—*Observations on temperature at Bucksport, &c.*—Continued.

Date.	Temperature. Air at H. H. 7 a. m.	Temperature. Air at H. H. 1 p. m.	Temperature. Water at H. H. 7 a. m.	Temperature. Water at H. H. 1 p. m.	Wind.	Remarks.
1874.						
Mar. 1	2	30	33	34	Southwest, light	Clear a. m.; cloudy p. m.
2	32	46	33½	34½	....do	Clear.
3	31	44	33½	34½	Southwest, fresh	Partially clear.
4	40	42	33½	34	Southerly, fresh	Rain.
5	19	28	33	33½	Northerly, fresh	Clear.
6	9	25	33	33½	....do	Do.
7	12	30	33	33½	Southerly, light	Mostly clear.
8	25	27	34	34	Northeast, light	Snow all day.
9	7	44	33	34	Southerly, light	Clear a. m.; cloudy p. m.
10	22	36	33	33½	Northeast, light	Snowing all day.
11	14	30	33	34	....do	Clear.
12	8	26	33	34	Northerly, light	Cloudy.
13	8	25	32½	33½	Westerly, light	Partially clear.
14	20	31	33	34	Northerly, fresh	Clear.
15	15	32	34	36	Northerly, light	Do.
16	20	40	34	36	Calm	Do.
17	27	40	34	35½	Southerly, light	Clear a. m.; cloudy and rain p. m.
18	37	42	34	35	....do	Rain most of the day.
19	37	44	34	35	....do	Foggy; thunder-shower.
20	36	36	34	36	Westerly, fresh	Clear.
21	30	41	34	36	Southwest, fresh	Do.
22	30	36	34	36	Northeast, light	Snow a. m.; squalls from north p. m.
23	24	30½	34	35	Variable	Snow a. m.; cloudy p. m.
24	1	12	33½	36	Northerly, fresh	Clear.
25	18	37	34	35	Westerly, fresh	Cloudy a. m., clear p. m.
26	35	41	34	36	Southerly, light	Cloudy a. m.; rainy p. m.
27	27	30	34	36	Northwest, fresh	Clear.
28	25	36	34	36	Easterly	A little snow a. m.; clear p. m.
29	20	24	34½	37	Northwest, fresh	Clear.
30	16	39	34	36½	Westerly, fresh	Do.
31	23	25	35	37½	Northwest, fresh	Do.
Sums...	670	1043.5	1043	1085		
Means..	21.61	33.36	33.64	35		

TABLE IX.—*Observations on temperature at Bucksport, &c.*—Continued.

Date.	Temperature.				Wind.	Remarks.
	Air at H. H.		Water at H. H.			
	7 a. m.	1 p. m.	7 a. m.	1 p. m.		
1874.						
April 1	5	21	34½	37	Westerly, light	Clear.
2	17	33	35.	38	Southwest, light	Do.
3	30	36	35½	36½	Southerly a. m., westerly p. m., light.	A little snow a. m.; clear p. m.
4	17	27	35½	36½	Northerly, fresh	Clear.
5	20	32	36	39	Northerly a. m., southerly p. m.	Do.
6	30½	40	35½	38	Southeast a. m., southwest p. m.	Snow a. m.; clear p. m.
7	34	39	36½	38	Southerly, light	Cloudy.
8	31	35	36½	37	......do	Do.
9	32	36	36	37	Northeast, light.......	Do.
10	29	31	35½	35½	Northeast, fresh	Snowing all day.
11	22	36	35	37	Southerly, light.......	Cloudy a. m.; snow p. m.
12	15	23	35	38	Northerly, fresh.......	Clear.
13	26	34	35	38	Variable, light	Mostly clear.
14	31	46	35	38	Southerly, light	Clear a. m.; cloudy p. m.
15	40	53	34½	37½	......do	Rain 9 a. m.; afterward mostly cloudy.
16	38½	42	35	38½	Northerly, fresh	Clear.
17	30	37	35	36	Variable, light	Cloudy; snow at 4 p. m.
18	33	42	34½	38½	Southerly, light	Clear.
19	36	45	34½	39	Southerly, fresh.......	Do.
20	33	46	35½	38	Southeast, light.......	Cloudy; snow at 5 p. m.
21	34	39	35½	37	Southerly, light.......	Cloudy.
22	33	47	36	39½	Northerly, fresh	Clear.
23	33	43	36	39	Southerly, light.......	Mostly cloudy.
24	35	45	36½	39	......do	Do.
25	29	47	36½	42	......do	Clear a. m.
26	30	34	36	36	Northeast, fresh.......	Snowing all day.
27	32	44½	34	38	Northerly, light.......	Clear.
28	32½	47	36	41	......do	Do.
29	35½	35	37½	37½	Easterly, light	Raining all day.
30	33½	36	36½	39	Westerly, fresh	Snow a. m.; cloudy p. m.
Sums ...	877.5	1151.5	1066	1139		
Means ..	29.25	38.38	35.53	37.97		

TABLE IX.—*Observations on temperature at Bucksport, &c.*—Continued.

Date.	Temperature.						Wind.	Remarks.
	Air at H. H.		Water at H. H.		Water at pond. 9 a. m.			
	7 a. m.	1 p. m.	7 a. m.	1 p. m.	Surface.	Bottom.		
1874.								
May 1	35½	44	38	39	......	......	Northerly, light.......	Cloudy.
2	34½	42	37½	39½	......	......	Northeast, light	Clear a. m.; cloudy p. m.
3	40	48	38	41	......	......	Northerly, light.......	Clear.
4	42	60	40	44	41	40	......do	Do.
5	38	52	43	47	43½	42½	Northeast, fresh	Clear a. m.; cloudy p. m.
6	35	53	44½	46½	46	44	Southwest, fresh......	Do.
7	38	51	44	49	45	44	Variable, light........	Cloudy a. m.; clear p. m.
8	37	51	45	48	47	46	Southerly, light.......	Cloudy.
9	38½	44	45	46½	47	46	......do	Cloudy and rainy.
10	43	47	46	48	47	46½	Northeast, light.......	Cloudy; rain at 3 p. m.
11	41	58	47½	51½	48	47	......do	Clear.
12	42	65½	48	51	50½	48½	Variable, light........	Do.
13	44	64	48½	53	52	48½	Southerly, light.......	Do.
14	55	74	52	57	54	49	Northerly, fresh	Do.
15	46	60	54	56	56	52	Southerly, fresh.......	Do.
16	45	44	54	54½	55	52	Southeast, light.......	Rainy.
17	48	64	52	55	54	52	Southwest, light	Cloudy.
18	52½	66	54	57	56	53	Southerly, light.......	Clear.
19	47	55	57	57	57	53	......do	Rain.
20	42	61	55½	58	57	53	Southerly fresh.......	Clear.
21	52	59½	55	58	57½	53	Southerly, light.......	Clear a. m.; rain 4 p. m.
22	44	55	55	57½	56½	52½	Variable, light........	Rain a. m.; cloudy p. m.
23	45	62½	57	60	56½	55½	Northerly, fresh	Clear.
24	48	66	56	61	58	56½	Variable, light........	Do.
25	48	62½	57	57	58	56	Southerly, light.......	Rain all day.
26	52	66	56	58	57	55½	Southwest, light	Clear.
27	56	74½	58	62	59½	56	Northerly, light.......	Do.
28	52	67	59	62	60½	56½	Southerly, light.......	Do.
29	61	69	62	64	62	58	Variable, light	Do.
30	56	76	62½	64½	66	58	Southerly, light.......	Do.
31	62	66	61	63	63	56½	Southerly, fresh	Clear a. m.; thunder shower p. m.
Sums ..	1420	1827.5	1582	1765.5	1510.5	1431		
Means ..	45.81	58.94	51.03	53.38	53.95	51.11		

TABLE IX.—*Observations on temperature at Bucksport, &c.*—Continued.

Date.	Temperature.						Wind.	Remarks.
	Air at H. H.		Water at H. H.		Water at pond. 9 a. m.			
	7 a. m.	1 p. m.	7 a. m.	1 p. m.	Surface.	Bottom.		
1874.								
June 1	52	56	61	63½	62	58	Northeast, fresh	Cloudy.
2	45	60	59½	63	61½	60	Northeast, light.......	Clear.
3	50	67	60	63	62	60	Southerly, fresh.......	Do.
4	47	56	59	60½	61	60	Southerly, light.......	Rain a. m.; cloudy p. m.
5	54½	70	60	62	62	60	......do	Foggy and clear.
6	57	64	62	64	63	60	Easterly, light	Rain most of day.
7	63	64	63	64	64	60	Southerly, light.......	Rain and fog.
8	54	74	61	65½	62½	60½	Variable, light...	Foggy and clear.
9	54	64	63½	67	64	60½	Northeast, light.......	Mostly clear.
10	47½	57½	62	63	63½	60	Variable, light	Clear a. m.; cloudy p. m.
11	46	64½	60½	67	62	61	Northerly, light.......	Clear.
12	46	45	60½	60	61	60	Easterly, light	Rain.
13	48	64	59½	63½	61½	59½	Northerly, light.......	Mostly clear.
14	60	72	60	66	62	59	Southwest, light	Clear a. m.; showery p. m.
15	56	74	62	69	64	59½	Northerly, light.......	Clear.
16	66	78	64	65	68	59	Southerly, light.......	Mostly cloudy.
17	54	55	59	60	63	59	......do	Rainy.
18	54	59½	59	62	61	60	Northeast, fresh	Do.
19	48½	47	56	59	59½	59½	Easterly, fresh........	Do.
20	48	50	56	57	57	57	......do	Cloudy a. m.; rain p. m.
21	52	64	56	59	57	57	Northeast, light.......	Mostly clear.
22	60	79	59½	63½	63	58½	Southerly, light.......	Clear.
23	57	84	60½	64½	64	59	......do	Mostly clear.
24	57	64	62	67½	64	61	Northerly, fresh	Clear.
25	54½	72	58	6 ½	62½	61	Northwest, fresh......	Do.
26	64	77½	62	70½	64	62	Northwest, light	Do.
27	54	82	63½	74	67	62	Southwest, light	Do.
28	59	79	62	71	67	63	Southerly, light.......	Do.
29	64	74	66	70	69	62	Variable	Shower a. m; cloudy p. m.
30	58	75	62½	72½	67	62	Variable, light........	Clear.
Sums ...	1630	1992	1819.5	1945	1889	1800		
Means ..	54.33	66.4	60.65	64.83	62.97	60		

TABLE IX.—*Observations on temperature at Bucksport, &c.*—Continued.

Date.	Temperature.						Wind.	Remarks.
	Air at H. H.		Water at H. H.		Water at pond. 9 a. m.			
	7 a. m.	1 p. m.	7 a. m.	1 p. m.	Surface.	Bottom.		
1874.								
July 1	57	71½	66	70	67½	64	Northeast, light	Mostly clear.
2	57	69	67	68½	67	64	Southerly, light	Cloudy a. m.; rain p. m.
3	50	52	62	63	64	64	......do	Rain all day.
4	54	70	62	65	63	63	Variable, light	Mostly cloudy.
5	52	56	62	63	63	63	Easterly, light	Rainy.
6	55	74	62	68	65	63	Variable, light	Clear.
7	51	62	60½	64	62	60½	Southerly, fresh	Cloudy.
8	61	78½	62	67	64	62½	Southwest, light	Clear.
9	66	80½	65½	74	68	63½	Northerly, light	Do.
10	64	81	68	72	71	64	Southerly, light	Clear a. m.; cloudy p. m.; rain at 5 p. m.
11	66	80	67	74	70	63½	......do	Mostly cloudy.
12	62	59	68	69	70	64	Easterly, light	Rain all day.
13	56	69½	64	68	68	64	Southerly, light	Cloudy.
14	64	84	64½	75	69	64	Westerly, light	Clear.
15	64	69½	69½	70½	72	64	Southerly, fresh	Do.
16	67	89½	......	......	73	64	Variable, light	Cloudy a. m.; clouds with showers p. m.
17	68½	77	......	......	72	66	Northerly, light	Clear.
18	62½	80	......	......	75	66	Southerly, light	Do.
19	64	76½	......	......	73	66	Southerly, fresh	Clear a. m.; cloudy p. m.
20	60	69	......	......	70	65½	Southerly, light	Cloudy.
21	63	75	......	......	70	68	Northerly, light	Cloudy a. m.; clear p. m.
22	58½	78	......	......	70½	70	......do	Clear.
23	57	78	......	......	72	69	Southwest, light	Do.
24	60	79½	......	......	71½	69	Southerly, light	Foggy and clear.
25	65½	77	......	......	72	68½	Southwest, fresh	Clear.
26	68	70	......	......	71	70	Southerly, fresh	Foggy a. m.; clear p. m.
27	61	72	......	......	70	69½	......do	Cloudy most of day.
28	62	81	......	......	70	69½	Southerly, light	Do.
29	62½	73	......	......	70	69	Southerly, fresh	Cloudy a. m.; rain p. m.
30	64	71	......	......	70	69	Northerly, light	Partly clear.
31	60	76	......	......	72	69½	Southwest, fresh	Do.
Sums	1882½	2279	970	1031	2145.5	2039.5		
Means	60.73	73.52	64.67	68.73	69.21	65.73		

TABLE IX.—*Observations on temperature at Bucksport, &c.*—Continued.

Date.	Temperature.				Wind.	Remarks.
	Air at H. H.		Water at pond.			
			9 a. m.			
	7 a. m.	1 p. m.	Surface.	Bottom.		
1874.						
Aug. 1	63	71	70½	68½	Southerly, light	Rainy a. m.; shower at 4 p. m.
2	60	82	70	69	Westerly, light	Clear a. m.; showery p. m.
3	56	68	69½	68	Northerly fresh	Clear.
4	52½	69	68	68	Variable, light	Do.
5	58	72	68	68	Northerly, light	Do.
6	60	69½	68	68	Northeast, light	Partly clear.
7	59	76	71	69	Westerly, light	Clear.
8	58	60	68	66	Southerly, light	Rain all day.
9	61	67	65	62	Southeast, light	Do.
10	65	71½	64	62	Northeast, fresh	Cloudy and rainy a. m.; partly cloudy p. m.
11	63	79	66	62½	Southerly, light	Clear.
12	62½	72	67	62½	Southwest, light	Foggy and clear.
13	64½	66	69	64	Northeast, light	Rainy all day.
14	57	56	66	62½	......do	Cloudy a. m.; Rainy p. m.
15	57½	69	64½	64	Northerly, light	Do.
16	55½	72	65	64	......do	Clear.
17	54½	70	65½	64	Southwest, fresh	Do.
18	57	74	66	64½	Southerly, light	Hazy.
19	55	72½	68	66½	Northerly, light	Clear.
20	57	72	67	66	Southeast, light	Rain p. m.; Clear p. m.
21	63	75½	67	66	Northeast, light	Partly cloudy.
22	56	66	68	67	Northerly, light	Clear.
23	44	72	67	66	Variable, light	Clear a. m.; cloudy p. m.
24	51	66½	66	64½	Westerly, light	Clear.
25	48	71	67	65½	Northwest, light	Clear a. m.; cloudy p. m.
26	48	68	66	64½	Northerly, light	Clear.
27	48	72	66	64	......do	Do.
28	50	74½	66	64½	......do	Clear a. m.; hazy p. m.
29	55	74	68	64½	Variable, light	Hazy.
30	64	74	69	65	Southwest, light	Clear.
31	57	77	68	64½	Southerly, light	Foggy and clear.
Sums ..	1760	2199	2084	2025		
Means .	56.84	70.94	67.23	65.32		

TABLE IX.—*Observations on temperature at Bucksport, &c.*—Continued.

Date.	Temperature.				Wind.	Remarks.
	Air at H. H.		Water at pond.			
			9 a. m.			
	7 a. m.	1 p. m.	Surface.	Bottom.		
1874.						
Sept. 1	56	69	67	65	Northerly, fresh	Clear a. m.; cloudy p. m.
2	56	68½	66	66	Northerly, light	Partly cloudy.
3	52	70½	66	65½	Southwest, fresh	Hazy a. m.; rain at 5 p. m.
4	45	64	64½	63½	Northerly, light	Clear.
5	50	63	64½	63½	Southwest, fresh	Do.
6	57	65	64½	63½	Southerly, light	Cloudy.
7	58	72	64	63½	Northerly, light	Mostly clear.
8	59½	68	64½	64	......do	Cloudy a. m.; showery p. m.
9	58	69½	65	64	Variable, light	Cloudy and clear.
10	56½	81½	65½	64	......do	Clear.
11	54	68½	65½	64	Northerly, fresh	Do.
12	44	60	64	64	Northeast, fresh	Do.
13	48½	69	66	64	Southwest, light	Do.
14	52	66	64	63	Southerly, light	Clear a. m.; hazy p. m.
15	57½	65	63	63	Southerly, fresh	Cloudy.
16	60	71	64½	63½	Southerly, light	Do.
17	56	58	64	64	Northeast, light	Do.
18	50	53½	61½	60½	..... do	Cloudy a. m.; rain p. m.
19	54	59	60	60	Easterly, light	Rain.
20	....	....	....	....	......do	Rain all day.
21	56½	62	60½	60	Northerly, light	Cloudy a. m.; clear p. m.
22	42	58	60	59½	Northwest, light	Clear.
23	40	60	60	58½	Southerly, light	Do.
24	47	65	61	58½	......do	Do.
25	54	64	60	58½	......do	Cloudy.
26	53½	60	60	59	Calm	Do.
27	52½	56	59½	58½	Southerly, light	Cloudy a. m.; clear p. m.
28	48½	62	59½	58½	Northeast, light	Cloudy; rain at 4 p. m.
29	61	59½	60½	59½	Southerly, light	Cloudy a. m.; rainy p. m.
30	60	60	60	60	Southerly and westerly, light.	Cloudy and rain a. m.; clear p. m.
Sums ..	1539	1867.5	1825	1799		
Means .	53.07	64.38	62.93	62.04		

TABLE IX.—*Observations on temperature at Bucksport, &c.*—Continued.

Date.	Temperature.				Wind.	Remarks.
	Air at H. H.		Water at pond.			
			9 a. m.			
	7 a. m.	1 p. m.	Surface.	Bottom.		
1874.						
Oct. 1	40	51	59	58	Northwest, fresh	Clear a. m.
2	45	55½	57	56	Southerly, fresh	Cloudy and rainy.
3	43	53½	56	55½	Northerly, light	Cloudy.
4	34½	50	54	54	......do	Clear a. m.; cloudy p. m.
5	42	54½	53½	53½	......do	Mostly clear.
6	45	60	54	53½	......do	Mostly cloudy.
7	39½	57	54	53	Southwest, light	Hazy.
8	41½	59	54	53	Westerly, light	Foggy and clear.
9	48	56	53½	53	Southwes·, light	Rainy a. m.; cloudy p. m.
10	45	59	54	53½	......do	Foggy and rain at 4 p. m.
11	50	60	54	53½	Northwest and variable, light.	Clear a. m.; cloudy p. m.
12	41	57	53½	52½	Westerly, light	Showers.
13	40	50	52	52	Northerly, light	Clear.
14	40½	49	51	51	......do	Mostly clear.
15	33½	52½	50	50	......do	Clear.
16	38	58½	50	50	Southwest, light	Do.
17	33	57	50	49½	......do	Clear a. m.; cloudy p. m.
18	50	52	50	50	Variable. light	Rainy a. m.; cloudy p. m.
19	34½	47	48	47½	Northerly, fresh	Clear.
20	36	52	47	46	Northwest, light	Do.
21	40½	48	47½	47	Variable, light	Hazy a. m.; clear p. m.
22	33½	58	48	48	Northwest, light	Clear.
23	28	47½	48	48	Southwest, light	Do.
24	30	52	48	47½	......do	Do.
25	44	57½	48	47½	Calm	Foggy and clear.
26	38	57½	49	48	Southwest, light	Clear.
27	48	53½	48½	48	......do	Foggy all day.
28	49	58	50	49	Variable, light	Cloudy a. m.; clear p. m.
29	37	50	50	50	Northerly, light	Mostly cloudy.
30	52	52	50	50	Variable, light	Cloudy a. m.; clear p. m.
31	42	50	50	50	......do	Mostly clear.
Sums ...	1262	1674½	1591.5	1578		
Means ..	40.71	54.02	51.34	50.90		

TABLE IX.—*Observations on temperature at Bucksport, &c.*—Continued.

Date.	Temperature.						Wind.	Remarks.
	Air at H.H.		Water at H. H.		Water at pond. 9 a. m.			
	7 a. m.	1 p. m.	7 a. m.	1 p. m.	Surface.	Bottom.		
1874.								
Nov. 1	36	41	......	......	50	49	Southwest, light	Cloudy.
2	28	42	......	......	48	48	Northeast, light.......	Mostly cloudy.
3	25	46	42	45½	47	46½	Southwest, fresh	Clear.
4	29	48	42	45	46	45½	Southerly, light	Do.
5	42	50	43	47	46	45½	Southerly, fresh	Hazy.
6	43	50	43	46	46	45½	......do	Rain a. m.; cloudy p. m.
7	41	42	43	44	45	45	Northerly, fresh	Cloudy.
8	28	45	39	42	44	44	Southerly, light.......	Do.
9	42	43	43	43	45	44½	Easterly, light	Cloudy; rain at 4 p. m.
10	36	44	41	44	44	43½	Northerly, fresh.......	Clear.
11	29	47	40	44	44	43½	Northerly, light.......	Mostly clear.
12	25	34	38	41	41	41½	Northerly, fresh	Clear.
13	25	31	37	38	40	40	Northeast, light.......	Mostly cloudy.
14	26	30	34	37	37	38	Northerly, fresh	Clear.
15	16	31	34	36	34	37½	Southwest, light	Cloudy.
16	29	34	35	36	.....	......	Northerly, light.......	Do.
17	19	34	34	36	.....	......	Variable, light	Do.
18	41	47	36	38	.....	......	Northwest, light......	Cloudy till 9 a. m.; then clear.
19	16	22	33	35	.....	......	Northerly, fresh	Cloudy in a. m.; clear p. m.
20	9	28	34	35	.....	......	Easterly, light	Cloudy; snow p. m.
21	29	35	35	35	.....	......	Variable, light	Snow in a. m; clear p. m.
22	13	17	34	35	.....	......	Northwest, fresh......	Clear.
23	11	28	34	35	.....	......	Southeast, light	Snow all day.
24	36	39	34	35	.....	......	Southwest, fresh	Partly clear.
25	29	34	31	31	.....	......	Westerly, light	Clear a. m.; cloudy p. m.
26	19	28	34	35	.....	......	......do	Clear.
27	14	33	34	35	.....	......	Southwest, light	Partly clear.
28	27	41	35	37	.....	......	Southerly, light.......	Clear.
29	49	50	36	37	.....	......	Southerly, fresh	Rain all day.
30	20	22	35	35	.....	......	Westerly, light	Clear.
Sums ...	832	1118	1038	1085.5	657	657.5		
Means ..	27.73	37.27	37.07	38.7[illegible]	43.8	43.83		

TABLE IX.—*Observations on temperature at Bucksport, &c.*—Continued.

Date.	Temperature.				Wind.	Remarks.
	Air at H. H.		Water at H. H.			
	7 a. m.	1 p. m.	7 a. m.	1 p. m.		
1874.						
Dec. 1	4	16	35	36	Variable, light	Clear.
2	18	30	35	36	Southwest, light	Hazy.
3	37	44	35	37	.....do	Cloudy.
4	33	30	35	36	Northerly, fresh	Clear.
5	10	26	35	35	Southwest, light	Hazy.
6	15	32	35	36	Easterly, light	Cloudy.
7	33	34	36	36	.....do	Cloudy and snow.
8	28	33	36	36	Northeast, light	Cloudy.
9	13	29	35	36	Southerly, light	Do.
10	25	30½	35	36	Northwest, light	Clear.
11	29	33½	35	36	Southerly, light	Snow.
12	3	15	35	35½	Northwest, light	Clear.
13	8½	19	35	35	Northerly, light	Do.
14	15	9	35	34½	Northeast, fresh	Snow all day
15	−11	1½	35	35	Northerly, fresh	Clear.
16	− 8	14	35	35	Northwest, light	Do.
17	12	26	35	35	Easterly, light	Cloudy a. m.; snow p. m.
18	20	14	35	35	Northerly, fresh	Cloudy a. m.; clear p. m.
19	18	34½	35	35	Westerly, light	Mostly cloudy.
20	10	34½	35	35	Southerly, light	Cloudy.
21	3	8	34½	35	Northerly, fresh	Clear.
22	− 8	26	34½	35	Southerly, light	Cloudy.
23	35	42	35	36	.....do	Cloudy mostly.
24	31½	38	35	35½	.....do	Cloudy a. m.; snow and rain in p. m.
25	26	30	35	35½	Northerly, fresh	Clear.
26	11	29	35	35½	Southwest, light	Mostly cloudy.
27	14	32	35	35	.....do	Cloudy.
28	34½	39½	35	36	Southerly, light	Commenced raining at 10 a. m.
29	34	39	36	36	Southerly a. m., northerly p. m., light.	Squalls.
30	1	12	35	35½	Northwest, fresh	Clear.
31	− 6	4	35	35½	.....do	Do.
Sums	483.5	805	1087	1101.5		
Means	15.76	25.97	35.06	35.53		

TABLE IX.—*Observations on temperature at Bucksport, &c.*—Continued.

Date.	Temperature.				Wind.	Remarks.
	Air at H. H.		Water at H. H.			
	7 a. m.	1 p. m.	7 a. m.	1 p. m.		
1875.						
Jan. 1	2	17½	35	36½	Northwest, fresh......	Hazy.
2	10	19	36	37	Easterly, light........	Cloudy a. m.; snow p. m.
3	18	24½	36	37	Northerly, fresh	Clear.
4	— 2	30	35½	37	Southerly, light.......	Cloudy.
5	2	23	35½	37	Easterly, light	Cloudy in a. m.; snow in p. m.
6	—16	18	35	36½	Southwest, light	Clear in a. m.; hazy in p. m.
7	17½	22	35½	36	Easterly, light	Snow all day.
8	13	20	35½	35½	Northeast, light.	Cloudy a. m.; clear p. m.
9	6	22½	35½	35½	Easterly, light	Snow.
10	— 1	7	35	35	Northwest, fresh......	Clear.
11	—18	15½	35	35½	Westerly, light	Clouds till 9 a. m.; then clear.
12	—22	15	35	35½	Northwest, light......	Clear.
13	4	16	35	35½	Easterly, light	Cloudy; snow at 4 p. m.
14	15	21½	35	35½	Northwest, fresh	Clear.
15	— 1	2	35	35½	Northerly, fresh	Do.
16	0	15	35	35½	Northerly, light	Hazy.
17	— 2	7	35	35	Northerly, fresh	Clear.
18	— 7½	3½	35	35	Northerly, light.......	Hazy.
19	—13½	14	35	35	......do	Clear.
20	—28	8½	35	35	......do	Do.
21	—14	9	35	35	......do	Mostly cloudy.
22	8	19	35	35	Easterly, light	Snowing all day.
23	6	17	35	35½	Northwest, fresh......	Clear.
24	— 3	18½	35	35	Northerly, light.......	Clear a. m.; hazy p. m.
25	17	33	35	35½	Westerly, fresh.......	Clear.
26	1	11½	35	35	......do	Do.
27	— 1½	13	34½	35	Northwest, fresh......	Do.
28	1	23	34½	35	Southwest, light	Clear a. m.; hazy in p. m.
29	28	32½	35	35	Northeast, light.......	Mostly cloudy.
30	11	22	35	34½	..... do	Cloudy.
31	1	31	35	35	Southwest, light	Hazy.
Sums ...	31	550. 5	1088. 5	1101. 5		
Means ..	1	17. 76	35. 11	35. 53		

TABLE IX.—*Observations on temperature at Bucksport, &c.*—Continued.

Date.	Temperature.				Wind.	Remarks.
	Air at H. H.		Water at H. H.			
	7 a. m.	1 p. m.	7 a. m.	1 p. m.		
1875.						
Feb. 1	20	25	35	34½	Northeast, light	Mostly clear.
2	14	28	35	34½	Southwest, light	Hazy.
3	20	38½	35	35	Southerly, light	Cloudy a. m.; rain p. m.
4	27½	24	34	35	Northwest, light	Mostly clear.
5	−1	14	34½	35	Northwest, fresh	Clear.
6	10	19	34½	35	Westerly, fresh	Do.
7	−12	−4	34	35	Northwest, fresh	Do.
8	−6	1	34	34	Northerly, fresh	Snowing all day.
9	−16½	4	33½	34	Northerly, light	Clear.
10	−3	11	34	34½	......do	Do.
11	9	30	34	34	Southerly, fresh	Snowing all day.
12	10½	13	34	34	Northerly, fresh	Clear.
13	−18	9	34	34	Northwest, fresh	Do.
14	−17	9½	33½	33½	Northerly, light	Do.
15	−3½	4	33½	33½	Northerly, fresh	Do.
16	−6½	14	33½	34	Northerly, light	Do.
17	−12½	18	33½	34	Southeast, light	Cloudy a. m.; snow p. m.
18	1	11	33½	34	Northwest, fresh	Clear.
19	−7	26	33½	34	Southerly, light	Cloudy.
20	31½	39	33½	34	Northeast, light	Cloudy a. m.; rain p. m.
21	27	29	33½	34	Northwest, fresh	Clear.
22	4	22½	33½	34	Westerly, light	Do.
23	34½	41½	33½	34½	Southerly, light	Mostly cloudy.
24	35	43	34	34½	......do	Rain a. m.
25	33	41	34	35	Easterly, light	Rain 10 a. m.
26	25	2[illegible]½	34	35	Westerly, fresh	Clear.
27	13	27	34	34	Northerly, light	Cloudy.
28	12	13	33½	33½	Northerly, fresh	Clear.
Sums ...	224	580.5	950	960		
Means ..	8	20.73	33.93	34.29		

TABLE IX.—*Observations on temperature at Bucksport, &c.*—Continued.

Date.	Temperature.				Wind.	Remarks.
	Air at H. H.		Water at H. H.			
	7 a. m.	1 p. m.	7 a. m.	1 p. m.		
1875.						
Mar. 1	— 2	17	33	33	Westerly, light	Mostly cloudy.
2	19	20	33	33	Northeast, light	Cloudy.
3	2	21½	33	33½	Easterly, light	Clear a. m.; cloudy p. m.
4	9½	19½	33	33	Easterly, fresh	Snow.
5	— 3	32	33	33½	Easterly, light	Mostly cloudy.
6	27	40	33	33½	Southerly, light	Cloudy; snow in p. m.
7	33	40	33	33½	Southwest, light	Cloudy.
8	22	31	33	33	Northerly, fresh	Mostly cloudy.
9	16½	37½	33	33	Southwest, light	Cloudy; snow at 4 p. m.
10	27½	34	33	33½	Southerly, light	Snowing all day.
11	33	41	33	33	Northeast, light	Mostly clear.
12	33	39½	33	33½	Southerly, light	Snow a. m.; cloudy p. m.
13	27	41	33	33½	Northeast, light	Clear.
14	11	41	33	33½	Variable, light	Do.
15	31½	42½	33	34	Easterly, light	Cloudy.
16	33	37½	33	33½	......do	Do.
17	33½	39½	33	33	Southwest, light	Clear.
18	15	21	32½	33	Northwest, fresh	Do.
19	12½	25	32½	33	......do	Do.
20	12	18	33½	33	Easterly, light	Cloudy a. m.; snow p. m.
21	11	28	32½	33	Northerly, light	Clear.
22	11½	18	32½	33	......do	Do.
23	10	22	32½	33	......do	Do.
24	4	32	32½	33	Southerly, fresh	Clear till 10 a. m.; snow in p. m.
25	29½	31½	32½	33	Northeast, fresh	Snowing all day.
26	17½	39	32½	33½	Southwest, light	Clear a. m.; hazy p. m.
27	35	47	32½	33½	...do	Clear.
28	31	37	33	33½	Northerly, fresh	Do.
29	8½	41	32½	33½	Southerly, light	Do.
30	17	43	32½	33½	Westerly, light	Do.
31	28	41	32½	34	Southwest, light	Do.
Sums...	569	1018	1016.5	1032		
Means..	19.23	32.84	32.79	33.29		

TABLE IX.—*Observations on temperature at Bucksport, &c.*—Continued.

Date.	Temperature.				Wind.	Remarks.
	Air at H. H.		Water at H. H.			
	7 a. m.	1 p. m.	7 a. m.	1 p. m.		
1875.						
April 1	35	37½	33	33½	Southerly, fresh	Cloudy.
2	35	47	33	34	Southerly, light.......	Cloudy a. m.; mostly cloudy p. m.
3	40	43	33	34	......do	Cloudy and rain.
4	35	38	33	33	Northeast, light	Rain a. m.; cloudy p. m.
5	34½	35	33	33	Northeast, fresh	Snow a. m.; partly clear p. m.
6	28½	36	33	33	Northerly, fresh	Clear.
7	22½	35	33	33½	Northerly, light.......	Do.
8	25	46	33	33½	Southerly, light.......	Clear a. m.; cloudy p. m.
9	26½	43	33	34½	Northerly, light.......	Clear.
10	38	48	33	34	......do	Mostly clear.
11	41½	39	33	34	Northeast, light	Squalls.
12	29	38	33	34½	Northerly, light.......	Clear.
13	30½	35	33	34	Easterly, light	Cloudy.
14	28½	40	33	34	Northeast, light.......	Partly clear.
15	31	45	33	34½	Southwest, light	Clear a. m.; cloudy p. m.
16	40½	44	33½	34½	Southeast, light.......	Cloudy.
17	43½	41½	33½	34½	......do	Rain a. m.; mostly cloudy p. m.
18	27	37½	33½	35	Northerly, light.......	Clear a. m.; cloudy p. m.
19	25	37	33½	35½	......do	Clear.
20	19	29	33½	35½	Northerly, fresh	Cloudy a. m.; snow p. m.
21	21	33½	33½	35	Northeast, light.......	Snow a. m.; cloudy p. m.
22	31½	45	33½	39	Northerly, light	Clear.
23	39	55	33½	41	Northwest, light......	Do.
24	41	60	35	41½	Westerly, light	Do.
25	42	56½	36	42	Northerly, fresh	Do.
26	41	49	36	40	Northeast, light	Cloudy a. m.; clear p. m.
27	33	48	36½	42½	Northwest, fresh......	Clear.
28	31	47	38	44	Northeast, light	Clear a. m.; hazy p. m.
29	29	52	39	44	Southwest, light	Clear.
30	38	48½	38½	43	Southerly, fresh.......	Mostly clouds.
Sums ...	982	1289	1022	1094		
Means ..	32.73	42.97	34.07	36.47		

TABLE IX.—*Observations on temperature at Bucksport, &c.*—Continued.

Date.	Temperature. Air at H. H. 7 a. m.	Air at H. H. 1 p. m.	Water at H. H. 7 a. m.	Water at H. H. 1 p. m.	Water at pond. 7 a. m. Surface.	Water at pond. 7 a. m. Bottom.	Wind.	Remarks.
1875.								
May 1	40	52	38½	43	39	39	Northerly, light.....	Partly cloudy.
2	37½	39½	39	39	39	39	Southeast, light.....	Rainy.
3	36	47	38½	41	39	39	Westerly, fresh	Mostly cloudy.
4	41	52½	39	42½	39	39	Northerly, light.....	Mostly clear a. m.; cloudy p.m.
5	39	53	39	43½	40	40	Variable, light	Clear a. m.; cloudy p. m.
6	43½	58	41	45	42	41½	Southerly, light	Partly clear a. m.; cloudy p. m.
7	44	61	42½	50	44	43	Variable, light	Clear.
8	44½	54½	45	48½	46	45	Southerly, light.....	Hazy a. m.; cloudy p. m.
9	39	41½	45	46	46½	45	....do	Raining all day.
10	42	50	45½	47	47	46	...do	Cloudy.
11	42	61	46	54	47	46	Southwest, fresh....	Clear.
12	46	57½	49	51	49½	48	....do	Mostly cloudy.
13	46	61	49	57	50	49	Northwest, fresh....	Clear.
14	45	67½	51½	59	53	49½	Southwest, light ...	Do.
15	48	49	52	53	53	50	Southeast, light.....	Rainy from 9 a. m.
16	46	45	52	52	53	50	Northeast, light.....	Rainy a. m.; cloudy p. m.
17	42	57	51	56	51	51	Northerly, fresh	Clear.
18	41	59½	51½	57	53	51½	Northeast, fresh	Hazy.
19	43	49	51	53	51½	51½	Easterly, light	Rainy.
20	45	46	51	53	51½	51½	Southerly, fresh.....	Cloudy a. m.; rain p. m.
21	49	66	51	57½	51½	51½	Northerly, fresh	Clear.
22	50½	69	53	58½	54	52	Southwest, light	Do.
23	55	63½	55½	69	55½	54½	Northerly, light.....	Do.
24	51	64	56½	61	57½	54	Southwest, fresh....	Clear.
25	58	75	57	64	58½	57	Southwest, light	Hazy.
26	61½	74	61½	69	62	57½	Northwest, fresh....	Clear.
27	54	68	61	67	61½	60	Northerly, fresh	Do.
28	54	68½	60	67	61½	61	....do	Clear.
29	58½	67½	61	67	62	61	Variable, fresh......	Cloudy.
30	50	62	59½	63	61	60½	Southerly, light.....	Do.
31	55	63	59½	65½	61	60½	Variable, light	Mostly clear.
Sums ...	1447	1802	1552.5	1699	1580	1544		
Means ..	46.68	58.13	49.74	54.80	50.97	50.13		

TABLE X.—*General summary of observations on temperature at Bucksport, from June, 1873, to May, 1875, inclusive.*

Date.	Air at hatching-house.				Water at hatching-house.				Water at the pond.													
									9 a. m.						Surface.				Bottom.			
											Surface.		Bottom.									
	7 a. m.	1 p. m.	Max.	Min.	7 a. m.	1 p. m.	Max.	Min.	Surface.	Bottom.	Max.	Min.	Max.	Min.	7 a. m.	1 p. m.	Max.	Min.	7 a. m.	1 p. m.	Max.	Min.
1873.																						
June	56.13	73.13	88	46											a69.5	a71.4	75	66	a67.9	a68.2	71	66
July	62.9	80.06	92	55											71.77	74.03	80	67	70.74	71.61	76	67
August	58.26	76.16	86	46											68.74	70.8	77	60	68.26	68.8	74	58
September	49.83	63.97	84	37											60.4	61.67	66	56	60.07	60.67	65	56
October	40.87	54.54	69	27											52.19	53.65	59	46	52.03	52.65	57	47
November	20.85	30.7	48	—2½	37.1	38.18	48	33							b37.05	b37.66	46	32	c39.92	c39.65	46	36
December	15.52	26.45	44	—22	33.54	33.69	35	32½														
1874.																						
January	14.84	22.71	50	—13	33.19	33.59	34	33														
February	10.54	25.16	45	—21	33.43	33.83	34½	32½														
March	21.61	33.36	46	1	33.64	35.00	37½	32½														
April	29.25	38.38	53	5	35.53	37.97	42	34														
May	45.81	58.94	76	34½	51.03	53.38	64½	37½	53.95	51.11	66	41	58	40								
June	54.33	66.4	84	45	60.65	64.83	74	56	62.97	60.	69	57	63	57								
July	60.73	73.52	89½	50	d64.67	d68.73	75	60½	69.21	65.73	75	62	70	60¼								
August	56.84	70.94	82	44					67.23	65.32	71	64	69	62								
September e	53.67	64.38	81½	40					62.93	62.04	67	59¼	66	58¼								
October	40.71	54.02	60	28					51.34	50.90	59	47	58	46								
November	27.73	37.27	50	9	f37.07	f38.76	47	33	g43.8	g43.83	50	34	49	37¼								
December	15.76	25.97	44	—11	35.06	35.53	37	34¼														
1875.																						
January	1	17.76	33	—28	35.11	35.53	37	34½														
February	8	20.72	43	—18	33.93	34.29	35	33½														
March	19.23	32.84	47	—3	32.79	33.29	34	32½														
April	32.73	42.97	60	19	34.07	36.47	44	33														
May	46.68	58.13	75	36	49.74	54.80	69	38½							50.97		62	39		h50.13	61	39

a Average of observations from June 21 to 30 inclusive.
b Average of observations from Nov. 1 to 19 inclusive.
c Average of observations from Nov. 1 to 13 inclusive.
d Average of observations from July 1 to 15 inclusive.
e No observations made September 20.
f Average of observations from Nov. 3 to 30 inclusive.
g Average of observations from Nov. 1 to 15 inclusive.

B—THE SALMON OF LAKE CHAMPLAIN AND ITS TRIBUTARIES.

BY W. C. WATSON.

SIR: I take great pleasure in complying with your request "to prepare a paper on the salmon of Lake Champlain and its tributaries". I fear, however, that I shall not succeed in furnishing anything novel or interesting, or add essentially to the views I have already published.

1.—ABUNDANCE OF THE SALMON IN EARLY TIMES.

Since the receipt of your favor, I have sedulously tried to trace old residents, from whom I might derive some new facts or incidents, illustrating the prevalence of the salmon at the early stages of the settlement of the region, or for observations disclosing fresh or unfamiliar traits in their habits. My efforts have been attended with only trifling success. When I first engaged in the investigation of this interesting subject, nearly a quarter of a century ago, I secured information from many persons, whose recollections extended almost to the period when the fisheries of the country were in their normal condition, or of those who had received traditions of the salmon from their immediate ancestors, which imparted much valuable intelligence. I garnered up from such sources many important facts; but now, when I attempt to renew these inquiries, I find that few of that class of persons remain, and that the field of research is very limited.

One fact, which is fully established in the traditions of the salmon-fisheries, has, I conceive, important bearing on the scheme in which you are so deeply and efficiently interested, and presents most favorable auguries of the success of the undertaking. I refer to the wonderful exuberance of this fish when the country was first occupied. I base the opinion upon the idea that this exuberance indicates that the locality was congenial to their habits, and that they were attracted to these haunts by peculiar causes. I will venture to suggest a few speculations on the subject, although they may appear crude and unphilosophical to your great experience and attainments.

I believe that no other waters, not even the tributaries of the Onion,* ever exhibited so extraordinary a copiousness of these fish—and certainly they could not have exceeded it—as they appeared to the occupants of the Champlain Valley in the latter part of the last century and early in the nineteenth. The natural causes are very obvious which produced this result, and among them a few circumstances may be indicated. Lake Champlain was readily accessible to the salmon from the ocean by the way of the Saint Lawrence and Sorelle or Richelieu Rivers, and was also comparatively contiguous to the cold northern seas. The streams emptying into the lake have generally a short course, and usually with long reaches

* Now called Winooski River.

of gravelly bottoms, are rapid in their currents, and start from cool lakes and ponds, and in their passages at that time were largely fed by cold springs, and shielded in their whole progress by the canopying of heavy umbrageous trees and bushes, which effectually shielded them from the influence of the sun's rays and the warm air. A coolness of the water not exceeding probably 45°, a temperature so delightful to the salmon, was thus maintained. Each of these qualities of the streams, impetuosity of the current, a gravelly bottom, a low temperature, to which may be added great purity, is a condition of nature eminently attractive to the salmon. They enjoyed repose and impunity amid the utter silence and seclusion they loved. They were not hunted by the ruthless sportsman, or even disturbed by the spears and nets of the Indian. They had easy and safe access to their favorite breeding-grounds. When Champlain entered the lake in 1609, he found its shores unpeopled and silent. The smoke of not a single wigwam arose in the atmosphere on either shore. The bloody and perpetual incursions, along the common highway it afforded, of the Mohawks and Algonquins in their reciprocal attacks, had driven the savages that once inhabited the beautiful territory into the recesses of the interior for security. The region bordering on the lake was a scene of total desolation, and continued in that condition to the middle of the succeeding century, and was but sparsely occupied until near its close. In the view I have embraced, this aspect of nature rendered the lake and its affluents singularly adapted to the habits of the salmon, and attracted them in the remarkable abundance which we shall see did exist.

The fact of the exuberance of the salmon in these waters when the environs were first occupied by civilized man is established by the most ample and satisfactory testimony, and appears to me worthy of perpetuation, as interesting in its relation to natural history, and as calculated to aid and illustrate the future researches of the student of nature.

The first historic notice of the prevalence of salmon in the region, I think, appears in the correspondence between William Gilliland, the pioneer of the Champlain Valley, and Arnold, who was cruising on the lake with the American flotilla in the summer of 1776. His letter states that on a single occasion Gilliland had presented seventy-five salmon to a petty-officer of Arnold, and asked the services of the ship's carpenters to repair his "salmon-crib and apparatus, which had been carried away by a great flood". He also affirms, in a memorial to Congress in 1777, that he "had complimented the American Army with fifteen hundred salmon in one year". When the writer first became a resident of the district in 1824, many of the original settlers of the country were yet living, who were men of respectability and position, and of undoubted veracity. Their tales of the abundance of the salmon which prevailed at that time demanded for their acceptance an exercise of the strongest faith in the truthfulness of the narrators. Coming from the unimpeachable sources they did, and corroborated by uniform traditions and the current of universal testimony by actual observers or participants of the incidents, there was no hesitation in receiving the statements as authentic and true. I have heard the account from several of these individuals that when they immigrated many streams were so thronged by the salmon that it was unsafe at particular seasons to ride a spirited horse into them, for the reason that the fish were so abundant and bold that they would fearlessly approach the horse and strike him with great force by the powerful muscular action of their bodies. It was often represented that it was a common pastime, as well as a most desirable means of obtaining food at that time, to drive a team into some of the shallow tributaries of the river, and from the wagon spear the salmon with pitchforks, and thus obtain in a few minutes all the fish needed for consumption. Many of the salmon taken in this primitive method would reach twenty pounds in weight.

Among the various persons from whom I have received interesting information in aid of my inquiries, I am particularly indebted to Silas Arnold, esq., of Reeseville, for several facts which were communicated to him by his father, Hon. Elisha Arnold. This gentleman was one of the earliest prominent settlers, and subsequently attained high social and political standing in the district. Among these incidents, Mr. Arnold recalls the following circumstance, which coming from so intelligent and reliable an authority amply corroborates the almost incredible traditions of the former copious prevalence of the salmon in these waters. About the year 1800, or possibly a year or two previous, at any rate it was at so early a period in the occupation of the country that the pathway through the woods, leading from the residence of Judge Arnold, situated near the center of the present town of Peru, to Plattsburgh, was marked by a series of blazed trees. As he was proceeding to the latter place, in fording the Little Au Sable, a small shallow stream, near its mouth, the passage of his wagon was largely impeded by the throng of salmon which was in the stream, and he readily caught and threw upon the bank all he wished to take.

Mr. Arnold has called my attention to a familiar fact, which is observed among all gregarious fishes, and is peculiarly characteristic of the salmon family, and tends to relieve the marvelous tales of the early exuberance in the Champlain region of the salmon from their incredible aspect. He says that they ascended the streams in shoals, or schools, which intermitted in their progress, and that the flow of the fishes was not constant or continuous as might be inferred by the language of the traditions; that when encountered in the vast masses so often described, they were passing a particular locality, consolidated in one of these shoals, or schools.

Mr. Oscar F. Sheldon, formerly of Willsborough, Essex County, communicated to me a record, which he deems perfectly authentic, of five hundred salmon being taken in a single afternoon early in the present century, from the river Bouquet. The Bouquet is a tributary of Lake

Champlain, and may be regarded almost as an estuary up to the falls, a distance of about three miles, and is navigable to that point by vessels of light draught. It was therefore peculiarly adapted to the habits of the salmon, and beyond the falls I think they could not penetrate.

The record of the circumstance of capturing fifteen hundred pounds of salmon in the year 1823, at a single haul of the seine, near Port Kendall, in the town of Chesterfield, in the county of Essex, was said to have been among the papers of Levi Highby, esq., in 1852. He was a man of high character, and was, I understood, an actor in the achievement. This fact is not only memorable for the extraordinary quantity of the fish taken, but it also illustrates the singularly erratic and inscrutable habits of the salmon. In all my investigations on the subject, this is the only instance that I have learned of the salmon being taken in any great quantities except from the rivers and their branches. The facts connected with this incident seem to claim some attention, as calculated to throw a little light on the history of the fish. Between the Bouquet and Au Sable Rivers, no stream of any magnitude enters the lake except the brook that debouches at Port Kendall. This brook plunges over a sheer precipice of at least forty feet, directly into the waters of the lake, without any or scarcely any space intervening. The immense catch of salmon recorded could not therefore have been taken while they were attempting to reach their spawning-grounds, but were found near the shore, although in the open waters of the lake. They must necessarily wander through the lake in schools; but this is the only case which I have been able to trace where they have been captured except in streams or in the act of entering into them.

These facts, which might, I think, be accumulated by a large catalogue of similar incidents, are sufficient, in my judgment, to sustain the proposition that the waters and the tributaries of Lake Champlain were teeming at a former epoch with salmon to an extraordinary, if not unexampled, extent.

2.—THE DISAPPEARANCE OF THE SALMON, AND ITS CAUSES.

Unhappily, another fact, alike regretted by the sportsman and the political economist, is equally clear—the total disappearance for many past years of this prince of fishes from all the region. An event of such importance has elicited much inquiry and speculation, but it still remains a problem that will probably never receive a satisfactory solution. Various theories in regard to the agencies which have caused this singular revolution have been suggested and may claim investigation. If any physical condition of the country, or the waters, or their channels, formed allurements that attracted the salmon, the decay or removal of these conditions would necessarily dispel such attractions, and tend to the abandonment of the region by the fish. I have referred to the uncommon repose and seclusion, even in a wilderness region, that marked the borders of the lake, as one explanation of the original exuberance of salmon in these tranquil scenes. The first occupation of the country began to disturb that repose; and, as the population increased, the solitude and quiet of the fish were more and more invaded, until ultimately the clangor of machinery, the tumult of business, and, with far greater effect than all the rest, the jarring of the engines of steamboats and their fierce disturbance, expelled the salmon from their ancient and loved haunts.

In regard to the effect of steamboats on the salmon-fishery, the Hon. Thomas B. Watson, of Peru, Clinton County, communicates to me the following statements, which he received from an aged man whose whole life has been devoted to fishing. He says that the salmon run from the lake into the rivers during the night, and that he has frequently seen them, when a steamer was merely crossing the mouth of a stream, so excited by alarm and panic at the noise and agitation as to rush impetuously over a shallow bar into the deep water of the lake. The same person informed Judge Watson that the opinion prevailed among old fishermen, when the decadence of the salmon-supply first began to be observed, that it was caused by their disturbance on the Richelieu River from the steamboats; and, in support of this idea, he said that he was engaged in 1838 in capturing between fifty and sixty salmon in the Au Sable River, and that no salmon had appeared in that stream for the fifteen preceding years, and by a singular coincidence, which confirmed in their minds this theory, the only steamer plying on the Richelieu had been burned the same season. However correct may be this conclusion, any impediment or disturbance which may have existed in that narrow and shallow stream may be enumerated among the possible causes of the expulsion of salmon from the lake. That all fishes (and the fact may be exhibited especially in a family so sensitive and shy in its nervous organization as the salmon) are frightened from their haunts by noise and agitation has been sufficiently demonstrated on Lake Champlain in the recent construction of the New York and Canada Railroad. This work was attended by heavy explosions near the waters, which fish had been accustomed to frequent in great copiousness. I have understood that immediately afterward these resorts were generally, at least for the time, abandoned by the fish. The quiet the salmon constitutionally delights in and its sense of security have been invaded, with consequences still more effective, by another agency, which became augmented by the increase of population. I refer to the persistent and inexorable hunting that not only assailed them by the net and the jack-light and spear, but pursued them to their gravelly beds and breeding-grounds, and there not only ruthlessly slaughtered the mothers and millions of the embryo, but drove innumerable multitudes in panic and alarm from the waters, probably never to return to their former haunts.

Another reason may be assigned, and I conceive with much force, for the salmon relinquishing localities which were once their favorite resorts. They love, as I have stated, to seek cool waters, and this gratification they attained in the normal condition of the region; but when in the progress of improvement "the forests primeval" that embowered the streams, and aided in imparting a delightful coolness to the waters, were removed, and the waters exposed to the action of the sun and air, while the cold springs that fed them were desiccated, the temperature of the water was raised higher than to be congenial to the habits of the salmon. This condition may be discerned in nearly every stream that flows into the lake. Another qualification of the water which is essential to the comfort and enjoyment of the salmon is that it should be pure, and, in the words of Judge Watson, "highly aërated". The rapid erection of saw-mills, until they occupied almost every water-power, literally extinguished in almost every stream this native condition. The sawdust stained and polluted the water, and the sediments and *débris* of the mills settled largely on the gravelly bottoms, which had been so alluring to the salmon, changed their character, and revolted the cleanly habits of the fish. Mr. Arnold mentions another effect from this cause, which may have exerted a greater influence. He has observed, in his own experience, that the sawdust with which the water was charged was necessarily inhaled by the fish with the fluid, and that particles of it were not ejected, but remained adhering to the gills. This mechanical effect must have produced annoyance to the creature, with succeeding suffering and possible death.

The most formidable and indeed insuperable obstacle to the ascent of the salmon were the innumerable dams constructed on almost all the streams near their mouths. These were usually of a perpendicular height so great as to utterly repel the attempts of the fish to overcome them. This cause of the disappearance of the salmon is so paramount and obvious that the discussion of any other would be superfluous were it not that it seems appropriate in a paper like this to present every possible view of the question before us, and for the very conclusive reason that several streams, of which the Au Sable River is a striking instance, that have equally suffered with the others from the abandonment of the salmon, have never impeded the run of the fish by dams or any other artificial obstruction. Had the advent of the salmon in the rivers been coincident with the season of high water, their ascent of these impediments would have been immensely facilitated, but their run was precisely at the usual occurrence of the lowest flow of the streams. The volume of water was almost totally exhausted by the flumes, and at times scarcely trickling over the apron of the dam, without furnishing any supply to the slopes or sluices constructed in accordance with the statute. The popular excitement became at length so deeply inflamed by acts which were then regarded as encroachment on public immunities that the grand jury of Clinton County, New York, were impelled, in the year 1819, to present an indictment against the proprietors of the dam erected at the mouth of the Saranac River in Plattsburgh. The indictment, among other averments, alleged that previous to the erection of this dam "salmon were accustomed to pass, and actually did pass, from Lake Champlain into and up the Saranac River for a distance of twenty miles; * * * that before the dam was built salmon were seen above the site;" and that "after it was built many were caught at the foot of the dam, but none above it;" "that salmon begin to ascend the river from the lake in June and July, but largely in August and September". It appeared that the dam was fourteen feet high, and the sluice-way forty feet long, and arranged at an angle of 30°.

This indictment was vehemently pressed, and resulted in a protracted and bitter trial in the circuit court. It was calculated to open a thorough investigation of the habits and movements of the salmon in connection with that particular stream. A great mass of witnesses, embracing most of the early settlers then living, were introduced, and, had the great volume of testimony taken on that occasion been preserved, we should now be in possession of all the essential facts and incidents necessary to form a history of the salmon-fishery of that period and locality. Although the case was elaborately argued in the supreme court (Johnson's Reports, 17, page 195) both on the merits and the law, the decision, which was in favor of the defendants, unfortunately rested purely on legal and technical views, and we have but slight references to the facts in the report. We detect, however, faint glimmerings of the evidence in the arguments of counsel. It seems to have been in proof that the water in the sluice-way was too shallow to admit the passage of the fish. It is worthy of remark that one point of Mr. Walworth, the future eminent chancellor, as counsel for the defense, and evidently based on some features of the testimony, was that "no fish visit the lake from the ocean; the salmon ascend from the lake, and are fresh-water fish".

And it appears from a point made by the opposing counsel that "the evidence in the case is that salmon abounded at the foot of the dam, and would ascend the river if not hindered by that obstacle".

We may perhaps appropriately refer, as a subordinate cause of these results, to the depredations of other fish upon the salmon by assailing them on their spawning-grounds, destroying the ova, killing the young fish on their passage to the sea, and frightening the salmon from their usual haunts. This cause, of course, always existed, but circumstances might have stimulated its development.

These changes in the physical condition of the region seem adequate to producing the abandonment by the salmon of the Champlain waters, but they were entirely local. The eccentric and capricious nature of all fish, which produces many strange phases in their movement, and from the general operation of which the salmon is not exempt, may be referred to as another possible cause of their disappearance from these waters. The idea is probably fanciful; but as my purpose is to unfold the whole subject, it may not be unworthy of a moment's inquiry. Is it wholly improbable that the abandonment of the Champlain waters by the salmon may be due to their finding more genial resorts and fresh and more attractive feeding-grounds? I will venture to present a few facts in support of this suggestion. During my long residence on the borders of Lake Champlain, I have observed that a particular kind of fish will occasionally, through several successive seasons, be very abundant; that the supply gradually diminishes, until, in the end, they nearly disappear, while another variety becomes predominant, rapidly increases as the first decreases, and they also pass through the same changes. The smelt, a marine fish, was, until, a comparatively recent period, almost unknown to the fishermen of the lake; but in late years it is often taken in vast quantities through the ice, while in some seasons it is rarely seen. Such, also, has been largely the history of a choice fish known in this region as the lake-shad.

3.—TRAITS OF THE SALMON.

The pertinacity of the salmon in renewing, after repeated failures, their attempts to leap up falls too high for their powers, and the vast muscular force they exhibited, was witnessed by the settlers with equal wonder and admiration. I do not know that the myth, which once prevailed in the popular faith of England and Scotland, that the salmon taking the tail in its mouth formed a wheel and thus rolled up the cascade, ever obtained in this region; but the stories of the pioneers and old fishermen were almost equally marvelous. The fish ascended the precipice by the mere exertion of physical strength; but the method which it is said they adopted to secure a safe descent reveals a wonderful instinct or a rare exercise of sagacity and intelligence. They were accustomed, it is related, to approach very near the verge of a fall, and instead of allowing themselves to be precipitated headlong or rolled sideways down the current, with the imminent peril of being dashed upon the rocks below or drowned, they would deliberately turn their tails toward the cascade and by the vigorous action of their fins and motion of their bodies would maintain their position and be borne safely down the obstacle.

The progress of the salmon in their annual migration from the sea to the tributaries of the lake seems to have been singularly slow and methodical. Instead of diffusing themselves at once and promiscuously through the lake, the advance from the north was apparently controlled by a system or some law of instinct. The old fishermen all concur in the recollection that a considerable interval, varying in their statements from one week to a month, always occurred between the time of arrival of the fish in the Saranac and their appearance in the Au Sable, although the mouths of these streams are only separated by a space of about twelve miles. Incidents in the habits of the salmon, which came under my personal observation more than fifty years ago, expose some traits which possibly may be regarded in the measures in progress to rehabilitate the streams with these fish. A high bridge spanned the Saranac, near its mouth, in the village of Plattsburgh; a massive dam stood a few rods above, as it did at the commencement of the century; on the west end of the dam, the statutory trough or slope had been constructed, and on the opposite end was situated a large saw-mill, which discharged a strong and impetuous volume of water through a race-way. I saw schools of salmon swimming below the bridge, and individuals speared from it at a height of fifteen or twenty feet. They seemed to be wandering in confusion, ascended to the foot of the dam and returned, paying no attention to the sluice-way, which was indeed impracticable for their ascent from the slight supply of water that passed down the slope. They were constantly attracted to the race-way, and plunged into it as if its rushing current was congenial to their habits, or perhaps in the vain hope of reaching by that channel their appropriate breeding-grounds. A weir was built in this race-way, in which, during the season, salmon were daily captured.

4.—THE AU SABLE RIVER.

The contemplated scope of this paper does not embrace any notice of the policy which has been initiated for restoring salmon to the waters of this region; but I will venture to express a regret that the experiment was not extended to the Au Sable River. The reasons for this view will best appear from a brief notice of the peculiarities of the stream and the salmon-fishery connected with it. It will be seen that it retains, more than any other tributary of the lake, its original qualities and conditions.

The river measures from the lake to a high vertical fall, which was never surmounted by the salmon, a distance of about six miles. Nearly one-half of this space is below the chasm, and occupied by heavy rapids or gentler ripples, with occasional short ranges of slackwater. A placid and deep pool lies immediately at the foot of the chasm, where the water seems to rest after its turbulent passage through the gorge. Above this point, the water rushes with impetuous violence, and in part of its course is compressed within a narrow natural canal, where a human foothold cannot be maintained for a moment, and which no fish but the salmon could ascend. In the short space between this canal and the falls, the stream somewhat expands and although rapid is less vehement than below. Through its whole course, with brief intervals, it is overshadowed by masses of trees and thick bushes, or it leaps and roars beneath lofty precipices that cast a perpetual shade, where the rays of the sun have never penetrated. At one period, the whole line of the river above this fall was studded with saw-mills; but to-day not one of any magnitude exists within twenty miles of the lake, while below this point no dam or other artificial obstruction has ever been erected on the river. Such is the present aspect of the Au Sable, and such was nearly its condition a hundred years ago. In the six miles I have described, it is as quiet and secluded as it is possible any stream can be in the midst of a populous and cultivated territory. The remarkable circumstance to which I have adverted of the appearance of the salmon in the Au Sable River in the year 1838, and long after they had abandoned all the waters of the Champlain system, while it is highly significant in several respects, has an important bearing on the point we are examining. Were they allured back to the stream by its peculiar and exceptional condition? Were they an advance-party exploring their former haunts, with a purpose of recolonization by their tribe? The Au Sable never abounded with salmon to the extent that characterized other streams in the vicinity. No traditions exist of its having teemed with vast schools of the fish. They frequented it, however, in numbers to make the fishery highly satisfactory. The salmon, it is supposed, left this river simultaneously with their abandonment of all the other tributaries of the lake. We have seen that no dam or other artificial obstruction ever existed on the lower portion of the river, and therefore the disappearance of the fish from that particular stream cannot be imputed to the existence of any of these impediments. We must account for this result on some different theory. Modern improvement has created structures over the Au Sable which may affect the successful introduction of the salmon into the stream. The New York and Canada Railroad crosses the river not far from its mouth, and has constructed a bridge over both the branches, which form a delta of the river. The bridges are much elevated above the usual level of the water; I have felt apprehensive that these structures and their use might impair the value even of the common fisheries on the stream. The hunting of the salmon at that period in the Au Sable was by unusual methods and specially exciting. An aged man is still living who informed Dr. George F. Bixby, of Plattsburgh, that, in his boyhood, he was in the habit of carrying a torch or jack-light for a sportsman to spear salmon in this stream, and that they killed them, often weighing twenty pounds. They would descend the high bank and enter the river near the head of the natural canal, and, wading in the water toward the fall, found the fish lying upon the bottom, who, either dazzled by the light or careless in their refuge, would allow the spearsman to approach them sufficiently near to strike. He represented the fish as appearing, when the torch-light was reflected from their mottled backs, like bunches of hay sunken in the water.

The valued correspondent from whom I have frequently quoted, writes me that when a child he saw a man sitting in a boat at the head of one of the rapids I have described, and drawing in the salmon with great rapidity; that he cast a long line and a common hook baited with a piece of pork into the rapids, and that even before the hook touched the water the fish would seize it with the eagerness that is often displayed by the trout. This is the only instance that my inquiries have disclosed of salmon being taken in these waters by the hook. It was a common sport, fifty years ago, to seek the salmon on the falls, where they were speared in great numbers, as they attempted to leap up the precipice.

APPENDIX C.

FISH-CULTURE,

RELATING MORE ESPECIALLY TO

SPECIES OF CYPRINIDÆ.

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XXV.—NOTES ON PISCICULTURE IN KIANGSI.*

By H. Kopsch.

Fish-culture having attracted much attention of late years in Europe and America, a few notes on the manner in which it is conducted in this part of China may be of interest.

It is well known that "the Chinese have long bestowed more attention on pisciculture than any other nation, and with them it is truly a branch of economy, tending to the increase of the supply of food and the national wealth—not merely, as it seems to have been among the Romans, an appliance of the luxury of the great.

"The art of breeding and fattening fish was well known to the luxurious Romans, and many stories are related about the fanciful flavors which were imparted to such pet fishes as were chosen for the sumptuous banquets of Lucullus, Sergius Orata, and others. The art had doubtless been borrowed from the ingenious Chinese, who are understood to have practiced the art of collecting fish-eggs, and nursing young fish, from a very early period. Fish forms to the Chinese a very important article of diet, and from the extent of the watery territory of China, and the quantities that can be cultivated, it is very cheap. The plan adopted for procuring fish-eggs in China is to skim off the impregnated ova from the surface of the great rivers at the spawning season, which are sold for the purpose of being hatched in canals, paddy-fields, &c., and all that is necessary to insure a large growth is simply to throw into the water a few yolks of eggs, by which means an incredible quantity of the young fry is saved from destruction."

Such is the description given in Chambers's Encyclopedia, of pisciculture in China, but as all details are omitted, it is proposed to supply a few from observations made in this vicinity. Fry-fishing commences here (Kiu-Kiang, on the Yangtse) about the middle of May, and lasts from ten to fifteen days. The preliminaries for this kind of fishing are not numerous. The net, which is of coarse gauze, dyed brown, is fixed on its proper frame, and the whole cast alongside the river-bank, where there is a moderate current, sufficient, however, to keep the net in position, and to sweep the fry into the trap.

A single frame as it floats upon the water represents our letter V, and measures about 15 feet long, and 8 feet across the mouth. The net

* Land and Water, XX, No. 510, October 30, 1875, pp. 338–339.

attached to it is submerged about a foot, thus serving to collect the fry as they are drifted by the current into the trap at the end of the frame. The bottom of this V-shaped frame is not closed together, a little space being left to allow the spawn to pass through the throat of the net leading into the trap, which floats perpendicularly and to prevent its collapsing; it is tied to splints run through the four corners of its frame, as will be seen from the drawing forwarded.*

As many as four or six of these V-shaped frames are attached to a long bamboo moored close to the river-bank in rows one above the other, at distances of from 15 to 20 feet apart, where they are left all night and day.

But let us look into one of these traps. The net-tender, who lives in a mat-hut on the river-bank hard by, or in the sampan (small boat) used to visit the nets, readily gratifies our curiosity.

Taking an ordinary-sized rice-bowl, he dips it into one of these cages, which it should be noted appear to require emptying every hour, and hands us about a quart of muddy river-water, perfectly alive with wriggling, transparent looking fry, measuring from an eighth to two-eighths of an inch in length, with heads and eyes greatly out of proportion to the size of their bodies. Even in the muddy water there was no difficulty in discerning them, as one would be led to suppose from Abbé Huc's statement "that it is impossible to distinguish the smallest animalculæ with the naked eye." Experts are said to be able to detect the different kinds of fry as soon as they are caught; but as they would be too small to handle, their knowledge would be of little practical value. In a week or so they become large enough to distinguish one from the other. After the fry are collected from the small traps they are put into a floating reservoir made of net, exactly like the trap shown in the sketch, but much larger in size, where they are kept until purchased for conveyance inland.

Those sold for breeding in the neighborhood are carried on the shoulders of coolies in water-tight baskets to the ponds and lakes, of which there are a great number in this circuit. Along the Yangtse fry, is sold by the jar or bowl, according to the quantity of fish it contains, and from five to six hundred cash (equal 1*s*. 8*d*. to 2*s*.) appears to be the average price per jar, according to the statement of the boatmen.

Most of the fry is conveyed inland by boats, which come from the interior for the especial purpose of loading with this freight. These peculiar-looking craft generally hail from Kan-chow-fu, a large town to the south of the province, on the Khan River; also from Kuei-hsi-hsien, in Kuanghism department, to the east of the province; and those that load here generally rendezvous at Kuan-pai-chia, a small village about a mile west of Kiu Kiang, on the south bank of the river. Tea-boats are likewise used to carry fry, but not so extensively as those from Kan-

* Sketches illustrating the article were forwarded to the office of "Land and Water," London.

chow. Foreign residents on the Yangtse are too well acquainted with the craft to need any description.

The Kan-chow boats, or *yu-miao-chuan* (spawn-boats), are of much larger carrying capacity, and measure about 78 feet long, 15 feet beam, 11 feet from bottom to top of mat-cover, and draw, when loaded, from 3 to 4 feet. They are built in water-tight compartments, and are propelled by sails, tracking, or *yuloeing*—that is, by long sculls rigged out about 18 inches or two feet from either side of the boat, on outriggers, forward of the mainmast, and worked parallel to the side of the boat by four or six men at each scull. About twenty men comprise the boat's crew, who also attend to the fish in turns, their wages averaging 2,000 cash (equal 6*s*. 8*d*.) per month, with food. The boats are worth from 450 to 500 taels each (£150 to £167). Their cargoes brought to this port consist chiefly of timber (hewn as if for railway sleepers), wood for making coffins, planks, water-chestnuts, water-chestnut flour, grass-cloth, and sundry sweet-smelling flowers; probably small speculations of the crew, such as *Kuei hua* (*Olea fragrans*), *Mo-li-hua* (*Jasminum*), *Lan-hua* (*Epidendrum*), *and Tay-lai-hsiang* (*Stephanotis*), &c., which fetch a good price here.

But as several of these boats are nearly laden, it will be curious to see how they stow their freight. From the bottom boards of the boat to the level of the gunwale we find the holes filled with red earthenware jars (made of flower-pot clay), each measuring 18 inches in diameter and 12 inches deep, arranged in tiers, one above the other, five high, and as we counted eleven jars on the top row amidships of the two tiers put into a compartment, between which room is left for a man to pass, we may roughly estimate one hundred jars in each compartment, or five hundred jars in the five sections into which the hold is divided. A stout plank, about 5 inches broad, is laid across the wide-mouthed jars to support the upper ones, and to spread the weight more evenly, but the plank is not so wide as to interfere with the bailing out of the vessels. The jars are fastened to the sides of the compartment by a little splint of bamboo, made fast to an eye in the bulk-head, and which is made to catch under the unturned rim of the jar, on the same principle that a small-mouthed vessel is lifted by a piece of wood being put crosswise into the opening. To strengthen the rim, it is sometimes bound round with a bamboo hoop. On the upper row of jars another plank is laid to receive the water-tight baskets, which, being much lighter than the jars, are placed on the top, and piled up from the level of the gunwale to the roof of the boat. The baskets are securely lashed to poles braced athwart the boat to prevent their sliding out of position, as at such a height a slight knock would capsize them, although they are placed in a wicker-stand to steady them and ease the strain on the sides of the baskets.

As the number of these baskets appears to be about the same as that of the jars, we have a total of say one thousand jars and baskets of fry in one boat. After all the internal arrangements are completed the fry are poured into the jars and baskets, and when all are full, the boat proceeds on her voyage. Kan-chow-fu, as I have remarked, is the chief market for spawn, but much of it finds its way into the Canton, Fo-kien, and Che-kiang provinces, when it has to be carried across the boundary range of mountains, about a day's journey, before gaining the waterways of the neighboring provinces.

The water is changed day and night, and after the muddy Yangtse and Po-yang Lake have been left the young fish require feeding, chopped yolk of hard-boiled egg being the food administered to them, with a certain amount of bread paste. A cargo of fry is estimated to be worth from 400 to 500 taels (£133 to £167), but on arrival at its destination realizes fully 1,000 taels or £300, the fish being then sold at so much apiece instead of by the jar.

Reliable information as to the mortality *en route* could not be ascertained, but all agreed that it was considerable, though chiefly dependent on the "good luck" accompanying the boat. The distance by water to Kan-chow is 1,055 li or 350 miles, and occupies from ten to fifteen days, according to the weather. The navigation is against the stream all the way after entering the Po-yang Lake. During the journey the fish are separated into different jars; the most important thing to be observed is to keep the wild fish (*yay yu*) from the domestic fish (*chia yu*); the former, said our informant, being of a restless nature, will not live peaceably in confinement, but commences to prey on the others.

The *Kan yü* or pike appeared to be the wildest fish, and most to be dreaded. The fry caught here and conveyed inland is chiefly that of the *Pang tou yü*, *Kuei yü* (perch), *Lien yü* (bream), and *Huen yü*, drawings of which are given.

The *Pang tou yü* measured 24 inches long, 13 inches girth, and weighed 7 pounds, but it often attains a weight of 20 pounds to 24 pounds, and 4 feet in length. Its flesh is rather coarse and flavorless, which is the chief complaint of most Yangtse fish. It is sold here at this season of the year (May) for 40 cash, say 1½*d.* per catty, equal to a pound and a third. This is, of course, river-caught fish. *Kuei yü* (perch), or "Mandarin fish," as our "boys" often call it, from the fact of its being the best fish to be found in the market almost at all times of the year, grows to a large size, is of excellent flavor, and very firm if full-sized. The specimen in the illustration is only average size, and measured 23 inches in length, 18 inches round the body, and weighed between 7 pounds and 8 pounds. The price ranges from 40 to 60 cash, equal 2*d.* to 3*d.* per catty (1⅓ pounds), according to season and time of day; but even at the latter price, "Mandarin" fish would not be a very expensive luxury, yet the lower classes seldom indulge in it. After the *Kuei yü*, the *Lien yü* ranks next, being a rich and firm fish. It often grows 3 feet long and 20 pounds in weight, but the dimensions of the one in the illustration were 22 inches long, 13 inches girth, and weight 6 pounds. The *Huen yü*, though a coarse-looking fish, has an excellent flavor, and in the proper season is a very acceptable change at one's table, after the everlasting perch with which our cooks continually supply us. The length of the specimen given was 17 inches, 8¼ inches round, and weighed between 7 pounds and 8 pounds. The fry of the *Shih yü*, or shad, which ascends the river in May to spawn, does not appear to be caught or bred in ponds or lakes. It is greatly esteemed by the Chinese, and is undoubtedly the best fish of their rivers. The season for it is soon over, lasting from about the middle of May to the third week in June. In former years this fish used to be taken from Nanking to Peking for the Emperor's table, but the labor of getting it there fresh was so trying to the people engaged to carry it, that the Emperor was induced to forego this luxury, and the practice was discontinued.

The pike of these waters grow to a very large size, as will be seen from the cut forwarded, the dimensions of which were 49 inches long, 21 girth, and weight 36 pounds. All attempts made by Europeans at fishing with hooks appear to have failed, few even being rewarded with as much as a bite, nor are Chinese often seen angling with rod and line on the Yangtse. The system of taking spawn by forcible parturition as practiced in the United States—a long description of which was given in Harper's Magazine for June, 1874—does not appear to be known along the Yangtse, and it is a question which fish-culturists can decide, whether the Chinese method of spawn collecting, or that adopted in America and Europe, is the most effective.

It is said that at Canton fish are caught and their spawn expelled, and afterward impregnated with the milt of the male fish, as described in the magazine quoted, but the statement has yet to be verified.

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XXVI.—ON THE CULTURE OF THE CARP.

A.—ON CARP-PONDS.*

As the price of fish and of other articles of food is gradually increasing, greater attention is given to fish-culture, in order to have constantly on hand an adequate supply in ponds. These reservoirs are either natural sheets of water or artificial excavations. Those artificially constructed are, of course, preferable, especially when the greatest care has been taken to provide everything that will secure a good supply. Fish can also be reared in marl or peat bogs; yet, as a general rule, these are suitable places of abode only for the crucian carp, the roach, &c.; and fish from such bogs can be used only as food for other fish, such as pike and trout.

The two kinds of fish to which we direct our attention at present, in connection with pond-culture, are the trout and the carp. We shall confine ourselves in this article to carp-ponds, as these seem to be the more popular with us. In former times such ponds were quite common in Denmark, and traces of them may still be seen near many of our old castles and manor-houses.

The chief difficulty in rearing carp is, that a large number of ponds is absolutely necessary in order to meet the expense of culture, and to make the time and labor bestowed upon it remunerative. Wherever carps are raised, a complete system of ponds is arranged, the most important of which are those designed for the young carp, and those provided for the mature fish.

The *pond for young carp* forms, as it were, the basis of the whole establishment, and must be large enough to furnish young carp for the other ponds. If this is not the case, it is best to have several ponds for the young. Ponds having an area of from six to ten acres are considered the best. Such a pond must only be fed from field-ditches, and must by no means be connected with other ponds, brooks, or streams. In this way only is it possible to preserve the pond free from pike, which are the most dangerous enemies of the young carp. Immediately in front of the chief embankment, the pond must have a depth of at least five feet, while in other places two feet is sufficient. At its bottom a main ditch is dug out, into which several smaller ditches lead from the sides, so that in emptying the pond all the water can be drawn into a deeper

* Lidt om Karpedamme. [*anon.* Af A. F.] < Nordisk Tidsskrift for Fiskeri.—Ny Rœkke af Tidsskrift for Fiskeri. Anden Aargang. Kjobenhavn. 1874. (pp. 79–84.)

ditch outside. By this means the young carp can gather in the inner ditches of the pond, from which they are taken. It is necessary to do this as quietly and quickly as possible, as the young fish are very tender, and speedily perish.

The pond for young carp should have flat and even banks, so that the sun may readily warm the water and thus quickly hatch the eggs which are pasted to plants and roots. Hence it is not necessary to introduce much fresh water during the spawning season, as the water in the pond would thus become too cold, and so retard, and even completely frustrate, the spawning and hatching process. During the spawning season (from the end of May till some time in July) the plants which grow in the shallow places should not be removed, and care should be taken that neither cattle, ducks, nor crows, as well as other birds, approach the pond. Nor should perch, tench, or other fish be allowed to enter it.

In those countries where carp are reared on a large scale, any piece of ground which seems suitable is taken as a site for a pond for the young fish, on the principle that the risk in raising any sort of grain is much greater than that of rearing carp. In consequence of the high price of fish, carp-ponds are now generally used year after year continuously, while formerly the piece of ground was used one year as a fish-pond and the next as a corn-field. It seems now to be the general opinion that the keeping of fish year after year continuously in the same pond has no deteriorating influence on their growth. When, however, the grass at the bottom of the pond begins to disappear and gives way to reeds, the pond ought to be drained, and then plowed and sowed with some grain. It is an easy matter, however, to arrange the ponds in such a manner as to be proof against such contingencies. It is of course necessary that the pond should be secure from inundations, and it is always an advantage if no spring flows into it or issues from the bottom. It is likewise important that the embankments should be made so strong as not to be easily broken. A clayey or pulverulent bottom is preferable to any other.

It is best to stock the pond for young fish in the spring, when there is no longer any danger of severe cold or snow. Two male carp, which ought not to be less than four nor more than seven years of age, are taken from the winter pond and placed in the pond for young fish, the number of fish taken, however, being in proportion to the size of the pond. Besides these fish, there are put into the pond about ten strong carp, three years old; from forty to fifty two years old; and about six hundred one year old. Care should be taken that all these fish be placed in the pond in as perfect a condition as possible, and that they be put down carefully in shallow places, so that it may be readily seen whether the fish continue strong and healthy. Fish which have lost some of their scales, or which have been injured in any other manner, grow slowly. The experience of many years has proved that carp which are ready to spawn, spawn but rarely, if there are no young carp in the same pond. But even if the mother carp, notwithstanding all the care taken, should not spawn, the pond would thus still yield some profit.

We cannot give here, in full, all the different regulations to be observed in transplanting fish; they are, on the whole, the same as those used in shipping any live fish. The main thing to mention is, that in emptying a pond for young fish, it should be done slowly, so as to allow the fish sufficient time to collect in the ditches at the bottom of the pond. While the process of emptying is going on, every other opening should be closed in order to prevent the carp escaping.

The *ponds for grown fish* may cover an area of about sixty acres. Carp two and three years old are kept in these ponds, and even sometimes those only one year old, provided the pond can be preserved free of pike. If, however, fish one year old are not placed in these ponds, no fear need be entertained of pike, especially if a grating has been placed at the openings where the water flows in and out, since this permits the passage of small pike only. Great care must be taken not to allow the fish to slip out. When it rains hard and the flow of water is considerably increased, the young carp will immediately swim against the current even into narrow and shallow ditches; there it becomes an easy prey to various animals, or else, remaining there after the water has flowed off, dies on the dry ground.

Carp ponds are used exclusively for rearing carp that are more than two years old. Two-year-old carp, after having been kept for two full years in these ponds, ought to be fit for sale; and three-year-old carp ought likewise to be ready for sale after having been kept there for one year, or, at any rate during one whole summer. The growth of the fish will be dependent on the nature of the soil and the character of the water. The water will be most suitable if it flows from all the neighboring farms. The bottom of a carp pond should be as even as possible, and not rise in any place above the surface of the water, as such small islands easily become the abodes of the enemies of the fish.

Small pike, perch, and tench may also be kept in these ponds. The pike will find ample food in the perch, which increase very rapidly, and the tench generally keep themselves so well concealed in the mud that they escape the pike. The pike, perch, and tench alone will, as a general rule, repay all the expenses of constructing the reservoir. Carp-ponds are emptied in October.

Winter ponds are used for preventing the fish from perishing in very severe winters, when the other shallow ponds easily freeze to such a depth and for such a length of time as to cause the death of the carp. It is best that these ponds be so arranged that the fish may be supplied with good fresh water during the entire winter. The other ponds can easily be so arranged as to preserve fish in them over winter; but although in this way the difficult labor of emptying the ponds in the spring and autumn is avoided, it will always be best to have separate winter-ponds, since, at any rate, the tench cannot be left over winter with the carp in the shallow ponds, inasmuch as they constantly stir up the sediment at the bottom and thereby disturb the young carp. In the winter-ponds the different kinds of carp can easily be kept together, as they generally remain very quietly at the bottom as soon as they have found a place to suit them.

Sale-ponds are receptacles only for fish ready to be sold. They should not be too large, since it is desirable that the fish may easily be taken out with a bag-net. It is best to have them near the house, or at any rate well guarded and locked. A constant stream of water should pass through them, and at the place where the water flows in there should be a strong wooden embankment, as the carp are apt to excavate the earth round the opening. The sides of these ponds are sodded, and the channel through which the water flows off should be so arranged as to be proof against every danger of a break. These ponds ought to be examined and cleaned every summer. They should have a depth of 6 feet, so that the bottom may not freeze.

Care should be taken in winter to keep some openings in the ice and maintain the inward and outward flow of the water. This object is most effectually secured by placing bundles of straw or reeds in both the openings. One or more holes, in proportion to the size of the pond, should constantly be kept open in the ice.

It must be understood that there are many rules to be observed, and much work to be done, which, if minutely treated, would require a very lengthy and detailed description, and which, indeed, would be out of place here, as there are so many local differences to be taken into account in deciding what is the best plan to pursue.

In Holstein, where carp-raising on a large scale has been carried on from very early times, almost every farm has its own method of procedure. In one thing, however, all are agreed, viz, that carp-raising can only be carried on regularly and profitably by the most judicious treatment. A careful choice of ponds, the selection of a superior breed of carp, and careful treatment of the fish will always yield the largest profits.

B—CARP-CULTURE IN EAST PRUSSIA.

By R. STRÜVY.*

The undulating character of the surface of East Prussia favors the construction of ponds, and led to extensive breeding of fish at an early day, the heavy rains of that northern climate furnishing the necessary water in abundance.

At the time of the Teutonic Order the province is said to have possessed an unusual supply of fish, and traces of that period are even yet to be seen, not only in the numerous ruined dams, but also in some that

* Unsere Karpfenzucht. <Landwirthschaft und Industrie. Herausgegeben von August Wieneke. Berlin: 7. Jahrgang, 1875, Jan., p. 8, 9.

are still well preserved, on account of the practical plan upon which they were constructed. A heavy pine tree, more rarely an oak one, was simply dug out in such a way that it was hollow four feet from the butt, and for the rest of its length was hewn out trough-shaped, and covered with heavy cross-boards. It was supplied with a round hole near the butt from which a tap projected at right angles. This was laid as a discharging-pipe beneath the dam, the latter being formed, on the side toward the pond, of planks or hewn timber, over the middle of the hollow portion of the log, which was four feet long, as before stated. In order to prevent the loss of fish, when the water was drawn off, screens were placed at the tap and tap-hole. The dam was then banked up high enough to cause the water to overflow upon a piece of gently-sloping meadow-land. Flood-gates could therefore be dispensed with, it being only necessary to see that the water never passed over the dam. If this was sodded at first, and the pond did not remain dry too long, it never leaked, since moles and rats only penetrated dams when the ponds were dry. Strong streams should not be led into such dams unless the escape for the water around them is well situated, otherwise it may be washed out, and afford an outlet for the water.

The abandonment of a large number of these works occurred, chiefly, between the years 1830 and 1860, because it seemed more profitable to convert the land into meadows or farming-land. Afterward the dams necessarily disappeared entirely, as the land was drained and leveled. The price of fish consequently advanced so high, on account of their scarcity, that those who had retained their ponds found their business very profitable. In the last few years the larger farmers have turned their attention again, with more earnestness, to this branch of production, but skill and knowledge in regard to it have been lost, and such losses have been suffered that it is absolutely necessary to consider the matter practically and resort to exchanges of experience, since theory alone does not answer.

Three annual courses of spawn, fry, and table-carp mainly require attention. How, then, are good eggs to be obtained? Theory suggests that a shallow pond be constructed which can be kept free from predacious fish, and that about five males and five females, of at least five pounds in weight to the acre, be placed in it in the spring, and that ten to twelve young carp be added for chasing; old carp are said to be too inactive about spawning-time, and the more the water is disturbed the better the eggs will be fertilized. The writer, in spite of having followed these directions closely, obtained no eggs during the past year, but purchased 108,000 from a relative, who, in consequence of inability to finish his spawning-pond in time, had placed his eighteen spawning-carp in a pond of twelve and one-half acres, among the fry, and some table-carp that had been left. The fry also grew finely.

The cause of the failure to obtain any eggs became very apparent. When the pond was drawn off in the spring, before setting out the spawning-fish, by way of precaution, on account of previous high water, a number of large pike and perch were found, and carefully removed; but in the operation they lost their spawn. The pond was therefore allowed to remain dry for eight days. This, however, was not sufficient, since, instead of the expected carp, six bucketfuls of pike and perch, as long as a hand, were obtained, and the workmen repeated the old absurdity, that in some years carp spawn pike. Predacious fish make their appearance of themselves where carp are bred. They seek the ponds from the nearest streams during high water. The writer had the opportunity, during the past spring, of witnessing the persistent efforts of a pike, of four pounds in weight, in attempting to reach a carp in a ditch so shallow that he was easily killed with a cane. But pike and perch are not alone to be feared on account of their ravages; the green edible frog is also suspected of consuming the spawn. Large bastard-carp are also supposed to injure the eggs by their attempts to fertilize them, thus rendering them unproductive. The writer, however, doubts this, as he has obtained pure carp-eggs among bastard-carp. In order to produce valuable carp-eggs, the milters and spawners should be large and healthy, rather more of the former than of the latter, and, above all, they should receive gentle treatment in the spring, and neither be squeezed nor struck. The pond should be preserved absolutely free from predacious fish, and should have gently-sloping, sunny, grass-covered banks; it is even more beautiful if the grass grows down into the pond. Ducks and geese, like all water-fowl, are injurious. The water must be pure and not too cold, (spring,) nor in any degree fouled, since the formation of mold may injure the whole lot of spawn. Only the strictest attention in this particular can insure success, for one instance of neglect generally injures the whole yield.

At the end of October, or the beginning of November, the ponds are drawn off and the eggs, fry, and spawning-fish are removed to their winter-quarters from all that are not kept up during the winter. From this time to spring carp eat exceedingly little, and can be kept, if necessary, in very small inclosures, which are not liable to freeze, or which are fed by water continually splattering into them. In East Prussia preservation for the winter presents great difficulties, and is attended too frequently with decided losses. If the pond is large enough, and is supplied by a never-failing source of water, no air-holes should be cut in the ice; but if once made, they must be kept open throughout the winter. The appearance of carp at these holes is always a suspicious circumstance, as healthy fish are seldom seen at them. Turbid snow-water, dammed back, also often destroys the whole winter-stock in a short time. Where fish are crowded together light feeding, of soaked peas and chopped bread, is advisable; care, however, is necessary with all easily putrescible matter, as animal offal, &c. Much has been said in regard to the good or bad character of ponds, with reference to the flavor of the fish. This may, however, be regarded as a matter of secondary importance, for although carp may acquire a moldy flavor in ponds with marshy and turfy bottoms, this unpleasant quality often disappears a few days after they are placed in pure water, so that when carp of very fine flavor are desired by the writer, he places them in the basin of his fountain for two to three weeks. In case there are several ponds, therefore, the worst should contain the fry, and the better ones the marketable fish. With a liberal supply of food, carp, three years old, will have a weight of three to four pounds, and they are then in the best condition for the table, since old carp are tough and fibrous, and those under three pounds are generally too full of small bones. For this reason the ponds should never be overstocked. From 15 to 24 dozen of eggs should be allowed to the acre, because of considerable loss, and 45 young fish, and, only where there is great abundance of food, double this number. In this way a clear return of 10 to 25 pounds per hundred square yards will be obtained, and even more if no accident prevents.

If old carp-culturists are disposed to smile at this brief account, and to find nothing new in it, they are earnestly requested to communicate their experience, as it was admitted in the beginning that skill and experience have both been lost, and everything must be learned anew. The losses experienced, too, have been too great to permit the business to get fairly under way; in fact a large company failed for want of the necessary experience. Since, however, there is no intention of abandoning the enterprise until fine, fat carp, from East Prussia, appear as delicacies on the tables of Berlin, further information is desired.

C—CARP-PONDS.*

The value of a fish-pond depends upon an adequate supply of water, and the amount of food for fish it affords. The latter condition is affected, to a great degree, by the character of the soil and the depth of the pond. Thus a sandy soil yields but little food, but of excellent quality, while loamy and peaty soils are good, and a loamy mold excellent indeed; but those of tenacious meager clay, as well as stony soils, are very inferior. These statements are especially true in regard to ponds for carp. The first consideration in laying out new ponds is the power to regulate perfectly the supply and discharge of the water. A pond is seldom formed by excavating the earth, but generally by constructing an embankment across the lowest part of an uneven piece of ground. By employing the earth adjoining for this purpose the fish-pit is generally formed at the same time. The best material for the dam is loam and clay. When the soil is sandy a foundation of loam must be prepared in order to retain the water, when a supply of the latter is not at command. A new soil yields the largest return, which is diminished by reedy growths and muddy sediment. A pipe for draining the pond, which can be opened or closed on the water-side at pleasure, is laid

* Landwirthschaft und Industrie, Berlin, Dec. 1, 1875, 170. Translated by Prof. C. F. Himes.

through the dam at its lowest point. It usually consists of heavy hollowed logs, imbedded in soft moss. These will last much longer if the bark is uninjured. It may also be constructed of bricks, or of earthenware pipes, with cement. On the water-side it passes through sheet-piling, or a cemented wall, and is closed by a plug, or better, by means of a drop-valve, which can be opened by a rod with a screw attached. A stand-pipe is also often placed vertically upon the horizontal discharge-pipe. It is closed on the front, from the bottom to the water-level, with sluice-boards placed on top of each other. These may be placed in position or removed at will, according as it may be desired to raise or lower the water in the pond. Where small streams flow through the pond, this arrangement affords the additional advantage of keeping the depth of water uniform, since it flows out over the top board through the drain-pipe. A wooden grate is placed at the entrance of the drain-pipe, to prevent the fish from passing into it. It is entirely submerged to preserve it from decay. Iron grates are altogether unsuitable, on account of their rapid destruction by rust. The fish-pit is an excavation in which the fish collect when the pond is emptied. It must be capable of being completely drained, and in loose, soft soil it is well to line it with wooden or stone walls, and give it a firm bottom of sand, stone, or boards. The greatest attention should be given to the fish-pit, and it should be carefully freed from all mud whenever fish are caught. It is also advisable to form a pit, called in Bohemia the sluice-pit, at the outlet of the drain-pipe, in order to catch any fish that may escape through a defective grate; and for this reason it should also be supplied with a grate at its outlet. When the ponds are large, this is lined with wood or stone. It should be kept full of water that the discharge-pipe may be preserved from decay. After some time the flow of water renders the interior of the drain-pipe so rough that the fish are so injured in their passage through it, that it is very undesirable that they should be found in the sluice-pit. The bottom of the pond is traversed with ditches, so that the water may flow off freely and rapidly from all sides, and the fish find their way easily into the fish-pit, and also that the rich, muddy soil may dry off rapidly, and soon permit the passage of draught-animals over it, if the pond is to be put in order. Depressions in the pond, from which the water cannot be completely drained, are very objectionable, since a great number of fish are lost in them, and the removal of the predaceous fish is prevented. No trouble should therefore be spared to drain such depressions. If the supply of water is such that the pond can be filled with certainty in the spring, it is well to allow it to become dry after the fall fishing, in order that the soil may be freshened, and a portion of the enemies of the fish may be destroyed. Ponds which are supplied exclusively by rain or snow water must be filled again in the fall immediately after they have been emptied. The water from villages and cultivated land is very advantageous, on account of the nutriment contained in it, and in Wittingau ponds are fed from the drainage of the soil rather than from streams, because the former is richer in nutriment. By leading in water from the adjoining water-sheds, from cultivated land, and villages, the ponds are much improved. When creeks or brooks flow through the pond, a brush-weir, formed of layers of untrimmed brush-wood, in such a way that the fish cannot pass over it, must be placed so as to prevent the ascent of the fish in the stream. The water-level should, as a rule, be maintained as constant as possible; and, in summer, a sudden, large influx of water should be prevented, because the fish swim very eagerly toward the current of fresh water, and are thus drawn from their feeding-ground and are liable to be stolen. In a dry season, if the addition of water is unavoidable, it should only be allowed to flow in during the day and be stopped at night. It is important to be able to turn fresh water into the fish-pit, when the pond is fished out, in order to revive the fish when they become languid. If the water falls in dry weather, the borders become dry, fermentation and putrefaction of the marsh-vegetation occur, and the carp leave their feeding-ground for deep water. The spawn laid on the grass in the breeding-ponds also become dry and dead. On the other hand, it is advantageous to allow ponds, prepared the summer before, to dam up gradually, so that the higher portions may be pastured, and breeding-places be afforded to insects. As these portions are in succession rendered accessible to the carp, by the gradual rise of the water, they are eagerly sought out by them. This plan has greatly increased the productiveness of the ponds in Peiz, as well as in Wittingau. Since carp find their food, for the most part, on the flat margins of the pond, it is in general better to lay out several small, shallow ponds than one large, deep one. Floating masses of vegetable matter and marshy growth reduce the productiveness. Repeated mowing in summer, under water, and burning the roots when drained and dried by exposure, are employed to prevent the latter; the former are intersected in different directions by ditches, when the knots of vegetable matter will float to the shore, and may be drawn out; or the marsh may be covered, when drained, if necessary when frozen, to the depth of several inches with sand, which will prevent their floating when the pond is filled. In the winter it is beneficial to allow the water to flow in and out of the pond. If it becomes covered with ice, this is removed, at such a distance from the wintering-place of the fish that they may not be reached with a spear. In Wittingau, such openings in the ice, in the larger ponds, are cut from 40 to 65 feet long and 3 to 4 feet wide, and the ice is removed twice a day by means of hooks. If a decided thaw occurs, when the ice is covered with a considerable depth of snow, and the latter becomes saturated with water, and freezing weather follows, the preservation of the fish through the winter becomes doubtful. The water generally changes color to yellowish, milky-white, or brownish; and sluggish insects appear at the openings in the ice and die, and also fish that are weak and gasping after air. The craw-fish perish first, next the frogs, then the predaceous fish, and finally the carp, and the openings are surrounded by crows. The remedies for dangers from these sources are increase of the number of openings, flooding, and finally immediate fishing-out of the pond. A general destruction of fish may also occur in summer, if the water becomes so low in hot weather that vegetable and animal matter begins to putrefy and scum becomes prevalent, or also if much manure or ditch-water flows into the pond. The fish, in such cases, swim along the surface, gasping after air, and finally die. A heavy rain is usually the most efficient remedy, in the absence of which nothing remains but copious additions of water, or immediate capturing of the fish. A pond in which the fish have died in this way should be drained dry and put in order. It is very important not to stock the pond too full. This was considered impossible in Bohemia two hundred and fifty years ago, but the evidence in recent times is conclusive that not only smaller fish are obtained, but also less total weight of fish, when the stock exceeds certain limits established by experience. In Schleswig-Holstein it is assumed that, in a good pond, one carp can be fattened per 150 square feet, but that generally 70 to 80 fish to about two-thirds of an acre are plenty. The carp in ponds there are marketable at three years, but generally only after four years. Small ponds may be stocked proportionally heavier than large ones. In general, it is not advisable to stock a pond with carp of different sizes.

XXVII.—THE GOLD ORFE, (CYPRINUS ORFUS.)*

A—ON THE RAISING OF THE "GOLD ORFE," (CYPRINUS ORFUS.)

By M. Kirsch, *Director of Fisheries at Wiesbaden.*

The "Orfe," *Cyprinus orfus* Linn., "l'orfe" in French, and bearing a variety of names in German, such as "Nerfling," "Gold nerfling," "Erfel," "Elft," "Urs," "Urf," "Rötlling," and "Ladies' Fish," is distinguished by its beautiful orange-colored back, and its belly-scales, which glitter like silver. Taking into account its slender, trout-like shape, it may well be called the most beautiful fish of our country.

Having been for many years occupied in raising the "Gold-orfe," in addition to my raising large quantities of trout, pike, and carp, I desire to state briefly the reasons why the Nassen Fishing Society has devoted so much attention to this fish, and has spared no pains in raising it.

We think that it is not only the duty of all larger piscicultural establishments to prevent the entire disappearance of a species of fish so near extinction, but have also found after careful examination of everything that has been said concerning this fish in old works, and of all we had gleaned from our own experience, that the raising of the *Cyprinus orfus* is of incalculable value to the practical pisciculturist.

There is scarcely a fish which as an ornamental fish so satisfactorily meets all the demands made of it, as the *Cyprinus orfus*, which, in summer and winter, is constantly seen near the surface of the water. It does not sleep in winter like the carp and tench, and never makes the water muddy. Ever restless, the *Cyprinus orfus* constantly swims near the surface to seek its food, and even when ice thickly covers the ponds, red spots indicate that this active fish is alive.

Gold-fish, gold tench, and carp only occasionally rise to the surface of the water, while they seek their food at the bottom, and thus make the water continually muddy.

The raising of the *Cyprinus orfus* as an ornamental fish has a peculiar advantage over that of the gold-fish, which in early youth is black, and only assumes its golden color during the second year, while the numerous young of the *Cyprinus orfus*, floating about in large schools, even when leaving the eggs present a remarkably beautiful appearance.

*From "Circular No. 4," published by the *Deutsche Fischerei-Verein*, Berlin, March, 1872.

Having a thickness of about two lines, and a length of one-half to one centimeter, their color being a bright red with a black head, the easily frightened shoal swim with lightning-like rapidity from one place to the other. Among the many hundreds which we have raised, there was not a single one which had even a black spot or any change of color, thus proving that the red "orfe" is no variety of the black "orfe," which, with us, spawn more than a month later. It is certain that a fish which immediately on leaving the egg answers its purpose as an ornamental fish so completely, is preferable to the gold-fish, which does not, till the second year, assume a brilliant color.

In the year 1558, *Gessner* wrote, in his "Natural History," p. 1268, that the "orfe" enjoyed a high reputation as an article of food, especially when fried, particularly in the months of April and May (a season when with us trout can scarcely be recommended). Permission to sell the "orfe" was only given when it had reached a certain size, as they were considered an excellent food for the sick, and consequently it was desirable not to let the species die out. This fish was also considered a wholesome and strengthening food for women in confinement.

Dr. Bloch, in "Our Fishes," Parts I, II, III, published in 1782, pp. 138 and 139, acknowledges the excellence of the "orfe" as an article of food, even giving the best mode of preparing them in the most palatable manner, which this naturalist certainly would not have done if he had not considered it his duty to awaken a more general interest in behalf of this fish.

Jockisch, in his "Manual of Fisheries," 1802, p. 39, says: "The flesh of the orfe has an excellent flavor, is very digestible," &c.

Bose, in his "Dictionary of Fisheries," 1811, p. 103, likewise says that the "orfe" has a most delicious flavor.

La Cépéde, in his "Histoire naturelle des poissons," 1796, states that the "orfe" excels other fish, through its fine flavor.

Oken, the famous naturalist, says in his great "Natural History," vol. vi, p. 303, that the "orfe" is distinguished by its beautiful color, and the wholesomeness and excellent flavor of its flesh.

I therefore think that I am not too bold if, relying on the words of these authorities, I recommend the raising of the "orfe" as a wholesome, palatable article of food, for I am convinced that people in 1558, 1782, 1796, 1802, 1811, and 1836 knew just as well as we whether a fish had a good flavor or not; and it is evident that such authorities would only recommend as good what was generally acknowledged to be so.

Besides the excellence of the *Cyprinus orfus* as an ornamental fish and as an article of food, it possesses a still greater importance for the ichthyologist, because it is very hardy and can be more easily transported to far distances than most other fish.

Our reports regarding the result of sending the *Cyprinus orfus* to Cologne, Berlin, Lübbinchen, Dresden, Hanover, Cassel, Freiburg, and to still more distant places, the fish being on the road two days and longer without being accompanied by a fish-breeder to pump in fresh air or change the water, &c., will with pleasure be submitted for examination to any one who desires to see them; and it will be found that even when several hundred were sent together, not a single one was lost. The reader will know that none of the other superior kinds of fish could stand such long journeys.

All the fish belonging to the family of salmonoids require for their well-being cool and deep or pure and running water, and whether their flesh, which is mostly very fat, can be considered a wholesome, digestible food, such as the "orfe" makes, I will leave to the physicians to decide.

It is, at any rate, certain that there are a large number of stagnant waters in which no salmonoids can be raised, because these waters contain such large quantities of noxious substances that not even tench, carp, or pike can live in them; in such waters I advise the reader to place *Cyprinus orfus.* As was mentioned above, they live near the surface, making use of the purest portion of the water, do not touch the noxious substances accumulating at the bottom, and seek their food near the surface.

But if any one should distrust my experience of many years, I refer to the above-mentioned authorities, who tell us in every place that the *Cyprinus orfus* has in former times been raised in the muddy, stagnant water of the moats of the ancient cities of Nuremberg and Augsburg.

Let every unemployed and unproductive pool of stagnant water be a reproach to German pisciculturists, and an incentive to free themselves from their old unpractical methods, and to raise not only fish which fashion momentarily favors, but such fish as are suitable for the existing sheets of water.

Our guide for the future of pisciculture is not only the little knowledge of our times, but let us examine what has been done in the dim past, and let us gratefully adopt that which is really useful and profitable.

B—CORRESPONDENCE RELATING TO THE GOLDE-ORFE.*

By Prof. C. Th. E. v. Siebold.

In a letter which the bureau of the German Piscicultural Society at Berlin has addressed to the president of the Fishing Society at Munich, dated December 5, 1871, the question is asked whether this society possesses any information regarding the breeding and the value of the gold-orfe (*Cyprinus orfus*), which at present is raised at Weisbaden in large quantities, which would justify its introduction into other regions, especially North Germany? If such were the case, the German Piscicul-

* From "Circular No. 1," published by the *Deutsche Fischerei-Verein*, Berlin, 1872.

tural Society would gladly lend a helping hand in furthering any experiments in raising it.

As far as the undersigned knows, the gold-orfe has so far only been raised in South Germany, by Mr. Scheuermann, at Dinkelsbühl, Bavaria, chiefly with a view of providing the aquaria with an ornamental fish. If people in Wiesbaden have succeeded in raising this fish as a palatable article of food, the cause of this may be found in the circumstance that the neighborhood of Wiesbaden must be entirely destitute of better-flavored fish, for, otherwise, the gold-orfe would certainly not have been used as an article of food. Judging of the experience of our well-supplied Münich fish-market, it appears that this fish does not at all find a ready market among the fish-loving Münich public, since scarcely any of this fish and its variety (the *Leuciscus orfus*) are sold as articles of food, their flesh being very insipid and full of bones.

Young "gold-orfe" are only sought after by keepers of aquaria, as, on account of their beauty, they form a very good and cheap substitute for the Chinese gold-fish. The larger fish of this kind are mostly used for ornamenting lakes in parks and the basins of fountains. The undersigned very much doubts whether even the most expert cook could so heighten the flavor of the "gold-orfe" as to compete successfully with the salmon.

MUNICH, *December* 15, 1871.

XXVIII.—DIRECTIONS FOR USING BLANKS FOR RECORDING THE PROPAGATION AND DISTRIBUTION OF FISH.

A series of blanks has been prepared for the purpose of facilitating the record of the artificial propagation and distribution of fishes in the United States. They will also, if carefully and fully filled out, supply excellent data for determining the influences of natural agencies upon the abundance of the food-fishes, their periods of migration, and the hatching of the spawn. For example, the record of the temperature of the air and water, together with that of the fish taken, will afford definite conclusions as to the effect of a cold late spring in retarding the migrations of the shad; while a comparison of the same temperatures with the numbers of spawn taken and hatched will show the effect of a high temperature upon the vitality of the eggs.

TABLE A is intended to record the operations at a hatching-station where the eggs are taken from the parent fish and either hatched, or distributed after the development has partially advanced.

Thus if the operation of hatching shad is being carried on at South Hadley Falls, Mass., the reading would then be:

RECORD of *shad-hatching* operations conducted at *South Hadley Falls, Mass.*, on the *Connecticut River*, from *July* 20, 1874, to *August* 22, 1874, on account of *Connecticut State Commissioners*, by *Charles C. Smith.*

The column under LINE, NO., relates to the numbering of the lines from top to bottom. The column under DATE relates to the day of the month in which the work was performed. In the HOUR-column are to be given the hours of the day in which the physical observations of temperature, wind, condition of sky and water and of tide are made. As many successive lines should be appropriated for these records as observations have been repeated at different hours during the day. Thus, if observations are made at 7 a. m., 12 m., and 7 p. m., three lines are required. The record of *Air* and *Surface-water* temperatures needs no explanation. In the record for *Bottom*-temperature, the depth should be specified. If it is always at the same depth, recording it at the head of the column once is sufficient. The *Direction* of the WIND may be given approximately from the eight points of the compass most commonly referred to. The *Intensity* may also be expressed in the words Gentle, Fresh, Strong, Gale, Hurricane, &c. The CONDITION OF *Sky* may be specified by the words Clear, A few light clouds, Cloudy, Cloudy with showers, rain, &c.; the CONDITION OF *Water* as Clear, Muddied, Very turbid, &c. TIDE can be referred to by using L for low water and H for high water; approximately half-way between these points of the tide by ½. The record under SEINE HAULED should give the hours of the day between which successive hauls were made, and the number of seine-hauls in the time specified. Under FISH TAKEN should be recorded the entire number of shad from the seine-hauls, divided, according to sex, under *Males* and *Females;* under RIPE FISH, the number of "spawners" and "milters" under *Male* and *Female* respectively. EGGS OBTAINED is intended for the total number of eggs for the day. The PERIOD OF HATCHING can be obtained without difficulty or error if the spawning-boxes are numbered and a record made of the date and hour when the eggs are placed in each box. This record and the following ones have, of course, no reference to the date in the preceding column. The LOSS will be estimated with more or less accuracy according to the method used for the purpose. Under REMARKS, a variety of record incident to the day may be inserted: as, "The temperature of the water was so high that the eggs impregnated showed no vitality;" or, "The heavy northwest wind and sea capsized twenty-five of the boxes;" or, "50,000 young fish from eggs impregnated on July 24 and 25 were released into the river."

TABLE B is for the operations of hatching-houses which have received eggs from stations at the streams where they have been impregnated and carried forward to the point of development when they can be shipped with safety.

The blank, if filled out for Vermont, would read:

RECORD of operations of *M. C. Edmunds*, fish-commissioner of *Vermont*, conducted at *Charlestown, N. H.*, in hatching and distributing young of *Penobscot River salmon*, from *October* 22, 1874, to *January* 5, 1875.

The heading LINE, NO., relates to the numbering of the lines from the top of the page downward; the DATE refers to the time at which the eggs were received; under RECEIVED FROM, the Government or State commission or other source contributing the eggs is to be recorded; WHENCE RECEIVED relates to the locality of the spawn-procuring station; TIME OF JOURNEY, from the date at which the eggs were packed for shipment to the time of their arrival at the hatching-station and the transfer to the hatching-troughs; GENERAL CONDITION refers to their condition on arrival; under NUMBER OF EGGS RECEIVED: *From the United States*, relates to those supplied by the United States Commission; *From other sources*, all others, and *Total* the sum of these two supplies; LOSS IN UNPACKING means the bad eggs that have been injured before arrival, which may include all that give evidence of loss of vitality within twenty-four hours after they have been put in the hatching-apparatus, providing, of course, that there is no evidence apparent of injury from other causes than those incurred in transportation; FISH HATCHED is intended to include all that emerge from the egg, except such as may hatch prematurely from injuries received during the transportation of the eggs; the YOUNG DISTRIBUTED relates to the number that are put alive into their destined waters; WHERE PLANTED should include the name of the main river, the name of the tributary, and the name of the town, city, or village near where the fish are planted; the column of REMARKS may include anything important incident to the series of facts recorded, as loss in journey to point of distribution; as, "Bellows Falls, Vt., only five fishes;" or, "An accident to the railroad delayed the train some hours, the weather was warm, and the fish in such precarious condition that they were put into the Connecticut River to save them, though they were intended for the Merrimack River."

TABLE C is for record of distribution of any species of fish from the hatching-establishment to the waters in which they are planted. It should be filled out even where reference has been made to the distribution in TABLE B, as it contains the details of the transfer and planting more fully than the latter. Filled out it might read: RECORD of distribution of *shad* made from *June* 23, 1875, to *July* 5, 1875, by *Jonathan Mason*, under the direction of the United States Commission of Fish and Fisheries.

NO. OF LINE refers to the numbering of lines from the top of the page downward; DATE OF TRANSFER, the time of placing the fish into the cans; OBTAINED FROM, the fish-commission or private source supplying the eggs; PLACE WHERE TAKEN, the name of the hatching-station whence fish were obtained; PERIOD OF JOURNEY, the time the fish were in the cans; NUMBER OF FISH *Originally taken*, the number put alive into the cans; *Actually planted*, the number put alive into the destined waters; INTRODUCTION OF FISH includes *Place*, name of nearest town, village, or city; *Stream* refers to the name of the tributary in which the fish are placed, and *Tributary of*, to the name of the main river; TRANSFER IN CHARGE OF, to the person having the responsibility of the fish *en route;* REMARKS, to any important incident of the transfer.

The following specimen-tables will illustrate the nature of the data to be recorded:

A.

Record of *shad-hatching* operations conducted at *Washington, D. C.*, on the *Potomac River*, from *July* 20, 1875, to *August* 22, 1875, on account of *United States Commission*, by *Mason & Welsher*.

Line, No.	Date.	Hour.	Temperature of— Air.	Surface-water.	Bottom, (20 feet deep.)	Wind. Direction.	Intensity.	Condition of— Sky.	Water.	Tide.	Seine hauled.	Fish taken. Males.	Females.	Ripe fish. Males.	Females.	Eggs obtained.	Period of hatching.	Loss. Number.	Per cent.	Remarks.
			°	°	°															
1	July 25	7 a. m.	76.8	69	68	N. N. E.	Gentle .	Clear..........	Roily............	L.	....	....	....	....	....	....	....	....	....	
2	....	12 m ...	79	77.5	76	E. N. E.	Fresh...	Light clouds..	Moderately clear.	H.	7.30 a. m. to 1 p. m., 8 times.	112	265	20	6	75,000	3 days 13 hours.	4,000	5⅓	Fish released July 31.
3	....	7 p. m.	77.4	77	76	S. W.	Gentle .	Cloudy	Clear............	L.	....	....	....	....	....	....	....	....	....	
4	....	11 p. m.	77	76	75.8	S. S. W.	Strong .	Heavy clouds .	Clear............	½	8 p. m. to 11 p. m., 4 times.	265	285	43	31	400,000	3 days 2 hours.	12,000	3	Fish released July 30.

B.

Record of operations of *G. C. Anderson*, fish-commissioner of *New Jersey*, conducted at *Bloomsbury, N. J.*, in hatching and distributing young of *California salmon*, from *October* 22 to *January* 5, 1875.

Line, No.	Date.	Received from—	Whence received.	Time of journey.	General condition.	Number of eggs received—			Loss in unpacking.		Fish hatched.		Young distributed.		Where planted.	Remarks.
						From the United States.	From other sources.	Total.	Number.	Per cent.	Number.	Per cent. of eggs.	Number.	Per cent.		
1	Oct. 22	United States Commissioner.	McCloud River station.	9 days 2 hours ..	Fair ..	225,000	......	225,000	23,000	10	191,250	85	80,000	....	Delaware River.	No loss.
2													75,000	....	Susquehanna River.	Loss, 300.
3													20,000	....	....do	Loss, 550.
4													15,000	....	Raritan River	Loss, 350.
	Total distribution												190,000	$99\frac{1}{3}$		

C.

Record of distribution of shad made from July 27, 1874, to August 5, 1874, by Oren Chase and C. D. Griswold, under direction of Connecticut fish-commission.

No. of line.	Date of transfer.	Obtained from—	Place whence taken.	Period of journey.	Number of fish—		Introduction of fish.			Transfer in charge of—	Remarks.
					Orig'ly taken.	Actually planted.	Place.	Stream.	Tributary of—		
1	July 27	Massachusetts Commission.	South Hadley Falls, Mass.	7 hours....	100,000	97,000	Burlington, Vt....	Winooski River..	Lake Champlain..	Oren Chase.	
2	July 29	......do	......do	6 hours....	90,000	88,000	New Milford, Conn	....	Housatonic River.	C. D. Griswold.	
3	July 31	......do	......do	20 hours...	100,000	96,000	Mattawamkeag, Me.	Mattawamkeag, River.	Penobscot River..	Oren Chase and C. D. Griswold.	
4	Aug. 3	......do	......do	5 hours....	100,000	99,000	Vergennes, Vt....	Otter Creek.......	Lake Champlain..	Oren Chase	
5	Aug. 7	......do	......do	53 hours...	20,000	19,500	Detroit, Mich.....	Detroit River.....	Lake Erie	O. Chase and C. D. Griswold	
6	Aug. 7	......do	......do	60 hours...	80,000	79,800	Ionia, Mich.......	Grand River......	Lake Michigan ...	......do	

APPENDIX D.

THE RESTORATION OF THE INLAND FISHERIES.

CONTENTS.

XXIX.—FISHERIES AND FISHERY LAWS IN AUSTRIA AND OF THE WORLD IN GENERAL.

By CARL PEYRER.*

[The following article was prepared by Mr. Carl Peyrer, at the request of the department of agriculture of Austria, for the purpose of giving an account of the present condition of the fresh-water fisheries of that empire, and incidentally of Europe in general, as also to furnish an explanation of the causes which have made it necessary to provide by legislative enactment and by various methods of artificial propagation for the preservation and further increase of the fish.

The article concludes with an account of the legislation which has been adopted, and the general principles on which such legislation is founded. All the points brought forward by the author apply to a greater or less extent to the United States; and for the purpose of bringing the general history of the subject up to the present date, and of showing the necessities of other countries and what has been done to meet them, I have thought it proper to translate and publish the report of Peyrer, so as to prepare the way for a national system ot uniform regulations for the protection and improvement of the fisheries of the United States.

SPENCER F. BAIRD.]

A—GENERAL CONSIDERATIONS.

1.—EARLY PROTECTIVE MEASURES.

Reports have been made at different times on the state of the fisheries, and on the existing fishing-privileges, in the different provinces of Austria, as well as on the means of improving them, and especially upon changes or complete reforms in the fishery laws. Draughts of new laws have repeatedly been made, and have been thoroughly examined and discussed by committees appointed for the purpose, these committees being assisted by persons who had made fishing a special study, by representatives of the central government, by the provincial authorities, and by agricultural societies.

In looking over the reports made at different times on one and the

* Fischereibetrieb und Fischereirecht in Österreich. Eine vergleichende Darstellung des österreichischen Fischereiwesens mit dem Fischereibetriebe und der Fischereigesetzgebung anderer Länder, insbesondere Deutschlands, verfasst im Auftrage des k. k. Ackerbauministeriums von Carl Peyrer, Sectionsrath im k. k. Ackerbauministerium. Wien. Druck der k. k. Hof- und Staatsdruckerei. 1874. 8 vo. pp. iii, 159.

same fishery-law, one is struck by the peculiar changes of views regarding the most important points in question.

Prior to the year 1848, the fishing-privileges were nearly everywhere considered as an essential part of the rights belonging to every land-owner, and a strict fishery-law would have appeared as an attempt to give renewed stability to the claims of land-owners, which, even at that time, were frequently attacked, and considered as untenable; the desire for such a law, which was expressed by several persons, consequently found but little support.

In the following years, after the fishing-privilege had come to be considered as only an individual claim, which any one might obtain, when new landed properties had been formed and were still forming, such a law appeared to many as an unjustifiable infringement on the rights of individuals, while most people thought it an unnecessary measure, justified by no actual want; others thought it a very small matter that the government should make laws regarding the size of meshes, the size of fish which might be caught, the seasons for fishing, &c. Such laws, they said, could never be fully carried out, and would only produce a hateful and inefficient police surveillance; the government, in its zeal to promote the fishing interests, should confine itself to the diffusion of useful information, to money-grants, and similar favors. But even at that time, these views found their opponents. Zealous naturalists and sound political economists joined the intelligent proprietors in showing the pernicious consequences of neglecting the fisheries, and also showed the possibility of improving them by laws based on sound scientific principles. The certain hope was expressed that the constant growth of intelligence among the population would make the belief in the usefulness and the necessity of such laws more universal, and increase the possibility of carrying them out. These views, however, did not succeed, as their opponents were still too powerful.

2.—IMPROVED APPRECIATION OF THE INTEREST.

The reports of the last few years are in every respect more satisfactory. Natural sciences, which have become better known, having taught men not to surrender unconditionally to the powers in nature, but to combine them in a practical manner with human activity, this principle was also applied to the fisheries. Here, more than in many other fields, have the scientific and economical interests, which called to life the artificial propagation of fish, and the consequent system of scientific fish-culture, produced a radical change. The growing productiveness of the fisheries in those countries in which the right to fish is restrained by strict laws; the better knowledge of the actual condition of the fisheries and of the historical development of the fishing-privileges in the several provinces of Austria; the acquaintance with foreign laws in all their details, and the manner in which they are carried out;

and the glaring evils in the Austrian system: all these causes have combined to eradicate the former indifference and have, among those men in Austria who take an interest in the subject, produced an overwhelming majority in favor of suitable laws for protecting and improving this branch of industry.

The objection that such laws could not, under existing circumstances, be carried out, has become powerless; on the contrary, it is fully expected that the laws themselves will pave the way for more correct views, for greater energy in carrying on the fisheries, for order and respect for law; and that, through the better understanding and the awakened interest of the population, the laws will gradually grow in efficiency.

At first we shall have to be satisfied with small beginnings, and leave it to the educating force of legislation gradually to produce a better state of affairs. In some parts of the country the fishery-law may even now bear its full fruit, and be put into practical execution in all its details; in other parts, however, where, for the time being, the conditions are not so favorable, individual intelligence and perseverance will no doubt secure a firm footing for the more important regulations.

The greatest change of views, however, is observable not only regarding the question of the necessity and feasibility of a fishery-law, but also regarding the extent of such a law. While the former laws did not go beyond sporadic regulations, having the character of police-ordinances, such as might seem desirable to a local observer, the more recent reports have aimed at a thorough exposition of the object and basis of the new legislation, as well as of the several conditions on which the healthy development of the fisheries depends; they endeavored to define clearly all the judicial points growing out of these conditions, and to urge the settlement of all these points by a fishery-law which should be as nearly complete as possible. They also aimed to call into life institutions calculated to improve the fisheries still further. From a mere police ordinance, the fishery-regulation is to rise to the dignity of an organic law.

3.—THE OBJECT OF FISHERY LEGISLATION.

The object of fishery legislation, as of all other economical enactments, is to make a lasting and advantageous use of the waters containing valuable food-fishes, and to place this interest in its proper relation to all the other industries, *i. e.*, to increase the quantity of fish as much as the due regard to other industries will permit. As, according to Roscher, every industry rests on scientific, technical, and economical principles, which are combined for reaching a certain definite, practical object, viz, the most advantageous carrying on of this industry, therefore must all economical legislation, with a view to the right adjustment of these, be made scientific, technical, and economical principles.

Fishery legislation must have due regard to the teachings of science concerning the nature of fish, their different species, propagation, growth, location, migrations, &c.; to the teachings of technology concerning the different methods of catching fish, the implements employed, the contrivances for protecting fish against hurtful influences, for favoring their migration, &c.; but no less must it study the principles of political economy, the ways and means of carrying on business in the most advantageous manner, the mode of holding property and the uses made of it which are hostile to modern civilization, in order to replace them by such as will suit the fisheries and further their interests; it must likewise study the true relation toward each other of all the industries carried on by means of water, the effect of laws on industrial pursuits so as not to make laws which would decrease the net profits and would deter people from engaging in fishing industries.

Fishery legislation must also have due regard to judicial and administrative considerations; it must be based on a thorough knowledge of the condition of fisheries in other countries, of the fishery-laws of these countries, as well as of the laws and administrative regulations of all branches of industry related to fishing; and it must study the manner in which laws are carried out in foreign countries and the effect of such laws on the fishing interests.

These several elements of fishery legislation had, therefore, to be studied as thoroughly as possible, and made perfectly clear, before a law could be drawn up.

All the legal questions regarding fisheries cannot be settled at once by passing fishery-laws, since many of them will have to be solved by different forms of legislation, such as penal laws, special laws, &c.; but even for such laws, the study of the above-mentioned principles will be of great use.

Although the passing of fishery laws is an important step toward furthering the fishing interests, it is neither the law nor the government which calls fisheries into life; the law would be powerless if it were not energetically supported by the will of the people; the activity of those persons who possess fishing-privileges, and the spirit of enterprise in individuals can alone, under the protection of the law, bring about continued improvements; and further changes in the fishing-privileges will favor the formation of societies, produce equitable methods of renting out the fisheries, and common regulations for their protection and improvement. Such individual activity must then be followed by further administrative measures on the part of the communities, the provincial assemblies, and the central government, for clearing away hinderances and creating new means of promoting the fisheries.

From the government, we must, above everything else, expect that it will strictly carry out the laws made for protecting the fisheries against illegal encroachments, and against the unwise exhaustion of the waters by those who possess fishing-privileges, as well as against interruptions in fishing by the unlimited extension of the rights of third parties; to the government we must likewise look for those general, far-reaching, and, therefore, successful measures which the fishing interests require from time to time even where there is a good fishery-law. Such measures likewise demand a thorough knowledge of the principles on which the fishery-laws are based.

The sad experiences of the Austrian fisheries, which are related in every one of the reports of competent men from all the provinces of the Austrian empire, and which could not be passed over silently in this report, will increase conviction that the former neglect and the consequent exhaustion of the rivers and lakes cannot go on without this indispensable harvest of the waters dwindling down to utter insignificance, and the supplies of this wholesome and cheap food diminishing. It must become a question of vital interest to the whole population to put an end to the exhaustion of the waters by cultivating them.

B—THE FISHERIES.

4.—THE FORMER CONDITION OF THE AUSTRIAN FISHERIES.

In olden times, the waters of Austria were rich in fish of every kind, supplying the population with a considerable quantity of cheap and wholesome food, and the fishers with a fruitful source of income. On all the more important waters, there were well organized fishing-associations, guilds of fishermen and traders; in all the larger towns, there were fish-markets, the names of which are alone left in many cases. Old account-books giving the quantities of fish used and sold, market-statistics and service-lists of the number of fish to be paid to landed proprietors, convents, cities, and markets, by their dependents, show in figures the immense wealth of fish in the olden times; not to mention the many almost legendary reports of enormous hauls of fish, of the complaints of servants that they were nauseated by the too frequent appearance on the table of salmon and trout, which are found in the often quoted regulations and service-compacts of many cities on rivers flowing into the Baltic and the North Sea, as well as on the Danube, in Salzburg, Bohemia, and in other provinces of Austria. As late as the first decades of our century, the wealth of fish in the several provinces of Austria was very considerable. Some rivers of Moravia, as late as thirty years ago, furnished so many trout that these fish formed the common food of the laborers, a good sized tubful being sold for about 5 cents.

Even during the period 1850–'58, trout were so numerous in the rivers and rivulets of the Böhmer Wald that an observer counted one trout to every fathom, the breadth of the water being 4 feet and its depth 1 foot, (Woldrich, Ueber die Fische und ihr Leben in den Waldbächen des Centralstockes des Böhmerwaldes, 1858,) while the same observer, in 1870, found the same streams almost without any fish whatever, on account of fishing during the spawning season.

Twenty-five years ago one might have seen, in the Vienna markets, immense sturgeons, frequently 10 to 15, each weighing 250 to 500 pounds.

The wealth of fish in our beautiful mountain lakes and in the numerous rivers and streams in the Austrian Alps was world-renowned.

The saying of M. Coste, who, imitating a well-known wish of Henry IV, promised, after the introduction of artificial fish-breeding, a trout to every Frenchman, seemed to be fulfilled in Austria.

5.—THE PRESENT CONDITION OF THE FISHERIES AND ITS CAUSES.

In our day, most of the waters are almost depopulated; salmon and trout formerly nearly worthless, being counted among dainties which only the wealthy can enjoy. In many waters formerly visited by migratory fish, especially salmon, these migrations have ceased entirely; fishing-privileges, once highly valued, have in most places become worthless, and the fishing trade is languishing. Not only has the quantity of fish decreased, but the number of fine and full-grown specimens of the better kind of fish has also diminished considerably. In former times, when fishing in our rivers and lakes was carried on with due regard to the protection of the younger generations of fish, they grew to a considerable size, and the pictures in some of our old castles and town halls, of fish caught in the olden times, represent them of astonishing dimensions. In many cases, the cause of this depopulation of the waters must be found in the advance of human civilization, driving back animal creation.

The waves produced by steamers disturb and drive away the fish, throw a large number of eggs and young fish on shore, or cover them with mud in the spawning places. Embankments and other river improvements made in the interest of navigation, or as a protection against inundations or the formation of marshes, make the water-courses narrower, destroying many favorable spawning and breeding places, and drying many sheets of water entirely. The lowering of lakes destroys many of the old overgrown spawning places among the reeds and bushes on the shores; the increased number of water-works, especially of weirs and sluices for industrial purposes, likewise disturbs the propagation of fish, and makes their migration to the spawning grounds either very difficult or entirely impossible. Of the so-called salmon and trout paths, so successfully introduced in other countries, so far but little use has been made with us.

The constantly increasing devices for irrigation and for draining, made with a view to heightened agricultural productiveness; contrivances for floating lumber down the streams; the introduction into the water of hurtful salts, coloring matter, and other refuse of industrial and agricultural establishments; the filth of cities; the innumerable small particles of coal from steamers and factories, gas-works, &c., are all injurious to the fisheries, as they are apt to kill the young fish. After every violent rain, which washes out the old heaps of rubbish near alum and vitriol works and other manufacturing establishments, masses of dead or stunned fish may be seen floating on the surface of the waters.

Still more does the decrease of food in the fishing waters, which is brought about by various causes, diminish the number of fish to a great extent. The number of fish is in due proportion to the quantity of organic matter which annually passes into the water. The cultivation of the banks; the felling of trees; the clearing away of bushes; the frequent cleaning of the river beds; the rooting out of aquatic plants, which purify the air in the water and develop oxygen; the taking away of sand and mud; all these causes tend to diminish the conditions under which alone a healthy growth of fish can be expected. The consequent want of food, as supplied by aquatic plants and by the numerous insects living in the mud, decreases the number of fish, even in such waters as had the reputation of possessing inexhaustible wealth of fish. As man takes away more and more grain and straw from the fields and grass from the meadows, rain and snow-water can no longer bring as much organic matter into the lakes and rivers. Such organic matter as is carried along by the water is, moreover, hurried on in its rush, made more rapid by river improvements, and not permitted to become food for fish by settling in calmer waters and undergoing a series of chemical changes.

The combination of all these unfavorable conditions, which cannot be entirely removed, will always keep the productiveness of the fisheries in most of our waters below the average of former times. But even that degree of productiveness which *might* be reached has never been attained; and it can boldly be affirmed that the inland fisheries owe their decline more to themselves than to those outward causes mentioned above. The destruction of fish even extended to those numerous waters which had either entirely or partly escaped the hurtful influences described above, or which could, by suitable arrangements, be freed from such influences, and, even in spite of such unfavorable circumstances, still contain all the conditions necessary for successful fish-breeding.

The number of bodies of waters and rivers which are rich in fish is, even now, very considerable in several provinces of Austria; by proper care and cultivation, their number can be increased; and, considering the almost inexhaustible strength which nature develops in the increase of fish, even the smallest body of water can, from a state of poverty and neglect, be changed into a rich harvest field for the proprietor. We are sorry to see that hitherto but very little has been done in the way of caring for and and cultivating the waters, for keeping away hurtful influences, and for taking proper steps to promote pisciculture.

The want of the spirit of industry on the part of those who possess fishing-privileges, especially among the poorer and more ignorant, neither permitted the employment of the proper means for promoting the fishing interests, nor would it allow any clear light to be thrown upon the hurtful character of most methods now in use.

The young fish, amounting to millions, are carelessly thrown on shore or allowed to perish, when their preservation would be an easy and inexpensive matter. Everywhere the business is carried on with hurtful implements, destroying the eggs and the young fish. Because there is no season when fishing is prohibited, the fishermen destroy millions of eggs by catching during the spawning season, thus sacrificing great future wealth for the sake of inconsiderable present gain.

Nowhere are any efforts made to neutralize the hurtful influences of industrial pursuits on the life and propagation of fish; scarcely anywhere has an attempt been made to harmonize conflicting interests by such measures as are suggested by the advancement of science.

The legal relations of the fisheries, especially those pertaining to their renting or farming, are everywhere arranged in such a miserable manner as to lead to the total exhaustion of the waters. In no portion of political economy do we find so many antiquated legal forms, which are hostile to civilization, and so many unpractical and useless regulations, as here. Such a state of affairs not only encourages individual proprietors either to make the most reckless use of their privileges or to neglect them totally, but makes a rational fish-culture in larger bodies of water by all other privileged persons almost a matter of impossibility.

There are privileges for employing certain specified fishing implements, fish-weirs, automatic traps, &c., and for small spaces in larger bodies of water; privileges extending only over one-half of a stream, and those which change their possessor every year; privileges of a doubtful or disputed character in private bodies of water; fishing waters where any one or where all the members of a certain village or town may fish; and fishing waters which do not go beyond the extent of the shore, &c. The fisheries are nearly everywhere leased in small portions and on short time, thus preventing the lessee from making any improvements. Large estates possessing fisheries lease them frequently to their officials, to foresters, &c., who catch a few fish for their own use, or lease the fisheries to others. Even sheets of water belonging to the state frequently find no lessee on account of the arduous conditions of the lease. In some parts of the country, where fishing has been carried on in a reckless manner by the farmers or proprietors of the banks, the fisheries have, even in brooks that formerly possessed an endless wealth of trout, dwindled down to a mere pastime for boys, or are frequently carried on by vagrants, poor day-laborers, and mechanics not at all in a concealed manner, but quite openly and with the knowledge of the proprietors.

But very rarely are the fisheries in the hands of men who, by the intelligent and persevering application of sound principles follow a practical aim that is likely to preserve them from exhaustion. Legislation in our country so far has not endeavored to transfer the fisheries to a better class of men by regulating the system of leases, and by limiting the powers of possessors whose titles to property are drawn up in a form which is hostile to general civilization.

The state itself has hitherto set a bad example by leasing its waters in small portions and on short time to ignorant fishermen. Nowhere has the lease been made on scientific principles; frequently, the reeds of lakes and ponds are leased separately, or they are given away to poor peasants, in payment for work done, who capture the fish at all times, even during their spawning season, thus destroying even the very germs of a rational protection.

Nowhere have new species been introduced into waters rich in inferior fish and suited for the finest breeds, nor has any care been taken to increase the quantity, to improve the breed by crossing it, or to establish places where fishing should be actually prohibited, in which places artificial propagation might be utilized, or, in fact, to take any practical measures for bringing to greater perfection this important industry.

The organization of companies on a legal basis has not been attempted anywhere; associations of all the persons privileged to fish, such as existed in great number in olden times, have nowhere been formed, although they had proved eminently useful for making good fishing regulations, for organizing the fisheries either for the purpose of carrying them on in common or only for taking uniform measures for protecting and increasing the fish, for doing away with obnoxious privileges, for establishing fish-passages and places where fishing was prohibited, for stocking the waters with a superior breed of fish, for common protection, and for common sales.

No wonder that our beautiful lakes, even those where no steamer nor factory disturbs the fish, have gradually become just as depopulated as our large rivers and streams.

The increase of population and the easier means of transportation have produced a much larger market for fish, and made them the object of an eager pursuit by privileged and non-privileged fishermen. Instead of satisfying the increased demand brought about by the increase of population, through greater care in the breeding of fish and by strict protective measures, a perfect system of plunder has been introduced and is tolerated. Only the immediate demand is looked to and is satisfied by every means; fish-thieves of every kind plunder the waters, especially peddlers, traveling musicians, and actors, who seek the placidly flowing waters, the old river beds, and stupefy the fish by the seeds of *Cocculus indicus* mixed with other bait. Since the building of railroads has made blasting with dynamite more frequent, not only the laborers on the railroads, but, to their disgrace be it said, persons possessing fishing-privileges and farmers, have made great havoc by using explosives for catching fish. Those which have been killed or stunned in this manner or by the use of *Cocculus indicus* float on the surface, the larger ones are taken out, and the smaller ones perish uselessly.* Carl Vogt, the well known naturalist, says, in his work on artificial fish-breeding, †"As far as the article of food is concerned which is found in our waters in the shape of fish, we occupy entirely the stand-point of the hunter, or at best that of the roving shepherd, who seeks safe retreats for his flocks, but leaves all the rest to nature. Our fishery-laws do not even go as far as our game-laws, which at least protect the animals of the forest during their breeding time."

In reviewing all of the above-mentioned facts, we must, to our deep regret, consider the reproach justified, "that the present state of our fisheries and the manner in which they are carried on, are one of the most unpardonable crimes against bountiful nature, against our own palpable advantage, against the welfare of the nation, and the civilization of our age." Men have actually, in their inexcusable blindness, done everything to destroy not only the treasures of nature, but even the fountains from which these treasures flow, while the means of preserving, protecting, and increasing them are nowhere applied with true understanding, with energy, and perseverance.

6.—ARTIFICIAL FISH-BREEDING.

The power of propagating is extraordinarily developed in fish. Of the food-fishes trout deposit 6,000 eggs per annum; salmon, 25,000; tench, 70,000; pike, 100,000; perch, 200,000; sturgeon, upward of 2,000,000. This circumstance, as well as the high price of fish, but more particularly the invention and further development of artificial fish-breeding, have again awakened the desire for an extensive and well-regulated fish-culture; and in spite of all the hinderances mentioned above, which cannot be obviated, and in spite of the demands for the most unlimited use of the waters which navigation, industry, and agriculture are making, there is a possibility of again gradually making pisciculture a remunerative source of income in our country.

It would, however, be a delusive hope if, from the "mere possibility of multiplying young fish," we would at once deduct its practical realization on an extensive scale, and expect that the artificial impregnation of thousands of eggs, which, by means of a couple of fish, had

* From Daubrawka, near Pilsen, in Bohemia, the "Nar. Listy" communicates the following as the result of catching fish by means of dynamite: "The effect of the dynamite thrown into the water soon became apparent. A large number of fish floated on the surface; these, however, were such as had only been stunned by the explosion. When after the lapse of about half an hour the water had again become calm, so that one could see the bottom, a large number of dead fish could be seen, which, when taken out, proved useless, as they had spots and smelled very disagreeably. On the second day, the place became almost impassable, because the fish had commenced to putrefy. The result of this attempt was that the lessee of the fishery got about 40 pounds of fish, while at least 400 pounds had been killed and become useless."

† Die künstliche Fischzucht, Leipzig: Brockhaus, 1859, p. 2.

proved astonishingly successful, would immediately tend to restock all our lakes and rivers.

The law of nature by which fish are increased by the enormous fruitfulness of a single pair is counterbalanced by another law of nature, which permits the destruction of equally large numbers of fish during their period of development, thus restoring the proper balance in the household of nature. Hitherto, man has only disturbed this balance, and no endeavors were made to counteract destruction by taking measures for preservation and increase.

On the continent of Europe, many races of animals that were hostile to man, or at least useless, have, by this continued war of destruction, either been entirely annihilated or very much diminished, in numbers; those, however, whose preservation and propagation are protected by human laws and customs, those which have enjoyed the care of man, have not only been preserved and increased, but also considerably improved. Just as man in the care of his domestic animals does not leave everything to nature alone, but rears them on practical and scientific principles, he must also carry on fish-breeding in a similar manner.

It is the object of artificial pisciculture to make use of the spawn which nature provides in rich profusion, and to protect it against all hurtful influences in nature, as well as to provide the fish in a plentiful manner with the food which they require for their development.

Of the enormous number of fish-eggs, a large portion is never fertilized, the cause of this being the peculiar manner of impregnation, which takes place outside of the body, as the female lets the eggs (roe) drop into the water, and the male pours the semen (milt) over them. The eggs of most species of fish lie free on the bottom, only covered a little by pebbles and sand, or are by some, as is the case with the perch, pasted on aquatic plants and stones. During the breeding-season, which lasts several weeks, the eggs are exposed to numberless enemies. Wherever the spawning places have not been properly prepared, many of the eggs are either washed away by the water, or thrown on the dry land by the waves, or scattered by removing the plants or the sand. Some fish, which are in the habit of gliding along the bottom, such as the turbot, the groundling, and likewise the perch, feed almost entirely on fish-eggs during the spawning-season. No less hurtful are the numberless lar of insects, diminutive crabs, water-mice, and all aquatic birds, such as ducks, geese, &c. The vegetable kingdom also contains many enemies of the fish-eggs, such as the small plants of which mold is composed, whose germs sticking to the outer skin of the egg, soon commence to sprout forth, and destroy enormous quantities of them. The eggs of those fish which spawn in winter, among which there are some of the finest species, are frequently exposed to the danger of freezing to death. The young fish during the period when they lie helpless at the bottom, and receive their food from the umbilical bag, are threatened by numberless enemies such as fish of prey, insects and their larvæ, water bugs and their larvæ, salamanders, wagtails, &c., so that by computation out of 1,000 eggs laid by the trout or salmon under favorable circumstances, only one young fish reaches the age of one year. Nature scatters the seed with inexhaustible prodigality, but seems to make the least use of it in the water. Besides this it must be remembered that during the spawning season most fish come in large schools to the surface and to shallow places, and are therefore more exposed to the persecutions of man in the spawning places than anywhere else. It is, therefore, all the more the duty of legislation to protect these places in every possible way, and, wherever it can be done, to prepare them in a suitable manner.

As in artificial impregnation the roe and milt of the spawning fish are pressed out by human hands, and brought into contact by stirring them carefully in water, the fertilization becomes more complete than in nature; by suitable breeding-apparatus the further development of the eggs and the young fish are cared for. The better science succeeds in finding out the conditions of life of the several species of fish, the nearer nature can be imitated in this respect in the fish-breeding establishments, the better one succeeds in removing all hurtful influences from the fish, the richer will be the harvest, and the greater the economical usefulness of such establishments.

In selecting the species of fish, the quality of the water, as well as local and commercial conditions, have to be taken into account.

For artificial breeding, the finest and healthiest specimens of fish should always be selected. Brook-trout, for instance, should weigh at least a pound and be without a blemish. As with other useful animals, so especially with fish, the species selected is of the utmost importance for a favorable result of the trial, since it often requires long experience to find out the proper places from which to get breeding fish.

Streams or springs which have a considerable fall, fresh pure water, and even temperature, are essential conditions to a favorable result of artificial fish-breeding; before entering the establishment, they should have run for some time above the ground, and received the oxygen, which is necessary for the respiration of the fish; they should likewise be located near to good means of communication, especially railroads, so that the impregnated eggs can be rapidly shipped to their destination; favorable places for catching small fish should be near; clear brooks, which are not so deep as to allow the entrance of large fish of prey, into which the fish are to be transplanted from the hatching-houses, either in the immediate neighborhood or at least so located that they can easily be reached; finally, larger bodies of water, in which the fishing-privileges are regulated in such a manner as to insure to the proprietors of the hatching-houses the full benefit of their efforts. The chief and most essential point in artificial fish-breeding, however, is in all cases to supply the growing fish with cheap and sufficient food. The gain will be greatest in those places where the food grows as it were in the same water with the fish. This result is most easily obtained if, besides the breeding fish, small fish are raised to serve for their food. The eggs of the pollard, the ray, the minnow, &c., develop during the summer months, up to July, in as many days as during the winter season it takes weeks for the eggs of trout to develop. The manner of feeding with water insects and plants is a very simple one. Care should therefore be taken that they should be protected during the spawning season; that the banks should be planted with trees or bushes; that the water should contain aquatic plants, to which insects come of their own accord; that the scum of the water, which always attracts numerous insects, should not be allowed to escape, &c. At a later period, other food is used, such as various refuse, horse-flesh, coagulated blood, &c. The views of pisciculturists on the best manner of feeding fish still vary a great deal; many attempts, especially in feeding large numbers, have been made in vain; but, as a general rule, it can be said that a great deal of inventive genius has been displayed in procuring articles of food, which nearly everywhere vary according to local circumstances, (see the numerous propositions in the circulars of the *Deutsche Fischerei-verein.*)

Never were fish more plentifully supplied with food than by the lake-dwellers. All the refuse of the kitchen, remains of vegetables, and of wild and domestic animals, which the inhabitants had brought from the shóre into their villages built over the water, became the food of the fish or of those aquatic animals which formed part of their food. This explains the fact, which Herodotus relates in that passage of his works which has become so famous since the discovery of the remains of lake-dwellings where he says that the inhabitants let down a basket into the water, which, after a short time, they drew out filled with fish.

Fish-breeding has also made it possible to stock bodies of water with water with fine species, which hitherto were not found there. Although acclimatization is not yet entirely founded on scientific principles, many of the questions pertaining thereto are being gradually solved by continued experiments. Instances of magnificent results in experiments on fish rearing are not wanting.

The breeding-establishment founded by the French government at Hüningen, on the Upper Rhine, possesses vast arrangements, so that eight millions of eggs of various species of trout are hatched at the same time; these eggs are partly obtained in the establishment, but the larger number come from Switzerland, the Vosges Mountains, the Black Forest, from Bavaria, and even from Upper Austria, and are shipped when properly matured. The raising of fish is here only a secondary consideration; the chief object in view is to collect the largest possible number of fish-eggs, and when these have become impregnated to send them to all parts of the world either as an article of merchandise or as presents. The eggs sent to Hüningen by agents of the establishment are carefully counted, which is done by weighing, and registered, they are then put into the breeding-boxes which are covered by fresh running water protected against all hurtful influences, and they are shipped as soon as the eyes of the little fish can be seen through the skin of the egg. Up to the autumn of 1864 more than 110,000,000 eggs of fresh-water fish, among these 41,000,000 salmon and trout, had been impregnated at Hüningen, and shipped from there. This number has no doubt since then increased more than double.

The new German government, recognizing the beneficial influence which this establishment has had on the increase of fish in France, through the *Deutsche Fischerei-verein* takes all the necessary measures to make this new acquisition a benefit to the German fisheries. It has been made an imperial establishment, and the shipping of eggs is continued, no longer gratis, however, but at a moderate price—60 cents per thousand for impregnated eggs of the salmon-trout.

Recently successful experiments in sending fish-eggs to a considerable distance have been made in other establishments, as at Freiburg in Baden, but especially at Salzburg. From England, 100,000 salmon and 3,000 trout eggs, packed first in moss, and then in ice, were some years ago sent to Australia, where they arrived safely. In the autumn of 1869, 110,000 salmon-eggs were sent to New Zealand. Now they have in Australia trout measuring 19½ inches in length and weighing 3½ pounds; two-year-old salmon have also been seen, and some of them have been observed spawning. (*Zeitschrift für wissenschaftliche Zoologie*, 1869.)

The most famous British fish-breeding establishment is at Stormontfield, on the river Tay, where the young salmon raised from artificially-impregnated eggs are cared for and fed in several ponds till they are able to commence their journey to the sea as smolts. Originally calculated for 300,000 eggs, this establishment has been considerably enlarged. A similar establishment is located on the river Dee, in Scotland, which makes a business of raising and selling eggs and young fish, and realizes a considerable profit, although the managers pay an annual rent of $6,000.

The Irish "salmon-factory" of Thomas Ashworth, in Galway, likewise raises millions of eggs every year, and increases in importance from year to year. The establishments founded by private individuals, by associations, or joint-stock companies, seem to flourish most, while those which have been founded and are supported by the government have not in all cases been as successful. It seems to be sufficient if the government confines its activity to giving encouragement and assistance to these local enterprises.

The organization of artificial fish-breeding asssociations involves expenses which, in smaller bodies of water, are not in due proportion to the extent of water, nor does every fishing water offer a suitable place. For this reason, many proprietors of small fisheries prefer to buy impregnated eggs from the larger establishments, and place them in suitable places in the waters, in shallow and quiet sand bottoms near to reeds or bushes, or put them in wicker-baskets or boxes in streams, leaving the hatching to nature.

7.—PROGRESS OF FOREIGN FISHERIES.

Great Britain.—The most brilliant example of progress is in Scotland, whose rivers had for a long period been almost entirely depopulated by reckless fishing. The river Spey in Scotland scarcely contained any fish up to the year 1854; since then, and up to 1860, it has annually produced upward of $10,000 worth of fish; this has even been increased of late years, so that a single fishing-station belonging to the Duke of Richmond yields an annual income of $52,500 to $60,000. The annual yield of the river Tay has, in a few years, risen from $40,000 to $90,000, net income, not counting the large number of fish given to the fishermen; and all this in consequence of feeding, watching, and protecting the fish, and of introducing artificial breeding. By the same means, and in consequence of excellent laws and strict protection of the fish during the spawning season, the yield of some of the Irish fisheries has in a few years increased fourfold. In 1858, the revenues from the salmon and trout fisheries in Scotland and Ireland amounted to $3,500,000, while in 1863 they had increased to twice that sum.*

The constantly improved British fishery-laws, and many institutions called to life by the government, or at least encouraged by it, such as the appointing of inspectors of fisheries, are perseveringly following the object in view, to clear away all impediments to the progress of the fisheries, and to extend them by every possible means.

The report on the British salmon fisheries for the year 1870, by the inspectors Buckland and Walpole, shows a considerably increased harvest during the year 1869 in consequence of artificial breeding and proper protection of the fish; there are, however, still some complaints of hinderances and plundering the fisheries. In the seventeen salmon-rivers, the fish are still excluded from 7,990 square miles by weirs, and from 3,600 square miles by industrial poisoning of the water, so that there are only remaining 6,600 square miles for spawning and raising young fish. In order to do away with the weirs, water-mills are as far as possible to be changed to steam-mills, and those which are still in existence are to be made harmless by salmon-paths.

The poisoning of the rivers by factories is strongly condemned not only on account of the salmon but likewise on account of human beings, as it not only kills the fish, but has likewise been generally acknowledged to be a means of breeding fatal contagious diseases. Great efforts are therefore made in England to purify the rivers, whereby the industries are likewise brought to a higher degree of perfection, as the

*Die rationelle Zucht der Süsswasserfische und einiger in der Volkswirthschaft wichtigen Wasserthiere. R. Molin, Wien, 1864. p. 212.

Die Bewirthschaftung des Wassers und die Ernten daraus. H. Beta, Leipzig und Heidelberg, 1868. p. 67.

factories are obliged to put the refuse, which formerly was thrown into the river, to some use. Rivers which at an expense of many millions of dollars have been purified of the refuse of sewers and other poisonous matter, amply repay this outlay by the better health of the population and by the increase in fine fish. During the year 1869, 33,321 barrels of salmon each weighing 100 pounds, the whole valued at more than a million dollars, arrived at the wholesale market in Billingsgate; 2,405 of these barrels came from English rivers, which in 1864 had only supplied 752.*

France.—The French, in their establishment at Hüningen, have immediately carried out, on a large scale, the system of artificial impregnation, which was first discovered by a German, Jacobi, and much later by two Frenchmen, Gehin and Remy, and have thereby exercised a very beneficial influence on pisciculture throughout the whole country.

Even small bodies of water are cultivated, and the best possible use is made of the different character of the water: thus, in marshy places, eels are raised; in otherwise useless small streams, crawfish, imported from Germany, are increasing rapidly; and in the clear brooks numberless trout are found.

The cultivation of the oyster, which had been almost entirely destroyed by the former system of plundering, begins, though slowly, to revive on many parts of the coast.

Even the raising of turtles has been commenced; their eggs are gathered, and the young ones cared for and protected till they are old enough to take care of themselves.

In all parts of France, there are numerous private individuals who breed and raise all sorts of marine animals, partly as a pastime and partly for the sake of gain. The exaggerated expectations which in the beginning were connected with artificial fish-breeding in France have, however, not been fulfilled. Ignorance of the subject, which was very prevalent till better methods gradually gained ground by long experience and by many failures, demanded many sacrifices. It must, nevertheless, be acknowledged that, through the better cultivation of the water since the year 1849, when a beginning was made to extend the system of artificial breeding to the French rivers, and at first to those where there was the greatest amount of poverty, a new life has been developed along these rivers, so that many a poor fisher and farmer has become a man of means through his little fish-pond and his few pots for artificial impregnation.

One establishment belonging to the Marquis de Folleville at Imsleville in Normandy yields an annual income of $750 to $900 from one stream and pond which ten years ago did not produce a single dollar.

Before the war, France possessed about 4,600 (English) miles of navigable rivers; nearly as many miles of canals; 322 miles of mouths of rivers and bays; about 920 miles of private waters; more than 92,000

* Beta, (H.) *op. cit.* p. 31.

miles of not navigable rivers and streams; and more than 4,600 miles of lakes and ponds. The navigable rivers and canals belong to the government, and are leased to private individuals. In order to avoid all trouble, the sheets of water are carefully measured and accurately marked on special maps, so that every one knows the exact limits of his watery domain, within which he can fish with nets for an annual rent of \$4.50 to \$22.50. French statisticians compute the annual gain from the fresh-water fisheries at \$4,000,000, and the average annual rent of every hectare (1 hectare=2.47 acres) of water at \$15. The fisheries, however, are not yet able to supply the home demand.*

Germany.—Compared with the gratifying results in England, Scotland, and America, those obtained by the German fisheries can only be considered as small beginnings, and the complaints of the various hinderances to success are no less loud and numerous than in Austria, although it must be owned that of late years Germany has made considerable progress.

In Munich, the city-fisherman, Kuffer carries on fish-breeding, and has, according to a report published some years ago, during the last eight years impregnated about 300,000 eggs of the Bavarian salmon per annum, partly for the Bavarian waters, and partly for Switzerland, Austria, France, Italy, Russia, Denmark, and Prussia. During the last few years, he has shipped about half a million per annum. The establishment is well conducted, its location and the quality of the water are excellent. Kuffer has therefore often been commissioned to organize such enterprises in other countries, as for instance in Austria.

Würtemberg only possesses some small breeding-establishments, which owe their existence and success chiefly to the efforts of the royal agricultural department, (*Königliche Centralstelle für Landwirthschaft.*) This department, since 1861, has endeavored to encourage pisciculture among small proprietors by offering prizes for hatching-houses in connection with ponds; to persons who stock open waters with fish; for a rational system of pond-fisheries; for the union of small fishing districts with a view to carrying on the fisheries in a more systematic manner. Information is freely given to all who desire it, as well as impregnated and hatched trout-eggs.

A report, made in the year 1871, shows that nearly all these organizations were in a flourishing condition.

In Baden, a joint-stock company was formed in 1865 with a capital of \$20,000. In the neighborhood of Freiburg, the seat of this company, a breeding-establishment has been founded, which annually produces about half a million young fish. All of their fish which were placed in open waters, were flourishing. The company possesses several trout-brooks, which they lease for an annual sum of \$600.

The joint-stock fishery-company at Wiesbaden, besides raising fish in closed waters to sell, has also set itself the praiseworthy task to re-

* Beta, *op. cit.* pp. 48, 50.

stock all the neighboring waters, which had been almost entirely depopulated. Besides the numerous bodies of water owned by the company, about forty lakes and rivers have been leased by them on the longest possible time; new trout-ponds have been made in shady forests; nor has the commercial portion of the enterprise been neglected, since in addition to the model and experimenting branches, a flourishing business has been started with a capital of $62,500 in shares.

The fish-breeding establishment at Hameln, (Hanover,) originally founded by the Agricultural Society of Zelle, but which in later years has been taken and further enlargeed by the city of Zelle, has, during the last twelve years, placed 316,000 artificially-raised young salmon into the river Weser, and its revenue has been constantly on the increase. Other Prussian organizations have, according to the report of the economical department (*Landes-Oekonomie-Collegium*) for 1868, done well, although, as the report says, the artificial breeding of fish is not appreciated as much as it deserves, and there is as yet a great want of larger piscicultural institutions.

The fish-breeding companies in the Prussian province of Silesia have have for four years made efforts to introduce the cultivation of salmon into the Upper Oder and its tributaries, into which they placed no less than 307,000 young ones during the year 1872. The eggs were provided by the department of agriculture in Berlin, from the establishment at Hüningen, at the instigation of the *Deutsche Fisherei-verein.*

In accordance with an order of the Prussian commissioner of agriculture, dated January 23, 1871, the fish-breeding establishments in the Rhine province are to be subsidized in the following manner: A certain number of Rhine salmon, salmon-trout, and brook-trout, which must be at least five months old, shall be bought at a moderate price, which is to be settled every year, and placed directly into the water. A competent person shall be charged with buying the fish and placing them in the water. As the method of raising fish in the several establishments and the manner of feeding the young has the greatest influence on their ability to keep alive after they have been placed in the waters, the price of the fish bought will be regulated by the manner in which they have been raised.

The *Deutsche Fischerei-verein*, founded at Berlin in the year 1870, will doubtless prove a great benefit to the craft in that country. Its object is to further sea and inland fisheries throughout the whole of Germany, and to assist the several state governments in this direction. The society has resolved itself into five committees: for facilitating the transportation of stock; for the sea and inland fisheries; for the artificial breeding and raising of fish; for fishery legislation; and for the culture of the crawfish. It will also direct its attention to scientific investigations which will diffuse correct views regarding the true wants of the sea and inland fisheries.

The society intends to place itself in communication with pisciculturists in all parts of the country, and to form a central agency for promoting the fisheries, and for facilitating the raising and shipping of fish so as to benefit the whole population.

Through the efforts of this society, Berlin and other inland cities receive an increased supply of fresh sea fish; it has also suggested the introduction of the sterlet and other finer species of fishes instead of the common food-fishes, which have hitherto been supplied to the markets from sadly neglected fish-ponds.

In May, 1871, the society addressed a petition to the chancellor of the German empire that, for a number of years, an annual sum of $37,500 should be appropriated from the imperial German treasury to extend pecuniary aid to deserving pisciculturists and piscicultural societies, and to promote the interests of the sea-fisheries by procuring models of vessels and implements.

The circulars of the *Deutsche Fischerei-verein*, which are edited in a model way, give from time to time information both on the proceedings of the society and on all matters of interest to pisciculturists.

The society likewise directs its attention to the improvement of existing legislation. Thus, in its second session, it was urged to remedy the existing defects in the fishery-laws of North Germany, which at present contain no clauses enforcing the building of weirs in such a manner as to leave a free passage for migratory fish. The draught of a new fishery-law for Prussia, which has been published recently, owes its origin to a great degree in the exertions of this society.

8.—CONDITION OF PISCICULTURE IN AUSTRIA.

From the report of the ministry of agriculture for 1868, and from numerous special reports on piscicultural establishments, it will be seen that fish-rearing is gaining ground in Austria, and private enterprise has been successfully employed in this branch of industry. In nearly all the provinces of Austria there are piscicultural establishments, several of which have been very successful. Although there are no complete statistics, we shall, in the following pages, give all the information which can be gathered from the official reports and from articles in various journals. In comparison with the vast arrangements of other countries as described above, we can only chronicle small beginnings.

In Salzburg, a central establishment for fish-breeding was founded in 1864, by a joint-stock company, which has not, so far, been a pecuniary success, but which, nevertheless, has exercised a most beneficial influence on fish-culture throughout Austria. Since its foundation, it has sent a large number of eggs to nearly all the provinces of Austria and to foreign parts. During the season 1867–'68, it shipped 253,000 eggs of lake-trout, Rhine salmon, brook-trout, and pike. During the winter 1869–'70, orders for 815,000 eggs were received at the establishment, but only 572,000 could be shipped, partly because there was a lack of eggs on account of unfavorable weather and inundations which had interfered with the spawning, and partly because some of these orders came too late. The arrangements for raising fish were unfortunately very poor; the ponds were badly located and soon became marshy; there were no shade-trees, and the supply of fresh running water was insufficient Attempts had also been made in the beginning to breed a great variety of fish, while at present only salmon are raised, and the arrangements have been much improved. The rearing of fish in several lakes which the government has given to the institution has been much more successful.

In the Waller Lake, 19,000 young Rhine salmon were placed in 1869, and, so far as it is known, they are in a flourishing condition.

Last year, a new hatching-house for 300,000 eggs was built on the shore of the Hinter Lake.

On the headwaters of the Waller Lake, simple breeding-apparatus has been placed, so as to enable the stocking of all the streams with young fish from the lakes.

There is a constant improvement from year to year in the growth of the embryo business and in the stocking of the rented lakes.

During the season 1870–'71, the total number of impregnated eggs was 1,157,000, of which 575,000 were sold, while the rest were either hatched in the establishment or placed in the lakes. For two years, a considerable number of fish have been sold as food from the establishment at Hellbrunn; during the last year, many defects of the original plan were remedied and many new improvements were introduced.

The central establishment has recently begun to obtain impregnated eggs of brook-trout from the fishers on the rivers Vökla and Ager; of the *Salmo hucho* from the river Salzach, as well as from the streams of Upper Austria; spawn of the lake-salmon, of the *Salmo salvelinus*, and of the *Coregonus Wartmanni* from the Matt, Mond, Fuschl, Wolfganger, and Atter Lakes; and to ship them at the proper time.

In Upper Austria, fish-culture has been carried on for some time by the convent-chapter of Kremsmünster, which annually places 20,000 to 40,000 young trout hatched in the establishment, into the Alm Lake, as soon as the umbilical bag has disappeared, (usually in February,) so that a considerable increase in the number of fish in this lake can already be noticed. *Salmo salvelinus* is raised in the lake itself. The fish-ponds belonging to the chapter have been famous from time immemorial for their great wealth of fine fish. Some of the small landed proprietors, such as Rettenbacher at Sulzbach near Ischl, Köttl at Neukirchen near zipf, Schedl in Fischelham, and the Ischl Piscicultural Society, have, with comparatively small means, founded establishments which to some extent have proved a pecuniary success, thus furnishing another proof that this branch of industry is suitable for private individuals of limited means. Special mention must be made of Franz Rettenbacher, a miner, who on his little piece of ground at Sulzbach near Ischl, has for some years, without any assistance whatever, but with great enthusiasm, carried on, in a small way, pisciculture. Only by the strictest economy he was enabled to raise the required capital; with his own hand, in the spare time which the arduous life of a miner left him, he erected all the buildings, &c., so that the Upper Austria Agricultural Society, acknowledging his apparatus to be the most perfect in the whole province, gave him, in 1870, $100, the first government prize for pisciculture. We give here the full report of the committee sent by the Agricultural Society, as it is in every respect very suggestive and instructive:

"The piscicultural establishment of Franz Rettenbacher consists of two hatching-houses, five ponds for the growing fish, (*Streckteiche*,) and one floating hut with a boat. In the two larger connected ponds, which cover an area of about 1½ acres, a very pretty watch-house, with many exceedingly practical contrivances, has been erected, from which all the ponds of the establishment can be seen and watched; all the buildings and apparatus, by their simplicity, cleanliness, and practical arrangement, show the enthusiastic, enterprising, and rational pisciculturist, whose fish, both in the houses and in the ponds, are all exceptionally fine and healthy specimens. Franz Rettenbacher commenced his enterprise in 1858, on a very small scale; up to 1864, his work consisted of nothing else than the impregnation of several hundred, occasionally, several thousand, trout-eggs, and the placing of young fish in the running water (his own property) near his house. After having labored six years, no increase in the number of fish was observable, which doubtless was caused by the fact that the fish, when they had grown larger, got into the government waters, into which his little stream flowed, and even, when there was a means of communication, into the Traun Lake.

"In 1864, Rettenbacher resolved to raise and feed the young fish which might be hatched during the following winter in a closed house; in this he was entirely successful, as the 800 young fish (*Salmo salvelinus*) when one year old weighed from two to seven ounces. Unfortunately, many of the fish died after they had reached the age of one and a half years, without exhibiting any outward sign of sickness, and in the course of half a year one-half of the whole number had perished; then this strange mortality ceased of itself. According to later experience, Rettenbacher believes that he fed the fish too much; for, since he possesses a larger number of fish, and therefore has not been able to feed them so much as formerly, this mortality has ceased.

"Since 1865, Rettenbacher annually has raised several thousand fish, *Salmo salvelinus*, trout, and cross-breeds. Thecross-breeding, produced by impregnating the roe of the *Salmo salvelinus* with the milt of brook-trout, has been very successful, as also the raising of the *Salmo salvelinus* itself. Trout do not succeed so well, which seems to be caused by their being fed with meat. During their infancy, the fish get calves' liver and brains; later, lungs, entrails, and other cheap offal; also, horse-flesh. To every hundred-weight of live fish, Rettenbacher, on an average, allows five pounds of food per day.

"To feed such a large number of fish with insects is almost impossible, as insects, such as water-palmers, flies, their larvæ, &c., are very scarce in that neighborhood, and frog-spawn and cheap fish cannot be had. In Rettenbacher's opinion, every pisciculturist who cannot obtain insects and whose space is limited, should only raise the *Salmo salvelinus*, since this fish alone can in a small space be fed on meat from its infancy till it is ripe for the market, and has the lowest percentage (7 per cent.) of mortality. It is a very gregarious and tame fish, which does not seem to be disturbed by being placed among fish of different species and size, while the trout is always shy and of an unfriendly disposition, especially toward small fish.

"Rettenbacher sells his fish at the age of two and one-half to three and one-half years, and only those whose growth has been retarded, at the age of four and one-half and five and one-half years. Recently, he has commenced to hatch a larger number of fish than he requires, and, after a year or more, he throws those whose growth has been retarded into the open water, leaving them to shift for themselves, because, according to his theory, the gain is much greater if the expensive food is given to such fish as promise a better growth. His spawn he gets from the Aussee Lakes in Styria, where, during the spawning season, he annually buys several hundred female fish, impregnating their eggs with milt from male fish of his own raising, as very few male specimens of the *Salmo salvelinus* are found in those lakes, and as those few are mostly worthless. The female fish he keeps till next summer, when he sells them. In 1870, Rettenbacher did not hatch any fish, since he had such a large number left over from the year before as to make it impossible for him to supply all the necessary food. The water used in his establishment consists of several hundred small and large springs flowing from the ground, with a temperature of 5½ degrees Réaumur in winter, 6½ in summer; near the Traun river 3 degrees in winter and 9 in summer. In this water, the young fish leave the eggs after fifty or sixty days.

"Up to 1864, Rettenbacher had only two small hatching-boxes. In 1864, he built a hatching-house with four boxes and two tanks for the young fish; in 1865, he built a covered tank with three divisions; in 1866, he dug the two ponds; in 1867, he built a new hatching-house; and in the same year, after having obtained the upper portion of the Altwasser stream from the imperial forest office, in exchange for a portion of forest belonging to him, he stopped the communication between his springs and the Traun River by a stationary wooden gate of lattice-work, and built his floating hut and boat, and, in 1868, the watch-house, resting on pales. The total capital invested was $258.25. The location was extremely favorable for making the ponds, as but very little digging had to be done. According to the inventory taken, with a view to his obtaining the government prize, on the 29th and 30th of June, 1870, when all the fish were carefully counted and weighed, his establishment contained the following number of fish:

"Location.	Age.	Number.	Weight.
			Pounds, avoirdupois.
"In the building for young fish, No. 3	One and a half years	3,700	54
"In the building for young fish, No. 4	......do	2,100	67½
"In the hatching-house, No. 2	......do	3,000	171¼
"In the hatching-house, No. 1	Two and a half years	1,010	96¼
"In the small pond	......do	1,400	277½
"In the larger pond	Various	944	166¼
"In the largest pond	Three and a half years	250	150
"Total		12,454	982¾

"Of this number, 262½ pounds of fish could be sold during 1870.

"The quality of the fish was very good, since, even at a high price, they found a ready market. The capital invested has therefore borne its full interest."

A further proof that it only requires some encouragement in order to have our smaller pisciculturists make practical inventions and improvements is furnished by Mr. Köttl, a miller of Neukirchen. Formerly, the better kind of food-fish were brought direct to Vienna from the lakes and streams of Upper Austria; the fishermen not taking the least care of the eggs contained in many of these fish. Köttl, at present, gets what he can of these eggs, and immediately impregnates them. The female lake and brook trout which are on the point of spawning when caught by the fishermen are brought to him, and their eggs are impregnated by the male brook-trout from his establishment. In this manner he has, in a short time, impregnated 200,000 eggs of brook and lake trout, which, without his intervention, would have been sold in Vienna with the fish.

In Upper Austria, a fishing-club has recently been formed, and its preparations for pisciculture are progressing favorably. The headwaters at St. Peter, near Linz, have been secured by a lease of ten years, a hatching-house has been built, a covered pond for young fish is almost finished, and the digging of an open pond has been commenced. (Report for 1871.)

Another hatching-house has recently been started by Werndl in Steyer.

In Lower Austria, there is a piscicultural establishment at Hollenburg. Mr. Fichtner, in Atzgersdorf, diffuses a knowledge of pisciculture by lectures and publications. No noteworthy results, however, have so far been obtained. That encouragement is wanting which this branch of industry seems to require in its beginning.

In Styria, Baron de Washington, at Pöls, has made the most praiseworthy efforts to further the cause of pisciculture by the exhibition of models, by lectures, and by giving general encouragement.

The farmers and the middle class begin to take an interest in pisciculture, and there are small establishments at Werndorf, Voitsberg, Köflach, Hirschegg, Altaussee, and other places.

Baron de Washington has succeeded in making the raising of goldfish more common. These fish, which originally came from China, but with us increase almost as fast as the herring, are now raised by many farmers, whose income is by this means considerably increased.

In Carinthia, the only fish-breeding institution is at present at Lölling, which, however, on account of the limited extent of water, confines its rpoduction to the hatching and raising of young fish, (annually 12,000 to 18,000 *Salmo salvelinus*, lake and brook trout.)

In Tyrol, a fishing-club has been formed at Innsbruck, which, in December, 1870, received 20,000 impregnated salmon-eggs from Mr. Kuffer in Munich, from which, however, no more than 2,000 fish were raised. The club has not been discouraged by this failure, but believes if the hatching proves successful, if the eggs are carefully watched and treated, if the young fish are placed in favorable localities, and if some perseverance is shown, that it may do a great deal of good to Tyrol.

Mr. Glanzl, the city-fisher of Lienz, in Tyrol, has been more successful, as, according to his report, he was able, from 1865 to 1870, to transfer 260,000 young fish from his establishment at Moosbrunnen, near Lavant, o other waters. He raises principally trout and the *Thymallus:* and, as the spawning seasons of these two species of fish are far apart, the same establishment can be used for both. The finer the specimens which have been employed in artificial hatching the healthier and better will the young fish be. The catching of the adult fish previous to the spawning season, and their being kept in boxes till the spawn has matured, is considered useless by Glanzl, as they do not ripen properly, and as the female fish frequently does not let the eggs go.

According to the observations made by others, the catching of fish about to spawn is only considered hurtful if the eggs are not pressed out at once, while fish caught prior to the spawning-season mature their ova even in an inclosed space.

Glanzl made the observation that the hatching of the eggs in metal troughs, especially those made of zinc, succeeded much better when glass rods were laid in the vessels, which, as he thinks, neutralize the bad effects of oxidation.

He expresses his conviction that only by the artificial process, and by their more general industrial application, can an increase of fish be produced in the particularly suitable territory of the Drau and Isel, which is so rich in springs.

At the suggestion of the agricultural society, he accepted a subsidy of $200 from the ministry of agriculture.

In Trins, a fisherman by the name of Schlierenzauer has stocked several brooks with trout; and in Thiersee, Mr. Lerperger, a merchant, has devoted much time to this industry.

In Vorarlberg, the artificial hatching of fish has been introduced by Mr. Tiefenthaler, a landed proprietor of Meiningen, in the district of Feldkirch. As early as 1862, he endeavored to obtain fish-eggs for the purpose of hatching them, in which, however, he was unsuccessful for a long time on account of the prejudices of the fishermen in that neighborhood, who were afraid that their trade might thereby be injured. It was not till 1864 that he was enabled to impregnate 1,500 eggs of the lake-trout, which flourishes in Lake Constance and its tributaries; he was so successful in this that scarcely 10 per cent. were lost. He has now on his property several large basins after the best foreign models; bought of the village of Rankweil the privilege to fish in the Ehe or Malanka stream, which flows near his property, for $300; improved his establishment constantly on his own ideas; and, as early as 1867, he was able to raise 30,000 young fish. As there was a great want of water, the ministry of finance placed the remaining streams in that neighborhood which belonged to the government at his disposal; and the ministry of agriculture has repeatedly granted him subsidies for meeting the considerable expenses of his first establishment.

His example was imitated by other landed proprietors in Vorarlberg. With the subsidy granted in 1869, the agricultural society procured the model of a new hatching-box, and distributed six of them among the several pisciculturists of the province. We have reports of successful experiments made by some of these, which, on the one hand, have been favored by the excellent quality of the Vorarlberg water, but which, on the other hand, as the reporter of the agricultural society says, have been much impeded by the defective fishery-laws.

Bohemia in former times excelled all other provinces of Austria in her famous lake-culture; and, although a large number of lakes have been drained, this province has still maintained her old fame. Thus, 370,500 to 492,000 pounds of carp are every year sent to Vienna from the estate of Wittingau in the south of Bohemia. (*Die Teichwirthschaft mit besonderer Rücksicht auf das südliche Böhmen.* Wenzel Horák, 1869.) The great Rosenberg Lake in 1870 produced 192,660 pounds of different fish, which shows what large revenues can, with proper care, be derived from water.

The high prices have of late years made lake-culture more remunerative, and more attention is consequently given to it. This industry is particularly successful if there are separate lakes for spawning, for the raising of fish, and for those which are to be sold, and if they are several times transferred from one lake to the another. As in raising cattle and sheep, great care is likewise taken in fish-culture to select for breeding purposes the most perfect specimens; wherever artificial spawning cannot be applied, great care is taken to protect the young ones against all possible dangers; the different species are kept separate, and the lake-fish are well fed on various agricultural refuse, on refuse fish, and even frog-spawn, which is found in all marshes.

The occasional draining of the lakes, and the planting of their beds with corn or grass at the end of summer, usually every third or fourth year, has not only a very beneficial influence on pisciculture, but as also advantageous from an agricultural point of view by adding the rich harvest of one year.

In making estimates as to whether lake-culture will pay, the value of the soil, which thereby is abstracted from another culture, has to be taken into account; while the restocking of depopulated brooks, rivers, and lakes does not monopolize soil devoted to any other purposes.

In 1824, the artificial impregnation and raising of salmon was successfully carried out on the Horazdòvic estate in Bohemia, but it was not developed any further at the time, and was soon given up.

Quite recently, fish-eggs have been artificially impregnated in the neighborhood of Braunau, on the estates of Mabec and Tachau, in Glashütten near Pribram, in Opocno, in Hammer near Beichor, in Krumau, in Nedosim near Leitomischl, and in Frauenberg. Further successful experiments in brooks and lakes were made with salmon-eggs, which mostly came from Salzburg. The most successful experiments were those made by Mr. Vacek, of Nedosin, whose brook, in consequence of culture and protection, produced a constant increase of fish, 62½ pounds of trout in 1865, and 250 pounds in 1870. The amonnt of trout in the lower portion of the brook, where there was no protection and culture, was likewise increased to about 500 pounds, the trout from the upper portion being carried down especially in consequence of high water in spring; while the fish-thieves of that neighborhood did a still more flourishing business. In consequence of the 37,000 trout-eggs placed there by Mr. Vacek, the number of fish has considerably increased in every portion of this brook. In 1871, the salmon-breeding establishment founded by Dr. Fric at Herrenskretschen, near the Saxon boundary-line, commenced to place young fish in the Kamnitz, a small tributary of the Elbe. Preparations have been made to found another on a larger scale.

The fishing-waters of Moravia were formerly counted among the richest of the Austrian monarchy. Of late years, the fisheries have been almost totally destroyed, as in other places, by the want of any legal protection, and especially by the poisoning of the streams by the refuse from factories. The statistics which were published in the report of the Moravian and Silesian Agricultural Society for 1871 show, in spite of the deplorable condition of the fisheries, the beginnings of improvement. There are small piscicultural establishments in several places, as in Wisowitz, on the estates of Baron de Stillfried, whither, in 1868, 20,000 eggs of the trout, the *Salmo salvelinus*, the salmon-trout, and the salmon were brought from Salzburg. After the eggs had been successfully hatched, the young fish were placed in a mountain-stream, and in small lakes made specially for this purpose, where the trout are flourishing, while the salmon-trout and the salmon grow but slowly, most likely because the water is not sufficiently deep.

In Moravia, as in other countries, it is proposed to prohibit fishing, at least with nets, entirely, for at least three years.

In Silesia, Mr. Ernst Giebner, of Bielitz, has a very successful hatching-establishment.

In Galicia, there is one at Dublany, and another was founded in 1867 at Lubatowka, by Mr. Ludwig Lindes, of which he gives the following account in the Vienna Agricultural Journal, No. 51, 1869:

"From my own experience, I can testify to the fact that in a wild mountain-region, where, two years ago, the name salmon was entirely unknown, nobody having any idea how such a fish looked, at this day, every peasant is able to distinguish the trout from the *Salmo salvelinus*, and this from the lake-trout, &c.; that where formerly there were marshy openings, which, from times immemorial, had been entirely unproductive, there are now pleasant lakes, which are densely populated with all sorts of trout and salmon, which received the germ of life at the piscicultural establishment of Salzburg, and which, in an embryonic state, traveled a distance of 553 miles in order to reach their present dwelling-place. This became possible only through artificial hatching!"

According to later information, (*Der Wiener landwirthschaftlichen Zeitung*, November 5, 1870,) the establishment at present comprises thirty basins, or small lakes, covering a total area of 6 acres. From the year 1866 there were left over 4,000 fish, (*Salmo salvelinus*, salmon-trout, and lake-trout,) which in eighteen months had reached an average length of 11 inches, and a weight of 23 ounces, besides these there were 2,000 perch and 3,200 crawfish; of young fish, from 1869, 18,000, which, during the first six months of their life, reached an average length of 5 inches.

In Hungary, the government has recently appropriated $10,000 for fish-culture, of which $5,000 are to go toward the foundation of a piscicultural establishment, which will be supported by the government, and $2,500 apiece to the assistance of two existing private enterprises.

A fisherman who was educated in Salzburg is at the head of the well-managed private piscicultural establishment at Szomolany, in the district of Pressburg.

In Transylvania, fish-culture, according to the Hermannstadt Gazette, is in a flourishing condition, and there are several piscicultural societies. The trout-raising establishment in Ireck, founded in 1869, got its spawn from Salzburg and Tartlau; the result was a very favorable one, and it has now on hand 1,200 trout, varying in length from 4 to 6 inches, which might have been sent to market in the autumn of 1870.

From this review, it will be seen that the results which fish-culture has so far obtained in Austria are very small, as far as the increase of fish in the open waters, viz, in the lakes, rivers, and brooks, is concerned. There are only a few exceptions, such as the Alm Lake, belonging to the chapter of Kremsmünster, a few lakes and brooks in Salzburg, &c.

It is only recently that the Salzburg company has made a beginning of placing impregnated spawn in the open waters which were placed at its disposal. Most of our organizations have limited their activity to the trade in fish-eggs, or to the raising of a few fish, for which the small enclosed waters belonging to them were sufficient.

Agents of foreign piscicultural establishments, especially Hüningen and Stormontfield, visit several of the provinces of Austria every year, in order to buy trout and salmon spawn from the Austrian fishermen, as the irregular way in which our fisheries are managed does not, for the time being, offer any chances for an extensive use of this spawn at home. The smaller pisciculturists are not inclined to give it up to the larger waters, in which they have not the right to fish; while the proprietors of these larger waters do not feel encouraged to buy spawn, on account of the irregular manner in which fishing is carried on and the little protection it enjoys. Our smaller hatching-establishments are, nevertheless, of importance to fish-culture, because they have at least awakened an interest in this matter, and because they undoubtedly are the sources from which our domestic waters will be restocked.

9.—VALUE OF THE PRODUCTS OF THE FISHERIES.

Fish, crawfish, and many other marine products, form an easily digestible and pleasant food, which, it is maintained, is also calculated to stimulate mental activity. Civilized nations cannot do without this important aliment without detriment to themselves. Fish, even without any elaborate dressing, form a good and easily-prepared meal for the laboring classes.

Their flesh contains as large a quantity of proteine as pork; 100 pounds (Austrian) of fish-flesh contain as much nourishing matter as 200 pounds of wheat-bread or 700 pounds of potatoes.

It is an essential advantage of the fisheries that their products supply delicacies for the table of the rich, and wholesome cheap food for the poorer classes.

It is a great defect in the Austrian fisheries that the extraordinary quantity of fish procured by occasional lucky hauls does not find a ready market. The great number of huso caught in the Danube, occasional rich hauls in the Alpine lakes, or even on the sea-shore, prove of no benefit to the fishermen, and the dead ones have frequently to be cast back into the water.

All this should be remedied by better arrangements for preserving and shipping, by a well organized fish-trade, by improvements in the manner of smoking fish on the English plan, and finally by making use of the refuse for various purposes, as for fish-oil, and even for manure.

In 1865, Dr. Lorenz, as also quite recently Professor Gohren, (*Landwirthschaftlichen Wochenblatt des K. K. Ackerbauministeriums*, 1869, p. 114,) has directed attention to the importance of the fish-guano, which might, with great advantage to our Austrian agriculture, be made from the refuse of our fish, especially on the coast.

It must certainly be considered as in part the effect of a better system of fish-culture, of a well-organized fish-trade and stricter laws, that, according to calculations made some years ago, the daily consumption of fish per head amounts to $\frac{1}{7}$ pound (avoidupois) in London, $\frac{1}{20}$ pound in Paris, and $\frac{1}{40}$ pound in Berlin; while in Vienna, the capital of a country so rich in lakes and rivers, it is only $\frac{1}{400}$ pound. While in other cities the best kind of fish are seen in the markets, only inferior fish, frequently nothing but carps from the Bohemian lakes, are brought to Vienna.

According to the report of the market-commissioner, the following quantities of fish were brought to the Vienna markets from October, 1867, till October, 1870:

Place from which the fish were brought.	Kind.	Weight in pounds, avoirdupois.		
		1867–'68.	1868–'69.	1869–'70.
From the Lower Danube	Hausen, (*Acipenser huso*)	2, 346½	679¾	1, 111½
	Dick, (*Acipenser schypa*	....	185¾	....
	Schaiden, (*Silurus glanis*)	18, 154½	17, 290	17, 413½
	Schill, (*Lucioperca sandra*)	45, 695	61, 997	67, 554½
Upper Danube, Traun	Hucho (*Salmo hucho*)	....	370¼	....
	Pruto (?)	....	....	....
	Forelle, (*Trutta fario*)	....	5, 557½	12, 226½
Aussee	Salbling, (*Salmo salvelinus*)	....	....	....
Gmund Lake and Atter Lake	Lachsforelle, (*Trutta lacustris*)	....	247	1, 729
Southern Bohemia	Carp	714, 925	897, 845	911, 800½
	Hecht, (*Esox lucius*)	29, 207¾	26, 956½	28, 281½
Mayence	Lachs, (*Trutta salar*)	741	8, 367	12, 935¾
	Sea-fishes	78, 669¼	287, 384½	209, 703
Upper Austria	Crawfishes	39, 051, 300	30, 220, 450	123, 554, 950

To this must be added the sales made outside of the fish-market, which, however, are said not to amount to much.

Formerly, the Neusiedler Lake alone supplied Vienna with 864,500 pounds of fish; it has, however, been nearly drained.

The price of fish has increased considerably during late years, a pound of huso (1 Austrian pound equal to about 1¼ pounds avoirdupois) now costing from 40 cents to 90 cents, carp from 16 cents to 40 cents, white-fish 12½ cents to 15 cents. In spite of good railroad-communications, but very small quantities of salt-water fish are brought to Vienna, and no other cause can be assigned for this but the high price of fish. Although salt-water fish are very cheap in Trieste, and the freight is low, their price in Vienna is high, because there is no wholesale trade, the whole of this traffic being in the hands of a few fishermen, and because there is no suitable fish-market. When the market commissioners made an attempt to organize this trade, many fish were brought to Vienna, but they were—as is shown by a report on the subject—left lying too long outside the city custom-line, (a small duty has to be paid on all provisions entering Vienna,) or on the railroad, so that many were spoiled before they reached the market, and soon no more were sent. Poor people can only buy white-fish, (a small species of carp.)

It can safely be asserted that a well-organized system of fisheries, and suitable fish-markets, would, in Vienna, as in other large cities, increase the demand for salt and fresh-water fish, and all classes of society would be glad to buy them if, at all times good fish could be procured at reasonable prices.

The duty on provisions is, unfortunately, very high, not merely on rare fish, but also on the inferior kinds, which alone are within the reach of the poorer classes.

If, with this deplorable condition of the Austrian fish-trade, one compares the vast proportions of the London wholesale fish-market in Billingsgate, as graphically described by Beta, the enormous difference between neglected fisheries and those which are protected by suitable laws, and carried on with a spirit of enterprise, is placed in bold relief. "A large fleet of fishing-vessels, carrying a greater supply of fish for one day than Germany draws from the inexhaustible harvest-field of the sea, the lakes, and rivers during a whole year, supplies every night the daily demand for fish of the three-million city. While half a century ago fifty fishermen supplied London with fish, a fleet of a thousand vessels scarcely suffices in our day. The daily supply of fish is bought by the wholesale dealers; and the finny inhabitants of the sea, as well as of lakes and rivers, are offered for sale in every imaginable shape, in heaps, and boxes, smoked, salted, and fresh, in barrels, baskets, bundles, and kegs, by the hundred-weight and by the million. A magnificent market-hall, with clean and airy apartments of every size, tempts even the finest gentlemen to buy and eat on the spot marine delicacies of every kind, while in other places the poorer classes buy their daily supply. The inferior kinds of fish, such as herring, eels, &c., are sold in 'fisher-hundreds,' at 140 fish, in quantities of 20 pounds, or by the bushel, to the retail dealers. The more aristocratic fish, such as salmon and salmon-trout, which in summer reach London by railroad, packed in ice in barrels and boxes, are sold by the pound."

According to a report by District-Judge Friedel, in Circular No., 1 of the *Deutsche Fisherei-verein* for 1872, on the English fisheries, the city of London consumed, in 1870, 400,000,000 pounds of meat and 450,000,000 pounds of fish and shell-fish.

As a proof of the great number of fish brought to the London fish-market and the strict regulations of the fish-trade, it may be mentioned here that during the month of April, 1870, the officers of the London Fishmongers' Society condemned 51,877 fish, 340 bushels of shell-fish, and 138 gallons of crabs, lobsters, and crawfish, weighing in all 56,439½ pounds avoirdupois. (Circular No. 4, 1870, of the *Deutsche Fisherei-verein*, p. 21.)

It must be acknowledged that the better organization of the hitherto much neglected fish-trade in our larger cities would be the best means of reviving our fisheries.

In some other respects our Austrian fish-markets deserve the sharp criticism which Beta passes on those of interior Germany. Everywhere fish are offered for sale either half-dead on account of bad water, or sick, of an insipid flavor, and expensive, while they might be had much healthier, fresher, and finer flavored if, immediately after having been caught, they were killed by an incision between the brain and the spine, and were packed in some moist substance, and during summer in ice.

Ice has repeatedly during winter been sent by railroad to Vienna from our Alpine lakes; and if people were acquainted with the well-known easy methods of preserving ice, fish could be sent fresh to Vienna even in the height of summer.

The construction of a proper fish-market in Vienna, which has been suggested by the committee appointed to inquire into the causes of the rise in the price of provisions, would be greeted with joy as a welcome beginning to improving the condition of the Austrian fisheries.

10.—FISHERY-STATISTICS.

In our Austrian *Cataster** the fishing-waters have been treated in a very superficial manner. The several lakes, rivers, streams, and brooks have, it is true, been surveyed, and their areas have been put down; but since water, as a general rule, is not subject to any land-tax, the lakes, rivers, streams, and brooks have been thrown together with the roads, marshes, rocks, rubbish, heaps of broken stones, sand-hills, and other waste places, and have been given under the head of "*unproductive lands*."† The area of our fishing-waters can, therefore, not be given approximately, neither arranged according to their character, nor as a whole, important as such a statement would be for statistical and other purposes. The ministry of agriculture has taken steps to have a special survey taken and published.

There is, unfortunately, an almost entire want of accurate statistics of the products of our fisheries. Czörnig states that in 1861 the Austrian fisheries produced 145,000,000 pounds of fish, valued at $10,500,000; but these figures are only the result of approximate estimates. They give, however, some idea of the still considerable value of this portion of our national wealth, which surely could, by good fishing-laws, be increased many millions.

There are no reliable statistical data as to the market-prices at the capitals of all the provinces, and all that can be found are scattered statistics from a few cities.

It is an exceedingly difficult matter to gather the statistics of fisheries, since persons who have leased them are very loth to state the exact truth with regard to the income derived therefrom, for fear that their rent might be raised. The importance of such statistics for legislation and other government measures is, however, daily becoming more evident; for which reason the sixth international statistical congress, which met at the Hague in September, 1869, placed fishing-statistics on its programme.

In accordance with suggestions made by the above mentioned congress, the Austrian central committee for statistics has resolved to

* The record-book of the titles, boundaries, and ownership of lands.

† The law of May 24, 1869, No. 88, regarding land-tax, declares as free from this tax, among other things, marshes, lakes, and ponds, in as far as they do not yield a revenue from their fisheries, &c., as also the beds of rivers and brooks.

collect the accounts of the Austrian fisheries, and has adopted the schedules which were recommended by a select committee.

With a view to this, the statistics of the several species of fish, fishing-implements, as well as the fishing-seasons given in Heckel and Kner's work, "*Die Susswasserfische der Östreichischen Monarchie*," are to be thoroughly examined and revised by the agricultural societies of the various provinces; and it is to be ascertained what is the average price of fishing-implements, how many persons are employed in the fisheries, how many of each kind are on an average caught per annum, what has been the influence of artificial hatching on the increase of fish in depopulated waters, at what seasons the different kinds of fish spawn, and, finally, what proportion the actual season of fishing in fresh-waters bears to the legally prescribed fishing season.

Exact or even approximately reliable data must not, however, be expected, as the agricultural societies have not the means of obtaining such. To obtain fishing-statistics, it is indispensable that a law should be passed requiring correct lists of all the fisheries, of the waters where they are carried on, and of the different fishing-privileges, in the same manner as a recent law ordered the registering of all the existing hydraulic constructions and water-privileges. On these official lists, the statistical reports of competent men should be based.

Mr. Hey, a forest-inspector of Lölling in Carinthia, has, from very incomplete material, which he had increased and corrected as much as possible from personal observations, made a report on the fisheries of his province, which has been published in the reports of the Carinthia Agricultural Society for 1872, Nos. 18 and 19. According to this report, the following is the area of the fishing waters in Carinthia:

	Acres.
Large lakes	12,773
Small lakes and ponds	706
Rivers and brooks	8,912
Total	22,401

The quantity of fish which might be caught if there were sufficient protection against thieving and the present reckless system of plunder, is, for running waters, estimated at 50 pounds avoirdupois per annum to 1½ acres, for lakes and ponds at 87½ pounds, making a total of 7,483,606, including 617,500 pounds of fine fish valued at $35 for every hundred weight, (Austrian: equal to 123½ pounds avoirdupois,) and 6,866,106 pounds common fish at $15 per Austrian hundred-weight. This gives a total annual revenue of $258,394. The expenses for implements salaries, and taxes are estimated at $55,280, making the net revenue $203,114, or $9 per acre. These estimates appear by no means too high if compared with the revenues of other countries where the fisheries are well protected.

The *Deutsche Fischerei-verein* has also given its full attention to fishery-statistics. This society has, in its Circular No. 4 for 1872, published a form containing questions regarding the number, nature, and economical value of the useful fish and crawfish, thus paving the way for reliable information.

More reliable data regarding the numbers, the different species of fish, and their geographical location in the provinces of Austria have been collected by zealous naturalists. Fish-culture has, undoubtedly, of late years been studied very thoroughly on the before-mentioned basis of legislation.

11.—SCIENTIFIC INVESTIGATIONS.

Scientific researches, which have made us better acquainted with the mode of life of various animals, have encouraged numerous inventions, by which man has been enabled to derive the greatest possible benefit from the animal kingdom.

The excellent works of ichthyologists from those of Artedi and Linné down to Siebold's classic work, "*Die Süsswasserfische von Mittel-Europa*," as also very thorough works on fish-culture, such as Carl Vogt's "*Die künstliche Fischzucht*," Coste's "*Instructions pratiques sur la pisciculture*," and others, give the most important suggestions for fishing-legislation.

Brehm, in the last volume of his "*Illustrirtes Thierleben*," gives a masterly description of the life of fishes; Beta, in his work "*Die Bewirthschaftung des Wassers und die Ernten daraus*," by describing the untold wealth which is still hidden therein, endeavors to give a new impetus to its cultivation.

We owe it to the high degree of perfection to which scientific observations in general have been carried, and especially to the intelligent, thorough, and careful investigations of two Austrian naturalists, Heckel and Kner, in numerous essays by the former, and in the work on the fresh-water fish of the Austrian monarchy, published by them in common, as well as to the before-mentioned work by Siebold, for a faithful and complete natural history of the Austrian fresh-water fish, including the distribution of their species in the different waters, an exact description of the manner in which they are caught, and the implements employed in fishing.

Recently, several governments have endeavored to further scientific investigations by special institutions and by granting subsidies from the public treasury.

In 1862, the Austrian government sent Professor Molin to France and Western Germany to gather full information, both practical and theoretical, on the progress of the artificial culture of useful aquatic animals. He has published his reports on this journey as well as his important suggestions for fishery-legislation in his work, "*Die rationelle Zucht der Süswasserfische und einiger in der Volkswirthschaft wichtigen Wasserthiere*," R. Molin, Vienna: Braumüller, 1864.

In 1870 and 1871, the Bohemian ichthyologist Dr. Fric made a journey through Bohemia and other countries on the Elbe, with a view to studying the condition of the fisheries, especially the salmon fisheries and their international regulation, upon which journey he has likewise published a report.

In 1868, Professor Schmarda was sent to France by the Austrian ministry of agriculture, in order to report on the condition of fish-culture along the French coasts. Besides many excellent features, he observed many failures, and therefore recommends, above everything else, accurate scientific investigations as the only safe basis of future progress.

Schmarda remarks that economical progress can only be made by establishing experimental stations; these are just as important for a rational cultivation of the sea-coasts as for agriculture, and even more so, because the leading principles of water culture have yet to be learned. That something of the kind is necessary in order to put an end to the purely empirical system of exhausting and plundering will even now be clear to the unbiased observer of a large portion of the coasts of Europe. No half-measure, however, should be taken in founding such institutions, but they should be supplied with all the necessary scientific apparatus, and naturalists should be permanently stationed there. They will then flourish better than if some famous man whose time is necessarily occupied otherwise give his name to some expensive institution, but never visit it in person.

With the advancement of political economy, the advancement of fish-culture must go hand in hand.

In this respect, likewise, the great exertions of the Americans and English in investigating all the mysteries in the life of aquatic fauna, but more particularly the efforts made by France, deserve to be imitated. Everywhere, aquaria have been established for observing the mode of life of these animals. They have partly been founded by the governments, partly by scientific associations. One of the finest is the salt-water aquarium at Arcachon. A great deal has been done for fresh-water fish at Hüningen, and for other useful aquatic animals by the institution at Concarneau, which the French government has established under the supervision of Professor Coste, at an expense of $20,000. (See Professor Schmarda's report on his visit to Concarneau, in the annual report of the ministry of agriculture for 1868, p. 349.) In Berlin, a magnificent aquarium for fresh and salt water fish and artificial fish-culture has been erected on plans made by Dr. Brehm. Large aquaria are at present being constructed in Triest and Vienna, (in the Prater.)

The international maritime congress held at Naples in 1871 passed the following resolutions on the promotion of fish-culture, and more especially of the salt-water fisheries:

"This congress, acknowledging the importance of several inquiries made with the view of ascertaining the fruitfulness of the different species of fish, the number of those which reach the age of maturity, the laws of individual increase, and the places and seasons best suited for fishing, and taking into consideration the fact that the necessary studies and observations may vary according to the location, circumstances, and personal views of the observer, expresses a desire that the investigations which have been suggested be left to the private enterprise of the several practical scientific institutions; that such researches should be encouraged by these institutions, and by the several governments by granting subsidies and by offering prizes; and that every possible means should be employed to support and further them.

Austria so far does not possess any means for making scientific investigations in the interest of fish-culture. The central establishment for pisciculture at Salzburg would be well qualified to prosecute such inquiries. From inaccurate observations, which have not been made in a truly reliable and scientific manner, incorrect information may be spread even by the institutions themselves, such as the report of the fruitfulness of a cross-breed between the *Salmo salvelinus* and the trout, which had been raised in the Salzburg establishment, a report which, after repeated and more careful experiments, has not been confirmed. As late as 1871, the best modern works on lake-culture, fish-culture, and ichthyology could not be found in the library of this establishment. It is an essential condition of the well-being of every economical institution, by which it also serves the cause of science, to supply the means of study to the officials employed.

Recently, exhibitions have become a popular means of promoting fish-culture and spreading a knowledge of ichthyology. Large exhibitions of fishery-products, fishing-implements, &c., were held at Amsterdam in 1861, at Bergen in 1865, at Havre in 1868. At the Paris exposition of 1867, there was a special department for fisheries; at the Gottenburg exposition of 1871, the fish-sections formed the chief attraction. Nearly every one of our agricultural exhibitions also displays some fishery-products, improved fishing implements, and especially improved apparatus for piscicuture to show the progress which has been made, and to awaken an interest in the matter. We may surely expect that the Vienna world's fair of 1873 will prove of great benefit to the fisheries.

C—THE IMPORTANT FRESH-WATER FISHES.

According to Heckel's and Kner's accurate observations, the chief mountain ranges exercise the greatest influence on the distribution of the different species of fish, so that those rivers and streams whose springs are on the same mountain slope have generally the same species of fish, even if finally they empty into far distant seas. Since all the great rivers of Central Europe, for longer or shorter distances, flow through Austrian territory, and empty from the various slopes into four different seas, we can easily explain Austria's wealth in fish of all kinds, which from here spreads into all the neighboring countries.

Nearly all species of Central European fish are, therefore, represented in the Austrian waters, but distributed among the several provinces in accordance with the various slopes of the central mountain range, the Alps.

The following list of those fresh-water fish which are of most importance to our legislation has been compiled from the scientific works mentioned above, as well as from the reports of the several agricultural societies, and of many naturalists in the various provinces of Austria.*

12.—SALMON FAMILY, (SALMONOIDEI.)

The species of this family take the first place among fresh-water fish in regard to fishery legislation, both on account of their great value, and the exquisite flavor of their tender and boneless flesh, their rapid growth, their existence in nearly all the Austrian waters, and, finally, on account of their special adaptation to pisciculture, in which latter respect they excel most other species.

At the first glance, we can distinguish the individuals belonging to this kind by a double dorsal fin, consisting of a front one placed about the middle of the back, composed of soft rays of several joints, and a posterior one, being only a small piece of skin, a so-called fat-fin. They have mostly very small scales, thus differing entirely from the large-scaled fish of the carp kind.

Among the numerous genera of *Salmonoidei*, the following are the most important:

a. Trutta, comprising all salmon and trout, distinguished by a wide mouth with even teeth, and long vomer bone;

b. Salmo, with short vomer bone, the short front part of which alone has teeth;

c. Thymallus, with small mouth, fine teeth in the jaws, and powerful dorsal fin;

d. Coregonus, with a toothless mouth, fine bent teeth on the tongue, and a silvery-white body.

Carl Vogt divides the salmonoids of the genera *Salmo* and *Trutta*, according to their mode of life, a manner which is equally suitable for piscicultural and legislative purposes, into the sea salmon, the lake salmon or lake trout, and the brook trout. All the different varieties of this kind which are spread through Europe, Asia, and North America, as far as the northernmost limit of the circum-polar regions, are fish of prey, and have many characteristics in common.

Among the sea salmon we must count the common salmon, (Rhine salmon,) *Trutta salar*, the hook-salmon and silver-salmon, distinguished as different kinds by some naturalists, being only varieties of one and the same kind, and the sea-trout, *Trutta trutta;* these all spend a part of their life in the ocean.

The salmon are found in all northern seas, in the North Sea, and Bal-

* Along the coasts of Austria and Dalmatia the salt-water fisheries are of the greatest importance. These, however, require a separate treatise, and we therefore limit ourselves in this review to the fresh-water fish.

tic; in spring, they leave, and, favored by the sea-winds, come into the rivers flowing into these waters, and into their tributaries. In a short time, they reach a length of 3 and even 5 feet, leap over weirs and embankments if they are not too high, especially if contrivances, called salmon-paths or salmon-ladders, for making the leap easier have been placed there.

In order to find the best spawning and hatching places, they go very far up the rivers. They ascend the Elbe, and from thence into the Moldau, also, into the Oder and its headwaters in Moravia and Silesia; from the Vistula into the Dunajec, and into the Sau and its tributaries; the hook-salmon go into a small tributary of the Bug, and also into the Rhine as far as the falls at Schaffhausen.

Numerous experiments by marking fish have proved the fact that the salmon return to the same rivers and spawning places where they were born. In the establishment at Stormontfield, on the river Tay, more than 24,000 salmon were caught up to 1867, all of which had formerly been marked and placed in the sea as smolts.

In England, the young salmon born in the rivers, which as yet have no scales and cannot endure salt water, are called *parrs;* the older fish, which have scales and eagerly seek the sea, *smolts;* those which, for the first time, return from their voyage to the sea, *grilse;* and the fully-matured salmon, *salms.*

The spawning season usually commences in September, and lasts till the end of December; the smaller female fish frequently spawning from two weeks to a month sooner than the larger ones. During their stay in fresh water, and during the gradual development of the ova and milt, the salmon assume a darker color, and the male fish frequently show red spots on the sides and on the covering of the gills; old male fish show the most brilliant colors during the spawning-season, which disappear immediately when this season is over, and the salmon begin to return to the sea in a very emaciated condition. Like most of our food-fish, the salmon are fattest just previous to the spawning-season, but do not eat anything during this time, and are afterward scarcely fit for food. The old salmon are the first to go to the sea, while, of the young ones, only about one-half leave the rivers somewhat later the first year, (as smolts;) the other half remaining another year, (as parrs.) In the sea, they rapidly increase in weight and size.

The well-known ichthyologist Dr. Fric has recently made some very interesting observations on the life and habits of the Bohemian salmon. He says that there are in Bohemia three different ascents of the salmon during the year.

The first ascent frequently commences at the end of February under the ice, as a general rule in March, and lasts till May. These salmon are mostly large and strong, weighing from 25 to 50 pounds avoirdupois, and are famous in Bohemia under the name of "violet-salmon."

The second ascent begins in the middle of June, and lasts till August, if the rivers are not too low. These fish have a reddish flesh, and weigh from $12\frac{1}{2}$ to $22\frac{1}{2}$ pounds avoirdupois, and are known by the name of "rose-salmon."

These two classes of salmon are not ready to spawn when they arrive in Bohemia, and require a considerable stay in fresh water to develop their ova and milt.

The third ascent begins during the first half of September, and lasts till the end of November, in mild winters even till December. These fish are mostly weak, weighing from 3 to 10 and sometimes 15 pounds avoirdupois. Their flesh is of a pale color, and for this reason they are usually called "silver-salmon." They are fully prepared to spawn immediately on their arrival. The process commences in the mountain streams which flow into the Elbe, the Wild Adler, the Moldau, the Wotawa, and other small rivers.

Among the chief causes of the decrease of salmon in Bohemia, which formerly had large numbers of this fish, Dr. Fric places the high weirs built across the rivers which the salmon cannot leap over, especially at low-water; the stationary fishing apparatus, which frequently span the whole breadth of a river, especially near the weirs; the unprotected condition of the spawning places; the spearing of the fish with tridents during the spawning season, when they are half stupefied; and, finally, the want of well-protected hatching places, where the young fish can be safe from their numerous enemies on land and in the water.

No fisheries require proper legislation as much as those for salmon. On account of the large schools which ascend the rivers, the whole stream should be subjected to uniform laws and a uniform system of fishing, which only becomes possible by international treaties.

The sea-trout (*Trutta trutta*) does not reach the size of the common salmon, but is otherwise very much like it so far as its propagation and the localities which it seeks are concerned. Like the salmon, it ascends to the headwaters of the Oder and the Vistula, but does not go as far in the Elbe.

The lake-trout, lake-salmon, or salmon-trout, (*Trutta lacustris*,) are found exclusively in the fresh-water lakes of the alpine regions of Central Europe, from which, during the spawning season, they go up or down the stream in the rivers or brooks connected with them. Only in lakes whose tributaries do not have much water, or mostly consist of rapids, they are obliged to seek flat gravelly places near the shores to spawn. Most of them spend the greater portion of their lives in inaccessible depths, and only ascend to the surface under peculiar conditions of temperature, in order to catch small fish and insects During the spawning season, they come to the surface in larger numbers, their excursions in the brooks and rivers sometimes extend to a great distance, sometimes only to a few miles from their dwelling-place.

Those which ascend the brooks and rivers are caught with bow and stationary nets, which are placed near the mouth of the rivers or at the spawning places; in the lakes, however, they are caught with hooks and flies, which have been introduced from England.

Ichthyologists and fishermen have frequently confounded the lake-trout belonging to the alpine lakes with the sea-trout (*Trutta trutta*) of the North Sea and the Baltic. Those of different age and sex have also been mistaken for separate species. The lake species, with completely developed sexual organs, which, in some lakes, as in the Chiem Lake, is called salmon-trout, and on the Lake of Constance ground-trout, is distinguished by a plumper shape, grows rapidly like the other kind of salmon, and reaches a weight of 31¼ to 62½ pounds avoirdupois, and even more. Those which on the Lake of Constance, are called "floating-trout," (*Schwebforellen*,) and on the Austrian lakes May trout, remain barren and develop in a totally different manner from the fruitful lake-trout. They are less fleshy than the ground-trout.

The male of the lake trout changes considerably in color and quality of skin during the spawning season while he sojourns in running waters. According to whether they are caught in spring or autumn, in different localities, of different color or size, they are called by different names among the fishermen.

The brook trout to which, besides the common brook trout, (*Trutta fario*,) some Dalmatian species belong, such as the *Trotta* and *Pastrova*. The *Trutta fario* is of the utmost importance to protect, because it is found in nearly all clear waters, especially mountain and forest streams to a height of 5,000 feet; its flesh is universally esteemed, and its culture, both natural and artificial, is very productive, while it is easily kept and fed. It is therefore considered one of the most important fish to cultivate. The color, and partly also the size which it reaches, vary according to its location, the influence of light, the season, water, and food, and therefore several varieties are distinguished, such as the forest or stone trout, the alpine or mountain trout, the gold or pond trout, the lake-trout, and, according to the lighter or darker coloring the white trout, the black trout, &c. In this species, some are likewise found which are barren, and never spawn.

In the smaller and rapid mountain streams, which do not afford much food, the trout scarcely reach a length of 12 to 15 inches; while, in larger waters, such as lakes and ponds, with good and plentiful food, they occasionally reach a weight of 18¾ to 25 pounds. They can easily be fed with insects, small fish, &c. A beginning has even made on the sandy plains near Berlin, to dig artificial springs, in which trout are raised and fed. In our alpine regions, where nearly every village has a superabundance of fresh springs and brooks, much larger gains might be realized in a short time by imitating this example.

The brook-trout go up the stream for the purpose of spawning, but only for short distances, and make the most astonishing leaps over weirs and small water-falls; in winter, they go to the deeper waters, in order not to be overtaken by the ice in the small streams.

The female lays her eggs, which are of the size of a pea, from September to January, according to different climatic influences, in shallow pebbly places, between stones, logs of wood, and in little holes which they hollow out in the sand. The male, which follows the female with a sort of rage, squirts the milt over the eggs as they are laid. After the eggs have been impregnated, the fish do not care for them any more, but leave them to the stream. In comparison with other fish, the female of the brook-trout lays only a small number of eggs. By artificial culture, trout have been placed in many brooks where formerly they were not found. The spawning place is usually a small bay with a flat bottom, and with as much pure gravel as possible, so that the young fish may be protected against their numerous enemies. Such artificial spawning places should be guarded as much as possible by law.

As the trout do not make long migrations like the salmon, even the proprietor of small fisheries has them constantly within his reach, and can easily raise and feed them.

Beta, in his work so frequently referred to, on page 189, gives the following advice on trout-raising:

"Trout require very pure running spring-water, of the greatest possible evenness of temperature, which should be cool in summer and warm in winter, a gravelly bottom, and a shady forest or bushes on the banks.

"In order to hatch artificially impregnated trout-eggs, and to raise young fish, they have, in their brook or river, to go through a series of ponds. These consist of a succession of artificial ponds or widenings, which increase in size toward the mouth of the stream. In the first, which is the one occupying the highest ground, the young fish are kept for about a year, from the beginning of spring. Here care should be taken that they find natural food enough either on the gravelly bottom or between the aquatic plants near the banks, the water-cresses, &c., or artificial food has to be provided for them. Meat that has been chopped very fine and every kind of small worms are best suited for this. Pieces of spoiled meat can also be suspended over the water, from which, during summer, larvæ and maggots will soon fall down in sufficient quantity as a welcome food for the fish. They should be separated from the following division by a fine wire-work. In this division, the larger trout are kept till the end of the second year, and are during this time fed with snails, worms, young pike that have just been hatched, and bleak. In the third and fourth divisions, they commence to catch insects that fly over the water, but larger bleak should be thrown in to them or placed in the water for their food. In the third division, they are kept till the end of the third year; and in the fourth, the grown trout remain till the proprietor either sells them or uses them in his own household.

"The transfers from one division to another are generally made in the beginning of spring, when the weather gets warmer, say about March. The trout which are ready for the market weigh, on an average, 1½ pounds each, and are so strong and active that they are no longer attacked by their larger colleagues, and can undisturbedly chase the young fishes which have been placed in the water for them. No other fish should be kept in the ponds, and special care should be taken that young pike, which have been put in as food, do not escape the trout, and grow up to become merciless robbers."

The genus *Salmo* was formerly, by most ichthyologists, confounded with the *Trutta*, although there are very characteristic differences between the two. The chief representatives of the former are the *Salmo hucho* and the *Salmo salvelinus*.

The *hucho*, (*Salmo hucho*,) also called Danube salmon, is a fish belonging to the *Salmonoidei*, found in the territory of the Danube, in size and weight exceeding the salmon. The hucho reaches a weight of 50 to 75 and occasionally 125 pounds avoirdupois. Its sexual organs are not fully developed till it weighs about 5 pounds. It is not a migratory fish, like the salmon, returning to the ocean every year, but only leaves its dwelling-place during the spawning season to seek shallow and gravelly places. It is found in Austria, in the whole territory of the Danube, from Passau downward, but most frequently in the larger and smaller tributaries of the Danube flowing down from the Alps, especially in the Inn, the Salzach, Ager, Enns, Steyer, Traun, as far as the falls of the Traun, in the Traisen, Save, and Drau. It grows so rapidly that its weight annually increases about 2½ pounds. Its flesh is somewhat inferior to that of the salmon, but is nevertheless considered a great delicacy.

For the Austrian fisheries, the hucho is of the greatest importance on account of the large extent of country—the Danube and its tributaries—where it is found, and its rapid growth, produced through its great voracity. It is so fond of bleak that it can easily be caught with a hook baited with artificial fish of a whitish color.

The hucho does not spawn in winter, like all the other *Salmonoidei*, but usually in April and May. The eggs, sometimes 40,000 from one single female fish weighing about 50 pounds, mature much sooner than those of other salmon; the young fish weigh about 1¼ pounds after one year, while specimens weighing 5 pounds in the third year are quite frequent.

The chief causes of the decrease of the number of hucho are the weirs which recently have been built in the Upper Danube and its tributaries; no passage ways having as yet been left for them.

The *Salmo salvelinus*, also called red trout, is a lazy fish, but little inclined to prey upon other fish, and leaves the lakes during the spawning season. Its form is exceedingly variable, according to age, sex, and location, so that ichthyologists have frequently considered one or the other of the different forms in which it occurs as a separate species. It may be recognized by the color of its belly, which is orange, and even borders on vermilion, which colors are particularly bright in the male. It is found in the clear mountain lakes of the Alps of Upper Austria, Tyrol, Bavaria, Switzerland, as also in the Carpathian mountain lakes at a height of 6,000 feet above the level of the sea. These fish increase very rapidly, but grow slower than the lake-salmon. Their flesh is, according to the season, the lake in which they live, and the water in which they have been kept either of a reddish or a whitish color, but has always been considered a great delicacy.

The *Salmo salvelinus* of the Fuschler Lake is distinguished by its rapid growth in size and weight. Here, as well as in the Hinter Lake near Berchtesgaden, rare specimens are sometimes caught, weighing 22½ to 25 pounds. This fish has likewise been transferred to lakes where formerly it was not found. In Upper Austria, they are caught with seines drawn by four men in two boats.

Artificial fish-culture has produced many cross-breeds, especially of the *Salmo salvelinus* and the trout, which excel the pure breed in many respects. In Upper Austria, the eggs of the *Salmo salvelinus* are mostly impregnated with the milt of brook-trout.

The third genus of the *Salmonoidei* includes the "Asch," called "Aesche," in North Germany, (*Thymallus vulgaris.*) It is found throughout the whole of Central Europe, in clear, shallow, running water, with a stony bottom, less frequently in lakes near the shore and the mouths of rivers. Its flesh comes nearest to that of the trout; and they are caught in a similar manner to the trout, but in a peculiar manner in the river Vökla, in Upper Austria, by tying a female which is on the point of spawning to a pole rammed in the bottom of the stream, by means of a thread fastened to the dorsal fin; when the males approach the female, they are quickly raised out of the water by the net spread out below.

The *Thymallus vulgaris* is distinguished from all the other *Salmonoidei* by its remarkably large dorsal fin and by the great beauty of its varying colors.

In the ancient Austrian fishery-regulations, the *Thymallus vulgaris* is frequently mentioned, the young fish being valued very highly. At times it could only be caught for the imperial table, for sick persons, or pregnant women. In Upper Austria these fish are in the first year called "Sprenzling;" in the second, "Mailing;" in the third, "Aeschling;" and, finally, "Asch."

The fourth genus of the *Salmonoidei*, the *Coregonus*, especially the species *Coregonus Wartmanni* and *Coregonus fera*, live almost exclusively in lakes, and at the beginning of the spawning season gather in such large numbers that many are killed by the pressure of the crowd; at this time they may frequently be seen leaping out of the water. Closely pressed together, they drop roe and milt in the water. In large schools, they swim noisily at the surface, especially at night-time, and immense quantities are caught near the shore with floating drag-nets, and, where the water is deeper, with stationary nets. Their flesh is esteemed very highly; and, in some lakes where this industry is carried on a large scale, it is of as much importance as the herring-fishery. They cannot be easily caught with a hook and line. When taken out of the water and exposed to the air, they die almost immediately. Like herrings, they are salted, smoked, and pickled, and form a considerable article of commerce. It is difficult to distinguish the several varieties, as they mostly live together in large numbers; the different species of the same age keeping together, changing their outward appearance according to the season, the weather, the method of propagation, location, and mode of life, and being called by different names by the fishermen. The more important varieties are the lavaret, (*Coregonus Wartmanni*,) called "Reinanken" in Upper Austria and "Renken" in Tyrol and Vorarlberg; it weighs 1⅞ to 2 pounds, sometimes even 3¾ to 5 pounds; it is found in the Atter, Gmunden, and Fuschler Lakes, but in particularly large numbers in the Lake of Constance.

The *Coregonus fera*, called "Sandgangfish" in the Lake of Constance, "Knöpfling" in the Atter Lake, and "Rindling" in the Traun Lake, weighs little more than one-half pound.

The *Coregonus marœna* weighs as much as 12½ pounds, is found in the lakes of Pomerania, and deserves to be acclimatized in the Austrian waters.

13.—THE PIKE FAMILY, (ESOCINI.)

These fishes are easily recognizable by their broad, flat mouth and their strong teeth. They are represented in the fresh waters of Europe by the common pike, (*Esox lucius*,) the shark of the fresh waters, which, unless purposely destroyed, is found in all large streams and their tributaries, in lakes, ponds, and marshes. It feeds on any live animals found in the water, and reaches a weight of more than 50 pounds; a female pike of medium size will contain 60,000 eggs. It loves to spawn on inundated meadows and peat-bogs, and in their ditches. Its flesh resembles that of the trout.

14.—THE CATFISH FAMILY, (SILUROIDEI.)

The fishes of this family have no scales, and a broad low head. Many species are found in North America. With us only one is found, the common "Wels," or "Schaide," (*Silurus glanis*,) a fish of prey, living in the Danube and its tributaries, also in Moravia, Galicia, and other countries. Next to the sturgeon and huso, it is the largest fresh-water fish, and in the Danube reaches a weight of 494 to 617½ pounds; although its flesh is not universally esteemed, it is well suited for pond culture in peat-bog water.

15.—THE COD FAMILY, (GADOIDEI.)

The fresh-water representative is the *Lota vulgaris*, with a slender eel-like body. They spawn at different seasons, usually in December. During this season, they gather in schools of about 100. In the Danube, it weighs from 3¾ to 5 pounds; in the Fuschler and Atter Lake, 10 to 15 and even 20 pounds; and is found in the greater part of Europe.

16.—THE EELS, (MURÆNOIDEI.)

This group comprises long-bodied, snake-like fish of prey, without ventral fins. To this family belongs the river-eel, (*Anguilla vulgaris*,) which lives both in fresh and salt water, and flourishes particularly in peat-bog marshes. The manner in which it propagates its species is not yet thoroughly known.

The young of those eels which spawn in the sea ascend the rivers in spring by millions, and frequently go to running and stagnant waters which are far distant from the sea.

The ascent of the young eels into fresh water, called *montata* in Italy and *montée* in France, lasts three or four months in the spring-season. Their return to the sea (*calata*) is made from October to December, usually not until they have lived for several years in fresh water. It invariably takes place during very stormy and dark nights. On the Austrian coasts and in Italy, many fishermen at the mouths of the rivers are employed in catching the migrating eels, which in some places are by means of special canals led into entirely closed caves. The river-eel spawns during summer on sandy and gravelly banks, where the eggs are hatched in October, and where the young remain till April or May.

The flesh of the eel is valued very highly, forms the exclusive flesh-food of large populations, and, salted, smoked, or pickled, is an important article of trade. The eel is found in the larger part of Europe, especially in all those rivers and standing waters which are connected with the Baltic, the North Sea, the Atlantic Ocean, the Mediterranean, and the Adriatic; but it is entirely wanting in those lakes and rivers which send their waters into the Black Sea.

As soon as that care which it deserves is given to the eel-fishery, and especially to its culture in our waters, this fish would with us, just as in England, become a cheap food for the whole people. Numerous little ponds, with marshy bottom, which at present are useless, and even injurious, might be populated with eels, and would, with some care, yield a rich harvest, if, during the first weeks of spring and in the latter part of autumn, they were properly fed.

17.—THE CARP FAMILY, (CYPRINOIDEI.)

The Cyprinoids are distinguished from all other fish by small toothless mouths, the well-known carp-mouth. The greater number of our fish belong to this family; among them the numerous varieties of the bleak, the carp, the loach, the barbel, the tench, &c., which chiefly inhabit the fresh waters of the temperate zone, and "which are valued in places where there are no better fish," (Vogt.)

By transferring the various kinds of carp into waters where they were not originally found, by different modes of life to which they have been accustomed, by artificial culture, &c., numerous varieties of them have been produced.

The common carp, (*Cyprinus carpio*,) for centuries the fish belonging to our civilization, loves sluggish water, with a marshy bottom. During the spawning season, May and June, it retires to warm, brackish waters, which are exposed to the sun. The females, while surrounded by the male, paste their eggs to water-plants. A medium-sized female carp is supposed to produce annually 200,000 to 250,000 eggs. In lakes, they reach a weight of 5 to 6¼ pounds in three years. All vegetable and animal kitchen-refuse, agricultural and economical products of little value, the refuse of slaughter-houses, &c., supply a welcome food for them, if it is given to them in small soft pieces, so that they can easily grasp it with their toothless mouth and swallow it.

In some countries carps form an important article of trade, and are shipped to a great distance. In Austria, the "Danube carp" was once a favorite and cheap food of the common people; but, by the neglect of years, and by the reckless plunder of the tributaries of this noble river, once so rich in fish, their number has decreased very much.

The so-called mirror-carp, with disproportionately large scales; the leather-carp, which has no scales at all; and others, are only varieties of one and the same species. The barren carp, called "Laimar" in South Germany, and "Gelte carp" in North Germany, which is mentioned by Aristotle, and by him counted among the best fish, is also in our days highly esteemed on account of its tender flesh.

In Carniolia, the two varieties of the carp called "Alant" and "Jeses" are very much esteemed.

The crucian (*Carassius vulgaris*) usually weighs about 2 pounds, and is found all through Central Europe. Like the carp, it is cultivated, and its flesh is much esteemed.

The tench (*Tinca vulgaris*) has a yellowish-green color, and is a lazy fish, which is found in most parts of Europe in rivers, lakes, ponds, and clayey marshes. It can easily be shipped, and in clayey ponds which are too poor for other fish it can be cultivated with great profit.

The barbel (*Barbus fluviatilis*) grows rapidly, usually weighs 10 to 12 pounds, and is frequently caught with a so-called Pater-noster line. The roe of the barbel when eaten causes vomiting and diarrhœa.

The bream (*Abramis brama*) lives in lakes, gently-flowing rivers, ponds, and marshes. It is caught in large numbers with seines. In the spring of 1858, from 24,700 to 37,050 pounds of bream were in one day caught near Ermattingen on the Lake of Constance.

The bleak, (*Alburnus lucidus*,) called "Uckelei" in North Germany, is found in all the running and standing waters of Central Europe with the exception of mountain lakes and streams. From their scales, the so-called *essence d'orient* is prepared, by which glass beads are made to sparkle almost like the genuine oriental pearls.

Numerous other fish, besides the above mentioned, mostly designated as white fishes, belong to the carp family. The smaller of these are mostly used for feeding other fish. As they live on plants and refuse, their food is easily supplied, and during spring and summer numerous young fish are in a very short time developed from the eggs.

18.—THE PERCH FAMILY, (PERCOIDEI.)

The perch has a bright and beautiful color, and usually a wholesome finely flavored flesh. The front rays of their dorsal fin are actually like thorns, leaning backward like the bayonets of a column of marching soldiers.

To the perch proper (*Perca*) belongs the river-perch, (*Perca fluviatilis*,) with light-red ventral and anal fins, found nearly everywhere in large and small rivers and lakes. It is very voracious, readily takes the hook, and spawns in March, April, and May in calm water on a reedy bottom. A medium-sized female perch lays on an average 80,000 eggs per annum, which, pasted together in the shape of ribbons or lumps, stick to stones and water-plants. Its weight seldom exceeds 1¾ pounds; but in the Zeller Lake, (in the Pinzgau,) where it is found in very large numbers, it sometimes weighs from 4 to 5 pounds.

To the genus *Lucioperca* belongs the *Lucioperca sandra*, called "Zander" in North Germany, and in Hungary, when young, "Szüllö;" when old, "Fogas." It lives in lakes, larger streams and their tributaries, keeps at the bottom, in its voracity spares not even its own young, spawns from April till the beginning of June in shallow places near the shore where there are water-plants, thrives likewise in deep ponds, and grows as rapidly as the pike, to which also in other respects it bears a great similarity, and is, therefore, in Latin as well as in German, called pike-perch. If well fed, it weighs in a few years about 25 pounds. This fish was by an archbishop of Salzburg brought from the Neusiedler Lake and placed in the Waller Lake.

19.—THE STURGEON FAMILY, (ACIPENSERINI.)

The species of this family have no bones like the fish that have been spoken of, but instead, soft, flexible gristle. The sturgeon is for some countries as important as the salmon; it is mostly found in Eastern Europe, lives both in the sea and in large lakes, but at certain seasons of the year ascends the rivers in large schools, never going beyond a certain place. If supplied with good food, they reach a very large size; specimens weighing from 800 to 1,000 pounds having frequently been caught in the Danube in olden times.

There are few other fishes which are of greater use to man than the sturgeon. In Russia, a large portion of the population is supported by the sturgeon fisheries. Its flesh combines a certain firmness with excellent flavor, and is even preferred to veal by many persons. They are salted, dried in the sun, or smoked, and shipped to a great distance; the roe, packed in kegs, comes into the trade as caviar, and the inner skin of the air-bladder is made into isinglass.

Most fish of the sturgeon family are found in the Black Sea, the Sea of Azov, and the rivers flowing into them; some of them are found in the Danube beyond Pressburg.

All attempts to hatch sturgeon-eggs and to raise the young artificially have so far been failures; and, only recently, Dr. Koch, in St. Petersburg, is said to have succeeded in solving this problem.

The common sturgeon (*Acipenser sturio*) is found in the Atlantic Ocean, the Mediterranean, the Adriatic Sea, the North Sea, and Baltic, and ascends very far up the rivers.

The *huso* (*Acipenser huso*) weighs as high as 2,500 pounds, and ascends the Danube and some of its tributaries. On account of the persecutions to which it has been exposed on the Lower Danube, it has at present become very rare in Austria.

The finest kind of sturgeon, whose flesh is almost as high-priced as that of the salmon, is the sterlet, (*Acipenser ruthenus*,) which seldom measures more than two feet, and weighs from 8½ to about 9 pounds. It stays longer in the rivers than the other sturgeons, requires spawning places with gravelly bottoms and considerable fall, and is found in the Danube as far as Bavaria, in the Salzach, the Drau, and other tributaries, as well as in the Dniester, &c. Its air-bladder makes the finest isinglass.

The sterlet has recently been cultivated to a considerable extent in North Germany at the suggestion of the *Deutsche Fischerei-verein*. The Prussian ministry of agriculture, in 1872, accepted an offer of Dr. Koch, in St. Petersburg, to bring 100,000 young sterlets from the Volga to Germany, where they are to be distributed among the public rivers, private waters, and especially to piscicultural establishments.

20.—THE CRAWFISH, (ASTACUS FLUVIATILIS.)

The river crawfish (*Astacus fluviatilis*)* is considered to be very different from fish in the systems of naturalists; but, in the practical fisheries, it has to be treated in common with them, and the same legislation should apply to both. It is found in nearly all of our rivers, brooks, and even in ponds, though not always in such quantities as to supply cheap food for the masses of the people. With proper care, their numbers could easily be increased; all that has to be done is to give them cheap food, to observe the times when they should not be caught, and to plant alders and other bushes on the banks of those streams which, by too extensive fishing, have become drained of crawfish.

In France, the government has granted an appropriation by which more than 300 rivers and brooks can be stocked with German crawfish. Even these are not sufficient to supply the great demand, and large num-

*One species of Astacus is considered a great table delicacy in Europe and sells at high prices.—S. F. B.

bers are still imported from Germany. From Styria, fattened crawfish have been sent to Paris by Baron de Washington. Crawfish, likewise, increase very rapidly. Our present experience has shown that the eggs perish when torn off from the animals, so that it will not do to press them out and throw them into the water; all that can be done is to give ample protection to the female crawfish. In some places, young crawfish are kept and fed till they are able to take care of themselves. Considering the enormous demand for them, crawfish-culture in our numberless small brooks might soon become a remunerative occupation.

C—PROTECTIVE LEGISLATION.

21.—THE FISHING-PRIVILEGES.

We possess a great deal of valuable information on all the legal questions pertaining to fisheries in the thorough and exhaustive researches made by eminent jurists upon the historical development of the fishing-privileges in Austria and in other countries possessing similar laws, and also in special investigations of the subject.

The historical development of the fishing-privileges was, especially in olden times, very much the same in different countries.

Lette and Rönne, the well-known commentators on the "Agrarian Laws of Prussia," (vol. ii, p. 760,) briefly describe this development as follows:

"Originally, and far into the Middle Ages, every landed proprietor had the right to fish on his property; those who owned lands bordering on rivers could fish in these streams, and citizens of towns or villages had the right to fish in all the waters belonging to these communities. At a later period, the royal water and fishing privileges were established in connection with the hunting-privileges of kings and princes, and were in later times extended to nearly all the public rivers and streams, and either given or rented to private individuals. The right to fish in private waters, both standing and running, was, contrary to ancient usage, appropriated by the owners of estates and the local authorities to the entire exclusion of the vassals, (farmers.) These, as well as those inhabitants who did not possess any property, were frequently only allowed to fish with purse-nets and lines.

"Exclusive fishing-privileges are not acknowleged by the common law, and a person claiming such rights, as well as any others, must prove his lawful title to them. The right to fish in private waters is considered a natural consequence of owning property, and in running waters as belonging to persons holding landed property on the shores, all of which, however, varies according to the special laws and usages of different countries.

"Fishing privileges on foreign property must be considered as prerogatives of possession, (*Grundgerechtigkeiten.*)"

Most jurists express the same view, as in the text-books of German private law by Runde, § 110; Eichhorn, §§ 268 and 269; Mittermaier, § 290; Gerber, p. 214, &c.

In the following, it will be shown by various instances that these views on the historical development of the fishing-privileges are confirmed by the old Austrian law-books.

22—FOREIGN FISHERY LAWS.

Most European states have of late years directed their special attention to the fishing-privileges and the fishery-laws, with the view to reforming the whole system of the industry in conformity with the demands of the natural sciences, of changed social conditions, and the requirements of political economy.

From the great mass of material at our disposal, we shall only select a few paragraphs of foreign laws which are of special importance to Austrian legislation.

Prussia.—Prussian legislators have given much attention both to the fishing-privileges and to the fishery-laws. Besides those provisions of the common code of the Prussian monarchy, treating of the privileges of private individuals, there are numerous provincial laws and local regulations dating from different centuries, so that at present twelve different laws may be distinguished in Prussia.

It is generally acknowledged, even there, that these laws and regulations do not afford sufficient protection to the fisheries; that they are defective in many points, and not sufficiently uniform; that, regarding the nature and life of fish, they have not kept pace with the advancement of natural sciences; and that, even including the recent laws of the provinces of Prussia, Pomerania, and Posen, which in most respects have proved satisfactory, they leave great room for improvement. The draught of a new fishery-law has, therefore, been prepared.

The present Prussian legislation, in its most essential features, does, nevertheless, deserve our full attention. The regulations concerning private fishing-privileges, the laws on the abolition of such privileges, numerous regulations regarding supervision, &c., are not touched at all by the new laws; other provisions are changed but very inconsiderably; and it is of great interest in every respect to become acquainted with the progressive steps of this important legislation.

According to the common law of Prussia, fishing in public running waters is a royal prerogative. Those persons who have been granted fishing-privileges by the state, without defining certain limits, can only avail themselves as far as their property on shore extends. No person possessing them can extend his fisheries beyond their lawfully restricted limits.

Fishing in closed waters which do not extend beyond the boundaries of the estate in which they are located is as a rule the privilege of the proprietor of such estate. As a general rule, fishing in streams, lakes, and other waters can only be carried on by such persons as have received especial grants. In some fishing-regulations, as in the case of those relating to the gulfs of Dantzig and of Memel, those persons are allowed to fish who possess the privilege either by grants from the local authorities, by special arrangement with the treasury, or by prescription. The law of March 2, 1850, says that fishing-privileges in private waters, in as far as they are based on any relations of servitude, may be abolished by buying off, at the motion of either the landlord or of the one under obligations, in accordance with the principles of the agrarian law of June 7, 1821. The net annual revenue is to be estimated by competent persons, who have to take into account the average profit derived from the enterprise by those conducting it during the last ten years. The privilege can then be bought off either by payment of the annual interest or of the appraised value. In case the person under obligations has signified his willingness to buy off a privilege, the one holding it is entitled to have his fishing-implements likewise bought at their true value.

Some provincial laws contain still further fishing-regulations. According to those of the former Saxon provinces, fishing in the rivers Elbe, Mulde, Elster, Saale, and Unstrut is a royal prerogative. Fisheries belonging to towns or villages are to be rented out for the benefit of the community, or are to be carried on by two citizens successively, limited in this privilege to two days in the week.

In East and West Prussia, the right to fish in public waters can only be lost by its not having been exercised for forty years.

In the Prussian Rhine Province, especially in the district of Trèves, the government alone has the right to fish in navigable rivers, while in private streams the persons owning the shores have this right. (Article 538 of the civil law, law of the 17th day of Floreal, year X of the French Republic, royal cabinet order of June 23, 1838.) In navigable rivers, the governments rent out the fisheries.

The fishing-regulations, and the manner in which they are carried out differ in the several provinces.

The ordinance of 1669, Tit. 31, for the territory on the left bank of the Rhine, prohibits fishing during the spawning season, the employment of certain implements and methods of capture, and the taking of several species of fish below a certain size.

Special fishing-regulations were made in 1845, partly for different provinces, such as Posen and West Prussia, partly for certain waters, such as the gulfs of Dantzig and Memel, in 1859 for the province of Pomerania, others for the district of Cöslin, and in 1865 for the district of Stralsund.

Any closing of the fish-waters, hindering the migration of fish, especially salmon and sturgeon weirs and eel-traps, are prohibited, unless the government has granted special privileges for using such contrivances. New appliances disturbing the migration of fish cannot be permitted, unless they have been rendered harmless, or can be made so by certain conditions imposed on the owners. The police-authorities have to see to it that the conditions imposed, when privileges for such appliances are granted, are strictly fulfilled. Should such appliances be of great benefit to navigation, agriculture, or industry, the authorities may permit their use, even if they should be injurious to the fisheries, provided that the persons owning the fishing-privileges are properly indemnified. In as far as no existing rights are infringed on, the police-authorities have to prohibit every pollution of the water which, in their opinion, is injurious to the fish or fisheries; to remove all industrial or other establishments whose refuse makes the water impure; and to permit new establishments, whose refuse is to flow into the water, only on condition that competent men shall decide that such refuse will not hurt the fisheries. The authorities may, however, permit such establishments, if they will prove a considerable advantage to agriculture or industry; it being, of course, understood that the persons holding the fishing-privileges are properly indemnified.

Towns, villages, or other corporations holding fishing-privileges, if they have not obtained a special grant to carry on the business, must transfer it, either as a whole or in suitable portions, to competent and reliable persons.

Fishing can only be carried on in such a manner and with such implements as are not injurious to the preservation and increase of the stock of fish. The local authorities are entitled, and in duty bound, to enact more detailed restrictions on this point, in conformity with the local wants. Methods of capture and fishing-implements, whose injurious character is universally acknowledged, are prohibited by the laws.

According to some fishery-laws, only such implements can be employed as are mentioned in the respective deeds, feudal documents, written agreements, &c., in so far as their use is not interdicted by the existing code.

The size of the meshes of nets is fixed by law. The authorities are, however, empowered to prescribe the use of those with wider meshes for certain species of fish in certain localities, and to permit the use of such nets exceptionally for a period not exceeding five years in places where those with narrower meshes have hitherto been employed. Some fishing-laws prescribe in detail the methods of capture and the implements allowed in certain waters, and make the use of new implements and methods entirely dependent on the special permission of the government.

The seasons when the different kinds of fish in certain waters must not be caught are specially defined by government ordinances, and fishing during such seasons is either totally prohibited or limited according to local circumstances. In later ordinances, the seasons when the different species of fish cannot be caught are defined by legal provisions, and the capture and sale of spawning-fish and young fish are prohibited. In fishing, the running waters must not be obstructed, and bags, stationary nets, as well as other implements, tools, and contrivances used, must never occupy more than one-half the breadth of a river or stream.

The spawning-places of the finer kinds of fish are to be made known to the fishermen in a manner to be defined by the government. Fishing-apparatus which has not been removed from these hatching-grounds within twelve hours after notification, or which has been placed there after notice has been given, is to be confiscated, as well as all the fish which have been caught.

The fishery-laws of 1845 gave permission to persons holding fishing-privileges in one or more sheets of water, in case they unanimously agree to it, to abolish the confining regulations, either totally or in part, by a treaty which must be laid before the governing counselor (*Landrath*) of the district. The regulations of the district of Cöslin, passed in 1859, permit such deviations from certain specially mentioned rules, as have been agreed on by all the holders of fishing-privileges, inasmuch as a still greater protection of the industry is aimed at, and also the destruction of fish of prey, such as pike, or the stocking of the waters with fish, or the further increase of certain species of them, or the promotion of pisciculture. Such a contract must be approved by the governing counselor of the district, and the modified regulations must be clearly defined by the local police-authorities, and be properly promulgated throughout the whole district.

In some districts, special government officers are appointed to supervise the fisheries, such as higher fish-masters, fish-masters, fish-keepers, fishery-overseers, &c., all wearing a special uniform, and having their boats conspicuously marked, so as to be easily recognizable. Those private watchmen and other officers who are appointed by the proprietors of large fisheries are subordinate to the royal fish-master.

In other districts, the government has the right, in case the fishing-laws are violated by holders of privileges, and the fisheries are large and important, to appoint overseers at the expense of the proprietors. Fishing-permits have been allowed in some waters; they are to be issued on a mere request by the higher fish-master, but in case of litigation these permits cannot be used in giving judgment as to the rights of persons. The local police-authorities must every year make a list of all holders of fishing-privileges, and must exhibit them publicly for a certain period of time. Violations of the law are usually punished by a fine not to exceed the sum of $37.50. In punishing transgressors, prohibited implements are as a rule to be confiscated.

These cases come into the police-courts, (law of April 14, 1856,) before which the district-attorney makes his charges. According to the circular of September 19, 1864, forest-officers can be appointed as attorneys for all violations of the fishing-law occurring within their jurisdiction, whenever they have no private interest in the fisheries, as lessees, &c., in which case the regular district-attorney prosecutes the case.

According to ¶ 370 of the imperial German penal code of May 15, 1871, persons catching fish or crawfish without having a privilege or a permit, are punishable by a fine not to exceed the sum of $37.50, or by imprisonment.

According to ¶ 296 of the same code, persons who at night-time catch fish or crawfish by torch-light, or, in fishing, use injurious or explosive matter, are to be punished with a fine not to exceed the sum of $150, or by imprisonment for a period not to exceed six months.

In both cases of violation of the law, persons are prosecuted only if proper information has been given to the authorities.

Great as had been the care which the Prussian government had devoted to the framing of the several fishing-laws, many provisions had to be changed after a few years, showing how difficult it is to hit the right path at once in framing such a code. The published reasons for passing the law of April 22, 1869, changing the fishing-regulations of the law of August 30, 1865, in the district or Stralsund, contain the following:

"The law of August 30, 1865, is the result of thorough discussion during many years. The provincial authorities have gathered a vast mass of material for this purpose, which has been sifted and arranged by the ministry; and the provincial assemblies, as well as the Prussian parliament, have carefully considered all the propositions. If this law, nevertheless, after having been in force scarcely two years, is found to require a change, the cause of this is not a want of preliminary consideration, but the impossibility of making such consideration entirely exhaustive."

The published reasons for passing the law point out the fact that the criticising of the many views of private individuals and fishermen, often differing in the most essential points, requires a fund of general, local, and technical knowledge not often found in one man, so that the defects of the first law can be remedied only by experience.

It is a peculiar phenomenon that in the Rhine province, the fisheries have been regulated by an order of Minister Stein, of August 18, 1814—to whom Prussia owes her best agrarian laws—on those principles which are even now recognized there, viz, the formation of fishing-associations by government order, in all cases where the persons holding fishing-privileges cannot agree. This very excellent order was rescinded by the law of July 23, 1833, and when, in consequence of this, the renting-out of the fisheries in private waters was entirely stopped, the fisheries were completely ruined. During the last thirty years, fishing in private streams in the Rhine province has decreased very much, because they were almost depopulated by the reckless conduct of privileged and non-privileged persons. As nothing was done either to protect the propagation of fish, or to prevent abuses, the business has become almost the exclusive property of fish-thieves.

From these and similar reasons, several agricultural societies, and especially the *Deutsche Fischerei-Verein*, have recently pointed out the necessity of regulating the fisheries in the larger waters by the formation of protective societies.

In the Rhine province, these protective associations begin to find favor, although they have no legal basis, as is shown by those at Polch and on the Nims, in the Bitburg district. The mayors, who usually start these enterprises, are unfortunately obliged, through the lack of a law, to have recourse to ancient, almost fictitious laws, as for instance that those holders of fishing-privileges who were not present when a resolution was passed must be considered as having voted in the affirmative, that a resolution passed by the majority was binding on the minority, &c., all of which can only be enforced till one of the privilege-holders raises objections. (See Beck, *Beschreibung des Regierungsbezirkes Trier.*, vol. i, 549; iii, 305.)

In the autumn of 1872, the draught of a new fishing-law for the Prussian monarchy was published, and in December, 1872, brought, in a somewhat amended form, into the lower house of the Prussian parliament. This document is one of the most important in the history of fishing-legislation, and deserves our full attention also with a view to the adoption of a similar law in Austria.

In assigning reasons for passing such a law, the question is discussed whether it would be profitable to settle the whole matter as hitherto, by leaving it to the action of the local and provincial authorities, or whether a uniform fishing-law should be passed for the whole Prussian monarchy.

A careful consideration of this question showed that, although the fisheries differ very much in many respects, legislation for their benefit ought to be the same for all the provinces of the monarchy. In studying the different means of promoting the fisheries, no interests are found which are peculiar to any one province; they are, on the contrary, entirely independent of differences in the methods produced by local and climatic influences.

This being the case, an economical legislation demands general and uniform regulations. The means employed for promoting the fisheries will only then be successful if they are impartially applied to all portions of the country. It is true that, with regard to the inland waters, the body of every river flowing into the sea forms, so to speak, a separate and independent province; legislation, however, cannot follow the frequently not very clearly defined limits of these territories, whose tributaries often extend from one to the other, without getting confused and missing the object in view, viz: to establish firm and comprehensible rules for the fisheries, which gradually become indelibly impressed on the legal conscience of all parties concerned.

A fishing-law for the Prussian monarchy cannot entirely exhaust this matter, but must leave out some points which are to be settled according to local wants and by international treaties.

Rules which come under this head would mostly refer to the weight and measure below which certain fish could not be caught, sold, or shipped, as also to the limits of those seasons when fish are to be protected, and to the use and character of the fishing-apparatus.

These rules must be in conformity with the different methods in which the fisheries are carried on in the several provinces; but they must also have regard to the different species of fish found in the different waters and to local and climatic circumstances. If such rules were embodied in the general law, this would become unnecessarily large, and would no doubt frequently require to be changed; and would doubtless, to the injury of the industry, of which science and experience are constantly developing new aspects, it would be prematurely settled.

The existing law of Prussia, like all the older fishing-laws, is, with few exceptions, confined to this field, and in most of the provinces there are rules regulating details.

The proposed law leaves these regulations unchanged for the present; but takes into consideration a uniform settlement of all these points in territories which belong together by a royal ordinance, which in many cases will have to be preceded by treaties with neighboring states.

The following are the more important provisions of this code, by which existing laws are to be amended or changed:

Fishing-privileges, which are not connected with some specified landed property, and which have hitherto been enjoyed by all the inhabitants of a village or city, shall, in future, to their present extent belong to the body politic. (¶ 5.)

In those waters which form the boundary-line between two or more communities, without belonging to either, these communities shall enjoy equal privileges in that part of the water which is bordered by their territory. (¶ 6.)

Existing privileges which refer to the use of certain specified apparatus for fishing, fixed contrivances, (weirs, fences, automatic traps for salmon, eels, &c.,) stationary nets, those that obstruct the greater part of the river, &c., can be limited or abolished by completely indemnifynifying the persons holding them.

Further limitation or abolition of such privileges can be claimed:

1. By the state for the public welfare;

2. By holders of fishing-privileges, or by fishing-associations, in the lower or upper portion of any water, if it can be proved that these operations are of lasting injury to the industry, impeding the introduction of a rational and economical system of conducting it.

The petitions of holders of privileges and of fishing-associations are decided on by the district government, after they have been thoroughly examined by competent men.

If the parties cannot agree upon the indemnity which is to be paid, the authorities will fix the amount, which must be settled by the person or persons petitioning for the abolition of privileges.

The existing ordinances regarding the abolition of servitude for the fisheries are not touched by any of the preceding regulations. (¶ 4.)

It is said in the law that the abolition of fishing-privileges on foreign soil does not come within its jurisdiction; and reference is made to the above quoted abolition-law of March 2, 1850, which, as far as is required, is to be amended and completed. It is, however, considered as coming within the scope of this law to leave open a way for abolishing such fishing-privileges as form a lasting opposition to a rational culture of the waters and the preservation and increase of the stock of fish.

Towns or villages can only make use of the inland waters belonging to them through specially appointed fishermen or by renting them. It is not permitted to make the fisheries free to all persons belonging to the community.

The period of lease must, as a rule, not be shorter than twelve years, and exceptions to this regulation can only be allowed by the local authorities in special cases.

If the fisheries belonging to one community are to be subdivided into several districts which are to be rented separately, such action must be approved by the local authorities, who have to see to it that they are not subdivided too much.

The local authorities are empowered to fix the number of fishing-apparatus in the several districts, which is not to be exceeded.

If two communities possess equal privileges in the waters bordering on their territory, they can only carry on the fisheries in common. If such communities cannot agree as to the manner in which this is to be done, the local authorities will decide the matter. (¶ 7.)

Persons holding fishing-privileges in a larger connected sheet of water may, with a view to better supervision and protection of the craft, form themselves into an association, with a statute, which must be approved by the government; such association must be represented by a board, to be elected by all the members according to the statute.

Before such statute can be approved, the privileged persons must be heard on the formation of the association and its statute, and, if one of these raises objections, the representative assemblies of the district in which the sheet of water in question is located are consulted. By the consent of all parties concerned, the object of the association may by the law be extended to the cultivation of the fish-waters in common. (¶¶ 8 and 9.)

The draught of the law discusses the question whether, after the example of several old provincial codes and after the model of some modern German fishing-laws, such as those of the Baden and Würtemberg, a rule should be made that every person who desires to fish should have a permit. This rule, says the draught, is taken from the game-laws.

Hunting and fishing are industries which in some respects are closely related to each other, and which, nevertheless, are totally different in the very points in question.

The economical value of fishing to the life of a nation very considerably exceeds that of hunting. Fishing is the chief industry and frequently the only means of earning a living in numerous families, in entire villages and districts, while hunting nearly everywhere is an occupation carried on outside of the various trades or industries.

If hunting privileges have unhesitatingly been granted on permits, and a tax could be imposed on such favors, such taxation could scarcely be borne by the fishermen, who are as a general rule poor.

The most important reason for obliging all hunters to carry a permit is doubtless to insure public safety, and this reason entirely falls to the ground with the fishermen, not to mention other differences between the two occupations.

The introduction of such a measure to the above-mentioned extent is therefore not favored, as it would very much incommode the craft and the authorities charged with issuing or certifying the permits.

On the other hand, it is considered necessary, in order to prevent non-privileged persons from fishing, to demand some sort of identification of those persons who fish in the waters belonging to the holders of privileges, in the shape of some paper which such persons should carry with them when at work, and should exhibit, if requested to do so by an overseer. Those, however, who fish in their own waters would not require such a paper.

The right to issue permits to third persons should belong to the holder of a privilege within the limits of his jurisdiction; to the lessee of a fishing-district within the limits of his contract; and to the board of directors in waters belonging to an association.

Assistants employed in the presence of holders of privileges, or of persons having a permit, require no special permit.

The certifying of fishing permits by the local police-authorities must be done without any stamp or fee whatever. (¶¶ 10 to 15.)

The draught contains but very few regulations on the methods of fishing and the apparatus used. Apparatus, which is set for the purpose of fishing, in the absence of its owner must have a specified mark of recognition. (¶ 16.) Fishing with poisonous bait, or by other means which stun or poison the fish, such as explosives, is prohibited, (¶ 17,) as likewise the obstruction of more than one-half of any stream of water, (¶ 18.)

All other regulations regarding methods of fishing, apparatus, the weight or measure below which fish are not to be caught, the days and seasons when fishing is prohibited, the rules to be observed by fishermen for avoiding mutual disturbances, and in the interest of public traffic and navigation, as well as for making supervision easier, are left to government ordinances, which, as far as required, are to be passed for connected territories. (¶ 19.)

The code also contains prohibitions as to the sale of fish the catching of which is not permitted. (¶¶ 22 to 25.)

Great attention is given in this law to the establishment of places of safety, where the fish are to be absolutely protected; such places being considered as among the most important measures for protecting and preserving them.

The proposed law distinguishes two kinds of such places, viz:

a. Places of safety for spawning, *i. e.*, those localities which, in the opinion of competent men, are specially suited to the spawning of fine fish and the development of the young;

b. Places of safety for fish, *i. e.*, such portions of water in and before the mouths of rivers as command the entrance of fish from the sea into the inland waters.

Such localities (*a* and *b*) can be declared places of safety by the minister of agriculture, after having consulted with all the holders of privileges concerned; in association-districts, with the board of directors.

The limits of such places of safety are to be made known to all persons concerned by public proclamation; and they should be, as far as the locality permits, marked by special signs. In these spots, fishing of any kind is entirely prohibited.

In places of safety for spawning, all disturbances which tend to endanger the propagation of fish, such as their being cleaned out, the mowing of reeds and grass, the carrying away of sand, stones, mud, &c., should be avoided during the spawning season, as far as the tide and the claims of agriculture permit. More detailed regulations on these points as well as on the supervision of places of safety are, if necessary, to be made by the district authorities.

In selecting places of safety, preference should be given to those bodies of water in which the government has the exclusive fishing-privilege, or in which this has been transferred by law to political communities.

In these cases, no indemnity is paid for withdrawing the privilege of fishing in the places of safety.

If, however, the preservation or improvement of the fisheries demands the including of other waters as places of safety, the rights connected with such waters are withdrawn, and the holders of privileges must be fully indemnified from the public treasury; the amount of such indemnity, if not mutually agreed on, to be settled by a court of law.

If it should no longer be desirable to keep up a place of safety, it can be abolished by an ordinance of the minister of agriculture. In this case, the former laws and privileges regarding fishing come again into force. If, however, an indemnity for the withdrawal of fishing-privileges has been paid from the public treasury, they shall then remain in the possession of the government. (¶¶ 27 to 31.)

Fish-passes (trout-paths, salmon-ladders, &c.) are considered essential conditions for the lasting preservation of remunerative fisheries.

The bill makes a distinction between new hydraulic constructions and existing ones which hinder the passage of migratory fish.

In constructing new hydraulic works, or extending them, the proprietor has, at his own expense, to make such arrangements as are necessary for letting the fish pass through.

If any such work is only constructed for a certain period of time, *e. g.*, while brooks and small rivers are temporarily dammed for the purpose of irrigating meadow-lands, or if the passage of migratory fish in the respective waters is for the time being excluded by existing constructions or from other reasons, exceptions may be allowed under protest.

Proprietors of existing hydraulic works are obliged to permit the construction of fish-passes, if, *a*, the government demands such constructions in the public interest; or if, *b*, holders of fishing-privileges or fishing-associations intend to establish such passes in the upper or lower portions of the waters in question.

These rules only apply to natural waters, but not to artificial streams and to those hydraulic works which protect the lowlands against the flood from outside.

The proprietors of existing hydraulic works are to be fully indemnified for any injury done to such works. No indemnity is paid for any decrease in the value of the fisheries occasioned by the construction of a fish-pass.

The ground required for constructing a fish-pass must be given up by the proprietor; the full value thereof being paid to him.

In the fish-passes, any kind of fishing is prohibited. (¶¶ 33 to 39.)

The introduction into the waters of agricultural or industrial refuse of such quality and in such quantities as to injure the fish is prohibited.

In cases where the agricultural or industrial interests are of greater value than the fisheries, the introduction into the water of any of the above-mentioned refuse may be permitted by the authorities, provided that measures are taken to limit the possible injury of the fish to the smallest practicable amount.

If, through existing channels, agricultural or industrial refuse of an injurious character is introduced into the water to such an extent as to destroy or seriously endanger the fish, the proprietor of the establishments from which such refuse comes can, on the complaint of those persons whose fisheries are injured, be obliged by the authorities, after the case has been thoroughly examined, to make such arrangements as will remedy or at least diminish the damage that has been done, without, however, injuring his own establishment. The expenses of making such arrangements are to be refunded to the proprietor of the establishment by the complainants. (¶ 40.)

The rotting of flax and hemp in running waters is prohibited. Exceptions from this rule can be made by the local authorities, always under protest, however, in such districts where the locality is not suited for making rotting-pits, and where the use of running water for preparing flax and hemp is absolutely necessary for the time being. (¶ 41.)

The immediate supervision of the fisheries belongs to the government and local police-officers; in association-districts, besides these, to the board of directors; in all inland fisheries not belonging to associations, to each community within the limits of its own jurisdiction; in both cases under the superintendence of the local authorities. (¶ 42.)

The first draught of the law contained the following regulation in ¶ 43:

In superintending the operations, in carrying out the provisions of the law, and in supervising all measures for furthering the industry, the district authorities shall, if necessary, be assisted by inspectors of fisheries. The relation of these inspectors to the superior and subordinate officers is regulated by ordinances of the government. (¶ 43.)

Regarding the inspectors of fisheries, the preliminary report says:

"The appointment of inspectors of fisheries as competent counselors of the supervising officers has long since been recognized as an undisputed want, and becomes indispensable when all those measures are to be executed by which the sea and inland fisheries are to be promoted. It need scarcely be said that it is not intended to appoint at once an inspector of fisheries for every province; their number will, on the contrary, be at first a limited one, and will be increased as time and occasion demand."

The second draught does not contain the above paragraph; but the preliminary report says expressly that the appointment of commissioners in chief as counselors to the principal supervising authorities, and as their referees in all matters pertaining to fisheries, will in all probability become necessary, but that their number will have to be as limited as possible. It seems, therefore, to be the intention to regulate this whole matter by some future ordinance.

Whenever the general German penal code does not provide for (¶¶ 296 and 370) violations of the fishing-law, the punishment inflicted will be by fines of $7.50, $22.50, and $37.50, or with imprisonment.

Any person who violates the law through his servants, apprentices, or day-laborers is, besides being punished himself, made responsible for the payment of fines imposed on these assistants in case they are not able to pay them. (¶ 47.)

Bavaria.—In Bavaria, the government, in 1854, recommended that artificial fish-culture should, with the assistance of the agricultural society, be introduced as far as possible, and that, through it, natural propagation should be carried out by placing spawn of the finer species in the rivers.

By giving information and encouragement, the authorities should aim at having smaller fisheries combined, and see to it that they are leased as a whole for a longer period to enterprising fishermen, on condition of their being carried on in a rational manner. The several villages and towns should be urged to do the same with those under their control.

The police-authorities were ordered to afford the greatest possible protection to fish-culture; to remedy existing evils as soon as possible; and, wherever practicable, to fix the amount of the fines.

In 1855, the fishing and fish-market regulations, which were partly revised and partly new, were promulgated throughout the kingdom.

Violations of the fishing-law were spoken of in article 231 of the penal code.

The example of the neighboring states will soon prompt Bavaria to reform her antiquated regulations, which will also exercise a beneficial influence on the Austrian fisheries, since many of the Austrian and Bavarian waters are closely connected.

Würtemberg.—The Würtemberg fishing-law of November 27, 1865, is the result of discussions which were carried on for several years in the parliament. It contains regulations regarding permits, the leasing of the waters for several years by the communities, and prohibitions of entirely free fisheries; also full regulations on the rights of land-holders on the shores of the waters. In case of inundations, privileged persons can fish even beyond their shores, but are obliged to pay for any damage done to the land; after the waters have receded, every proprietor can catch the fish and crawfish left on his property, but must not place any contrivances which might hinder them from returning to the waters. During the spawning season of the finer species of fish, the cutting of wood near the shore, the mowing of reeds, &c., are prohibited.

Authorities and associations are urged to see to it that holders of fishing-privileges either carry on the enterprises in common, or lease them as a whole; the too great subdivisions of fisheries being in all cases considered as injurious.

Baden.—In Baden, the laws of March 29, 1852, and of March 26, 1853, provided that fishing privileges on foreign soil could be bought off by paying a sum equal to twelve times the average annual revenue, to be paid in ten yearly installments, at 5 per cent. interest.

The law of March 3, 1870, provides that smaller waters may be united into a whole by the privilege-holders, with the consent of the district authorities, if the interests of the fisheries require it.

The privilege-holders of such a united fishing-district form an association; resolutions passed by the majority, and approved by the authorities, decide where the permanent seat of the association is to be, and on its constitution, duties and rights, its members, organs, and the manner in which business is to be transacted. Before the law, those privilege-holders who combined own the largest extent of water, form a majority, even though, in point of numbers, they should be in the minority.

The associations mentioned here, as well as communities and corporations, can only carry on their operations through specially appointed fishermen, or by renting them; the term of the lease not to be less than twelve years.

The draught of the law contains detailed regulations forbidding injurious fishing-apparatus, mischievous transgression of the law, &c. Special ordinances are to regulate the weight below which fish must not be caught, days and seasons when fishing is prohibited, and to mention those implements which are forbidden. All engaged must have permits, and, during the seasons of protection, fish are not to be caught, or sold, or offered as food in restaurants.

Fines for violating the fishing-laws, to which also assistants are liable, as well as confiscated nets and apparatus, shall go to the holders of fishing-privileges. No one is to be prosecuted unless on the complaint of privilege-holders, their representatives, or one of the lawful overseers.

An ordinance of January 11, 1871, contains more detailed regulations on the formation of fishing-associations and on the establishment of spawning places and of places of safety. A minimum length has only been prescribed for *Trutta lacustris* Agass., *Trutta trutta* Lin., ($7\frac{4}{5}$ inches,) and for *Trutta fario* and *Thymallus vulgaris* Nilss., ($5\frac{3}{4}$ inches.) These fish, with the exception of the last mentioned, must not be caught from October 20 to January 20; all others may be taken, as well as the crawfish, from April 15 till the end of May.

The salmon-fisheries are to be regulated by future laws.

Fishing at night-time is prohibited, but exceptions may occasionally be made; the number of fish-weirs in public waters is to be limited as much as possible; the regular width of meshes and openings is fixed at 0.78 inch; spears and guns can only be employed in exceptional cases; automatic fish-traps connected with mills or other water-works are prohibited.

The public treasury may offer prizes for the best piscicultural establishments and for artificially hatched fish.

Saxony.—In Saxony, a new fishing-law was promulgated on the 15th October, 1868. By this law, the right to fish in running waters and their tributaries—if not otherwise settled by government grant or private title—belongs, *a*, in the original portions of the kingdom, to the proprietors of the shore as far as this extends, and, if both shores do not belong to the same person, as far as the middle of the stream; *b*, in Upper Lusatia, to the landed proprietors; *c*, in the rivers Elbe, Mulde, Elster, and in the Grödler and Elster Canals, to the state. If the fishing-privilege belongs to a community, or to the members of the community at large, or to a privileged class of citizens, or to a corporation, it can only be exercised through renting it or by appointing a special fisherman. Fisheries can only be leased to a corporation of professional fishermen or to *one* individual. Fishing-permits are issued, but only to such persons as are not privilege-holders, lessees, or professional fishermen. All persons, including holders of privileges and manufacturers, are prohibited from hindering the migration of fish by permanent arrangements, and manufacturers must, as far as practicable, make passages in their weirs. Also, in other ways, the law endeavors to harmonize the water-privileges with the interests of fishing and pisciculture. Various ordinances regulate the employment of injurious apparatus, the time when fishing is prohibited, the minimum weight of fish that can be caught, &c. So far, only one ordinance has been passed in regard to these matters, that of October 16, 1868.

Dr. Fric, in his report, says that the carrying-out of the law leaves much to be desired. Many fishermen seem scarcely to be aware of the existence of a law at all, and are still waiting for one. The fixing of the time when salmon are to be protected has been deferred till treaties can be concluded with all the other states bordering on the Elbe. The authorities seem to delay the carrying-out of the law, because they wait for a general fishing-code for the whole of the German empire.

Dr. Fric remarks that the fact of most of the shores and streams being under one and the same authority greatly favors the execution of the laws in Germany.

Lübeck.—In Lübeck, the piscicultural society has drawn up rules for the protection of fish during the spawning season, the size of meshes, the minimum size of fish that may be offered for sale, &c.; all of which rules have been adopted by the senate in its fishing-law of December 16, 1868. It is a matter of regret that the senate has been induced by the representations of selfish men, who were afraid to see their income diminished for a short time, to change some of the most important regulations by an amendment of February 15, 1869. Complaints are also made that the supervision of the fisheries is very defective; the market-police do not exercise the necessary control, from ignorance and want of interest; the directors of the fishermen's guild, whose duty it is to superintend the fisheries, are themselves fishermen, and therefore but rarely inclined to use the proper severity in proceeding against members of their guild. It is therefore the aim of the piscicultural society to have a fish-master appointed, who is to possess special powers, and whose duty it shall be to superintend the fisheries. This aim has not yet been attained, from purely financial reasons.

Switzerland.—In Switzerland, there are different fishing-laws in the different cantons. The most recent law is the one passed by the great council of the canton of St. Gall, December 25, 1870.

According to this law, the right to fish in the waters of the canton, whenever there are no special privileges of communities, corporations, or private individuals, belongs to the government.

The right to fish in government waters may be obtained by a lease or by buying a permit, ("patent.") The lease may be for a term of ten years and shall be sold at public auction.

A fishing-permit must be renewed every year. Certain specified persons are excluded from taking out permits. A permit to fish with nets and other implements costs \$4, and \$2 for every assistant; and a permit to fish with hook and line, \$1.20; which sums go to the treasury of the canton.

The law contains the usual regulations as to prohibited fishing-implements, the seasons when there is to be no fishing, and the buying and selling of fish.

In some waters, such as the rivers Thur and Rhine, and in the streams flowing into the Lake of Constance, the Wallen Lake, and the Lake of Zürich, fishing with hook and line is alone permitted; all other implements being entirely prohibited. The great council is, however, empowered to permit the use of nets, if in future times the increased number of fish in one or all these waters should justify such use.

The council is likewise empowered to extend the time when the fishing of salmon, salmon-trout, and trout is prohibited, in any water or in portions of it, to a whole year or several years, if their preservation demands such a measure.

The council can only make exceptions in the case of piscicultural establishments, allowing fish to be caught during the season of protection, or spawn to be taken for the purpose of hatching, if the establishment in question contributes its share toward restocking the waters of the canton. Such establishments are, if necessary, to be placed under special police protection.

It is forbidden to throw or otherwise introduce into fishing-waters refuse from factories or other injurious substances. Such refuse must be buried in pits. If the agricultural or industrial interests are of more importance than the fisheries, the council may permit exceptions to this rule.

The owners of water-privileges are obliged to build their weirs and dams in such a manner as to allow the fish to swim up the stream. Proper arrangements shall also be provided to prevent fish from getting entangled in mill-wheels, &c.

Violations of this law are punished—

a. By fines, varying from $1 to $20, or by imprisonment;

b. Withdrawal of the lease, or of the fishing-permit, for a certain period, or forever;

c. By confiscation of prohibited implements, or of fish bought or sold contrary to the regulations as to size and fishing-season.

The council is empowered to conclude treaties with the neighboring cantons or states, regarding the fisheries in waters which form boundary-lines, and, if circumstances require, to suspend some of the regulations of this law as far as boundary-waters are concerned, and to make special rules for such waters. It is also charged with carrying the law into effect by special ordinances.

Such an ordinance was promulgated by the council May 17, 1871.

This statute gives the division of the canton into districts which are rented, and districts where fishing can be carried on by permit; likewise regulations as to renting and issuing fishing-permits.

If no bid should be made on any district, permits may be issued for such a district; and, *vice versa*, if no permits are taken out, it may be rented.

An exception from the regulations contained in this law is made with regard to the fisheries in the Rhine, both as to the implements and the seasons of protection, as long as these fisheries are not regulated by treaties, or whenever the fishermen on the opposite shore do not of their own accord submit to these regulations. The obstruction of the Rhine by nets or other apparatus for more than half its breadth is even now strictly prohibited on both banks.

Lessees of fisheries who carry on artificial breeding, and can prove that they do this in a productive manner, not only can claim all those favors which the law accords during the season of protection, &c., but their rent may also be lowered in proportion as they give young fish to other waters of the canton.

The district-offices keep lists of all waters, leases, and fishing-permits. The local, district, and cantonal police-officers are to see that all the provisions of this law are fulfilled. If necessary, special overseers over the fisheries in one or more waters may be appointed.

France.—In France, exclusive fishing-privileges were abolished by the laws of July 6, July 30, and September 26 1793, as being a remnant of the age of feudalism. Navigable rivers and streams belong to the state, and are usually rented.

The fisheries have since been regulated by the law of April 15, 1829, which gives full details of the rights of the fishing-guards to examine implements, vessels, huts, tanks, &c. A few changes have been made by the law of May 31, 1865, and by an imperial decree of November 28, 1868.

The instructions given to the authorities to protect the fisheries in every way, to use all means for improving them, to stock rivers and streams with fish and crawfish, to establish places of safety, to plant the banks with trees and shrubs, &c., deserve great praise.

Italy.—In Italy, a special committee was appointed as early as 1861 to prepare the draught of a fishing-law; and a new committee for the same purpose was appointed in 1870.

The government, in 1870, had reports drawn up by the prefects of all the provinces relating to the several species of fish found in each province, the implements used in fishing, the spawning seasons of fish, &c., the number of piscicultural establishments, the number of fishermen, their relation to each other, the total area of water, and the existing rules and regulations; inquiries were also made regarding foreign fisheries and laws.

On the basis of these reports, the ministry of agriculture, industry and commerce, in the session of the chamber of deputies of January 24, 1871, laid before the chambers the draught of a fishing-law, together with a lengthy report containing the results of all the inquiries.

The annual value of the salt-water fisheries is estimated at $8,000,000, and that of the fresh-water fisheries at from $600,000 to $800,000.

As interesting to Austrian fishermen, it may be mentioned that on the Italian portion of Lake Garda 500 fishing-vessels, manned by 1,400 fishermen, are employed. The fisheries on this water, belonging partly to Austria and partly to Italy, must be regulated by an international arrangement, to arrive at which the first steps have been taken by the Austrian ministry of agriculture.

The draught of the new Italian fishing-law contains 54 paragraphs. The separate laws of the provinces are abolished, and a uniform code for the whole kingdom of Italy is to be introduced, extending also to the salt water fisheries.

The details of the code are modeled after the best modern fishing-laws, especially those of Germany, and contain not only provisions for the proper protection of the fisheries against reckless plundering by privilege-holders, but likewise such as are intended to regulate the legal relation to third persons. Many points are left to be settled by special ordinances.

These ordinances are to fix the boundaries between salt-water and fresh-water fisheries; to make rules and regulations regarding the time, place, methods, and implements of fishing; regarding the transportation of implements and fish and the sale of the latter; and, finally, regarding the supervision of the fisheries, which the proper protection and care of them requires. The nets and apparatus by which spawn and young fish might be injured are to be prohibited.

The ordinances have also to fix the limits of time and space of such prohibitory measures, and also the extent to which contrivances can be permitted which would hinder or disturb the free passage of fish. Special regulations are to be made for cases in which spawn and young fish may be used for scientific purposes, for piscicultural establishments, or as bait. Rules will be adopted as to the extent of regulations for the transportation and sale of water-products according as these come from private waters, from the open sea, or from foreign countries. Other regulations will decide how far weirs, sluices, and other hydraulic constructions which hinder the free passage of fish can be permitted in the interest of industry or agriculture, providing in all cases for the construction of passage-ways. Special decrees will decide how far refuse which is injurious to the growth and development of fish can be introduced into the water in the interest of industry or agriculture, or how far industrial or agricultural pursuits, which have the same effect, may be carried on near fishing-waters.

Without special permit, no water-plants, sand, stones, or mud can be removed from inland waters.

The ordinances will point out those private waters to which the foregoing provisions are to apply. The proper police-regulations for supervising the fisheries are also to be made.

By royal decree, a central commission of fisheries is to be appointed, besides the ministry of agriculture. It belongs to this commission to pass an opinion on the regulations of the above-mentioned ordinances, and to propose all those measures which they consider to be of benefit to the fisheries. Within one year, the provincial assemblies—and, in behalf of the salt-water fisheries, special committees from each district—have to hand in their draughts of these ordinances; the ministry promulgating them without delay in case of non-compliance with this decree. The ordinances may refer to several provinces and several districts or only to certain waters.

The ministry of finance will make proper regulations for the assistance which coast-guards and officers of the customs are to give in superintending the fisheries and in hunting up persons who have violated the laws. The ordinances will also decide how far the various communities have to assist in supervising the transportation and sale of fish and other water-products. Violations of the law are to be punished by fines not to exceed $60, and $200 in case of the tunny-fisheries.

The ordinances will also decide in what cases the implements of violators of the law shall be confiscated.

Two-thirds of the money coming from fines and the sale of confiscated articles is to go to the officers or agents who have discovered the violations, and one-third is to go to the public treasury or to special benevolent funds. The harbor-officers, as well as the prefects, may be present in court, in person or by proxy, when cases of violation of the fishery-law are brought up, in order to express their views on the case and to decide legal questions.

Professional fishermen may form themselves into associations, and elect from their number a board of directors, called "The trusty men of the fisheries," (*probi viri della pesca.*) These men shall pass decisions in private quarrels, shall assist in the superintendence of the fisheries, and they are entitled to propose changes in the ordinances to the ministry, and to suggest new measures which, in their opinion, will be beneficial to the industry. Special ordinances will prescribe the manner in which associations are to be formed, what persons may be active and honorary members, as well as rules for the guidance of the board of directors, in cases laid before them.

Denmark, Sweden, and Norway.—The Scandinavian countries, Denmark, Sweden, and Norway, have also regulated their fisheries, both salt-water and fresh-water, during the last twenty years, by new laws; Denmark, 1857–'60, 1861, and 1867; Sweden, 1852 and 1869; and Norway, 1854, 1863, and 1869.

The many changes in the fishing-laws which have been made in these countries during so short a period afford another proof of the difficulty of passing such definite laws as will answer all practical purposes.

Russia.—Of the Russian fisheries in the Dniester, Dnieper, the Volga, and the Black Sea, it is said "that laws, discipline, and work are so strictly and suitably regulated that other nations which consider themselves far more civilized might learn a great deal from them."

United States.—Even in the United States of North America, where hitherto the large lakes, streams, and seas have been plundered shamefully, and with most ingeniously-contrived nets, the people have now become afraid of exhausting their wealth of fish, and are endeavoring to bring about order and a system of protection by laws, treaties, and other measures. The last reports of the commissioners of the different States, whose duty it is to see to the proper execution of the laws, to propose new ones, and to promote the fisheries in every possible way, have been spoken of above.

Great Britain.—The British fishing-laws deserve our fullest attention. Since, about eighty years ago, the discovery was made that salmon packed in ice could be brought to London in a fresh condition, the demand for it, and the price paid, have been increasing so rapidly that there was imminent danger of seeing the British seas and streams entirely depopulated, and of having the traffic in salmon, the pride of the English fisheries, entirely destroyed.

Dire necessity has compelled Great Britain to protect and improve its fisheries in every possible manner. All technical inventions and improvements, artificial fish-culture, passage-ways for fish, &c., are put to the best practical use. Immense capital is invested in the fisheries by private individuals or by joint-stock companies. The laws afford the fullest protection to these enterprises. Holders of fishing-privileges have formed themselves into well-managed organizations, so that the majority is enabled to pass resolutions which will prove beneficial. The British fishing-laws afford protection against the factories, the poisoning of the waters, and their being obstructed by weirs; they protect the spawning places; see to it that the spawning seasons are properly observed; do away with injurious stationary nets; prevent the capture and sale of young fish, &c. Inspectors of fisheries possess full powers to control the privileges of angling in salmon rivers and of using a specified kind of nets; to have a strict eye to stationary nets and other apparatus; and to punish all violation of the law severely.

Although occasional complaints are raised that the acts of parliament are getting more and more confused, their complication is not so great as to injure the fisheries, and, with sensible firmness, injurious influences are constantly overcome, and improvements are made.

Many antiquated and impracticable laws have been replaced by new and better ones, especially since the beginning of Queen Victoria's reign. Still more important are the acts of parliament of 1828, 1842, 1850, 1857, and 1861. They refer either to special branches of the trade such as salt-water fishing, shell-fish and oyster dredging, and salmon catching, or to the fisheries in the several different countries composing the British monarchy, England, Scotland, Ireland, or to certain lakes or streams, as for instance the act of 1857, concerning the Tweed fisheries, which was amended in 1859.

In discussing the act of 1861, relating to salmon-fisheries, many were of the opinion that this entirely neglected British industry, the profits of which amounted to almost nothing, could never again be brought to a flourishing condition.

These opinions have proved to be erroneous, since that law has produced such favorable results; and it is expected that these results will be still more brilliant in the future. A commission was appointed in 1870, charged with considering the question in what respects the salmon-fishery laws could be still further amended. Improvements had been introduced into Scotland some time before this.

From the law of July 31, 1868, concerning the salmon-fisheries in Scotland, and from some older laws, which have been incorporated with it, we quote the following as of special interest for Austria:

"All the waters, streams, and rivers in Scotland which are of importance to the fisheries have been accurately described by special commissioners, and their limits toward the sea have been defined; as a general rule, they have been divided into an upper and a lower portion by a boundary-line. These commissioners have fixed the annual as well as the weekly-period of protection for each sheet of water or stream, when salmon-fishing is either entirely prohibited or only permitted with hook-and-line, and their decisions have been published in an appendix to the law. The different contrivances to be used in nets, salmon-traps, &c., in order to keep the seasons of protection, the size of the meshes, and certain precautions in using the nets, are separately prescribed for each body of water.

"If two owners of salmon-fisheries in a continuous district—no matter whether the waters at the time contain salmon or not—apply to the county sheriff to have a district-board appointed, such application must be granted. The clerk of the sheriff has to draw up a list of the upper and lower fishery owners, and call separate meetings of both, for electing a district-board. The district-board appoints an officer, whose duty it is to keep the list of owners constantly revised. If names have been left out of this list, or have been entered in a faulty manner, a complaint may be made to the district-board; and if its decision is unfavorable, the matter can be referred to the sheriff, whose decision is final, except in cases of hereditary rights.

"The district-board, at its meetings, decides all questions pertaining to fisheries by an absolute majority. The minutes of the meetings of the board, signed by the chairman, are considered evidence in a court of law.

"The district-board may, by a resolution to that effect, petition the ministry to make the following regulations:

"1. Change of the annual season of protection in the district, fixed by the commissioners; which season, however, is never to be less than one hundred and sixty-eight days. (It generally embraces the period from the 27th August till the 10th February, and for line-fishing from November 1 till February 10.)

"2. Change of the weekly season of protection in the district or in portions of it; such season to be no less than thirty-six hours per week. (From 6 p. m. on Saturday till 6 a. m. on Monday.)

"3. Change of the rules applying to the yearly or weekly season of protection.

"4. Change of the rules concerning 'cruives,'* and the dams and weirs belonging thereto, within the district limits.

"5. Changes regarding the establishment of mill-dams, aqueducts, and water-wheels, the placing of heks or gratings, the closing of sluices wherever they open into or from aqueducts within the limits of the district; provided that by such changes the supply of water to which persons are entitled who have the right to use an existing salmon-dam as a weir is not diminished.

"The votes of the district-board deciding such changes must be published in some paper of the district before they can be officially presented to the minister. The minister may collect information on the subject; and if the proposed change is not in opposition to any rights belonging to persons by royal grant, privileges, or immemorial possession, the minister shall consent to the change and publish it in the Edinburgh Gazette.

"Until some change shall have been made, the regulations settled for each district by the act of 1868 remain in force.

"The district-board is empowered to buy, from the proprietors, dams, weirs, cruives, and other stationary contrivances, whose removal they consider necessary for the welfare of the fisheries; heirs of entailed estates are likewise entitled to conclude such transactions with the district-board, even without the consent of their guardians.

"The district-board is also empowered to remove every natural hinderance in the bed of a river which might impede the passage of fish; to make fish-passes near the water-falls; to take all the measures and meet all the expenses which in their opinion appear necessary for the protection or improvement of the fisheries in the district, as well as for stocking the waters with fish.

"The above-mentioned right of buying weirs, &c., can only be applied if the resolution of the district-board relating thereto has the sanction of the owners of four-fifths of the total value of the district fisheries.

"The members of the district-board shall not receive any salary or fee.

"The board is empowered, with the consent of the minister, to contract loans for carrying into effect the above regulations; such loans not to be made for any period exceeding two years.

"A fine, not to exceed $25, is to be imposed on any person who fishes during the yearly or weekly season of protection, or assists in fishing, or violates a law relating to the season of protection, or uses nets with too narrow meshes, or catches salmon as they leap over a water-fall or some other impediment, or keeps them back after the leap, or prevents salmon from going through fish-passes, or catches them in such passes, or throws sawdust, chaff, or corn husks into fishing waters, or causes it to be thrown into it. For every salmon caught or killed contrary to

* A cruive is an inclosed space in a dam-wall, so contrived that when the fish enter it in their passage up stream they cannot escape.—S. F. B.

law, a further fine, not to exceed $10, is to be imposed; and the fish are to be confiscated.

"A fine of $25 is to be imposed on any person who fishes with a light or fire, a spear, lance, harpoon, or similar implement, with a cross-line or a drag-net, or who is found in possession of any of the above-mentioned implements under circumstances which convince the court before which he has been brought that he intended to catch salmon; his implements and the fish found in his possession are to be confiscated.

"A fine, not to exceed $10, is imposed on any person who uses fish-spawn for fishing, who buys, sells, exhibits for sale, or has in his possession, with a view to selling it, any salmon-spawn. This does not apply to spawn used in artificial fish-culture or for scientific purposes.

"A fine, not to exceed $25, is imposed on any person who catches, has in his possession, or sells a smolt, (young salmon;) who places contrivances in the water which delay the salmon on their journey; who intentionally damages salmon; who disturbs fish-spawn, spawning places, or shallow places where there might be salmon-spawn; or who prevents salmon from going to the spawning places.

"The district-board is empowered to use all suitable means for preventing the entrance of salmon into narrow streams or into spawning places where the eggs might be exposed to destruction; provided that industrial or agricultural establishments, and especially drainage, or any water-rights, shall not be injured thereby.

"A fine, not to exceed $25 for every fish, is imposed on any person who catches spawning salmon, or who buys, sells, or has such in his possession.

"Salmon which are intended for exportation must be registered by special officers of customs, in order that the law providing seasons of protection may not be violated. Persons who violate this rule, including those who ship the fish, are punished with a fine, not to exceed $10, for every salmon. Custom-house officers have the unlimited right of searching after salmon.

"The owner or lessee of a fishery must remove all fishing-vessels, oars, nets, and other apparatus used in salmon-fishing from the waters, from the landing-places and the portions of ground near to them within thirty-six hours after the commencement of the annual season of protection, and secure them in such a manner as to prevent their use during this season. Exceptions are made only for boats and oars used in line-fishing. At the same time, all *heks* of the *cruives* must be removed, as well as all planks and contrivances which might hinder the free passage of the fish through the *cruives*. Persons who violate these rules have their boats, nets, &c., confiscated, and are punished with a fine, not to exceed $50, for every day after the time mentioned.

"Ferry-boats must be marked with the name of the owner, and must, when not used, be kept under lock and key.

"The by-laws for the separate waters contain suitable regulations for observing the weekly season of protection, for using poles, weirs, pole-nets, fly-nets, and sack-nets. Persons violating any of these regulations are punished with a general fine, not to exceed $50 for every net used, and a special fine, not to exceed $10 for every salmon caught, during the weekly season of protection.

"Every constable, overseer, or officer of the district-board, as well as every police-officer, has the right to examine every boat, net, and other fishing-apparatus in the water, or to have them brought on shore, and to confiscate any salmon which have been caught contrary to law or which are found in the possession of non-privileged persons. For the right to fish in waters beyond the district, a written order from the sheriff or justice of the peace is required, which must be issued on the oath of some police-officer of the district that the person desiring such order is not in any way a suspicious person.

"Any person can, even without a special order, take up any violator of the above regulations, and take him before a sheriff or justice of the peace or any other magistrate, or have him taken there by a constable. He is then to be heard immediately, and according to the circumstances of the case, or, in default of bail, be kept in confinement till the next meeting of the court.

"All violators of the ordinance can be prosecuted before any sheriff, or before two or more judges who have the jurisdiction in the place where the law was violated, even if the clerk of the district court or any other person possessing the right should interfere; and the fines mentioned in the act can be imposed by such courts. The act prescribes a special summary procedure for such cases.

"Conviction in any case of violating the aforesaid act also involves the loss of all boats, nets, lines, hooks, spears, lances, or other implements used, as well as of all the salmon found in the possession of the transgressor. The objects which have been confiscated are either to be destroyed or handed to the district-board or to any person who acts as plaintiff in the case.

"If a person is convicted of two violations of the law at one and the same time, the fine must not be less than one-half of the highest amount for each violation; and, if convicted a third time, not below the highest amount fixed by law.

"No justice of the peace should be considered incompetent because he is a member of a district-board. No judge, however, shall preside in a case of violation of law committed in his own waters.

"If a law has been violated on some water forming the boundary-line between two counties, the case may be prosecuted in either county. If the law has been violated on the sea-coast or on the sea beyond the jurisdiction of a sheriff or justice of the peace, it is to be considered as if committed within the limits of some county bordering on the coast.

"All fines imposed by this act, and costs, can be assessed on a common complaint or before the debtors' court. The clerk of the district-board is entitled to receive all such moneys. The district-board may use all money coming from such sources in meeting the expenses of carrying out the regulations of this act."

23.—FISHING-PRIVILEGES AND FISHING-LAWS IN AUSTRIA.

A review of the fishing-privileges granted in olden times in the several provinces of Austria, and of the old fishing-laws, possesses not merely a great historic interest, but is likewise useful, because a portion of these, even some very old ones, have not been changed in the course of time, and because all of them frequently throw much light on the various demands which even a modern law must take into account. Many of the older laws, though their form be antiquated, therefore in many respects form the best guides for the framers of new ones.

The question which of the older laws are still in force is a very difficult one, and the following review, which divides them into old and still existing fishing-laws does not claim to be complete nor to be entirely free from errors.

Old fishing-laws.—A large portion of legislation, especially with regard to economical matters, and therefore also to the fisheries, was formerly in the hands of lower autonomous bodies, such as villages, towns, and corporations, and of smaller landed proprietors.

We therefore find numerous fishing-regulations from the oldest times in the legal documents containing the privileges of villages and landed proprietors. These ordinances partly define the limits of the fisheries, and partly prescribe the manner in which they are to be carried on.

The older documents frequently consider the catching of fish as a privilege belonging to the community or to the landed proprietors; but from the fifteenth century the right had fallen almost entirely into the hands of the government.

To mention a few examples: the Lower Austrian Law-Book of Möllersdorf, in the archbishopric of Vienna, gives the right to fish in the water called the Müll to the community of Möllersdorf. The king's bailiff and the bailiff of the convent-chapter are allowed to go to the water on Fridays and catch a "dish of fish." Strangers are not allowed to catch fish or crawfish, either with "tools" or with their hands. (Kaltenbäck, *Österreichische Rechtsbücher*, I, 482.) In Oberwaltersdorf, the community likewise possess a fishing grounds; the fisherman is appointed by the community, but is not allowed to sell fish to any one, unless he has called them three times on the bridge. Every person who sits "at his own fire-place" may fish in the stream with hook and line, (I, 35.) Similar regulations are given in the Lebarn Law-Book, (II, 114.)

According to the old Law-Book of Neunkirchen, the citizens of the town have the right to fish; servants who fish when not in the company of their master are punished. A later appendix to this law-book likewise indicates the transfer of the fishing-privileges in the following words: "When the market was changed, the fisheries were likewise changed, so that henceforth neither citizen nor servant is allowed to fish." (I, 488.)

In Minkendorf, every miller is allowed to fish as far as he can throw his "*bille*" (instrument used for sharpening the millstones) from his mill-wheel, either up or down the stream, (I, 541.)

In Moravia, the neighbors of millers' wives are allowed to fish every Thursday in the afternoon, and every Friday in the forenoon, and during the season when the ice and water flow from the mountains for three days in succession. (Chlumecky, *Märische Dorfweisthümer*, *Archiv für Kunde österreichischer Geschichtsquellen*, XVII, 70.)

In villages or towns where all the ground belongs to a landed proprietor, the fisheries likewise belong to him. The old law-books say, in such cases, that to him belong "the fish in the water," "the fish in the stream," "the fish in the pond," "the fish on the sand," &c. In all such domains, there were, however, free waters in which every one was allowed to fish.

On lakes and rivers where fishing is carried on as a trade, the privilege holders form an association, and have as such their own law-books, their autonomous and judicial power. They make their own regulations, and in their own court of justice decide all disputes between members of the association, and punish violations of the law. The lord of the manor, or his representative, presides at these courts of fishing-associations, as well as in village-courts. This applies as well to those free communities which elect their own presiding officers as in domains in which the fishing grounds belongs to the lord of the manor, while the villagers have only certain rights, either hereditary or temporary, which must be paid for in a certain annual number of fish or by some work.

On the Gmunden Lake, the fishery court was held every year on the days of the fishing apostles Philip and James, and, later, on St. Peter's day, and the mayor of the village of Ort presided, under the title, "Lake-judge." In special cases, the lord of the manor may call the court together on other days.

The prelate of Klosterneuburg holds an annual fish-court at that place, with the master-fishers of the Danube and their servants. Similar courts are held at St. Georgen on the Traisen. (Kaltenbäck, I, 600; II, 107 and 108.)

The law-book of Ort, on the fisheries of the Traun and Gmunden Lakes, gives very exact rules regarding nets and other fishing-implements; on the seasons when the various kinds of fish in these lakes may be caught; on the minimum length below which they must not be caught; of the rights of the individual fishermen; the fish-trade; punishments; the duties which fishermen owe to the lord of the manor, and especially the right of the latter to be the first bidder on all fish caught, &c.

This law-book is, like many old documents of the kind, arranged in the form of questions and answers. The questions are, as in our modern courts of law, addressed by the presiding judge to the jurors, or, as they are here called, "Schranne," (Old-German;) and the foreman of the jury, appointed by the community, gives the answers in the name of the jurors, and all the assembled citizens of the community or members of the association. If these answers meet with no objections from the assembly, they are considered as "judgments." The fish-court is opened by the judge with the well-known introductory questions, "Is this the right hour, day, and time that I should open the fish-court on the Traun Lake, as has been done from times of old?" The foreman answers, "Your honor, the judge of the fish-court, since you ask me whether this be the right time that you should hold a fish-court in the county of Ort, I solemnly affirm that this is the day, hour, and time that such fish-court should be held, seeing that this is St. James's Day." In this manner, the fishing-laws, as they have been in force on this lake from time immemorial, are given, with occasional later additions or changes, by "question and judgment," on every article of the law, on each commandment or prohibition.

From all these old documents we see that the fishermen's trade in its connection with agriculture was organized in a practical and liberal manner, with much of that spirit of self-government which does not shrink from energetic measures whenever these are considered necessary and practical.

The oftener attempts are made, on the one hand, especially in the larger waters, streams, and lakes, to enforce the royal prerogatives in the matter of fishing-privileges, and the more, on the other hand, the ownership of the fisheries by the monarch incites his disposition to control them, the more does this autonomous legislation of the lower classes disappear. From the sixteenth century, we find the fisheries more and more regulated by state legislation, by rules and regulations for certain provinces or for certain waters, and from time to time measures taken to make them more productive, and to prevent the reckless plundering of the waters by the lower classes.

Some of these government fishing-regulations date very far back. Instead of merely enumerating a great many of these provisions with their date, we shall attempt to give a fuller review of some of the laws enacted by the Upper Austrian government.

But few traces are found in these regulations of the fishing-privileges of olden times, when they formed an integral part of the common rights of each community to field and forest, because these societies, or, as they are usually called in Austria, these "neighborhoods," which had fields and meadows in common, still retained the right of fishing in those waters which were the property of the people at large. In the larger waters, especially in the lakes, the right to fish was in most cases a special privilege, some of these dating back as far as the time of Charlemagne. In granting such favors, a distinction is made between "large" and "small" privileges, differing according to the fishing-implements used. Thus, we read, in a document dated 813, "*Segena una ad piscandum.*" (*Mon. Boic*, 85.) By the term "*segena*" is meant a large drag-net, with all the fishing-apparatus belonging to it, large and small boats, and implements of every kind; sometimes this word also implies the fishing-privilege, and occasionally the district where such privilege may be exercised.

Besides the *segenæ*, or great fishers, there were small "carriers," or small fishers, who again were subdivided into "*Gärnlers*," (literally "netters,") who were allowed to use bow-nets, and "*Schnürer*," (literally "liners,") who were only allowed to use hooks and lines.

The oldest fishing-law of Upper Austria is that established by the Emperor Maximilian I, March 7, 1499, which is preserved in the archives at Linz. In this law, the emperor charges his vice-regent in the country above the Enns, George von Loserstein, to regulate the fisheries in the river Traun from the Falls to the Danube.

This law contains a paragraph ordering the fishermen only to use *segenæ*, or bow-nets, with meshes of a certain size, and to throw out all all fish which have not the prescribed length.

The government prescribed the size of the meshes on certain small stamped pieces of board, which were to serve as models for those blocks on which the fishermen knit their nets. Illustrations of such model blocks are frequently met with in old fishing-laws, and also pictures of fish of the exact size below which they must not be caught. Such pictures were frequently hung up in town and city halls, and may yet be seen there, as in the city-hall of Zürich.

A very similar fishing-law was proclaimed February 1, 1537, by the Emperor Ferdinand I. This law enumerates those fishing-implements which are entirely prohibited, such as double drag-nets, the outer one having smaller meshes than the inner one. It also prohibits the catching of fish during the spawning season. Specially appointed fish-masters are to examine the fish-tanks frequently.

A third fishing-law for Upper Austria was enacted by the Emperor Maximilian II, December 31, 1573, which is kept in the register's office for Upper Austria. This law for the greater part is a repetition of former laws, and contains certain limitations for protecting navigation on the river Traun.

Complaints having been raised by the provincial assembly against the former fishing-laws, a new one was proclaimed by the Emperor Rudolf II, June 3, 1583, which has not been displaced by any later code, but which has practically everywhere fallen into disuse. It is contained in the *Codex Austriacus*, I, p. 354, and relates chiefly "to the waters, rivers, and streams containing the greatest wealth of fish, viz, the Danube, Traun, Vökla, Ager, Alm, Krems, Enns, and Heier."

For the lakes, especially for the Mond, Atter, Wolfganger, Hallstädter, and Gmunder Lakes, there were special laws, which the emperor in former times had, to a great extent, examined and amended through his commissioners.

In the general fishing-law, the size of the meshes in all nets is exactly prescribed by a model block, of which an illustration is given in the text. Such a block is to be kept in every town and in every market. The exact size of the openings in box-nets is likewise given. They must not be placed in such a manner as to disturb navigation in the rivers.

No fisherman is allowed to interfere with the fisheries of another. Fishing in the Traun at night-time is entirely prohibited. The drag-nets forbidden by former fishing-laws are now permitted, but only for smaller fish, and during the period from St. Martin's Day (November 11) till Shrove Tuesday.

The owners or lessees of hereditary fisheries must observe the same rules.

Millers, owners of founderies, and other manufacturers shall abstain from all fishing in the waters flowing past their establishments, because thereby the finer kinds of fish might be exterminated, even if some of them should possess the privilege to fish as far as they can throw a hammer or pick. They are forbidden to fish with bow-nets, and even with hook and line, unless they have received a special permit. When, in cases of necessity, they wish to turn off the mill-streams, they must announce their intention to the privilege-holder three days beforehand, in order that the stock of fish be not destroyed. The privilege-holders are obliged to permit this four times a year. In the common or free fishing-waters, no person is allowed to fish, unless he possesses fields and meadows in common with his neighbors.

The neighbors are only allowed to fish two days in every week, viz, Thursdays and Fridays, with small nets with the meshes made of the size of the model block. Fishing at night and the taking of crawfish in the free streams are entirely prohibited. Those living near the waters who find any one violating this rule are empowered to take all his fishing-tackle and fish, and it is provided that the government shall punish the transgressor.

Any person who stuns the fish with prepared pellets so as to enable him to catch them with his hand shall undergo a severe corporal punishment.

No one is allowed to dig pits or to make marshes alongside of a fishing-water, for the purpose of fishing. Wherever there are such pits or marshes, they shall not be shut up when the water rises and fills them, so as to prevent fish which a higher water has brought into them from returning.

Fish remaining in uninclosed pits or marshes may be caught by the proprietor thereof, who is, however, obliged to throw all the young ones into the water. The rotting of hemp and flax in ponds, streams, and fishing-waters is strictly prohibited, and the government shall see to it that special pits and pools for rotting flax and hemp are prepared at a suitable distance from these waters. As the fish at times go from the Traun, the Enns, and other waters, into the Danube, and back again to those rivers, and are frequently prevented from leaving and entering, by the fishermen of the Danube, it is decreed that henceforth neither the Danube fishers nor any other fishermen shall close the streams flowing into that river with stationary nets or any other contrivances.

Fishermen shall be allowed to catch injurious birds in traps all the year round, but shall not injure swans and herons. Royal and other fishermen shall not catch, confine, or sell any fish of the genus *Thymallus*, any pike, carp, or *Salmo hucho*, in private, free, and other waters, unless their length from head to tail is exactly the same as that given on the model board as represented at the end of the fishing-law. If smaller fish get into the nets, which cannot always be prevented, they are immediately to be thrown back into the water. In order to carry out this provision of the law, the authorities, the fish-masters, the market-overseers, shall examine the fish as well in the open markets as in the fishing-huts, fish-tanks, and fish-boxes, and shall punish any persons violating this law.

During one month after St. Simon's Day, (18th February,) no fish except salmon shall be confined, caught, or sold, and no fish of the genus *Thymallus* for two weeks before and two weeks after St. George's Day, (13th April.) The seasons of protection for other fish, as given in older laws, shall be abolished, because there are a number of objections to such an arrangement, and because it can never do full justice to all the different kinds of fish.

The reckless fishing for the *Thymallus vulgaris*, by which the Traun, one of our finest waters, has almost been depopulated, is for the time being entirely forbidden, till the number of this fish has again increased in that river. An exception is made for the imperial table only, which may be provided with young fish caught before St. Catharine's Day, (30th April.)

During the seasons when fishing is prohibited, the authorities. lords of the manor, &c., cannot demand the professional services of the fishermen.

In the other forest streams not mentioned in the law, the lords of the manor, and those of their subjects who own fisheries or fishing-privileges, shall see that the laws are observed; and wherever several persons own a fishing ground in common, they may make an agreement among themselves not to catch fish out of season, nor to catch any which have not the prescribed length, nor to sell or send to market any such fish.

The fishing-law was considerably modified to suit the prejudices of the times, which is shown by the introduction of certificates of sale, and by the close supervision exercised over the sellers of fish, "in order that fish may be sold cheap." From this reason, the arbitrary market-laws of the period regulated the sale of fish. Salmon shall, at the market in Linz, be sold at 14 pfennige (value at the time a little more than 4 cents) apiece, and at 12 kreuzer (somewhat more than 14 cents) the pound, and a young fish of the genus *Thymallus* at 1 kreuzer 2 pfennige, (nearly 2 cents,) &c.

With fish imported from Bohemia or Bavaria, the regulations regarding size have nothing to do. The ordinances regarding the proper carrying-out of all the provisions of the fishing-law by specially appointed fish-masters are very strict.

For the lakes, there were special fish-laws. Such a law was passed in 1544 for the Mond Lake in Upper Austria.

When, in 1858, the district-officers of Upper Austria were asked to report on the fishing-privileges in their respective sections, the officer in whose district the Mond Lake is located reported that the law of 1544 was still in force on this lake so far as police-regulations were concerned; that, as a general rule, these ordinances were well observed, and were in many respects more practical than the draught of the new law which had been sent to him.

The jurisdiction over the Mond Lake belongs partly to the archbishop of Salzburg and partly to the abbot of the Mond Lake convent. Of the fines, one-third belongs to the archbishop and two-thirds to the abbot, exactly in the same manner as the division of fines prescribed in the law-books of Charlemagne, is made between the country law-courts and the lords of the manor. In the country-sessions, the fishery-courts are held every year, and the mutual rights and duties of the lords and other proprietors are defined.

Quarrels and abuses were the causes which, in 1544, led to the fisheries being regulated anew by a treaty between Archbishop Ernst of Salzburg and Sigmund, abbot of the Mond Lake convent.

The owners of the buildings called *segena* houses, do not possess the right to fish in the lake as a free property, nor after the manner of a lease, but as a hereditary privilege, and have in exchange to render service to the lords of the manor.

To the archbishop, and to his hereditary lessees, there belong 5½ fisheries; to the abbot of the Mond Lake convent, 10 fisheries; and to the Lord of Thury, 1. The abbot possesses, besides the 10 fisheries mentioned, which it seems were all rented on hereditary leases, two large fisheries, which supply the convent with fish, called the *dipper* and the *long segena*.

The length of each of these *segenæ* (seines) is accurately described. The *dipper* may be 360 feet long, and the "*long segena*" 276 feet. With the *dipper*, fishing was permitted during Lent, from the fourth Sunday thereof till Easter; at other times, only when the reigning prince comes to the Mond Lake. Fishing with the *long segena* was permitted twice a week, from Saint George's till Saint Michael's Day, (29th September.)

Every hereditary lessee has one broad *segena* 168 to 180 feet long, and a narrow *segena* 120 to 138 feet long. The size of the meshes in each *segena* is fixed very accurately according to the measure given in the fishery-law. Besides drag-nets and bow-nets, stationary nets are permitted for catching *Abramis brama*, *Coregonus Wartmanni*, *Salmo salvelinus*, and pike; their number and size is accurately given; angles are prohibited as well as several other fishing-implements, because the lake had thereby been almost depopulated; the places where each fisherman may operate, and the fishing seasons are very accurately defined.

By a special regulation, the peasants near the Mond Lake are forbidden to dig ponds and stock them with fish, because they are in the habit of taking the food-fish which they require for their ponds from the lake. The peasants had at that time dug a great number of such ponds. The hereditary lessees of fisheries, however, were permitted to have ponds for finer fish, especially for pike.

The length below which pike, *Abramis brama*, *Coregonus Wartmanni*, and *Salmo salvelinus*, must not be caught, is exactly prescribed; the law contains drawings of these fish in their natural size and of the meshes of nets. If smaller fish get into the nets, they shall, without injuring them, be put back into the lake.

The number of fishing-boats, the manner in which they are to be used, and the rules regarding the sale of fish are exactly prescribed. The government has the first bid, as merchants must first offer their fish for sale to the lords of the manor. Even those sent to the court of the archbishop of Salzburg are to be supplied by the fish-merchants in accordance with rules set down by the archi-episcopal fish-master.

The archbishop and the abbot each appoints an overseer of fisheries from the number of his officers. These overseers are to punish all violations of the law, and shall, once or twice a year, examine all fishing-implements and remedy all defects. The fishing-law, like all similar laws, is to be read and revised at the annual fishery-courts.

A law on the catching of fish and crawfish, made for the fishermen and fish-merchants of the city of Vienna in 1557 by the Emperor Ferdinand, regulates the trade in Vienna and shows the great wealth of the industry at the time; numerous places in the city being assigned to the fishermen for selling their stock.

The present fishing-law.—In 1864, reports on the fishing-privileges and fishing-laws of the several provinces of Austria were prepared by the minister of the interior. These reports and other more recent investigations have shown that there is the greatest variety of privileges and laws in the different provinces. The right to fish, especially in public waters and lakes, sometimes is claimed by the state as a royal prerogative, sometimes by communities, convents, former lords of the manor or other private individuals, in the shape of a privilege or a free possession, either for or without payment, or is exercised without any privilege or title whatever. Fishing in private waters is sometimes carried on by the owners of the waters or of the shores, sometimes by third persons as an independent right on soil not their own, mostly by former lords of the manor and other private individuals, by convents and communities; all of these basing their rights on widely different titles.

As the middle of running waters is usually considered the boundary-line between villages and townships, judicial and manorial districts, as well as between private properties, and as fishing-privileges usually belong to one of the above mentioned divisions, it is easily explained why numerous grants of this kind in all provinces only extend to the middle of a stream, while other parties have the right to fish in the other half.

In some provinces there are so-called alternate fisheries, in which the right to fish successively passes from one person to another at certain stated periods, usually one year.

Many fishing-privileges of different kinds are connected with mills and other water-works; such grants being mostly limited to mill-dams or to running water as far as a hammer can be thrown both up and down the stream, a custom evidently a remnant of the Middle Ages.

Fishing is sometimes an independent right, recorded in the law-books as a special grant; sometimes a right connected with some other privileges, or a right which may be sold, and as such entered on the public records. In some parts of the country, the fishing-waters are entirely free as they were in the Middle Ages; in others, they are the common property of communities; in the former, any one may fish, and in the latter, all citizens of the community. As the old limitations for such waters, such as that of fishing on certain days of the week and the use of prescribed fishing-implements, have been abolished, such waters have been recklessly plundered, and have consequently been almost depopulated.

In many lakes of Upper Austria, the fishing-privileges are very ancient, and entered on the oldest documents, which prove how carefully such rights were maintained in the olden times. In later times, however, we hear of complaints that these rights were no longer properly respected; that irregularities began to occur; and that at present the actual possession no longer tallies with the long neglected books; and that there is a universal desire to have order restored.

The question whether courts of law or the executive officers have to decide on fishing-privileges has, for a long time, been in practice answered in different ways. The ministry of the interior and the ministry of agriculture, to which all matters pertaining to the fisheries have been referred, have repeatedly decided that, in accordance with existing laws, the ultimate decision regarding the title to, and the possession of, waters, and the legal and actual possession of rights to fish in waters not one's own, wherever such matters do not come within the jurisdiction of the authorities appointed for regulating the buying-off of privileges, should rest with the courts.

The regulations regarding fishing are, in the older laws, usually combined with those regarding fishing-privileges. Most of these laws only relate to one province, and frequently only to one lake or stream.

Several river police-regulations also contain paragraphs on fishing;

thus, in Lower Austria, those for the lower part of the river March, dated May 7, 1825, Z.* 2739; those for the Danube of March 30, 1828, Z. 10198, § 23, (both in the Lower Austrian collection of laws No. 29 and No. 62.) The Styrian river police-regulations of October 9, 1826, section IV, contain such paragraphs for the rivers Mur, Drau, Save, and Sann, as well as special paragraphs regarding the other rivers and streams. (*Provinciale Gesetz-sammlung* 1826, vol. 8, page 228.)

Among the special laws which relate to the fishing-privileges, and to some extent also to the fisheries, the following deserve especial mention. The ordinance of the Empress Maria Theresa of March 21, 1771, is almost universally recognized as a binding law, though rarely carried out in practice, (*Gesetz-sammlung Kaiser Josef* II., vol. 8, page 506.) Referring to the ordinances of June 3, 1583, June 25, 1720, and June 12, 1728, this ordinance decides that no person is allowed to fish except owners of the waters, and those who, having learned the fishing-trade, have rented a privilege; fish of all those kinds which reach a heavier weight than one pound, such as pike, carp, &c., must not be caught if they weigh less; and those which do not reach a heavier weight, such as the perch, tench, &c., if they weigh less than one-fourth of a pound. The catching of young fish with narrow meshed nets of any kind is considered injurious to the fisheries; very narrow meshes are forbidden; their width shall not be less than one square inch; only exceptionally are smaller meshes allowed for catching very small fry to be used as fish-food. The use of hook and line is only prohibited in shallow water.

For fishing under the ice, a special permit is required. Forbidden fishing-tackle will be confiscated, and all persons violating these regulations will be punished in such a manner as the judge considers proper.

The royal ordinances of July 18, 1819, Z. 21529, (*Politische Gesetz-sammlung*, 1819, vol. 47,) and of July 23, 1829, Z. 9827, prohibitthe use of *cocculus indicus* and of *nux vomica* in fishing, and are in force in all the provinces of Austria.

For *Lower Austria*, a *tractatus de juribus incorporalibus* was promul gated in 1679. It is contained in the *Codex Austriacus*, I, p. 599, and partly also applies to other provinces, especially to Upper Austria. In its tenth section it treats of the fisheries. Unlawful fishing is prohibited by several ordinances, such as those of May 9, 1799, and May 30, 1823.

The inquiries with regard to the statistics of Lower Austria, made by the agricultural district societies, have shown that in most parts of this province the present arrangement of the fishing-privileges throws the greatest impediment in the way of all progress.

In some parts of the province, the domains rent their fishing-privileges in several small portions, in order to keep themselves in possession for the time being; for the division of privileges and disputes with the

* Z., abbreviation for "Ziffer," meaning figure, usually referring to the page of the law-book.—*Translator.*

lessees do not allow regular fisheries to be carried on. As an example, we mention those in the river Ybbs.

In this river, which once possessed a great wealth of fish, the right to catch on one bank belongs to the domain of Waidhofen, which rents it to numerous small lessees, while on the other bank it belongs to several peasants. All this does more harm to the fisheries than the floating of lumber in long rafts, recently introduced in the Ybbs, which, in some places, turn up the ground, and which, in the upper portions of the river, are moved by a rapid stream of water, which has been dammed up and suddenly let loose.

On account of the greater economical value of the lumber-trade, these evils have to be borne; if the fishing-privileges, however, were better regulated, the protected portions of the Ybbs and its tributaries might still contain a reasonable number of fish.

Salzburg is an example of a most fully-developed royal fishing-prerogative. Even here the privileges were in olden times considered as being an essential portion of landed possessions, and were in the oldest deeds of transfer of real estate given over to the new proprietor, with all other water-rights as part and parcel of the property, as is shown by the usual form of such documents: "*una cum campis, silvis, acquis acquarumque decursibus.*" In the lakes, however, there existed, even in the oldest times, special fishing-privileges, so-called *segenæ*, as in other provinces.

As in Salzburg the game and forest prerogatives of the archbishops have been established since the fifteenth and sixteenth centuries, the fisheries were in nearly all places included in these prerogatives and declared as such in the law-books, particularly in the archiepiscopal fishing-law.

The Salzburg fisheries were therefore organized in the following manner. There were:

1. Archiepiscopal lakes, or kitchen-lakes, in which no one was allowed to fish except the specially appointed court-fishers, who had to sell their stock, for a certain stipulated price, to the archiepiscopal kitchen. These were the Fuschel, Hinter, Tappenkar, and the Little Ael Lakes, likewise the Abbot Lake in Bavaria.

2. Lakes with hereditary leases, the Zeller, Matt, Waller, and Aber Lakes, and the Waginger Lake in Bavaria. In some of these the leases were given by the archbishop, some by the cathedral chapter, by other chapters, domains, &c.

On the Atter, Mond, Irr, and Zeller Lakes, in the neighboring province of Upper Austria, the archbishop likewise possessed some fishing-privileges.

3. The fisheries in the streams and rivers of Salzach were either under the protection of the archbishop, and given to specially appointed fishermen in exchange for a certain amount of fish and money, which helped to suppy the court kitchen, or they were rented out annually for a cer-

tain amount of fish and money. The officers of the government and clergymen received a stipulated supply of fish yearly.

The following list shows the number caught, of which an account was taken in 1804, at the Salzburg fishery-office; these being partly used in the court-kitchen and partly sold or given away.

	Pounds avoirdupois.
Saibling, (*Salmo salvelinus*)	5,166¼
Rutte, (*Lota vulgaris*)	240⅝
Forelle, (*Trutta fario*)	3,909⅜
Asch, (*Thymallus vulgaris*)	125½
Lake-trout, (*Trutta lacustris*)	486⅞
Hucho, (*Salmo hucho*)	310
Perch, (*Perca fluviatilis*)	$89\frac{1}{16}$
Waller, (*Silurus glanis*)	197½
Hecht, (*Esox lucius*)	4,885
Carp, (*Cyprinus carpio* and *var*)	2,038¾
Renke, (*Coregonus Wartmanni*,) (fresh)	5,850
Renke, (*Coregonus Wartmanni*,) (salted)	2,465
Schleihe, (*Tinca vulgaris*)	$431\frac{9}{16}$
Weissfisch, (*Alburnus lucidus*)	40
Schrätzer, (*Accrina Schraitzer*)	70⅝
Brachsen, (*Abramis brama*)	
Alte, (*Squalius cephalus*)	198⅛
Grundel, (*Gobio fluviatilis*)	
Koppen, (*Cottus Gobio*)	218¾
Pfrille, (*Phoxinus lævis*)	62½
Table crawfish	16,452½
Soup-crawfish	65⅚

From the archbishops, the fishing-privileges were transferred to the crown; and of late years they have been leased to some extent to private individuals.

Exceptions are only made with regard to a few small bodies of water, which convents or chapters have possessed as special grants from time immemorial, or which fishermen have held on hereditary leases, and which now, in consequence of the buying-up of all old privileges or servitude-rights resting upon the lands, are held by the fisherman in free possession.

The archbishops had preserved the fisheries as their property through numerous fishing-laws, as in the case of that of 1507, made by Archbishop Leonhard Kreutschach; of 1590, by Wolf Dietrich; of 1767, by Sigismund von Schrattenbach. For the lakes, there were special laws, which have never been officially rescinded, but which have gradually fallen into disuse. The Salzburg Historical Society has published some of them in its reports, vols. V and VI, among others the law relating to the Waller Lake, made by the Archbishop Cardinal Matthäus Lang, (1519–'40;) another one of 1567; the revised fishing-code relating to the

Matt Lake, made by the Archbishop Marcus Sitticus, in 1617; one relating to the Aber Lake, of 1692; and one for the Zeller Lake, of 1641.

Some provisions of these laws are also entered on the old statute-books. The common law of Altenthan, a district of Salzburg, dated 1625, prohibits the building of weirs in waters without special permission, "since the streams belong to the authorities, and because the fish would be much disturbed thereby." (*Salzburgische Taidinge, herausgegefen von der Akademie der Wissenschaften*, p. 24.)

A more recent law is the one passed by the Salzburg provincial government February 13, 1856, Z. 13666, which forbids fishing in the so-called "beaver-dams," marshy ponds much frequented by the beavers on account of the many willows. The same law allows fishing at night only after previous announcement to the forest-officers, and obliges fishermen to submit to the examination of their fish, baskets, boxes, or tanks by the officers, whenever these think it necessary.

The injudicious manner in which the Salzburg government till quite recently cut up its fishing-waters by either selling or renting them on short time in very small divisions—the lakes in very insignificant little patches, and the running waters frequently by shores—caused a petition to be addressed to the Salzburg assembly, asking that these small subdivisions be discontinued.

In *Styria*, great attention was in olden times given to the fisheries and the fishing-laws. A court fish-master was appointed, having his residence at Graz, and an inspector for Upper Styria to watch over the several privileges, especially the royal prerogatives, both possessing the most unlimited judicial and police powers. Since 1790, when a regular police was introduced, "the authority of these two mentioned officers began to be ignored," as we learn from a report. The court fish-master gradually became a privileged fish-merchant; the office of inspector disappeared entirely; and the numerous fishing-laws, such as those of March 24, 1641, March 9, 1673, February 27, 1676, May 30, 1699, May 24, 1747, March 21, 1771, fell into disuse, were lost from the archives, and forgotten by the people. In place of a regular system of fisheries, we find plundering expeditions by foreigners, and the most reckless capture of fish by privilege-holders and lessees.

A circular of the imperial government for the central provinces of Austria, dated February 24, 1790, had to be published to counteract the wide-spread "erroneous idea of the general freedom of fishing and hunting," and urged the holders of privileges to maintain themselves in their undisturbed possession, for the reason that they had obtained them "*titulo oneroso.*"

At present, we see nothing else in Styria but constant quarrels between privilege-holders and communities, over small domain fishing-privileges, which partly had their root in the feudal system, and which form a serious obstacle in the way of progress, as such small waters are not infrequently leased in smaller subdivisions, and are thoroughly exhausted by the lessees.

Owners of land even now consider themselves in most places as privileged to fish, and do not allow any fisherman or lessee to come on their property, even if no damage is done, threatening them and driving them away. Everybody fishes, and there is no supervision attempted, as it could scarcely be carried through. No more complaints are therefore made as to unlawful fishing; many of the privilege-holders consider their rights as almost lost, and wish to sell them out.

This, of course, strengthens the erroneous views which the larger portion of the population entertain.

Even in those parts where fishing-privileges are still somewhat respected, the organization of the industry is not much better. The privilege-holders rent their grounds in small portions and on short time, and the lessees catch everything that swims in the water.

Here and there we find fishing-privileges belonging to a number of persons in common; also so-called alternate fishing-privileges, (see above.) A reporter calls all these, "privileges for plundering and destroying."

In *Carinthia*, provisions are made for the fisheries in the law made by Charles VI, 1577, § 29, and also by a special resolution of the Carinthian assembly, passed June 17, 1715, and the privileges of lords and landed proprietors have been protected. Towns and market-places which have their own independent law-courts likewise possess the fishing-privilege.

The last reports complain very much of the senseless system of plundering, thieving, insufficient protection, and of the antiquated forms which are in the way of a healthy development of the fisheries. By these evils, it is said, the finest fish-waters are depopulated, and this, as well as the low price paid for the products, sufficiently explains the decline of the Carinthian fisheries.

At the general meeting of the Carinthian Agricultural Society, held January 25, 1872, a strong and almost universal desire was expressed to have the fishing-privileges bought off. Although the necessity for such a measure was fully recognized, no resolution was passed.

In *Carniola*, the state of affairs is very similar. Here also there are in some parts of the country alternate fishing-privileges, the fisheries changing owners every year or at longer intervals. No one doubts that such privileges are injurious to the fisheries, and both the Carniola assembly and the agricultural society have strongly urged their abolition.

By government ordinances of June 27, 1852, Z. 4881, (*Landesgesetzblatt*, XXV, p. 510,) and of September 18, 1852, Z. 8045, fishing-permits have been introduced in Carniola.

Istria does not possess any fresh-water fisheries of importance. The forest-streams mostly dry up during the summer; the Arsa Canal, which is fed from the Lake of Ceppich, the lake itself, and the small rivers Quieto and Risano, are but little suited for fisheries.

Görz and *Gradisca* possess fresh-water fisheries in the Isonzo and its tributaries, and in Wippach. The other streams have a full supply of water only during continued heavy rains, and the coast streams and canals are of no importance.

During the sessions of the Ecumenical Council of 1870, trout were for the first time sent regularly from Görz to Rome. It is thought that artificial fish-culture could be successfully introduced through associations. At present, there are no fishing-laws whatever.

Dalmatia is, according to Heckel and Kner, a very interesting country for ichthyologists, not on account of its wealth of fish, but on account of its great number of fresh-water species. In this respect, it is the most interesting portion of Austria; for, in its, for the greater part, insignificant streams, it has not only many species of fish similar to those of Lombardy and Southern Italy, but likewise a great many which are peculiar to this province, and which, continuing through Bosnia toward the East, are related to Syrian fish, and through these again to those of India.

It must, therefore, be regretted, from a purely scientific point of view, that pisciculture, like nearly all other branches of culture, is entirely neglected in this province.

Besides numerous smaller streams, which are entirely dry during summer, Dalmatia has several coast rivers and lakes. The former are particularly rich in fish near their mouths, which actually form arms or bays of the sea. Especially is this the case with the river Narenta, which is rich in eels, pike, and other fish. The total absence of any fishing-laws and regulations has prevented fishing in the rivers and lakes from becoming a source of income to the population.

Fishing in the rivers is generally free; only in some portions thereof the privilege to catch trout and eels has been reserved to private individuals, communities, or corporations, such as convents, through so-called "investitures;" legal documents dating from the times of the Venetian Republic: thus, the Franciscan convent of Vissovaz has the exclusive right to fish in the river Kerka, from the Slap Falls to the Scardona Falls; and the village of Almissa has the same exclusive right at the mouth of the river Cettina. In many waters, the fisheries were rented by the government, which is still the case at the mouth of the Narenta. Fresh-water fish are never offered for sale, and there is no market for them.

In the marshes and waters of the Narenta Valley, there were, in former times, extensive eel-fisheries; but these have likewise decreased very much in value through the unpardonable neglect of the last few years.

The government has the right to fish at the mouths of the Norino and Pranjak, in the Jesero-Malo and the Cernarizza, in the valley of Cutti, likewise at the mouth of the Pulinica, in the district of Logorie, which right is mostly rented. The total annual revenue was, however, only about $56. The village of Fort Opus has, through a grant from the former republic of Venice, the right to catch eels in the lake of Dragace, and in the river Jassenica-Struga. The income from these fisheries scarcely amounts to $100 per annum.

In *Tyrol*, there were fishing-laws enacted in 1575, 1753, and 1768; sections XVI to XXI of the 4th book of the common law of Tyrol, of 1573, also treat of the fisheries. In many parts of Tyrol, fishing is free; and in the remaining rivers, streams, and lakes, the fisheries belong to private individuals, village-communities, and landed proprietors, but especially to the state. The right to fish has frequently been acquired by purchase-deeds and other documents, and is in some cases subjected to taxation.

In the district of Bozen, there are several important fishing-grounds, which are considered as belonging to no one in particular, and where, consequently, anybody may fish.

Tyrol has several lakes, rivers, and numerous clear, mountain streams, which formerly were full of fish, and which in every respect are well suited for spawning places, places of safety, and waters where the finer kinds might be successfully raised.

According to a report of the fish-master, Wolfgang Hochleitner, of the year 1504, whole wagon-loads of fish came annually to Innsbruck from the Achen Lake alone.

Even to this day, the finer kind of fish are represented, some of them in Northern Tyrol, in the territory of the Danube, some of them in Southern Tyrol, in the territory of the Etsch, some again in the lakes, and some throughout the whole province; but their number has decreased very much, through reckless plundering, carelessness, and complete want of protection, so that in the markets, especially those of Southern Tyrol, only foreign fish are offered for sale.

In *Vorarlberg*, a full report on fishing-privileges has been made at the suggestion of Mr. Joseph Tiefenthaler.

Small as is this province, it, nevertheless, possesses the greatest variety of fishing-privileges. There are waters in which the state possesses the royal prerogative, and which are rented to private individuals, waters belonging to domains, waters which belong to the villages on whose territory they are found, and waters in which only those living near the shore have the right to fish. Some waters are partly in the possession of private persons, possessing their rights to fish through deeds of purchase; while other portions of the same waters are entirely free, fishing in them being carried on only by peasant boys; and of some waters it could not, even after the most thorough investigation, be ascertained to whom they belong.

Of the state fishing-privilege in the Rhine, small portions were sold to private individuals in 1858, so that only the following sections are left to it: from the mouth of the river Ill to the Lichtenstein boundary, about 6,000 feet on the Austrian side of the river; the Ill from Feldkirch upward to its source in the Montafone Valley; and the Dornbirner-Ach to its mouth.

The Vorarlberg Agricultural Society justly regrets that the senseless subdivision of the fishing-waters into insignificant patches throws almost insurmountable obstacles in the way of successful fish-culture; and these small patches of water have recently been still further subdivided, thus lowering the value of the fisheries still more.

In *Galicia*, several reports have during the last years been made regarding the fishing-privileges. These, on the strength of some old Polish and other laws, in some cases have been defined as rights pertaining to domains; in others, as royal prerogatives, or as rights belonging to the inhabitants of the shores or banks.

By a statute of Casimir the Great, dated 1346, fishing in rivers and streams in the former kingdom of Poland was declared to be the exclusive right of the inhabitants of towns or villages located on their banks; such right to belong to them as long as these rivers and streams remain in their original beds.

From this, as well as from a second statute of Casimir, dated 1457, and from another published by King Sigismund II, dated 1507, we see that even the common laboring people were permitted to fish.

By the statutes of Casimir Jagello, 1447, and Johann Albert, 1496, the rivers were distinguished as royal and free, in order to diminish abuses; and it was ordered that no weirs or poles should be allowed, but only nets.

It was claimed in the reports, in favor of the domains, that, in the kingdom of Poland, by its old constitution, all land lying within the jurisdiction of a landed proprietor was his absolute property; and that the lands given to the serfs, who themselves were property, only belonged to them as long as their master thought proper; and that consequently the fisheries on his land were likewise his absolute property. It was maintained that, by the charter which King Stephen Bathory signed at his election in 1576, the entire usufruct from lands had been made over to the owners; neither the king nor his successors having any right to deprive them of it. When Galicia became an Austrian province, the privileges of the landed proprietors were not interfered with. The government ordinance of May 6, 1808, was also thought to be in favor of the landed proprietors, as it says that the *Soltyssen* (free peasants) did not possess the right to grind corn, to cut wood, to sell beer, wine, and liquor, and to fish, even if these pursuits should be mentioned in the privileges of the *Soltyssen*, and they should actually be in the enjoyment of such rights. It was finally claimed that the imperial decree of January 31, 1823, had declared fishing to be among the prerogatives of landed proprietors.

To all these claims it was objected that the statute of Casimir, given in 1346, did not speak of landed proprietors, but of the inhabitants of villages on the banks of rivers and streams; that later statutes declared the rivers to be royal and free; that Stephen Bathory's charter only guaranteed to the nobility the usufruct of lands belonging to them, and not of the royal rivers; that the government ordinance of 1808 had been expressly annulled by the ordinance of March 26, 1826. It was said that the royal decree of January 31, 1823, had only exempted the fisheries from the tax on landed property, and had placed them under the category of trade-taxes; §§ 3 to 6 and 9 of part II, as well as §§ 108, 110, 111, and 113 of the old Galician law of 1797, proved that fishing in the public waters was not an exclusive right of the landed proprietors, but a prerogative of the state or of those persons to whom the state had granted it.

When these different views of the Galician authorities were laid before the imperial ministries in 1864, they resolved that in Galicia also the fishing-privilege should be considered a private right, because the general law in its § 414 had enumerated it among the other private privileges, and that no other explanation was possible; that, therefore, in Galicia, in public as well as in private waters, the actual possession, based on many different titles, should be recognized before the law as the only valid one. In this sense, the ministry of finance, in its decree of June 19, 1865, Z. 2711, directed the provincial finance-office at Lemberg not to enforce an exclusive fishing-privilege of the state in the rivers of Galicia, and that matters in this respect should remain *in statu quo* till otherwise regulated by some new law.

The reports of former Galician officials and of the Galician agricultural societies faithfully depict the chaotic state of the fishing-laws, which, in many parts of the province, had almost entirely exhausted this source of national wealth, and had seriously injured the salmon and sturgeon fisheries in the Galician rivers, which had formerly been very extensive. In some districts, the fisheries are carried on by the landowners; in others, they are managed by the village-communities as the common property thereof, and the revenues derived from them are used for meeting the common expenditure; while, in other parts, they are the independent property of private individuals.

One of the reporters writes: "The lower classes consider fishing in rivers and streams as belonging to nobody; at every season of the year, people practice it in the most reckless manner, and the privileges of other persons are entirely disregarded, since they are in no wise protected. The disorder exceeds all bounds; the most injurious methods of fishing are freely employed; and, contrary to common sense and law, the fishing in the rivers is carried on in such a manner as to hasten its entire destruction."

In *Bukowina*, which, since its incorporation into the Austrian monarchy, has been treated like Galicia, even in matters concerning which formerly a difference had existed, the condition of affairs has been very much the same.

Bukowina has, in proportion to its area, the largest number of rivers and streams of any Austrian province, and, in former times, had, besides these streams, more than 15,000 acres of ponds. These latter have gradually been decreased to 600 acres; most of the ground gained by draining the ponds being planted with corn, which, so far, has not proved a very profitable speculation.

The majority of the population, especially in the rural districts, belong to the Greek Church, and have to observe one hundred and ninety-four strict fast-days during the year, so that the demand for fish is consequently very large. It has been estimated that $56,000 worth of fish is annually imported into Bukowina from Moldavia and the cities on the North Sea. On account of their high price, these fish are mostly eaten only by the wealthier classes.

The agricultual society at Czernowitz deserves great praise for having recently given its full attention to the fisheries hitherto neglected.

With the exception of the ponds and a few mountain streams, nearly all waters in Bukowina are almost entirely deprived of their former wealth of fish by reason of the utter want of system in all matters pertaining to the fisheries; and it will take a long time for a fishing-law to gain ground.

In *Bohemia*, the revised law of Ferdinand II, dated May 19, 1627, was, till the year 1848, considered the constitution of the country. In consequence of the events which took place then, the political rights of the assembly were limited, but the rights of private persons (*jura privatorum*) were not touched, as will be seen from the preface of the law and from a comparison of its provisions with those of Maximilian's ordinance of 1564, and King Vladislaw's ordinance of 1500, which served as bases for the former, as well as from the charters of the Bohemian cities. In all these laws, the fisheries are protected against "arrogance and violence."

This protection, however, was only afforded to members of the assembly in their relations toward each other, and, according to Maximilian's ordinance, especially against their vassals and their servants; the vassals themselves had at that time no property of their own, and could only exceptionally enjoy the usufruct of property given to them by their masters for a short period, but could never be the actual possessors of any lands.

The laws of Maria Theresa and Joseph II were the first to afford thorough protection to subjects and their property; the ordinance of November 1, 1781, abolishing serfdom, gave a firmer basis to the security of subjects; and the common law declared that they might also hold property.

Thus it came that the fishing-privileges were transferred from their originally exclusive owners, the landed proprietors and the cities, to private individuals, by gift, sale, or exchange; and that they were exercised *de facto* on the ground of these various titles.*

* See Bericht der zur Revision der Fischereigesetze für Böhmen gewählten Landtags-commission of February 14, 1866.

Even in former times, numerous great and small fishing-privileges in rivers and brooks had been hereditary in certain Bohemian families; and the salmon and eel fisheries in the Elbe are carried on by nearly all millers on a large scale at their weirs with an apparatus called *Slup*.

The small fishing-privileges connected with mills and other water-works, especially the right to set so-called automatic traps, are in all countries considered as hostile to our modern civilization and as great obstacles in the way of rational fish-culture. A Bohemian inspector, Director Horak, of Wittingau, calls the salmon and eel traps of the millers on the Elbe and Moldau infernal machines, and remarks that, like the shark, they devour all fish, both young and old. In international treaties, the contracting parties usually agree to abolish such privileges as far as possible.

Among the Bohemian fishing-laws, we mention as important an article from the Bohemian river-police-regulations of February 10, 1854, which says that a permit from the authorities is required for setting salmon-traps in navigable rivers, and likewise decrees that the placing of bow-nets, catch-poles, &c., must not in any way interfere with navigation.

In Moravia, the state of affairs up to 1849 was very similar to that of Bohemia. According to the report, there were many waters in which fishing with hook and line had never been prohibited; and the free catching of crawfish in many running waters has been practiced for centuries.

The practices allowed by the law of 1859, which we shall give more in detail, have, with regard to those fishing-privileges which hitherto belonged to the landed proprietors, produced a state of disorder and uncertainty, which has contributed not a little to the neglect of the fisheries, so that reforms are urgently demanded.

In *Silesia*, the government, at the request of the assembly in 1866, had reports made on the fishing-privileges by the district officers, to be made use of in the preparation of a new law, by which they should be regulated.

Here, likewise, the titles to possession vary very much, and their validity has frequently been questioned. The bishop of Breslau had, from times immemorial, the fishing-privilege of numerous waters, but had likewise many obligations toward the communities, especially with regard to keeping the beds of rivers in order, protecting the banks, furnishing the wood for bridges, &c. Since these obligations have ceased, the fishing-privilege of the bishop is, as the agricultural society complains, found to be a heavy burden.

On the actual state of affairs in Silesia, the report of 1869 says:

"In many waters, everybody is allowed to fish; in some, the community is considered to possess this right, without its being clear whether it possesses it as a corporation, or whether it merely means that any person belonging to such community has the right to fish; sometimes the mayor of a village is mentioned as the privilege-holder, or the clergyman, or some landed proprietor; the fisheries are mostly considered as belonging to the former proprietors of the lands, among them the cities; and, in other cases, the privilege is said to belong to the inhabitants of the banks, and occasionally to these and to everybody."

In Bohemia, Moravia, and Silesia, these privileges are placed in a peculiar position by the regulations for buying them off.

In *Bohemia* and *Moravia*, fishing-privileges on the land of others have been abolished by the ordinances relating to the buying-off of privileges of June 27, 1849, § 4, Z. 3; and in *Silesia*, by the ordinances of July 11, 1849; and an indemnity has only been conceded to the former holders in cases where it could be proved that the privilege was based on a special contract with the owner of the soil.

The regulations for buying off privileges in the other provinces do not contain any paragraphs relating to the fisheries.

When, somewhat later, doubts were raised as to the proper meaning of different regulations, the ministries to whom this matter was referred consulted on them in common. The ministry of justice, in its note of December 30, 1851, Z. 13740, said that the fishing-privileges based on different titles had not been changed in the other provinces; but that in Bohemia, Moravia, and Silesia, this whole question had a different aspect. In these provinces, a change had already been made by the ordinances, (§ 4,) and, based on the abolition of all fishing-privileges on the soil of others, many new property-rights had been established, with, to some extent, respect for legal forms. If the state of affairs existing prior to the year 1848 was to be continued, or, properly speaking, created anew, any measure tending to this end must be preceded by a special law sanctioned by the emperor, declaring the above-mentioned § 4 null and void.

The ministry of the interior thereupon, by its ordinance of January 31, 1852, Z. 460, informed the commissions for regulating the buying-off of privileges, as well as the assemblies of Bohemia, Moravia, and Silesia, that, conditionally on some future possible regulation of these matters, every fishing-privilege which is *not* exercised in waters belonging to others shall be maintained; and that any one who desires to have his property freed from the burdensome, fishing-privileges, in accordance with the above-mentioned § 4, must bring absolute proof that he is the exclusive owner of the property in question, viz, the water, it being understood that all doubts as to the ownership will have to be decided only before the proper court. Wherever the mutual relations of the owner of the property and the holder of the fishing-privilege come under the law of September 7, 1848, the commissions named above have, conditionally on some future regulation of the fishing-privileges, to act in accordance with existing rules.

The other commissions for buying off privileges, and the assemblies, were at the same time informed by the ordinance of January 31, 1852, Z. 460, that by the laws regarding the purchasing of these rights, the fishing-privileges had not been abolished, and should therefore remain as they were in 1847, and that no buying-off should be allowed.

These ordinances have also been published in the official journals of several provinces.

The government of Silesia has at its request been informed by an ordinance of the ministry of the interior, of April 9, 1852, Z. 7997, that protection was not to be afforded to the arbitrary practices introduced in 1848, but to the laws as existing in 1847.

The ministry of justice, in its note of December 30, 1851, Z. 13740, declared that it did not consider it proper to construe the regulations for buying off privileges in such a manner as to make the proof of ownership of ground bordering on the water sufficient evidence as to the ownership of the water, because such an explanation would exceed the legally prescribed functions of the ministry, and would scarcely be noticed by the civil courts. It would then also be necessary, if any one, in accordance with § 4, had put himself in possession of some fishing-privilege, and a dispute should arise on this point with the former holder, that the decision, and therefore also the explanation of the law, should belong to the judge, inasmuch as the commissions themselves are not competent judges in disputes relating to titles of possession.

In reviewing the different notes and proclamations of the ministries in their connection, we are assured, beyond a doubt, that, in 1851 and 1852, they did not consider themselves justified in annulling, by a ministerial ordinance, the Bohemian and Moravian statutes of June 27, 1849, and the Silesian statute of July 11, 1849; and that such action was by no means intended by the ministerial ordinance of January 31, 1852, Z. 460, even if a faulty practice occasionally led to such erroneous views.

That the practice was not the same everywhere is stated expressly in a report on fishing-privileges of the Silesian assembly, (*Stenographische Sitzungsberichte*, 1869, p. 310,) in which it is said that in that province the landed proprietors did not always succeed, and that in fact they made no great exertions to restore the state of affairs that had existed before 1848.

In Bohemia and Moravia, fishing is likewise carried on in some waters by communities, or owners of the shore, without any dispute arising from this. It is an undoubted fact that the fisheries in these provinces have been declining rapidly since the year 1849, since the innumerable small subdivisions of the fishing-waters, where frequently the left bank of a stream has another owner than the right, do not admit of a rational and profitable culture, and since, so far, all attempts at reform have proved failures.

24.—THE BUYING-OFF OF FISHING-PRIVILEGES.

From the foregoing it will be seen what confusion was occasioned among the fishing-privileges in Bohemia, Moravia, and Silesia by carrying out the buying-off measures only to a limited extent. There has been no lack of attempts to solve the many difficult problems which in this respect present themselves in all the provinces of Austria.

The Silesian assembly, in order to put an end to this confusion, by enforcing the ordinance of July 11, 1849, and to give an ear to complaints which were coming in thick and fast, proposed to make a new law declaring fishing in the waters of others, in brooks, and non-navigable rivers, to be abolished, and to give the right to the owner of the river or brook, and, wherever the ownership cannot be properly proved, to the inhabitants on the banks, in proportion to the amount of property they possess. If the fisheries are to be developed, and there is no reason why they should not, there is no other way but to gain over to this cause the owner of the river-bed and the owner of the bank.

The assembly also recommended the method of ascertaining the amount of indemnity mentioned in the ministerial ordinance of July 11, 1849, in those cases where it could be proved that the fishing-privilege was based on a contract made with the owner of the ground. At the same time, it was proposed to establish, as far as possible, large fishing-districts, where the business could be carried on in a rational manner, and to lease them on long time. The net profits from these leases should be distributed among the inhabitants on the shores in due proportion to the extent of their property along the water's edge.

The above recommendations were referred to the committee on agriculture, but no discussion was reached in the assembly.

In the other provinces, the very important question was also frequently discussed, whether there should be any legal provisions prescribing the buying-off of those fishing-privileges which were exercised in the waters of others, or in those between banks owned by others in accordance with the older laws.

The imperial law of May 30, 1869, on those regulations regarding water-rights which are left to the decision of the imperial parliament, in §§ 2 to 7, establishes principles on the juridical character of waters which have been of great importance to the fisheries, and, in its § 2, says expressly that rivers and streams and their tributaries shall be public property from the place where they become navigable for ships or rafts; in § 3, the same is said with certain limitations of other waters; and in § 5, private brooks and other running waters shall, unless otherwise decreed, belong to those tracts of ground over which or between which they flow, in proportion to the length of bank occupied by each piece of ground.

It has been repeatedly proposed to turn over to the state or province all the fisheries, or at least those in the so-called public waters in streams, rivers, lakes, and large brooks; a proper indemnity being, of course, paid to the former privilege-holders. In making such a change, three methods or systems of developing the fisheries may be distinguished.

The first method would be for the state to lease the fisheries in large portions, and by the terms of the lease oblige the lessee to protect and increase the stock of fish. This system is at present in vogue in France and Belgium.

The second method would be for the state to sell the different water-courses and sheets of water in large and properly connected portions, as is done at the present time in England.

According to the third method, the state makes the fisheries free by issuing a certain limited number of fishing-permits, as is done in several cantons of Switzerland.

The two first mentioned methods presuppose that there is a sufficient number of capitalists who are willing to rent or buy the fisheries in large portions, and to carry them on in a rational manner; and all three methods presuppose that the state has become the exclusive proprietor of all the fishing-privileges, either by free agreement, or, as this can be hoped for only in a few exceptional cases, by an intricate and uncertain buying-off system, so that, at any rate, all those persons who earned their living from the fisheries should have no cause to complain.

All these different suppositions and conditions on which a radical change of the fishing-privileges would be beneficial to the fisheries do not exist with us, and the obstacles in the way of reform would be almost insurmountable.

Similar propositions have recently also been made in other countries, as in Italy. But even there, where there is no opposition from principle to such propositions, it is considered necessary, first of all, to make a good fishing-law. The Italian report says, "As soon as such a law shall have shown its beneficial effect, capitalists will be easily found willing to buy or rent our lake-fisheries, and then the time will have arrived to carry out the bold reform which has been proposed."

There is another proposition, to turn over the fisheries in large waters to the town or village communities owning the rights of the shore; and in other waters, ponds excepted, to the owners of the ground along the shore; to facilitate the buying-off in both cases by a law, which law should also, by forming suitable fishing-districts, regulate operations still further, such districts either to be leased or worked in the interest of the inhabitants of the shores.

The fisheries, or the usufruct thereof, were in future to be under control of districts, communities, or private individuals, or of whichever of these had paid the indemnity. The transfer should either be made on a certain day by law, and the indemnity paid later, just as in buying off privileges resting on landed property, and in accordance with the ordinance of September 7, 1848, or, only after the indemnity had been paid, in accordance with the ordinance of July 5, 1853. It should be made either by the authorities or by mutual agreement between the contracting parties.

Some think the provinces ought to issue bonds covering the amount of the exemption, while others would have the communities or private individuals owning the shores furnish the money required to pay the former privilege-holders.

Leaving out of view certain minor details, which could be arranged without much difficulty, the solution of the chief question should have proper regard to the fisheries as well as to social and other relations.

In order to make the owners of the river-beds, or, more properly speaking, of the shores, interested in the development of this industry, it should be considered an important point, when buying off the privileges, to remove out of the way the many causes of disputes between privilege-holders and owners of the shore; and to produce a well-established state of affairs on a secure legal basis. This has been done in Silesia, where the assembly, guided by the above-mentioned considerations, has taken measures to continue the buying-off of fishing-privileges, which had been commenced in accordance with the general regulations for buying off liens resting on landed property, but which so far had not yet been fully carried out.

In several reports, we find the remark that serious complications had arisen since 1848 where former rulers exercise the right of fishing between lands belonging to their former subjects; and that the abolition of fishing-privileges on the waters of others in the three provinces of Bohemia, Moravia, and Silesia had produced a desire in many other provinces to see the same thing accomplished with them. Fishing-privileges have frequently remained objects of dispute in the three above-mentioned provinces, because the regulations regarding them had not yet been fully carried out, and in other provinces, because the titles to property were in many cases not perfectly clear. This applies particularly to the fisheries in mill-streams, or in small tributary rivers, in small brooks, where fishing was rarely carried on, and where the area of the brook was frequently entered in the *Kataster** as belonging to village-communities, or to the persons owning the lands bordering on such brooks; they, at any rate, paying the taxes on such property. It is a natural consequence of such doubts and disputes that the owners of the shore endeavor to keep privilege-holders and superintending officers away from it, and seek to hinder all measures tending to the development of the fisheries.

Wherever such circumstances prevail, we cannot hope to see the fishing-laws carried out vigorously, or to see piscicultural establishments founded; and since the voluntary abolition of the fishing-privileges presents too many difficulties, most holders of them, communities, and

* A book containing the surveys, titles, and ownership of the lands.

owners of shore-lands would consider a law regulating the buying-off of privileges a great benefit.

Leases calculated to improve the condition of the fisheries would take the place of worthless fishing-privileges, from which the owners derive no real benefit; former privilege-holders, especially where they own part of the shore, would be afforded a chance to lease, and smaller owners of shore lands would see their income increasing by the rising rent.

It is hoped that, just as landed proprietors have quietly permitted their farmers to hunt on their property ever since the right has been recognized by the law as forming an integral part of such property, and since the rent forms part of their revenue, so also they will permit the lessees of fisheries, not only to catch, but also to protect fish, and to introduce all those measures, such as fish-passes, places of protection, planting of banks with trees, &c., which are essential to successful fish-culture, but which at present are almost unknown in Austria. Such a hope is also encouraged by the fact that even an extraordinarily large number of fish would do no injury to agriculture, which can certainly not be said of game.

It must not, on the other hand, be overlooked that, by abolishing the old fishing-privileges, and simply turning the fisheries over to the proprietors of the banks, a condition of affairs may be produced which is calculated to decrease rather than to increase the number of fish. This applies particularly to countries where it is difficult to execute the fishing-laws in an efficient manner.

The conditions on which privileges can be bought off should form the subject of another law. In this matter, regard should be had to the different wants of the several provinces regarding the fisheries, as also to all other circumstances which may be of influence, so that the question whether the time has arrived when such a law can be really beneficial should be answered separately for every province.

Whether the question of abolishing the privileges in any of our provinces is being discussed at the present time, or whether it is referred to some future period, it will, under all circumstances, be desirable that such abolition should not take place before a good fishing-law has definitely settled all questions relating to the protection and practice of the fisheries, especially those belonging to communities and owners of shore lands, fishing-associations, &c. If this is not done, the abolition of privileges and the transfer of the fisheries to communities and owners of shore lands will do more harm than good to the industry. It would also be an inestimable benefit if the new owners could enter on their possessions with that feeling of security which only a practical and well-executed law produces, and if the great landed proprietors, who at present own fisheries, could have the chance of improving them further and of making them more valuable.

The question of abolishing the fishing-privileges has not yet been fully discussed in all the provinces, nor has an accurate list of all such privileges been made out. The above remarks on this subject, suggested by the material at my command, will suffice for the present; any further discussion being at this time neither desirable nor possible.

25.—INTERNATIONAL FISHERY-TREATIES.

Many of the finer kinds of Austrian fish are migratory species, some of which live part of the time in the sea. The salmon come from the sea into the Bohemian, Moravian, Silesian, and Galician rivers and their tributaries, spawn there, and then return. In the Rhine, the salmon only go as far as the falls near Schaffhausen. The eels, on the other hand, usually spawn in the sea; the young ones ascend into the fresh water, and live there till they are able to propagate their species, when they return to the sea.

Other fish remain in fresh water, lakes, rivers, and brooks, but change their location according to their size, the character and depth of the water, temperature, the quantity and quality of food found, and the more or less favorable location of the spawning places. What has been said of salt-water fish applies likewise to several lake species, and to some living in large rivers, which, during the spawning season, ascend the tributaries and brooks.

These migrations cause a community of interests in all the countries of one connected water-system, chiefly with regard to the cultivation of the fish and the protection of the fisheries.

If, for example, the free passage of the salmon and eel from the Lower Elbe is prevented by the fishermen of that region, if they are there caught at the wrong season, or in too great numbers, all the fisheries on the Upper Elbe will suffer from this, and all the efforts to improve those of Bohemia will prove futile.

In the Netherlands, especially in the mouths of the Rhine, the salmon-fisheries are at present carried on in such a destructive manner, with immense seines, that only in very exceptional cases, high water, &c., the fish escape and ascend to the spawning places; for during the season when the salmon ascend the rivers, these seines are hauled uninterruptedly, even on Sundays; they take up the whole stream, and a few of them, worked at short distances from each other, are sufficient to catch every salmon entering the river.

The lower fishers, however, are likewise entirely dependent on those higher up; for, if the latter disturb the salmon while they are spawning, and catch and destroy the young fish, none go to the sea, and consequently none return from there.

In large connected fishing territories, divided between several countries, each one is dependent on the others for its fisheries. Every country by itself can do much to destroy the fisheries of the whole territory; but, without the co-operation of the other countries, it is not able to keep them up, even with the best and strictest fishing-laws.

The community of interests is still more striking in rivers which form the boundary-line between different countries. Of what use would it be to prescribe times of protection when the fishermen on the right bank were not allowed to fish, if those on the left bank were allowed to catch all through the spawning season?

In such a manner are the Austrian fisheries, especially the more valuable ones, such as those for salmon in Bohemia, Moravia, Silesia, and Galicia, dependent on those of the neighboring countries. The absence of a good fishing-law in North Germany, more especially respecting lawful seasons of protection; the lack of any law regarding places of protection; the utterly destructive way in which here and there salmon are caught with seines; the many weirs and other hydraulic constructions in most North German rivers, which hitherto have not been made harmless by fish-passes; the poisoning of the waters by the introduction of noxious substances; the numerous automatic salmon and eel traps near the mills in those rivers and streams which from our country flow into North Germany; all these causes combined have injured our salmon-fisheries to such a degree that at present but few salmon ascend to our waters from the sea.

The Austrian government, for these reasons, endeavored to conclude treaties with all the states bordering on the Elbe, as early as 1857, so as to secure the free passage of salmon and eels from the sea to the Bohemian waters and *vice versa*. These negotiations have been interrupted, but will be taken up again.

It has been proposed to conclude treaties establishing uniform regulations between Baden, Bavaria, Lichtenstein, Austria, Würtemberg, and several cantons of Switzerland for the benefit of the fisheries in the Lake of Constance and its tributaries. Such a treaty was, on December 9, 1869, concluded between the Baden government and the Swiss federal council.

A similar treaty was concluded November 27, 1869, by the delegates of all the states on the Lower Rhine, from Basle downward, but failed to be ratified by the Dutch government, as the lower house of the parliament, by a majority of four, voted against the treaty; and it is sought to reach a uniform legislation by other means.

In the Netherlands, there is at present a new law in preparation, which is to regulate the salmon-fisheries in the Rhine; and the *Deutsche Fisherei-Verein* hopes, by laying its suggestions before the most famous ichthyologists, both at home and abroad, to induce the Dutch government, in its own interest, to pass not only such laws as will include the Mannheim propositions, but will even be an improvement on them by prohibiting the catching of salmon in the Rhine for at least thirty-six hours every week.

A fishing-treaty between all the states bordering on the Danube has been proposed, as likewise one relating to the fisheries in Lake Garda between the Austrian and Italian governments.

Such treaties make it necessary that the fishing-laws of the several countries should accord with all the points touched in the treaties.

We give below the full text of the treaty between Baden and Switzerland, relating to the fisheries in the Rhine, including the Unter Lake, (a portion of the Lake of Constance.) This treaty is based on scientific principles, and on the experience of countries where strict fishing-laws have been successfully in force for some time.

"For the protection and increase of the valuable kinds of fish in the Rhine, including the Unter Lake and its tributaries, between Constance and Basle, the government of Baden and the federal council of Switzerland have resolved to draw up uniform rules for the fisheries in these waters, and have, for this purpose, appointed the following delegates: His Royal Highness the Grand Duke of Baden, his Privy-Counselor in the Ministry of Commerce, Dr. Rudolph Dietz; the Federal Council of the Swiss Confederation, the Federal Counselor, Dr. Karl Schenk: between whom, after their credentials had been found to be correct, the following treaty, waiting a future ratification, was drawn up:

"ARTICLE 1. In the Rhine fisheries, including those of the Unter Lake and its tributaries, between Constance and Basle all stationary apparatus (fish-weirs) and the use of stationary nets, which at the common low-water mark on a line drawn at right angles from the bank obstructs more than one-half of the breadth of the river, thus hindering the migration of fish, are prohibited. This prohibition only applies to those waters which contain salmon. The distance between the several poles forming the fish-weir intended to catch salmon, as well as the distance between the connecting cross-poles, must be at least 10 centimeters, (1 centimeter=0.39 inch.) If several such stationary apparatus, or several stationary nets, are set at the same time, near one and the same bank, or on the opposite bank, they must be placed at a distance from each other amounting to at least twice that of the largest apparatus.

"ARTICLE 2. No fishing-implements of any kind or name must be used, if, when moist, their openings do not have the following dimensions: *a*, for salmon-fishing,—bow-nets, 6 centimeters, inside 4 centimeters; *b*, for catching other large fish,—3 centimeters; *c*, for catching small fish,—1½ centimeters. Implements used in taking fish for bait are not subject to these regulations.

"In the Rhine between Schaffhausen and Basle no nets are to be used whose openings are larger than 3 centimeters.

"In regulating nets and other implements, the difference of one-tenth centimeter shall not be counted.

"ARTICLE 3. Floating nets must not be placed in such a manner as to stick to the bottom or remain attached to anything.

"ARTICLE 4. All means employed to stun fish, as well as the use of traps with springs, spears, guns, or pistols, explosive cartridges, poles, and other contrivances tending to wound the fish, are forbidden.

"The authorities in the different parts of the country may permit exceptions as to the use of spears and guns or pistols.

"Fishing with hooks and lines is allowed.

"It is forbidden to drain any water-courses dry for the purpose of fishing.

"The governments which adopt this treaty will see to it that the so-called automatic traps connected with mills and other water-works are as much as possible removed.

"The placing of new traps of this kind is forbidden.

"ARTICLE 5. The following kinds of fish must neither be offered for sale nor sold, if, from the eye to the commencement of the anal fin, they have not at least the following length: Salmon, (*Trutta salar* Lin.,) 35 centimeters; lake-trout, (*Trutta lacustris* Agass.,) 20 centimeters; brook-trout, (*Trutta fario* Lin.,) grayling (*Thymallus vulgaris* Nilss.,) Rötheli, (*Salmo salvelinus*), 15 centimeters. The authorities of the two countries may, for these measures, substitute the corresponding weights.

"If fish are caught which have not this weight or measure, they must immediately be thrown back into the water.

"ARTICLE 6. In order to increase the number of salmon, fishing is every year entirely suspended in the Rhine and its tributaries, from Basle upward, from the 15th October till the 1st January.

"In the time from the 1st September till the 1st January, it is forbidden to offer for sale, to sell, or to transport Rhine salmon which are capable of spawning.

"During the seasons of protection, the respective authorities may allow the taking of salmon to be used in piscicultural establishments for impregnating eggs. These fish, after they have been used for this purpose, may, under the proper supervision of the authorities, be offered for sale, sold, or transported.

"ARTICLE 7. From the 20th October till the 20th January, it is forbidden to fish, offer for sale, or to sell lake-trout, salmon-trout, and brook-trout. If, during this period fish of these kinds are caught accidentally, they are to be thrown back into the water immediately.

"The respective authorities may permit the taking of these kinds of fish, during the seasons of protection, for piscicultural purposes, and also the offering for sale and the sale of lake-trout after these have been used for impregnation, under proper supervision.

"ARTICLE 8. From the 15th April till the end of May, the catching of any kind of fish—except salmon and lake-trout—with nets and bow-nets of any kind, is prohibited.

"ARTICLE 9. The taking of fish for artificial culture, and the catching of small fry to serve as food for the fish in the piscicultural establishments, may, by the respective authorities, be permitted even during the season of protection mentioned in article 8.

"ARTICLE 10. It is prohibited to throw refuse from factories or other substances of a like character into the waters in such quantities as to injure the fish thereby.

"If, in some places, the agricultural or industrial interests are of greater value than the fisheries, the respective authorities may permit such substances to be thrown into the water, taking measures, however, to limit the injury as much as possible.

"The respective authorities will likewise decide whether and how far the above regulations shall apply to existing conduits for leading agricultural or industrial refuse into the water.

"ARTICLE 11. Both contracting states will see to it that the number of salmon in the Rhine and its tributaries is increased by hatching a number of eggs every year, and by placing the young in suitable portions of the above-mentioned waters. They will likewise see to it that so-called salmon-ladders are put in suitable places, to assist the salmon and trout in ascending the river.

"ARTICLE 12. Each of the contracting states engages to make the necessary regulations for carrying out the articles of this treaty, to repay violations by suitable punishments, and to appoint the necessary officers for this purpose.

"The present treaty shall not prevent either of the contracting states from making still stricter regulations for the protection of fish on their territory.

"ARTICLE 13. Each of the contracting states shall appoint a commissioner of fisheries for its territory.

"These commissioners are to inform each other of all new measures regarding the fisheries which their governments have adopted; communicate to each other the annual reports on the results of the salmon-fisheries, as well as on the young salmon which have been artificially hatched, and placed in the water; and shall, by correspondence and occasional meetings, further the mutual interests of the fisheries in the Rhine and its tributaries.

"ARTICLE 14. The contracting governments will, according to some plan to be agreed on at some future time, make investigations as to the nature and life of fish, especially of the *Salmonoidei*, and communicate to each other the results of these investigations.

"ARTICLE 15. This treaty will take effect on the 1st of July, 1870, and remain in force for ten years counting from that day; and if no warning shall have been given by either of the contracting parties twelve months before the end of the period mentioned, it shall continue from year to year till the end of a year after the day on which either of the contracting parties will have given warning.

"ARTICLE 16. If the treaty concluded November 27, 1869, between all the states bordering on the Rhine should from some cause not take effect on the 1st July, 1870, but at a later date, the present treaty will likewise not take effect till this later date.

"ARTICLE 17. Those governments on whose territory there are portions of the Lake of Constance and its tributaries may become parties to this treaty.

"Those portions of the Lake of Constance and its tributaries which are either on Swiss or Baden territory are subject to the articles of this treaty as soon as all the other governments holding portions of the Lake of Constance and its tributaries will have become parties to this treaty.

"ARTICLE 18. This treaty shall be ratified, and the customary documents exchanged, on the 1st March, 1870, or, if possible, at an earlier date, in the city of Berne.

"In witness whereof we have signed this treaty and affixed our seals.

"Done in the city of Berne, December 9, 1869."

26.—SALT-WATER FISHERIES, AND THE LAWS RELATING TO THEM.

There are very important salt-water fisheries on the Austrian coasts, viz, in the districts of Triest, Görz, Gradisca, and Istria, and in the kingdom of Dalmatia.

These may be considered under the divisions of high-sea fisheries and coast-fisheries. The former are carried on in the open sea, and the latter in gulfs and inlets and all along the coast as far as a gun-shot will reach.

From many sources we glean the fact that the salt-water fisheries in olden times contributed more to the thrift and wealth of the towns on the coast than nowadays. Of the high prices which the products of the sea bring in far distant markets, the poor fishermen reap but little benefit. It often happens that they sell the results of their laborious and dangerous trade on board their vessels to speculators for a trifling sum, and these latter reap the profit of the valuable products which the fishermen have brought up from the store-houses of the sea. There is no doubt that a suitable organization of the salt-water fisheries on a legal basis, the encouragement of such institutions as the *valli di pesca*, (see below,) and of the trade in salt-water fish with Vienna and other large cities, would increase the profits of the fishermen considerably.

As being of special importance, we mention the so-called *valli di pesca*, which includes inlets, canals, or brackish ponds near the coast, that have been artificially closed, and are used for raising salt-water fish and shell-fish. As is done by the French ministry of marine, we likewise grant small strips of land near the coast to private individuals for establishing such artificial waters, so that every inhabitant of the coast is enabled to have his own little fish-pond or oyster-bed.

Mr. Smarda says that the arrangements of these brackish ponds on the Austrian coast far excel anything of the kind in France.

The taking of some kinds of salt-water fish, such as sardines, mackerel, and tunnies, is most profitable if carried on in common by a number of fishermen, and should therefore be regulated with a view to founding properly organized associations.

The attention of legislators has most frequently been given to the methods of fishing termed *a cocchia* or *al fondo*, and those termed *a bragozzo* or *a tartana*.

Fishing *a cocchia* is carried on with a deep, narrow-meshed net, tapering off into a long bag, which by leaden weights is lowered to a great depth, even to the bottom of the sea, where it is dragged along by two boats sailing parallel with each other at a small distance apart. Fishing *a bragozzo* or *a tartana* is carried on with a similar net, which, however, is only fastened to one boat by means of poles. As these nets, which are frequently many hundred feet long, are for hours dragged along the bottom of the sea, before the fishermen haul them in at some point which long experience has indicated to them as particularly favorable, they catch not merely all the fish in those portions of the sea, but likewise destroy the algæ and sea-weeds growing on the bottom.

Fishing *a tartana* has been carried on from time immemorial, while fishing *a cocchia* came into use on our coasts only during the last century.

The greatest masters of fishing *a cocchia* are the inhabitants of the island of Chioggia near Venice, who visit all the Austrian coasts, especially those of Dalmatia.

Since the middle of the last century, there has been no lack of prohibitions against both these methods of fishing, which, however, have invariably soon been revoked or permitted to fall into disuse.

There have been different causes for such contradictory measures. It could not, on the one hand, be proved that these methods of fishing had diminished the number of fish very materially. Just as the harvests of fields vary in different years, so was the decrease in the quantity of marine products only a temporary one; in a few years, the fish came again in large numbers, and certain species which had disappeared entirely, returned after some time.

It must be granted, on the other hand, that fishing *a cocchia* is undoubtedly the most ingenious and efficient method employed on our coasts, which has been settled on by the fishermen after long thought, and the experience of many years, and that it would be exceedingly difficult to substitute any other method. It was not only a feeling of pity for the families of poor fishermen which prompted the authorities to relax their severe measures, which generally were caused by the loud complaints of some community on the coast, desirous of obtaining a secure monopoly by excluding all strangers; but as long as no sufficient proof has been adduced of the injurious character of these methods of fishing, such prohibitory measures would only tend to raise the price of fish, and, in this manner, they would be anything but beneficial to the poor fishermen and the general public.

Fishing *a cocchia* is, at any rate, almost impossible on most coasts on account of the uneven, and especially the rising bottom, and the dense growth of sea-weeds on which fish deposit their spawn; if, therefore, a few spawning places should be destroyed by the large nets, the number remaining would still be very large.

Although, as we have seen, the entire prohibition of this and of similar methods of fishing is scarcely justified, it is necessary that there should be certain legally prescribed limitations; economical and, still more, administrative reasons demand the proper regulation of the coast-fisheries, and certain rules as to the formation, rights, and duties of associations.

In this respect, the coast-fisheries, especially those carried on in bays and inlets, do not differ much from the inland. In such places, the exclusive rights of communities and landed proprietors have been respected; while, outside of such narrow limits, salt-water fishing has been free.

Legislation has, therefore, directed its attention to the above-mentioned limited portions of the sea, although not to the same extent as to the inland fisheries. As an example, we mention that, till the definite regulation of the coast-fisheries, the use of torpedoes and other explosives has been prohibited.

With regard to the high-sea or open sea fisheries, other considerations prevail.

The productive power of the ocean, in its unlimited extent and its unfathomable depths, is, with regard to its various processes and their causes, far less known and far less accessible to human observation than that of the inland waters.

It is true that there have been complaints of the decrease in the wealth of fish in the ocean; and the injurious methods of fishing are partly assigned as the cause.

It is maintained that some species of the most valuable and numerous salt-water fish, from which millions of money were formerly gained, have been almost totally destroyed. This is certainly true of the gigantic whales, which, even twenty or thirty years ago, were so numerous on the coasts of the islands in the north of Scotland. It is likewise said that a decrease in the number of sardines, cod-fish, &c., has been observed; while others deny this, especially as far as the sardines are concerned.

We consequently find two opposing views on the high-sea fisheries: the one demanding complete freedom from all those limitations which only quench the spirit of enterprise, and do not benefit the fisheries; the other fearing that the erroneous idea of an unlimited and indestructible supply of fish, the disregard of all protective measures, and of all regulations limiting the methods of fishing, will, in the end, prove disastrous to the salt-water fisheries, in the same way as with our river and lake fisheries, and with the oyster-beds, which have been almost totally destroyed in some parts.

Of late years, there have been many attempts to obtain a legal and economical basis for the high-sea fisheries; and seasons of protection, artificial impregnation, and hatching, &c., have been spoken of. The difficulties in the way of legislation are much greater, however, than with the fresh-water fisheries.

The open sea, beyond the reach of a gun on shore, is the common property of all nations, and individual states have no right to legislate concerning it.

From the oldest times, fishing in the open sea has been a free trade, bound by no guilds or other limitations. As an old document says, "The fishermen are here allowed to fish as far as they want to risk their necks."

No individual state would desire to limit the enterprise of its subjects on the open sea, thus offering a chance for foreign fishermen; and, as to international legislation, there has been too little material collected on which to build up such a code in spite of the numerous reports on the subject made by individual states, and the trustworthy investigations of the influence of certain methods of capture on the fisheries.

E.—CONCLUSION.

In reviewing the whole subject under consideration, we can briefly give the following more important points, which should be kept in view for any future regulation of the Austrian fresh-water fisheries.

The reports from all provinces of Austria agree that the fisheries which formerly were in a very flourishing condition have declined. The causes of this decline are nearly the same in all provinces. Not to mention those unavoidable injuries which they have suffered from the progress of civilization in other directions, we must assign, as prominent causes, the entire want of protection; numerous rights and privileges which absolutely hinder or even destroy them; the reckless plundering of the large connected waters by privilege-holders, each one being at war with the other; and the total neglect of all measures which tend to do justice to the fisheries in the exercise of water-rights, even in cases where conflicting interests might easily have been harmonized. All reports agree as to the necessity of passing laws for protecting and promoting them.

In some provinces of Austria, there are at present, if we except laws applying to the whole monarchy and a few regulations in general ordinances, no laws whatever relating to the fisheries. Other provinces possess old fishing-laws; but although we see in them the proof that our ancestors desired to protect this important branch of economy, although they might in many respects—with regard to the formation of associations and the establishment of proper protective regulations—serve as models, it is doubtful whether these laws, which in many points are utterly at variance with modern ideas and statutes, could at this day be enforced, either as a whole or in part. Many of the provisions of these old laws no longer agree with the present advanced state of natural sciences and technology. The most important relations which a statute is intended to regulate, especially with regard to other trades or industries, are not touched in the fishing-laws of the several provinces. The regulations regarding punishments are entirely antiquated, and there were no measures for making the law more effective, even in the olden times. Most of these statutes have fallen into oblivion, so that it may justly be said that in none of the provinces of Austria do the fisheries enjoy that protection by laws which is an essential condition of their success.

The decline of the fisheries must, therefore, be mostly ascribed to defective legislation, or, more correctly expressed, to the utter want of legislation regarding the protection and practice thereof. Most civilized nations are either ahead of us in making new fishing-laws suited to the demands of modern science, or are on the point of re-organizing their old ones.

The beneficial influence of such practical laws, and of the institutions called to life by them, is universally recognized among these nations, and has in many cases been proved by figures.

There is not the slightest doubt that the natural conditions in Austria are extremely favorable to the improvement of the fisheries. Few other countries possess such a wealth of inland waters, streams, rivers, brooks, lakes, and ponds; most of these have, even at the present day, an ample supply of fish, somewhat diminished as to numbers, but still excelling through its great variety of fine and valuable sorts. Science and experience have in our time produced such a number of improvements in the fishing-trade—such as the different ways of preserving fish, and the different uses to which the products of the water are put—that by their aid it becomes possible to revive our fisheries, in spite of unfavorable influences to which they are exposed, and without in the least injuring the more important interests of navigation, industry, and agriculture.

The spirit of enterprise has also in Austria again turned toward this branch of productive industry; and it is a matter of great satisfaction that not only many great landed proprietors, but also many small land-owners, peasants, mechanics, and workingmen have founded establishments for artificial fish-culture, and derive considerable profit from small sheets of water either owned or rented by them.

In some provinces, associations have been formed, having for their object a system of rational fishing and fish-culture; and there is no doubt that such associations, adapted to the peculiar wants of the fisheries, will, if supported by legislative measures, gain ground constantly.

The above mentioned manifold evils, which have hastened the decline of the fisheries, have also prevented any practical benefit being derived from the numerous modern improvements in fishing and the fish-trade.

If one considers the enormous profit which other countries derive from their lawfully protected fisheries, and then applies this standard to our extensive waters, it becomes absolutely certain that as soon as a proper legislation has paved the way for the introduction of all the modern improvements and institutions, the results of the fisheries in Austria will be no less brilliant; our national income will then likewise increase, and these advantages must be rated all the higher, because the point in question is to provide a cheap and wholesome article of food, accessible to all classes of our population, for which no substitute of equal value can be found.

Our government is earnestly endeavoring to extend such favors to the fisheries, at first in the inland waters, as are commensurate with their importance to the welfare of the nation, and is at present discussing the draught of a new fishing-law, based on the most careful consideration of all the reports sent to the ministries. Our review may serve as a forerunner of this law, and in some portions as a fuller commentary on the subject, than the necessarily limited report preceding the law is able to give.

XXX.—HOW CAN OUR LAKES AND RIVERS BE AGAIN STOCKED WITH FISH IN THE SHORTEST POSSIBLE TIME?*

By Mr. von dem Borne,
Landed Proprietor at Berneuchen, near Wusterwitz, Neumark, Prussia.

The decline of our fisheries is only in part to be ascribed to the progress of civilization; for, to a great extent, it has been caused by the senseless manner in which the fisheries have been carried on. If, therefore, the fisheries are carried on in a rational manner, it would certainly be easy to stock our waters completely, especially if we take into consideration the extraordinary fruitfulness and the rapid growth of fish. Mr. Horak, the superintendent of the immense ponds at Wittingau in Bohemia (covering an area of about 15,043 acres), told me he was confident that he could in a few years stock the Elbe to its utmost capacity with fish, if a stop were put to the plundering of the river; and I am thoroughly convinced that Mr. Horak is right.

The first question to be settled would be what kinds of fish would be best suited for making our waters productive. We have migratory fish, like the salmon and the May-fish, which live in the sea, but spawn and spend their first youth in the rivers; for the brooks with gravelly bottom, we have the trout and the grayling; and for the deep lakes, the saibling, the different varieties of the muræna, the raaken, &c., are of importance. For shallow lakes, and for rivers and brooks which have no gravelly bottom and flow slowly, the carp is undoubtedly the most suitable fish. We will now devote our attention to the last-mentioned kinds of waters.

Our lakes and rivers contain fish which require very different food, and we accordingly divide the fish into *fish of prey* and *peaceful fish*, or into *fish living on fish*, those *living on insects*, and those *living on plants*. The pike chiefly lives on fish, the perch lives on fish and insects, and the carp on plants and insects. In the household of nature, the occurrence of fish of prey and peaceful fish side by side is of the utmost importance. Those fish which live on plants are important, because they find most of their food in the water, and consequently produce the greatest quantity of flesh in a given sheet of water. But if their number exceeds a certain limit, so that the quantity of food does no longer suffice to supply the demand, the fish not only decrease in size but also in number, so that the total weight of fish produced by that sheet of water declines steadily from year to year. This is remedied by the fish of prey, especially the pike, not only because they eat the small fish, but also because they

* From Circular No. 1, 1876, of the Deutsche Fischerei-Verein.

prevent the fully-matured fish, particularly the carp, from spawning. In lakes where one wishes to produce a great quantity of young fish, it will, therefore, be advantageous to have no fish of prey; but where one intends to produce large and heavy fish by preventing the water from one lake to enter another, the presence of fish of prey offers the double advantage, that they make use of the small and worthless fish, and that they further the growth of the other fish by diminishing the number.

Among the fish living on plants, the carp is the most valuable, on account of its rapid growth and its great value for the table. It has, moreover, the following qualities, which are very desirable for the pisciculturist: it is very easy to produce a very great quantity of young carps; the carp is a very hardy fish, and has but few wants; and, finally, there is scarcely a fish with whose conditions and mode of living we are so well acquainted, as it has been raised for centuries and has almost become a domestic animal.

The carp flourishes so well in our stagnating and slow-flowing waters that, more than any other fish, it is suited to make our fisheries productive in a very short time.

For producing great quantities of young carps, shallow ponds are required, which contain no fish of prey, and can be drained entirely. It will be well to protect the young fish from fish of prey for one year, and place fish two years old into the open waters. They are at that age so large that fish of prey cannot hurt them much. If there are no ponds where the young fish can be placed, thus making it necessary to let the young fish free at an age of one year, this should, if it is in any way possible, be done in spring. During winter, the carp is in a state of torpor, and is so lazy that it becomes an easy prey to the pike, which is particularly voracious at that season. In spring, on the other hand, the carp is lively, while the pike, on account of his spawning, has become languid and sickly.

Unless the country is perfectly level, there is nearly everywhere a chance to make ponds for the young fish ("*Streichteiche*"), as nearly every flowing water is suitable for filling such ponds, and as in case of necessity even rain and snow will supply the required quantity of water.

We will now, in accordance with the experiments made on the estate of Cottbus-Peitz, in Lusatia, calculate what sized sheets of water can be stocked in one year from a pond of a given size. The areas of the different ponds at Peitz are as follows:

For fish of the first year, (spawning and young fish), 1 *Morgen**.

For fish of the second year, (growing fish), 2 *Morgen*.

For fish of the third year, 3.4 *Morgen*.

For fish of the fourth year, (when the fish reach their full size), 12 *Morgen*.

If one wishes to raise two-year-old fish for the market, 15.4 *Morgen* water-area would be required for the next two years for every 3 *Mor-*

* One *Morgen* = 0.6888 of an acre.

gen, occupied the first year with young fish, if such ponds are used as the ones in Peitz. If, as I propose, the open waters shall be used for the complete development of the young fish, the fact must be taken into account that our lakes and rivers contain fish of prey, and that, because they cannot be drained, they can never become so entirely exhausted as the ponds. The open waters can, therefore, not be stocked as fully as the "*Abwachsteiche*" (ponds where the fish reach their full size) without running the risk of crowding them too much, particularly as the increase of the carp in the open water must be taken into account. I would, therefore, propose that ponds used for raising two-year-old carp for the market should every year stock an area ten times their size, believing that such an area will then get its full supply of fish.

If, for instance, the Wittingau lakes in Bohemia, which have an area of 15,043 acres, were to be used for restocking the open waters with fish, 150,430 acres would have to be completely stocked every year, and in ten years 100 German square miles of water would be fully supplied with fish.

All our waters could doubtless reach the highest degree of productiveness in a few years, if we were to raise two-year-old carp in our ponds, and let the open waters take the place of the ponds where the fish reach their full size.

That the owners of ponds would be fully repaid for their trouble will be evident from the following instance: On the estate of Baron von Rothschild, in Upper Silesia, 2 to 3 feet deep puddles in the villages are used as ponds for raising two-year-old carp for stocking-purposes, and are drained every year. These ponds, by the sale of such two-year-old carp, yield annually a net profit of 150 *Mark* (about $37.50) per *Morgen*. They yield, consequently, ten times as much as good carp-ponds, in which fish are raised for the table, and more than the best arable land. An owner of ponds can, therefore, best increase his income by favoring as much as possible the production of two-year-old carp for stocking-purposes.

As many proprietors of fisheries fear that it would be difficult to catch carp in the open water, I can assure them, from personal experience, that if the waters are well stocked, large quantities of fish can be caught with the different nets, both in winter and summer.

In accordance with the above, 1 *Morgen* would have to be stocked with about sixty two-year-old carp.

APPENDIX E.

NATURAL HISTORY.

XXXI.—PRELIMINARY REPORT ON A SERIES OF DREDGINGS MADE ON THE UNITED STATES COAST SURVEY STEAMER BACHE, IN THE GULF OF MAINE,

UNDER THE DIRECTION OF PROF. S. F. BAIRD, UNITED STATES FISH COMMISSIONER, DURING SEPTEMBER, 1873.

By A. S. Packard, Jr., M. D.

Though it was the original intention to devote the month to an exploration of the Saint George's Banks, it was decided, on account of our defective boilers, to work nearer shore, and extend the work of the United States Fish Commission, for the season located in Casco Bay, the dredging operations being conducted under the charge of Professor Verrill. This involved an examination of certain unexplored portions of that great indentation lying between Cape Sable, Nova Scotia, and Cape Cod, which is laid down on the charts as the "Gulf of Maine."

Through the researches of Messrs. Stimpson, Verrill, myself, and others, in the Bay of Fundy, and of Drs. Gould, Wheatland, Stimpson, and others, in Massachusetts Bay, together with the very thorough examination of Casco Bay and vicinity, pursued during the past summer by Professors Baird and Verrill, we had obtained a very complete knowledge of the coast-fauna of New England north of Cape Cod. Moreover, the exploration of Saint George's Banks, made by Messrs. Smith, Harger, and myself last year in the Bache, had given us some idea of the nature of the sea-bottom, dredging having been carried on at a depth of 432 fathoms by Messrs. Smith and Harger.

It now remained to explore some interesting localities within Saint George's Banks, and at a distance from the coast. This report embraces an account of a reconnaissance of Jeffrey's Bank, lying south of Mount Desert Island; Cash's Ledge, another bank lying southwest of Jeffrey's Bank; of Jeffrey's Ledge, a northeastern submarine prolongation of Cape Ann; and Stellwagen's Bank, a northerly submarine extension of Cape Cod. As intermediate points were investigated, the series of dredgings may be regarded as conducted along six main lines running out easterly from the shore between Portland and Cape Cod.

On the 2d of September, the Bache, with Lieutenant Jaques temporarily in command, left Peak's Island, Casco Bay, the headquarters of Professor Baird, and made a harbor for the night at Booth Bay. Early the next morning, we ran out and dredged about "Monhegan Falls" in 60 fathoms, searching with dredge, tangles, and trawl for the arctic coral, *Primnoa lepadifera*, a species of sea-fan, which grows about three feet in height. It is occasionally met with in the fiords of Norway at a depth of 300 fathoms, while fishermen have been said to find it on the ground known as "Monhegan Falls", and a specimen two feet high, from Saint George's Banks, is now in the Museum of the Peabody Academy of Science at Salem, Mass. Our efforts to find it were, however, unavailing.

We then ran out to Jeffrey's Bank, and trawled in 82 fathoms, bringing up a fine *Alecto* or *Comatula*, a near ally to the Crinoids. This was the first specimen taken by the Fish Commission during the summer. The head of another specimen was captured on Cash's Ledge. Near Jeffrey's Bank, we also dredged in deep brown mud, at a depth of 107 fathoms, with a temperature of 39½°, *Hyalonema*, apparently intermediate between *H. boreale* of Lovén and *H. longissimum* of Sars from Northern Europe. This had previously been found off Casco Bay by Professor Verrill. Interesting sponges, allied to *Holtenia*, also occurred. Everywhere on Jeffrey's Bank and Cash's Ledge the mud was reddish-brown, and was possibly brought by currents from the Bay of Fundy. This red mud probably extends as far west as the mouth of Kennebec River. The mud about Jeffrey's Ledge and in Massachusetts Bay is of the ordinary blue color.

At noon of September 4 the sea became too rough to dredge, and we ran into a harbor at George's Island, north of Monhegan, for shelter, and on the succeeding day returned to Portland for repairs.

On September 12 the Bache left Portland for a farther exploration of Jeffrey's Bank, and on the 13th a series of dredgings was made on each side of the southern extremity of it, at depths of 60, 105, and 100 fathoms, with excellent success. The weather appearing threatening, we ran into Portsmouth.

On the 16th we began to dredge on a line extending from Portsmouth to Cash's Ledge. Stopping to dredge on either side of Jeffrey's Ledge, we found, in a deep mud-hole, 95 to 98 fathoms, fourteen miles S. E. ¼ E. of Boon Island light, with a temperature of 37½° and 41°,* living *Schizaster fragilis*, a beautiful sea-urchin; *Molpadia oölitica*, a sea-cucumber, not previously recorded so far north on the coast of North America; *Macoma proxima* and *Aporrhais occidentalis*, two shells rivaling in size individuals dredged by the reporter in shallow water in Labrador; and tubes of *Spiochætopterus typicus* Sars. This abyss, so near the shore, afforded the lowest temperature found during the month's work.

The results of the exploration on Cash's Ledge were extremely interesting. At depths ranging from fifty to eighty fathoms, over a hard, gravelly bottom, characterized by multitudes of *Ascidia callosa*, or sea-potatoes, the richest assemblage of life was found that we met with in

* The readings of both thermometers used are given, the lowest temperature, that given by a new Casella-Miller thermometer from the Smithsonian Institution, and probably nearly correct.

the gulf. It was a rare sight to see the tangle come in over the ship's side hung with that gorgeous star-fish, the bright-red *Astrogonium phrygianum*, measuring fully eight inches across, with lesser forms of sea-stars, *Asterias*, *Cribella*, and sand-stars, an enormous sea-spider or *Nymphon*, *Hyas aranea*, an arctic spider-crab, and a species of *Janira*, with beautiful sponges allied to *Tethya*, *Thecophora*, and *Holtenia*-like forms four or five inches in diameter, these latter appearing in the trawl with *Tealia* and tubes of *Cerianthus borealis* of Verrill, a large sea-anemone. The excitement was shared by the crew, some of whom aided in the tedious work of separating the collections from the strands of the tangle.

On our way back to Gloucester we again dredged on each side of Jeffrey's Ledge at depths of 112 and 118 fathoms, at the former station east of the bank dredging the rare *Myxine limosa* Girard, (hag-fish,) in soft mud, with a bottom temperature in both stations of 39°.

On the 23d, dredgings were made in Salem Harbor and off Marblehead. Two days, the 25th and 26th, were devoted to investigating the summit of Jeffrey's Ledge, at a distance of nine to eighteen miles east of Cape Ann. The temperature here was between 46° and 49° in about twenty-five fathoms, a difference of about ten degrees from that of the abysses on each side of this submarine elevation. Both here and afterward we used two dredges, one being thrown over from the bows, the other cast from the stern of the vessel, while the tangle was put over from the side.

On the 27th, we began to run a line of dredgings and soundings from Cape Ann to Cape Cod, crossing the middle of Stellwagen's Bank.

Dredging in depths between fifty and sixty fathoms in soft, blue mud, northwest of Stellwagen's Bank, in the deepest portions of Massachusetts Bay, the fauna was found to closely resemble that of similar localities on each side of Jeffrey's Ledge, the assemblage not more southern in character, while the temperature of the bottom water ranged between 41½° and 45° (two thermometers being used as before). In one haul of the tangle, ninety-five *Ctenodiscus crispatus*, the common pentagonal star-fish of muddy bottoms, were brought up, with several very large *Asterias vulgaris?* and several young *Solaster endeca* and *papposa*; also a gigantic *Corymorpha*, a hydroid polyp, six inches in height, and fully half an inch in diameter near the base. We found on Stellwagen's Bank, in 22–30 fathoms, coarse sand, temperature 48½° to 50½°, an abundance of *Mactra polynema*, the hen-clam, *Cyprina islandica*, a shell resembling the quahaug, and *Glycimeris siliqua*, with five sponges. The *Corymorpha* was abundant here, and the tangle brought up at a single haul from 300 to 400 star-fish, mostly *Asterias*. At night, about ten miles north of Cape Race, the tangle was kept over from half past ten until two o'clock, when it came up loaded with *Astrophyton*, or Medusa's-head, and other kinds of star-fish, the temperature being between 48° and 50°, at a depth of 34 fathoms.

But by far the most interesting results were obtained at a distance of about 20 miles east of Cape Race, in depths of 117 and 142 fathoms, with a bottom temperature of 39° to 43½°, the former (39°) probably the more accurate determination. Here, in a remarkably tenacious soft blue mud, we found indications of an intermixture of the abyssal fauna, characteristic of depths in the North Atlantic, between 100 and 1,000 fathoms, with a temperature of about 39° Fahrenheit. At the first station examined, in 142 fathoms, temperature 39° to 42°, a large female *Geryon*, of a deep-reddish flesh-color, occurred, having more spines on the carapace than in *G. tridens*, and with eggs. Associated with this arctic crab occurred two fragments of a true cup-coral, allied to *Cyathophyllum*. On submitting the specimen to Count Pourtales, he at once pronounced it a species of *Deltocyathus*, and, on comparison with specimens of *D. Agassizii*, Pourtales,* from depths ranging from 60 to 327 fathoms between Cuba and Florida, our specimens did not differ specifically. Pourtales remarks (page 15) that this coral has been pronounced by Dr. Duncan identical with the fossil species *D. italicus*, and, though closely allied, yet readily distinguished by the costæ and other characters. I may say here that the indications are that the coral was not transported to this spot. This is the only truly southern form which has occurred so far north. With the crab and coral occurred *Schizaster fragilis* and certain shells and worms.

The other station was ten miles northwest, in 117 fathoms, with the same soft, tenacious mud, the temperature 39½° to 43½°. Here occurred a smaller *Geryon*, perhaps a male, and apparently, judging by Wyville Thomson's figures in his work "The Depths of the Sea" (page 88), identical with Kroyer's *Geryon tridens*. With this crab were associated shells and worms. This day ended our explorations, and at night the Bache arrived in Salem.

In my work I was assisted by Mr. C. Cooke, assistant in the Museum of the Peabody Academy of Science at Salem. I would also express my obligations to Captain Howell and the officers of the Bache for the efficient aid they rendered me.

* Illustrated Catalogue of the Museum of Comparative Zoölogy, iv. Deep Sea Corals. By L. F. de Pourtales, assistant, United States Coast Survey. 1871.

XXXII.—LIST OF THE MARINE ALGÆ OF THE UNITED STATES.

By W. G. Farlow, M. D.*

Class ALGÆ.

Subclass FLORIDEÆ.

Order RHODOMELEÆ (inc. LAURENCIEÆ).

AMANSIA MULTIFIDA, Lmx.
Key West; West Indies; Brazil.

DASYA GIBBESII, Harv.
Key West; Cuba.

DASYA ELEGANS, Ag. *Chenille.*
Key West to Cape Cod; Salem, Mass?; Southern Europe; West Indies.

DASYA RAMOSISSIMA, Harv.
Key West.

DASYA HARVEYI, Ashmead.
Key West.

DASYA MOLLIS, Harv.
Key West; Cuba.

DASYA MUCRONATA, Harv.
Key West.

DASYA WURDEMANNI, Bailey.
Key West.

DASYA CALLITHAMNION, Harv.
San Diego; Santa Barbara, Cal.

DASYA TUMANOWICZI, Gatty.
Key West.

DASYA LOPHOCLADOS, Mont.
Key West.

DASYA PLUMOSA, Bail. and Harv.
Pacific coast.

* The classification adopted is a modification of that given by Thuret in Le Jolis's *Liste des Algues Marines de Cherbourg.*

BOSTRYCHIA MONTAGNEI, Harv.
Key West.

BOSTRYCHIA CALAMISTRATA, Mont.
Key West; West Indies; Pacific Ocean.

BOSTRYCHIA RIVULARIS, Harv.
Isle of Shoals, N. H., to Florida; Australia.

BOSTRYCHIA TUOMEYI, Harv.
Florida; Pacific Ocean.

BOSTRYCHIA MORITZIANA, Mont.
Florida; Guiana; and the West Indies.

POLYSIPHONIA URCEOLATA, Grev.
New York, northward; California. North Atlantic and Pacific. Var. *patens*, Cape Ann, Mass.; Santa Cruz, Cal. Var. *formosa*, New England.

POLYSIPHONIA SENTICULOSA, Harv.
Santa Cruz, Cal.; Vancouver's Island.

POLYSIPHONIA HAVANENSIS, Mont.
Var. *Binneyi*, Ag., Key West; France; West Indies.

POLYSIPHONIA FERULACEA, Ag.
Key West; West Indies; Pacific Ocean; Australia.

POLYSIPHONIA SUBTILISSIMA, Mont.
Jackson's Ferry, West Point, N. Y.; Providence, R. I.; Newburyport, Mass.; southward to Guiana.

POLYSIPHONIA SECUNDA, Ag.
Key West; Southern Europe.

POLYSIPHONIA FRACTA, Harv.
Key West.

POLYSIPHONIA ECHINATA, Harv.
Key West.

POLYSIPHONIA HAPALACANTHA, Harv.
Key West.

POLYSIPHONIA GORGONIÆ, Harv.
Key West; Loo Choo Islands.

POLYSIPHONIA OLNEYI, Harv. *Dough-balls.*
Long Island Sound.

POLYSIPHONIA HARVEYI, Bail. *Nigger-hair.*
New York, northward. Var. *arietina*, Harv., same limits.

POLYSIPHONIA HIRTA, Ag.
Key West; Mediterranean.

POLYSIPHONIA ELONGATA, Grev. *Lobster-claws.*
Long Island Sound to Lynn, Mass.; Europe.

POLYSIPHONIA VIOLACEA, Grev.
New York, northward; Europe.

POLYSIPHONIA FIBRILLOSA, Grev.
Noank, Conn.; Orient Point, L. I.; Wood's Hole, Mass.; Europe.

POLYSIPHONIA COLLABENS, Ag.
San Diego, Cal.?; Southern Europe.

POLYSIPHONIA VARIEGATA, Ag.
Cape Cod, southward; Europe.

POLYSIPHONIA PENNATA, Ag.
Southern California; Southern Europe; Australia.

POLYSIPHONIA PARASITICA, Grev.
California; Rhode Island?; Europe. Var. *dendroidea*, Ag., California; Chili.

POLYSIPHONIA BAILEYI, Ag.
Pacific coast.

POLYSIPHONIA PECTEN-VENERIS, Harv.
Florida.

POLYSIPHONIA EXILIS, Harv.
Key West.

POLYSIPHONIA ATRORUBESCENS, Grev.
New York to Cape Ann; west coast?; Europe; Africa; Falkland Isles.

POLYSIPHONIA BIPINNATA, Post. and Rupr.
West coast; North Pacific.

POLYSIPHONIA WOODII, Harv.
West coast.

POLYSIPHONIA NIGRESCENS, Grev.
East and west coasts; Europe.

POLYSIPHONIA VERTICILLATA, Harv.
California.

POLYSIPHONIA FASTIGIATA, Grev.
New York, northward; California?; Europe.

ODONTHALIA ALEUTICA, Ag.
Oregon; North Pacific.

ODONTHALIA LYALLII, Harv.
Vancouver's Island.

ODONTHALIA DENTATA, Lyngb.
California; New England?; Northern Europe; Nova Scotia; Canada.

RHODOMELA LARIX, Ag.
Oregon and California; North Pacific.

RHODOMELA FLOCCOSA, Ag.
Oregon and California; North Pacific.

RHODOMELA SUBFUSCA, Ag.
New York northward. Var. *gracilis*, same limits. Var. *Rochei*, Long Island Sound; North Atlantic, and Pacific

DIGENIA SIMPLEX, Ag.
Key West; Southern Europe; Indian Océan; Red Sea.

BRYOTHAMNION TRIANGULARE, Ag.
Key West; West Indes; Brazil.

BRYOTHAMNION SEAFORTHII, Ag.
Florida to Brazil.

ALSIDIUM BLODGETTII, Harv.
North Carolina and southward.

ACANTHOPHORA THIERII, Lmx.
Florida to Brazil; Pacific Ocean.

ACANTHOPHORA MUSCOIDES, Ag.
Florida to Brazil; east coast of Africa.

ACANTHOPHORA DELILEI, Lmx.
Florida; Mediterranean and Red Seas.

CHONDRIA DASYPHYLLA, Ag.
Cape Cod, southward; Europe; Australia.

CHONDRIA STRIOLATA, Ag. (*C. Baileyana*, Mont.).
Cape Cod, southward; Adriatic Sea.

CHONDRIA TENUISSIMA, Ag.
Long Island Sound; Europe; Australia.

CHONDRIA LITTORALIS, Harv.
Wood's Hole, Mass.; Florida; Mexico.

CHONDRIA ATROPURPUREA, Harv.
Charleston, S. C., and southward; California.

CHONDRIA NIDIFICA, Harv.
Pacific coast.

LAURENCIA PINNATIFIDA, Lmx. *Pepper-dulse.*
California; Europe; Pacific and Indian Oceans and Red Sea.

LAURENCIA VIRGATA, Ag.
California; Cape of Good Hope.

LAURENCIA OBTUSA, Lmx.
Florida; California; common in all tropical seas.

LAURENCIA IMPLICATA, Ag.
Key West; West Indies.

LAURENCIA CERVICORNIS, Harv.
Key West.

LAURENCIA GEMMIFERA, Harv.
Florida.

LAURENCIA PAPILLOSA, Grev.
Florida; common in all tropical seas.

LAURENCIA PANICULATA, Ag.
Key West; Atlantic coast of Spain; Mediterranean and Adriatic Seas.

ORDER CHYLOCLADIEÆ.

CHYLOCLADIA OVALIS, Hook. (*Lomentaria*, Endl.)
California. Var. *Coulteri*, Harv., California; Europe.

? LOMENTARIA SACCATA, J. Ag.
California.

ORDER SPHÆROCOCCOIDEÆ.

GRINNELLIA AMERICANA, Harv.
Long Island Sound to Norfolk, Va.

DELESSERIA SINUOSA, Linx.
Long Island Sound, northward; Europe; Arctic Ocean.

DELESSERIA QUERCIFOLIA, Bory.
California; Cape Horn and Antarctic Ocean.

DELESSERIA ALATA, Linx.
Nahant, Mass., northward; Northern Europe.

DELESSERIA ANGUSTISSIMA, Griff.
Gloucester, Mass.; Great Britain.

DELESSERIA WOODII, Ag., Bidrag.
Vancouver's Island.

DELESSERIA HYPOGLOSSUM, Linx.
Charleston, S. C., and southward; Europe.

DELESSERIA TENUIFOLIA, Harv.
Key West.

DELESSERIA INVOLVENS, Harv.
Key West.

DELESSERIA LEPRIEURII, Mont.
West Point, N. Y., and southward; in tropical and subtropical seas.

DELESSERIA DECIPIENS, Ag., Bidrag.
West coast.

NITOPHYLLUM PUNCTATUM, var. *ocellatum*, Grev.
Smithville, N. C.; Key West; Europe; Tasmania.

NITOPHYLLUM SPECTABLE, Eaton, mscr.
California.

NITOPHYLLUM LACERATUM, Grev.
California; Europe.

NITOPHYLLUM LATISSIMUM, Ag., Bidrag.
California.

NITOPHYLLUM AREOLATUM, Eaton, mscr.
California.

NITOPHYLLUM FRYEANUM, Harv.
California.

NITOPHYLLUM (NEUROGLOSSUM) ANDERSONII, Ag.
California.

NITOPHYLLUM RUPRECHTIANUM, Ag., Bidrag.
West coast.

NITOPHYLLUM FISSUM, Ag., Bidrag.
West coast?; Cape of Good Hope; Peru.

CALLIBLEPHARIS CILIATA, Kütz.
Cape Ann, Mass., northward; Europe.

GRACILARIA MULTIPARTITA, Ag.
East and west coasts; Europe. Var. *angustissima*, Harv., New York to Cape Cod.

GRACILARIA COMPRESSA, Grev.
Key West; Europe.

GRACILARIA CERVICORNIS, Ag.
Key West to Brazil.

GRACILARIA CONFERVOIDES, Grev.
Charleston, S. C., and southward; California; Oregon; Europe; East and West Indies; Australia.

GRACILARIA ARMATA, Ag.
Key West; Mediterranean and Adriatic Seas.

GRACILARIA DIVARICATA, Harv.
Key West.

GRACILARIA POITEI, Lmx.
Key West; West Indies.

?GRACILARIA DAMÆCORNIS, Ag.
Atlantic coast.

GRACILARIA? BLODGETTII, Harv.
Key West.

ORDER CORALLINEÆ.

*CORALLINA OFFICINALIS, L.
New York, northward; California and Oregon; Europe; North Atlantic and Pacific.

CORALLINA SQUAMATA, Ellis and Sol.
California; Europe.

JANIA RUBENS, Lmx.
Key West; San Diego, Cal.; Europe; Cape of Good Hope; Pacific Ocean.

JANIA CUBENSIS, Mont.
Key West; Cuba.

JANIA CAPILLACEA, Harv.
Key West.

AMPHIROA FRAGILLISSIMA, Lmx.
Florida; West Indies.

AMPHIROA DEBILIS, Kütz.
Florida; West Indies.

AMPHIROA CALIFORNICA, Decaisne.
West coast.

MELOBESIA MEMBRANACEA, Lmx.
East coast; Europe; Australia.

MELOBESIA FARINOSA, Lmx.
East coast; Europe; Australia.

MELOBESIA PUSTULATA, Lmx.
East and west coasts; Europe; Australia.

LITHOTHAMNION POLYMORPHUM, Aresch.
Eastport, Me.; Europe.

HILDENBRANDTIA ROSEA, Kütz.
New England coast; Europe.

ORDER GELIDIEÆ.

GELIDIUM CORNEUM, Lmx.
Florida; California. Var. *crinale*, Charleston, S. C.; New Haven, Conn.; Wood's Hole, Mass.; Portland, Me. Found in almost all seas.

GELIDIUM CARTILAGINEUM, Grev.
Santa Cruz; San Diego, Cal.; Cape of Good Hope; Madagascar; Philippine Islands; Brazil.

GELIDIUM COULTERI, Harv.
California.

WURDEMANNIA SETACEA, Harv.
Key West.

EUCHEUMA ISIFORME, Ag.
Key West; West Indies.

EUCHEUMA? ACANTHOCLADUM, Ag. (*Chrysymenia*, Harv.)
Key West.

ORDER HYPNEÆ

HYPNEA MUSCIFORMIS, Lmx.
Wood's Hole, Mass., and southward; California. In nearly all temperate and tropical seas.

HYPNEA? CRINALIS, Harv.
California.

HYPNEA DIVARICATA, Grev.
Key West; Gulf of Mexico; Australia.

HYPNEA CORNUTA, Ag.
Key West; Pacific Ocean.

ORDER RHODYMENIEÆ.

RHODYMENIA PALMATA, Grev. *Common dulse.*
North Carolina, northward; west coast?; Europe; Cape Horn, &c.

RHODYMENIA PALMETTA, Grev.
Halifax, N. S.; Southern California; Europe.

RHODYMENIA CORALLINA, Grev.
Southern California; Chili; New Zealand; Antarctic Ocean.

EUTHORA CRISTATA, Ag.
Nahant, Mass., and northward, common; dredged off Block Island, R. I., and off Gay Head, Mass.; Northern Europe.

PLOCAMIUM COCCINEUM, Lyngb.
West coast, common; East coast?; found in some form in nearly all seas.

STENOGRAMMA INTERRUPTA, Mont.
California; Australia; Europe.

PIKEA CALIFORNICA, Harv.
California.

CHAMPIA PARVULA, Harv.
Cape Cod, southward; Europe.

LOMENTARIA BAILEYANA, Farlow (*Chyloeladia*, Harv.).
Cape Cod southward to West Indies.

LOMENTARIA ROSEA, Thuret.
Newport. R. I.; Gay Head, Mass.; Portsmouth, N. H.; Europe.

RHABDONIA TENERA, Ag., Bidrag (*Solieria chordalis*, Ner. Am. Bor.).
Cape Cod, southward; West Indies.

RHABDONIA COULTERI, Harv.
California.

RHABDONIA RAMOSISSIMA, Ag., Bidrag (*Chrysymenia*, Harv.).
Key West.

?CORDYLECLADIA HUNTII, Harv.
Narragansett Bay.

CORDYLECLADIA? IRREGULARIS, Harv. (*Chylocladia rigens*, Ag.).
Key West; West Indies.

CORDYLECLADIA CONFERTA, Ag.
San Diego, Cal; Spain; Algeria.

ORDER SPONGIOCARPEÆ.

POLYIDES ROTUNDUS, Ag.
New York, northward; Europe.

ORDER SQUAMARIEÆ.

PEYSSONNELIA ATRO-PURPUREA, Crouan?.
Key West; Eastport, Me.; Europe.

ORDER BATRACHOSPERMEÆ.

HELMINTHORA DIVARICATA, Ag.
Key West; Europe.

NEMALION MULTIFIDUM, Ag.
Watch Hill, R. I., and northward; Europe.

SCINAIA FURCELLATA, Bivon.
Newport, R. I.; Gay Head, Katama, Mass.; California. Var. *undulata*, San Diego, Cal.; Europe. Generally in the warmer seas.

LIAGORA VALIDA, Harv.
Florida.

LIAGORA PINNATA, Harv.
Florida.

LIAGORA LEPROSA, Ag.
Key West; Gulf of Mexico; Loo Choo Islands.

LIAGORA PULVERULENTA, Ag.
Key West; Gulf of Mexico; Japan.

LIAGORA FARIONICOLOR, Melville.
Key West.

LIAGORA CAYOHUESONICA, Melville.
Key West.

ORDER WRANGELIEÆ.

WRANGELIA PENICILLATA, Ag.
Key West; Southern Europe.

WRANGELIA MULTIFIDA, Ag.
Key West; Europe.

ORDER GIGARTINEÆ.

PHYLLOPHORA BRODIÆI, Ag.
Long Island Sound, northward; Northern Europe.

PHYLLOPHORA MEMBRANIFOLIA, Ag.
Long Island Sound and northward; Northern Europe.

PHYLLOPHORA CLEVELANDII, Farlow.
San Diego, Cal.

GYMNOGONGRUS NORVEGICUS, Ag. (inc. *G. Torreyi*, Ag.).
Penobscot Bay; Peak's Island, Me.; Beverly, Nahant, Mass.; also near New York; Europe.

GYMNOGONGRUS TENUIS, Ag.
California; West Indies.

GYMNOGONGRUS GRIFFITHSIÆ, Ag.
California; Europe.

GYMNOGONGRUS LINEARIS, Ag.
California.

AHNFELTIA GIGARTINOIDES, Ag.
West coast.

AHNFELTIA PLICATA, Fr.
New York, northward; west coast; Europe.

AHNFELTIA? PINNULATA, Harv.
Key West.

CYSTOCLONIUM PURPURASCENS, Kütz.
New York, northward; Europe.

CALLOPHYLLIS LACINIATA, Kütz.
Cape Henlopen, N. C.; California; Europe.

CALLOPHYLLIS VARIEGATA, Ag.
California; Peru; Antarctic Ocean.

CALLOPHYLLIS OBTUSIFOLIA, Ag.
San Diego, Cal.; Southern Ocean.

CALLOPHYLLIS DISCIGERA, Ag.
California; Cape of Good Hope.

CALLOPHYLLIS ORNATA, Mont.
California?; Auckland Islands.

CALLOPHYLLIS FLABELLULATA, Harv.
California; Vancouver's Island.

CONSTANTINEA SITCHENSIS, Post. and Rupr.
Oregon; Santa Cruz, Cal.; Alaska.

GIGARTINA ACICULARIS, Lmx.
Florida; Europe; Indian and Southern Ocean.

GIGARTINA CANALICULATA, Harv.
West coast.

GIGARTINA MOLLIS, Bail. and Harv.
Puget Sound.

GIGARTINA MAMILLOSA, Ag.
Massachusetts Bay, northward; Oregon; Santa Cruz, Cal.; Europe; North Atlantic and Pacific.

GIGARTINA MICROPHYLLA, Harv.
California.

GIGARTINA JARDINI, Ag., Bidrag.
California.

GIGARTINA VOLANS, Ag.
West coast?.

GIGARTINA SPINOSA, Kütz.
California.

GIGARTINA RADULA, Ag.
Westcoast. Cape of Good Hope; Australia; Auckland Islands; Var. *exasperata*, West coast.

GIGARTINA CHAMISSOI, Mont.
California?; Peru; Brazil.

*CHONDRUS CRISPUS, Lyngb. *Irish moss.*
North Carolina; New York, and northward. Very common.

CHONDRUS AFFINIS, Harv.
California.

CHONDRUS CANALICULATUS, Ag.
California; west coast of South America.

IRIDÆA LAMINARIOIDES, Bory. (including *Iridœa minor* and *Iridœa dichotoma*).
West coast of North and South America.

IRIDÆA PUNICEA, Post. and Rupr.
Santa Cruz, Cal.?; Sitka.

ENDOCLADIA MURICATA, Ag.
West coast.

GLOIOPELTIS FURCATA, Ag.
Oregon; North Pacific.

ORDER CRYPTONEMIEÆ.

CRYPTONEMIA CRENULATA, Ag.
Key West to Brazil.

CRYPTONEMIA LUXURIANS, Ag.
Key West to Brazil.

CHRYSYMENIA ENTEROMORPHA, Harv.
Key West.

CHRYSYMENIA HALYMENIOIDES, Harv.
Key West.

CHRYSYMENIA AGARDHII, Harv.
Key West.

CHRYSYMENIA UVARIA, Ag.
Key West to Brazil; Europe.

HALYMENIA LIGULATA, Ag.
Key West. Var. *Californica*; Santa Cruz, Cal.; Europe.

HALYMENIA FLORESIA, Ag.
Key West; Europe.

CORYNOMORPHA CLAVATA, Ag., Bidrag (*Acrotylus*, Harv.).
Key West.

PRIONITIS LANCEOLATA, Harv.
West coast.

PRIONITIS ANDERSONII, Eaton, mscr.
Santa Cruz, Cal.

*SCHIZYMENIA EDULIS, Ag.
Oregon; Europe; Japan.

SCHIZYMENIA ? COCCINEA, Harv.
Santa Cruz, Cal.; Vancouver's Island.

GRATELOUPIA GIBBESII, Harv.
Charleston, S. C., and southward.

GRATELOUPIA CUTLERIÆ, Kütz.
California; Chili.

GRATELOUPIA FILICINA, Ag.
Florida; West Indies; Europe; Indian Ocean.

NEMASTOMA? BAIRDII, Farlow.
Gay Head, Mass.

ORDER DUMONTIEÆ.

HALOSACCION HYDROPHORA, Ag.
West coast.

HALOSACCION FUCICOLA, Post. and Rupr.
West coast.

HALOSACCION RAMENTACEUM, Ag.
Gloucester, Mass., and northward; Northern Europe.

CATANELLA PINNATA, Harv.
Key West.

ORDER SPYRIDIEÆ.

SPYRIDIA ACULEATA, Kütz.
Florida; Gulf of Mexico; Europe; Red Sea.

SPYRIDIA FILAMENTÓSA, Harv.
Massachusetts Bay, southward; Europe; all warm seas.

ORDER CERAMIEÆ.

MICROCLADIA COULTERI, HARV.
West coast.

MICROCLADIA CALIFORNICA, Farlow.
California.

MICROCLADIA BOREALIS, Rupr.
West coast.

CENTROCERAS CLAVULATUM, Ag.
Key West; California. Common in all tropical and subtropical seas.

CENTROCERAS EATONIANUM, Farlow.
West coast.

CERAMIUM NITENS, Ag.
Key West; West Indies.

CERAMIUM RUBRUM, Ag.
Everywhere.

CERAMIUM DESLONGCHAMPSII, Ch.
Nahant, Mass., and northward; Europe; Tasmania.

CERAMIUM DIAPHANUM, Roth.
Occasionally found on the New England coast; California; Europe; Cape of Good Hope; Australia.

CERAMIUM STRICTUM, Harv.
New England; Europe.

CERAMIUM YOUNGII, Farlow, mscr.
Canarsie, L. I.

CERAMIUM TENUISSIMUM, Lyngb.
Key West; Europe.

CERAMIUM FASTIGIATUM, Harv.
Southern New England; Europe.

CERAMIUM BYSSOIDEUM, Harv.
Key West.

PTILOTA DENSA, Ag.
Southern California.

PTILOTA HYPNOIDES, Harv.
California.

PTILOTA ASPLENIOIDES, Ag.
Oregon, northward.

PTILOTA PLUMOSA, Ag.
East and west coasts. Var. *filicina*, west coast. Var. *serrata*. New England from Nahant northward; also northwest coast; Northern Europe.

PTILOTA ELEGANS, Bonnem.
New York, northward; Europe.

GLOIOSIPHONIA CAPILLARIS, Carm.
Long Island Sound to Cape Ann, Mass.; Europe.

CROUANIA ATTENUATA, J. Ag.
Key West; Europe; Australia.

HALURUS EQUISETIFOLIUS, Kütz.
New York.?; Europe.

GRIFFITHSIA CORALLINA?, Ag.
New York to Gloucester, Mass.; Europe; Australia.

CALLITHAMNION ARBUSCULA, var. *Pacifica*, Ag. (*C. Pikeanum*, Harv.).
California.

CALLITHAMNION TETRAGONUM, Ag.
New York to Cape Cod; Europe.

CALLITHAMNION BAILEYI, Harv.
New York, southward.

CALLITHAMNION PTILOPHORA, Eaton, mscr.
California.

CALLITHAMNION SQUARRULOSUM, Harv.
California.

CALLITHAMNION BORRERI, Ag.
New York to Nantucket; Europe.

CALLITHAMNION POLYSPERMUM, Ag.
New York, southward; west coast; Europe.

CALLITHAMNION BYSSOIDEUM, Arn.
Nahant to New York; Europe.

CALLITHAMNION DIETZIÆ, Hooper.
Long Island Sound.

CALLITHAMNION CORYMBOSUM, Ag.
New York, northward; Europe.

CALLITHAMNION VERSICOLOR, Ag., var. *scirospermum*, Harv.
New York, northward; Europe.

CALLITHAMNION PLUMULA, Lyngb.
Long Branch, N. J., to Gay Head, Mass.; Europe; Southern Ocean.

CALLITHAMNION HETEROMORPHUM, Ag., mscr.
California.

CALLITHAMNION AMERICANUM, Harv.
New York, northward; Vancouver's Island.

CALLITHAMNION PYLAISÆI, Mont.
Orient, L. I., and northward; Europe.

CALLITHAMNION FLOCCOSUM, Ag.
Massachusetts Bay, northward; Northern Europe. Var. *Pacificum*, Harv. Santa Cruz, Cal.

CALLITHAMNIUM CRUCIATUM, Ag.
New York to Cape Cod; Europe.

CALLITHAMNION LEJOLISIA, Farlow, mscr.
San Diego, Cal.

CALLITHAMNION TURNERI, Ag.
New York to Cape Cod; Europe.

CALLITHAMNION ROTHII, Lyngb.
New England coast; Europe.

?ORDER PORPHYREÆ.

*PORPHYRA VULGARIS, Ag. *Laver.*
Everywhere.

BANGIA VERMICULARIS, Harv.
West coast.

BANGIA FUSCOPURPUREA, Lyngb.
East coast; Europe.

?FLORIDEÆ.

INCERTÆ SEDIS.

CHANTRANSIA DAVIESII, Thur.
Gloucester, Gay Head, Mass.; Europe.

CHANTRANSIA SECUNDATA, Thur.
Peak's Island, Me.

CHANTRANSIA VIRGATULA, Thuret.
New York, northward; Europe.

ERYTHROTRICHIA CILIARIS, Thuret.
Charleston, S. C.; Europe.

ERYTHROTRICHIA CERAMICOLA, Aresch.
Buzzard's Bay, Cape Ann, Mass.; Portland Harbor, Me.

GONIOTRICHUM ELEGANS, Zanard.
Cotuit Port, Mass.

SUBCLASS MELANOSPORÆ.

ORDER DICTYOTEÆ.

HALYSERIS POLYPODIOIDES, Ag.
North Carolina; Europe.

PADINA PAVONIA, Lmx. *Peacock's-tail.*
East coast from North Carolina southward; Europe; in most warm seas.

ZONARIA LOBATA, Ag.
Key West; West Indies; Cape of Good Hope; Brazil; Pacific Ocean.

ZONARIA FLAVA, Ag.
California?; Southern Europe and Northern Africa.

ZONARIA INTERRUPTA, Ag.
California; Cape of Good Hope; Australia; New Zealand.

TAONIA ?SCHRŒDERI, Ag.
Florida to Brazil.

DICTYOTA FASCIOLA, Lmx.
Florida; Mediterranean Sea.

DICTYOTA DICHOTOMA, D. C.
Charleston, southward; common in all warm seas.

DICTYOTA CILIATA, Ag.
Key West; West Indies.

DICTYOTA KUNTHII, Ag.
San Diego, Cal.; Peru; New Zealand.

DICTYOTA BARTAYRESIANA, Lmx.
Key West; West Indies.

DICTYOTA ACUTILOBA, Ag.
Key West?; Sandwich Islands.

ORDER FUCACEÆ.

SARGASSUM VULGARE, Ag.
Atlantic coast, from Cape Cod south; Atlantic Ocean generally; Australia.

SARGASSUM AFFINE, Ag.
Florida; West Indies.

SARGASSUM BACCIFERUM, Ag. *Gulf-weed.*
Gulf Stream and floating off the southern coast; Europe; Indian and Pacific Oceans; Australia; New Zealand; forming great masses in what is known as the Sargasso Sea in the Atlantic.

SARGASSUM FILIPENDULA, Ag.
Key West; Gulf of Mexico.

SARGASSUM DENTIFOLIUM, Ag.
Key West; Red Sea.

SARGASSUM AGARDIANUM, Farlow, mscr.
San Diego, Cal.

SARGASSUM PILULIFERUM, Ag.
Guadeloupe Island, off California; Japan.

TURBINARIA VULGARIS, Ag.
Key West; West Indies; Red Sea; China; Indian Ocean; Australia.

PHYLLOSPORA MENZIESII, Ag.
Var. *glabra*, west coast.

HALIDRYS OSMUNDACEA, Harv.
West coast.

FUCUS FASTIGIATUS, Ag.
West coast.

* FUCUS (OZOTHALLIA) NODOSUS, L. *Rock-weed.*
East coast, north of Charleston; Europe; North Atlantic.

FUCUS DISTICHUS, *L.* (*F. filiformis*, Gm.).
Marblehead, Mass.; Europe.

*FUCUS FURCATUS, Ag.
Nahant, Mass., and northward; California.

FUCUS CERANOIDES, L.
East coast; Europe.

FUCUS HARVEYANUS, D.c. ne.
Monterey, Cal.

*FUCUS VESICULOSUS, L. *Rock-weed.*
East coast, north of Charleston; west coast; Europe; North Atlantic and Pacific; Australia?.

FUCUS SERRATUS, L.
Newburyport, Mass.; Nova Scotia; Europe.

ORDER PHÆOSPOREÆ.

SUBORDER LAMINARIEÆ.

*MACROCYSTIS PYRIFERA, Ag. *Great kelp of Oregon and California.*
West coast of North and South America; Australia; and Antarctic Ocean.

LESSONIA NIGRESCENS, Bory.
Oregon; Chili; southward.

*NEREOCYSTIS LÜTKEANA, Post. and Rupr. *Great bladder-weed.*
Monterey, Cal., and northward.

POSTELSIA PALMÆFORMIS, Ruprecht. *Kakgum-chale.*
Santa Cruz, Cal., and northward.

PTERYGOPHORA CALIFORNICA, Ruprecht. *Kcha balba; Mangai.*
Santa Cruz, Cal., northward.

*ALARIA ESCULENTA, Grev. *Badderlocks. Henware.*
Cape Cod, northward; Monterey, Cal., northward; Europe.

ALARIA FISTULOSA, Post. and Rupr.
Northwest coast.

ALARIA MARGINATA, Post. and Rupr.
Northwest coast.

COSTARIA TURNERI, Grev.
Northwest coast.

DICTYONEURON CALIFORNICUM, Ruprecht.
Northwest coast.

LAMINARIA DERMATODEA, De la Pyl.
Peak's Island, Me.; Eastport, Me.; Newfoundland; Kamtschatka; Vancouver's Island.

*LAMINARIA SACCARHINA, Lmx. *Devil's apron; Kelp.*
New York, northward; west coast; Europe; Japan?.

*LAMINARIA LONGICRURIS, De la Pyl. *Devil's Apron; Kelp.*
New England, northward; Northern Europe; North Atlantic and Pacific.

*LAMINARIA FLEXICAULIS, Le Jolis. *Devil's apron; Kelp.*
New England; Europe; California?.

*LAMINARIA PLATYMERIS, De la Pyl.
New England?; Newfoundland.

AGARUM TURNERI, Post. and Rupr. *Sea-colander.*
Nahant, Mass., northward; northwest coast.

THALASSIOPHYLLUM CLATHRUS, Post. and Rupr.
Northwest coast.

SUBORDER SPOROCHNEÆ.

STILOPHORA RHIZODES, Ag.
Long Island and Vineyard Sounds; Europe; Tasmania; Southern Ocean.

STILOPHORA PAPILLOSA, Ag.
Chesapeake Bay; Adriatic and Mediterranean Seas.

STRIARIA ATTENUATA, Grev.
Flushing, L. I.; Europe.

SUBORDER ASPEROCOCCEÆ.

ASPEROCOCCUS COMPRESSUS, Griff.
Gloucester, Mass.; Europe.

ASPEROCOCCUS SINUOSUS, Bory.
Key West; San Diego, Cal.; Southern Europe; tropical and subtropical oceans generally.

ASPEROCOCCUS ECHINATUS, Grev.
New England coast; Europe.

HYDROCLATHRUS CANCELLATUS, Bory.
Florida to Brazil; Mauritius; Australia.

RALFSIA VERRUCOSA, Aresch.
Nahant, northward; Europe.

SUBORDER CHORDARIEÆ.

CHORDA FILUM, Stack.
New York, northward; Europe.

CHORDARIA FLAGELLIFORMIS, Ag.
New York, northward; Europe; North Atlantic and Pacific; Cape of Good Hope; Chili.

CHORDARIA ABIETINA, Rupr.
Santa Cruz, Cal., northward.

CHORDARIA DIVARICATA, Ag.
New York to Gloucester, Mass.; Europe.

CASTAGNEA VIRESCENS, Thuret.
Wood's Hole, Gloucester, Mass.; Portland, Me.; Sand Key, Fla.

CASTAGNEA ZOSTERÆ, Thuret.
Wood's Hole, Mass.; Europe.

LIEBMANNIA LEVEILLEI, Ag.
West coast; Europe.

Suborder MYRIONEMEÆ.

Leathesia tuberiformis, Gray.
New York, northward; Europe.

Elachista fucicola, Fr.
New England; Europe.

Myrionema strangulans, Grev.
Fisher's Island, N. Y.; Wood's Hole, Mass.; probably everywhere.

Myrionema Leclancherii, Harv.
Gay Head, Mass.

Suborder ARTHROCLADIEÆ.

Arthrocladia villosa, Duby.
Wilmington, N. C.; Europe.

Suborder SPHACELARIEÆ.

Cladostephus spongiosus, Ag.
New England coast; Europe; Cape of Good Hope; Australia; Cape Horn, &c.

Cladostephus verticillatus, Ag.
New England coast; Europe.

Sphacelaria fusca, Ag.
On *Amphiroa Californica*, San Diego, Cal.; England.

Sphacelaria radicans, Ag.
New England coast; Europe.

Sphacelaria cirrhosa, Ag.
New York, northward; Europe.

Suborer ECTOCARPEÆ.

Myriotrichia filiformis, Harv.
Penobscot Bay; Rhode Island; Europe.

Ectocarpus brachiatus, Harv.
Boston, northward; Europe.

Ectocarpus firmus, Ag. (*E. littoralis*, Harv.).
New England coast?; Europe.

Ectocarpus Farlowii, Thuret.
Peak's Island, Me.; Marblehead, Mass.

Ectocarpus longifructus, Harv.
Penobscot Bay.

Ectocarpus siliculosus, Lyngb.
Charleston, S. C., northward; Europe; Australia.

Ectocarpus amphibius, Harv.
New York; Great Britain.

ECTOCARPUS VIRIDIS, Harv.
Charleston, S. C., and northward.

ECTOCARPUS LUTOSUS, Harv.
Greenport, L. I.

ECTOCARPUS TOMENTOSUS, Lyngb.
Boston, northward; Europe; Cape Horn.

ECTOCARPUS FASCICULATUS, Harv.
New England coast; Europe.

ECTOCARPUS GRANULOSUS, Ag.
Boston Harbor; Santa Cruz, Cal.; Europe.

ECTOCARPUS DURKEEI, Harv.
Portsmouth, N. H.; Wood's Hole, Mass.?

ECTOCARPUS MITCHELLÆ, Harv.
Nantucket.

ECTOCARPUS HOOPERI, Harv.
Greenport, L. I.

ECTOCARPUS DIETZIÆ, Harv.
Greenport, L. I.

SUBORDER DICTYOSIPHONEÆ.

DICTYOSIPHON FŒNICULACEUS, Grev.
Long Island Sound, northward; Europe.

SUBORDER DESMARESTIEÆ.

DESMARESTIA ACULEATA, Lmx.
New York, northward; Europe; Kamtschatka.

DESMARESTIA VIRIDIS, Lmx.
New York, northward; Europe; North Pacific; southern part of South America; Kerguelen's Land, &c.

DESMARESTIA LIGULATA, Lmx.
Monterey, Cal., northward; Europe; Cape Horn; Cape of Good Hope; Australia.

DESMARESTIA LATIFRONS, Kütz.
Santa Cruz, Cal.

SUBORDER PUNCTARIEÆ.

PUNCTARIA LATIFOLIA, Grev.
New York, northward. Var. *Zosteræ*, Le Jolis, same limits; Europe.

PUNCTARIA PLANTAGINEA, Grev.
New England coast; Europe.

SUBORDER SCYTOSIPHONEÆ.

PHYLLITIS FASCIA, Ktz.
New York, northward; Europe; Cape Horn, &c.

SCYTOSIPHON LOMENTARIUS, Ag.
New York, northward; California; Europe; very generally diffused all over the world.

Subclass CHLOROSPORÆ.

Order SIPHONEÆ.

Caulerpa prolifera, Lmx.
Florida; Mediterranean Sea.

Caulerpa crassifolia, Ag., var. *Mexicana.*
Florida; West Indies.

Caulerpa plumaris, Ag.
Florida; West Indies; generally in the warmer seas.

Caulerpa Ashmeadii, Harv.
Key West.

Caulerpa ericifolia, Ag.
Florida; West Indies.

Caulerpa cupressoides, Ag.
Key West; West Indies.

Caulerpa lanuginosa, Ag.
Key West.

Caulerpa Paspaloides, Bory.
Florida to Brazil.

Caulerpa clavifera, Ag.
Florida; in all warm seas.

Halimeda Opuntia, Lmx.
Florida; in most warm seas.

Halimeda incrassata, Lmx.
Florida; West Indies.

Halimeda tuna, Lmx.
Florida; Mediterranean Sea; Pacific Ocean.

Halimeda tridens, Lmx.
Key West; West Indies.

Udotea flabellata, Lmx.
Key West; West Indies.

Udotea conglutinata, Lmx.
Key West; West Indies.

Codium tomentosum, Stack.
Florida; west coast; Europe; in all tropical and subtropic seas.

Chlorodesmis? Vaucheriæformis, Harv.
Key West.

Bryopsis plumosa, Lmx.
Whole eastern coast; nearly all temperate oceans.

BRYOPSIS HYPNOIDES, Lmx.
Key West; Europe; warmer seas generally.

VAUCHERIA PILOBOLOIDES, Thuret.
Wood's Hole, Mass.?; Europe.

ORDER DASYCLADEÆ.

DASYCLADUS OCCIDENTALIS, Harv.
Florida; West Indies.

DASYCLADUS CLAVÆFORMIS, Ag.
Key West; West Indies; Mediterranean.

ACETABULARIA CRENULATA, Lmx.
Florida and West Indies.

CYMOPOLIA BARBATA, Lmx.
Key West; West Indies.

ORDER VALONIEÆ.

CHAMÆDORIS ANNULATA, Mont.
Key West; West Indies; Mauritius.

PENICILLUS DUMETOSUS, Dne.
Florida; West Indies.

PENICILLUS CAPITATUS, Lmx. *Mermaid's shaving-brush.*
Florida; West Indies.

PENICILLUS PHŒNIX, Lmk.
Florida; West Indies.

BLODGETTIA ?CONFERVOIDES, Harv.
Key West; West Indies.

ANADYOMENE FLABELLATA, Lmx.
Key West; all tropical seas.

DICTYOSPHÆRIA FAVULOSA, Dne.
Key West; all tropical seas.

ASCOTHAMNION INTRICATUM, Kütz.
Key West; Mediterranean.

ORDER ZOÖSPOREÆ.

ENTEROMORPHA INTESTINALIS, Link.
Everywhere.

ENTEROMORPHA COMPRESSA, Grev.
Everywhere.

ENTEROMORPHA CLATHRATA, Grev.
New England coast; west coast; Europe.

* ULVA LATISSIMA, Linn. *Sea-lettuce.*
Everywhere.

ULVA LACTUCA, Linn.
With the last, but not so common.

ULVA FASCIATA, Delile.
California.

CLADOPHORA REPENS, Ag.
Key West; Europe.

CLADOPHORA MEMBRANACEA, Ag.
Key West; Mediterranean.

CLADOPHORA RUPESTRIS, L.
New York, northward; Europe.

CLADOPHORA CARTILAGINEA, Rupr.
California.

CLADOPHORA ARCTA, Dillw.
New York, northward; Europe.

CLADOPHORA LANOSA, Roth.
Boston ?; Europe.

CLADOPHORA UNCIALIS, Fl. Dan.
New England coast; Europe.

CLADOPHORA GLAUCESCENS, Griff.
Charleston, S. C., northward; Europe.

CLADOPHORA FLEXUOSA, Griff.
New England coast; Europe.

CLADOPHORA REFRACTA, Roth.
Charleston, S. C., northward; Europe.

CLADOPHORA MORRISIÆ, Harv.
Elsinborough, Del.

CLADOPHORA ALBIDA, Huds.
New York and New Jersey; Europe.

CLADOPHORA RUDOLPHIANA, Ag.
Jackson's Ferry, N. Y.; Europe.

CLADOPHORA GRACILIS, Griff.
Beesley's Point, N. J.; Rhode Island; Nahant, Mass.; Europe; Australia.

CLADOPHORA BRACHYCLADOS, Mont.
Texas.

CLADOPHORA LUTEOLA, Harv.
Key West; Cuba.

CLADOPHORA LÆTEVIRENS, Dillw.
New York Bay; Boston Bay; California; Europe.

CLADOPHORA DIFFUSA, Harv.
New York ?.

CLADOPHORA FRACTA, Fl. Dan.
Eastern coast; in fresh and brackish water all over the world.

CHÆTOMORPHA PICQUOTIANA, Mont.
New York, northward.

CHÆTOMORPHA MELAGONIUM, Web. and Mohr.
Boston Harbor, northward; Europe.

CHÆTOMORPHA ÆREA, Dillw.
East coast; Europe; North Pacific; Australia.

CHÆTOMORPHA OLNEYI, Harv.
Rhode Island.

CHÆTOMORPHA LONGIARTICULATA, Harv.
Massachusetts and Rhode Island.

CHÆTOMORPHA SUTORIA, Berk.
Stonington, Conn.; Europe.

CHÆTOMORPHA BRACHYGONA, Harv.
Key West.

CHÆTOMORPHA TORTUOSA, Dillw.
Nahant, Mass., northward; Europe.

HORMOTRICHUM YOUNGANUM, Dillw.
New England coast; Europe; Northern Atlantic and Pacific.

HORMOTRICHUM CARMICHAELII, Harv.
Boston ?.

ORDER CYANOPHYCEÆ.

SUBORDER OSCILLARIEÆ.

LYNGBYA MAJUSCULA, Harv.
Cape Cod, southward; Europe; Pacific Ocean, &c.

LYNGBYA FERRUGINEA, Ag.
New England coast; Europe.

LYNGBYA LUTEO-FUSCA, Ag. (inc. *L. fulva*, Harv.).
Stonington, Conn.; Noank, Conn.

LYNGBYA NIGRESCENS, Harv.
Peconic Bay, L. I.

LYNGBYA CONFERVOIDES, Ag.
Charleston, S. C.; Europe.

LYNGBYA PUSILLA, Harv.
Sullivan's Islands, S. C.

LYNGBYA HYALINA, Harv.
Key West.

CALOTHRIX CONFERVICOLA, Ag.
Everywhere.

CALOTHRIX SCOPULORUM, Ag.
Everywhere.

CALOTHRIX VIVIPARA, Harv.
Seaconnet Point, R. I.

CALOTHRIX PILOSA, Harv.
Key West.

CALOTHRIX DURA, Harv.
Key West.

MICROCOLEUS CORYMBOSUS, Harv.
Key West.

SUBORDER NOSTOCHINEÆ.

SPHÆROZYGA CARMICHAELII, Harv.
Noank, Conn.; Wood's Hole, Mass.; Europe.

SUBORDER RIVULARIEÆ.

RIVULARIA ATRA, Roth.
New England; Europe.

RIVULARIA PLICATA, Carm.
Cohasset Narrows, Mass.; Europe.

ORDER PALMELLEÆ.

CRYPTOCOCCUS ROSEUS, Kütz.
New England; Europe.

ADDENDA.*

LITHOTHAMNION FASCICULATUM, Aresch.
Robbinstown, Me.; Europe.

AMPHIROA NODULOSA, Kütz.
San Diego, Cal.; Venezuela.

GRIFFITHSIA OPUNTIOIDES, J. Ag.?.
Santa Cruz, Cal.

PETROCELIS CRUENTA, Ag.
Nahant, Mass.; Eastport, Me.; Europe.

FUCUS PLATYCARPUS, Thuret.
Eastport, Me.; Europe.

LAMINARIA ANDERSONII, Eaton, mscr.
Santa Cruz, Cal.

MESOGLOIA ANDERSONII, Farlow, mscr.
Santa Cruz, Cal.

RALFSIA CLAVATA, Crouan.
Eastport, Me.; Europe.

SPIRULINA TENUISSIMA, Kütz.
Eastport, Me.; Europe.

RIVULARIA NITIDA, Ag.?.
Wood's Hole, Mass.

PROTOCOCCUS CREPIDINUM, Thuret.
Eastport, Me.

LIST OF THE PRINCIPAL USEFUL SEA-WEEDS OCCURRING ON THE UNITED STATES COAST.

USED AS FOOD.

1. CHONDRUS CRISPUS, Lyngb., commonly called *Irish moss.* Is abundant on the New England coast, particularly to the north of Cape Cod, growing just below low-water mark. It is gathered in large quantities at Hingham, Mass., and sold for making blanc mange, puddings, and sea-moss farine. It is also used by brewers for clarifying, and by calico-printers.
2. SCHIZYMENIA EDULIS, Ag. Found on the west coast; is eaten in Europe.
3. RHODYMENIA PALMATA, Grev. *Common dulse.* Sold rough-dried in the seaport towns of the Northern States; principally eaten by sailors and children. That found in our markets is generally imported from the British provinces, although the plant is very common in New England.
4. PORPHYRA VULGARIS, Ag. *Laver.* Eaten stewed in some parts of Europe. Imported from China by the Chinese living in this country, even by those as far east as Massachusetts, although the plant is common on the Massachusetts shore.
5. ALARIA ESCULENTA, Grev. Common on the New England coast north of Cape Cod. Is eaten in Scotland, but not in the United States.

No doubt, EUCHEUMA ISIFORME of Key West, GIGARTINA MAMMILLOSA, often gathered by mistake for the true *Irish moss*, the Californian species of CHONDRUS, and some of the species of GRACILARIA are quite as good for culinary purposes as the *Irish moss.*

ULVA LATISSIMA, L., *sea-lettuce*, is used by owners of aquaria for feeding some of the marine animals, particularly MOLLUSCA.

USED AS FERTILIZERS.

The larger dark-colored sea-weeds are roughly distinguished by the inhabitants of the shore as *rock-weeds*, or those furnished with small bladders or snappers, and *kelp.* The *rock-weed* of New England is composed almost entirely of three species of FUCUS, F. VESICULOSUS, F. NODOSUS, and F. FURCATUS. The *kelp* of New England is composed of the *Devil's aprons*, species of LAMINARIA, the *sea-colander*, AGARUM TURNERI, and ALARIA ESCULENTA. The *rock-weeds* and *kelp* are all useful for manure, and are either scattered over the land and allowed to rot, or else manufactured together with other substances into marketable fertilizers.

The red sea-weed, POLYSIPHONIA HARVEYI, is said, at times, to be washed ashore in Peconic Bay in such quantities that it is used as manure.

USED FOR THE MANUFACTURE OF IODINE.

The *rock-weeds* and *kelp* furnish nearly all the iodine of commerce. The largest manufactories of iodine are in Scotland, where use is made of the same species of FUCUS and LAMINARIA as are common on the New England coast.

THE GREAT KELP OF CALIFORNIA.

MACROCYSTIS PYRIFERA forms entangled masses, which serve as natural breakwaters on the exposed portion of the California coast. The leaf-bladders of the same plant are used by sailors in high southern latitudes for rolling up into cigarettes.

The very long slender stems of NEREOCYSTIS LÜTKEANA, the *Great bladder-weed* of the west coast, are used as fish-lines by the Indians of the Northwest.

The rough-dried stems of LAMINARIA SACCARHINA, L. LONGICRURIS, L. FLEXICAULIS, and other large species of LAMINARIA, under the name of *Artificial staghorn*, are used for making handles to knives, paper-cutters, and other ornamental purposes. At one time, an attempt was made to establish a manufactory of buttons out of dried LAMINARIA stems at Marblehead; but the attempt was given up, as the buttons did not bear washing.

The dry stems of the LAMINARIAE, particularly the digitate species, as L. FLEXICAULIS, are used by surgical-instrument makers in the manufacture of sponge-tents.

CORALLINA OFFICINALIS, L., was formerly used in medicine as a tonic.

ALPHABETICAL INDEX.

XXXIII.—LECTURE ON THE ORGANS OF REPRODUCTION AND THE FECUNDATION OF FISHES AND ESPECIALLY OF EELS.*

By Dr. Syrski.

INTRODUCTION.

The subject which I propose to speak of on this occasion is "On the organs of reproduction of fishes, and especially of eels", a subject belonging to zoology.

Every one knows what this word means, and its derivation is quite clear, viz, from the Greek word "*zoon*", a living being, an animal, and "*logos*", a word, a rational discourse. Any further definition of this branch of natural science might therefore seem superfluous. And still we hear people call "zoology" what is taught in the lower classes of our "real-schools" as well as what is studied in the higher courses of the university. Most people understand by this name the description of the external forms of animals. In general, by zoology is meant a description of animals.

In the first place, it is only an exposition of some zoological data; in the second place, it is the expression of what is known of the inner life of animals during a certain given period, and indicates a simple period in the development of zoology, the standard of the first and last development, *i. e.*, the genealogical as well as philogenetic and individual development of animals, the conformity of their outer forms to their inner organization, of their functions, of the mutual relations between them and the rest of nature, and finally the manner in which man makes use of them. Zoology therefore embraces *zoogeny*, treating of the origin of animals; *philogeny*, *i e.*, the development of the species; *ontogeny*, also called *embryology*, *i. e.*, the development of the individual being; *morphology*, which treats of the form; *anatomy*, which relates to structure; *physiology*, which concerns itself with functions, and which, in a wider sense, also comprises ontogeny, the geographical distribution of animals, and their uses.

The classification of animals according to their affinities, being nothing but the result of a knowledge of the animals, must therefore naturally be modified as this knowledge increases.

Some also comprise zoology together with botany, mineralogy, geology, paleontology, in some cases even geography, under the common name *natural history*, only applying the designation *natural science* to

* Degli organi della riproduzione e della fecondazione dei pesci ed in inspecialità delle anguille, *in Bollettino della Società Adriatica di Scienze naturali in Trieste*, No. 1, pp. 10-32, December, 1874. Trieste, 1875.

chemistry, physics, and astronomy. But the objects of the first, which consist of organic and inorganic forms and vital phenomena, being nothing but the results of chemico-physical forces, also properly belong to the domain of natural science. My lecture to-day will be confined to the description of the organs of reproduction in fish, in so far as relates to anatomy and in part to physiology.

THE ORGANS OF REPRODUCTION AND FECUNDATION IN FISH IN GENERAL.

The organs of reproduction in nearly all fish are distributed between two individuals, in which the sexes are separate, viz, female and male. So far we know only three species of hermaphrodites, in which the male and female organs are found united in one and the same individual. These hermaphrodites are the well-known "*Perga comune*" (*Serranus scriba*), "*Perga dalmata*" (*Serranus cabrilla*), and the "*Sacchetto*" (*Serranus hepatus*).*

There are three typical forms of the female organs, or ovaries, in fish.

Fig 1.

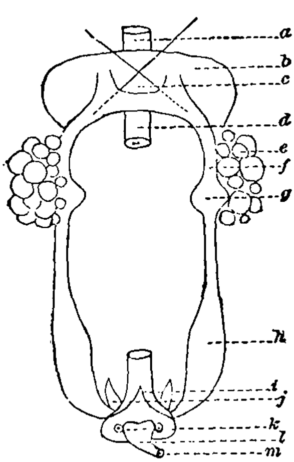

FIG. 1. *Ovaries with oviducts, seen from below.*

- *a.* Œsophagus, front part.
- *b.* Peritonæum.
- *c.* Inner opening, common to the two oviducts.
- *d.* Œsophagus, rear part.
- *e.* Left ovary.
- *f.* Oviduct, front part.
- *g.* Glandula of the oviduct.
- *h.* Uterine part of the oviduct.
- *i.* Intestine, partly split open lengthwise.
- *j.* Urinary bladder.
- *k.* Separate outer openings of the oviducts.
- *l.* Urethral papilla.
- *m.* Outlet of the urethra.

Fig. 2.

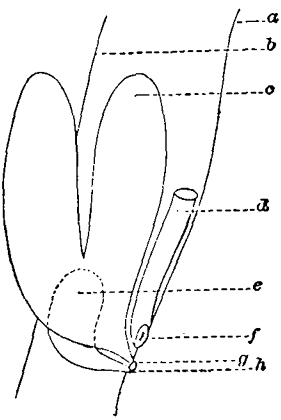

FIG. 2. *Ovaries, seen from the right side of the abdomen.*

- *a.* Abdominal wall.
- *b.* Dorsal wall.
- *c.* Left ovary.
- *d.* Intestine.
- *e.* Urinary bladder.
- *f.* Anus.
- *g.* Genital orifice, with its outlet in the—
- *h.* Urethral orifice.

The *first form* (fig. 1), peculiar to the plagiostomes, among which we mention the "pesci-cani" (dog-fish, or *Mustelus*), the "gatte" (*Scyllium*),

* Hermaphroditism also occurs in the genus Lutjanus or Ocyurus, Poey having discovered a hermaphrodite of his *Ocyurus ambiguus*.—(T. G.)

"squæne" (*Squatina*), "tremoli" (cramp-fish, or *Torpedo*), "rase" (ray, or *Raja*), consists of one or two masses of eggs inclosed in a cellular tissue which resembles that of the ovaries of birds. The eggs, when loosened from the ovary in the abdominal cavity, enter two tubes, placed laterally, called the oviducts, across their inner, common orifice; and in some species, such as the majority of the dog-fishes (*Mustelus*), the cramp-fish (*Torpedo*), &c., develop there till they become perfect animals, while in others the eggs are surrounded by a solid horny shell, and their development is completed in the water. The oviducts debouch in the terminal part of the intestine.

The *second form* (fig. 2), which is the most common among fish, is found in nearly all osseous fishes, and consists of two sacs (one in the "girai," &c.), uniting toward the posterior end in a single oviduct, which discharges outside behind the anus. Of a similar form are also the ovaries of the hermaphrodites, so far known (fig. 3), in the parietes of which are found the spermatic organs, and of which the vasa deferentia discharge into the orifice of the oviduct. The ova contained in such sacs taken from the "volpine" and the "branzini" during the spawning-season are sold by our fishermen under the name of "*Bottarga*".

Fig. 3.

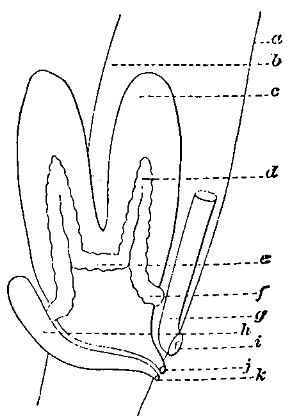

FIG. 3. *Hermaphrodite organs.*

a. Abdominal wall.
b. Dorsal wall.
c. Left ovary.
d. Left testicle.
e. Abdominal commissure.
f. Dorsal commissure.
g. Intestine.
h. Urinary bladder.
i. Anus.
j. Genital orifice.
k. Urethral orifice.

Fig. 4.

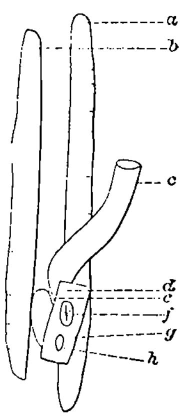

FIG. 4. *Ovaries.*

a. Right ovary.
b. Left ovary.
c. Intestine.
d. Part of the abdominal wall.
e. Urinary bladder.
f. Anus.
g. Genital orifice.
h. Urethral orifice.

In nearly all fish (except the "scarpene," &c.), these sacs have on their inner surface leaflets, placed crosswise or lengthwise, and containing the eggs by thousands, which increase in number and size during the spawning-season, and distend the ovarian sacs.

In some other fishes, the ovaries resemble two ribbons (fig. 4), more or less twisted, running along both sides of the intestine to the dorsal wall of the abdominal cavity, as in the sturgeons, salmons, and also in the eels. The ripe egg, when it separates from the ovary in the abdominal cavity, passes through a hole which opens on the outside behind the anus.

The *male organs* of fish, or spermatic organs, commonly called milts [testicles,] which produce the sperm—*i. e.*, a fluid containing small organic bodies, which, moving about, penetrate the egg, impregnate it, and start the development of the embryo—are likewise of different forms.

In the "pesci-cani" (dog-fish, *i. e.*, *Mustelus*), the "rase" (ray, *i. e.*, *Raja*), &c., the male organs resemble two thin laminæ (fig. 5) elongated, twisted, and partly lobate, composed of partitions, from which small tubes start, which unite and compose a somewhat larger tube, terminating in the right as well as the left side in a canal, which serves for the emission of the sperm.

Fig. 5.

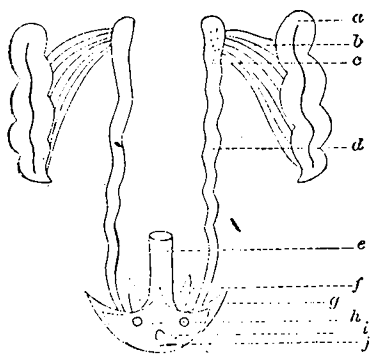

FIG. 5. *Testicles.*
a. Left testicle.
b. Vasa efferentia.
c. Left epididymis.
d. Deferent canal.
e. Intestine.
f. Urinary bladder.
g. Left seminal vesicle.
h. Opening of the deferent canals.
i. Urethral orifice.
j. Cloaca.

Fig. 6.

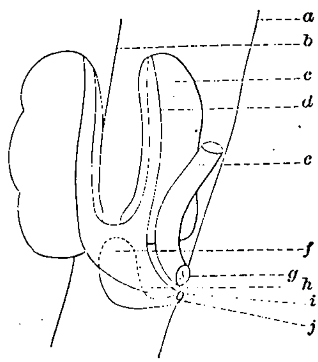

FIG. 6. *Testicles.*
a. Abdominal wall.
b. Dorsal wall.
c. Left testicle.
d. Left deferent canal.
e. Intestine.
f. Urinary bladder.
g. Anus.
i. Genital orifice.
j. Urethral orifice.

In the greater number of *osseous fish*, the spermatic organs consist of two elongated bodies (fig. 6), more or less triangular, or in the form of thin laminæ, composed of compartments, which, beginning on the outer surface, converge toward the interior of the organ, giving rise to a canal called "*vas deferens*", which in many fishes consists of a net-work of conduits; which "vasa", those of the opposite sides uniting, form a single excretory canal, which debouches in many fish first in the urethra, usually on a small papilla placed behind the anus.

In other fishes, the spermatic organs are composed of lobes united by means of vasa deferentia.

Fig. 7.

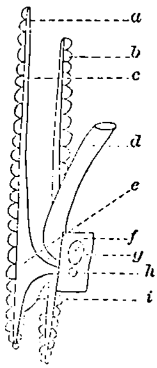

FIG. 7. *Testicles.*
a. Right testicle.
b. Left testicle.
c. Deferent canal.
d. Intestine.
e. Seminal pouch.
f. Part of the abdominal wall.
g. Anus.
h. Uro-genital orifice.
i. Urinary bladder.

In the male eel, these lobes form two lateral rows (fig. 7), extending nearly the whole length of the abdominal cavity.

The eggs of fish (like those of other animals) are, in the beginning of their development, of microscopic size, and consist of a transparent yolk, which incloses the germinal cell (fig. 8). In the state of maturity, however, they differ considerably in size, and in some cases, though rarely, in form, as to their contents, and in their covering. The mature eggs of the "pesci-cani" (dog-fish), the "tremoli" (*Torpedo*), &c., which are as large as hen or goose eggs, consist of a yellow yolk inclosed in a membrane, and a germinative disk, measuring about three millimeters in diameter, placed on the surface of the yolk under the membrane, and which contains the germinative cell (fig. 9). From the disk of the fecundated egg is formed the embryo, to which the yolk serves as food.

Fig. 8.

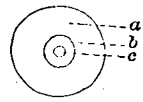

FIG. 8. *Young transparent egg.*
a. Yolk.
b. Germinative vesicle.
c. Germinative dot.

Fig. 9.

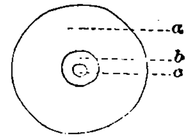

FIG. 9. *Egg.*
a. Yolk.
b. Germinative vesicle.
c. Germinative dot.

Fig. 10.

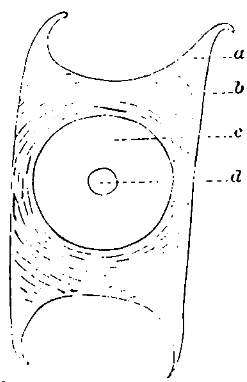

FIG. 10. *Egg.*
a. Corner of the shell.
b. Horney shell of the egg.
c. Yolk of the egg or nutrive yolk.
d. Germinative disk, or yolk of evolution.
e. Gelatinous matter surrounding the yolk in the same manner as the white of the egg in birds' eggs.

When the egg has entered the oviduct, it becomes covered with a layer of gelatinous matter, and in the "gatte" (*Scyllium*), "rase" (*Raja*), &c., also with a solid horny case, produced by the glands of the oviduct (fig. 10).

The mature eggs of osseous fish (fig. 11) are about one to six millimeters in diameter, and sometimes even less than one. When they are half-matured, they are of a yellow or white color; and when quite mature, they are almost transparent.

The sperm of fish, commonly called *milt*, is a thick, white liquid, containing innumerable small spermatic bodies, or spermatozoa, forming the essential part of the sperm, and moving about when in a fresh condition. They consist of an anterior thicker part, the so-called head, and a more attenuated part, or tail.

The spermatic corpuscules vary both in size and shape. In the "pesci-cani" (*Mustelus*), the "rase" (*Raja*), &c., they are larger, with the head more or less fusiform, and the tail more or less spiral (fig. 12).

In the osseous fishes, the spermatic corpuscules are, as a general rule, smaller, with the head rounder, and the tail quite attenuated and filiform (fig. 13).

Fig. 11.

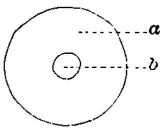

FIG. 11. *Ripe egg of the Pike* (ESOX LUCIUS), *seen from above.*
a. Nutritive yolk.
b. Germinative disk.

Fig. 12.

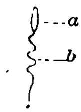

FIG. 12. *Spermatic corpuscle.*
a. The elongated head.
b. The spiral-formed tail. These corpuscles execute rotary movements with their spiral part, while the other part has a trembling, vibrating, and darting motion.

Fig. 13.

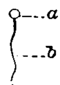

FIG. 13. *Spermatic corpuscle.*
a. Head nearly round.
b. Filiform tail.

The fecundation of the egg consists in the entry of the spermatic corpuscules into the egg (fig. 14), and in the production of a division of the germinative disk, which phenomenon is called the process of segmentation, or furrowing (fig. 15), followed by a series of successive changes, of which the final result is the embryo, which, feeding on the yolk, gradually develops into the perfect fish.

Fig. 14.

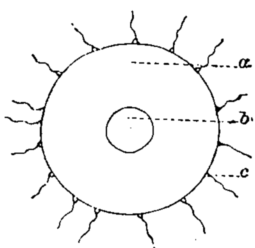

FIG. 14. *Ripe transparent egg of the "Rayno"* (*Weaver*=TRACHINUS RADIATUS), *with spermatic corpuscles.*
a. Yolk.
b. Lump of fat.
c. Spermatic corpuscles.

Fig. 15.

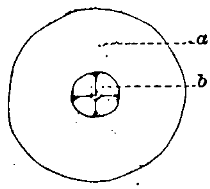

FIG. 15. *Egg after fecundation, during the period of segmentation, or sulcation, of the germinative disk.*
a. Nutritive yolk.
b. Germinative disk, or yolk of evolution, divided into four segments.

The fecundation of the egg is effected in the "pesci-cani" (*Mustelus*) and other viviparous species inside the body of the animal, while in the great majority of fish it takes place outside the body in the water, where the male fish, during the spawning-season, pursues the female, squirting his sperm over the eggs; and this fact makes artificial fecundation and pisciculture possible.

THE REPRODUCTIVE ORGANS OF THE EEL.

Although the eel is one of the most common fishes, it is, nevertheless, one of the least known. As, even up to the present day, only the female of the eel is known, and this even imperfectly, some naturalists have supposed that the females propagate the species without the help of the male, which mode of reproduction actually takes place in some insects, and is called *parthenogenesis;* while others, having recently recognized in a fatty formation, which is found in the abdominal cavity by the side of the ovaries, the male organs of the eel, have declared it be a *hermaphrodite—i. e.*, an animal in which both male and female organs are found in the same individual.

Only a few naturalists have maintained, and as we shall see not without reason, that male individuals must be found among the eels.

Basing their opinion on the reproductive organs, the majority of naturalists have with good reason supposed that the eels are *oviparous* animals, while others, almost exclusively amateurs, have always considered them as *viviparous* animals.

It will be of interest to cast a glance on the endeavors of the more distinguished naturalists to find the ovaries and the spermatic organs of the eel, and on some erroneous assertions with regard to this matter, in order to bring out in bolder relief the object in view, viz, to give through a history of a science an outline of this science.

Aristotle (fourth century before Christ[1]), the greatest naturalist of antiquity, the founder of zoology, recognized the ovaries of the "grongo" (*Conger vulgaris*) by the crackling of the eggs when placed over the fire, but maintained that the eel, notwithstanding that its ovaries resemble those of the "grongo" in every respect, is born from worms produced by mud.

Pliny (first century A. D.[2]), who, in great part, like the majority of his compatriots, only copied Greek works, especially those of Aristotle, differs from him as regards the reproduction of the eel, maintaining that it rubs itself against rocks, and that from the fragments coming off during this rubbing process the young eels are born.

Albertus Magnus (thirteenth century A. D.[3]) accepts Pliny's hypothesis, but says that he has heard that eels are also born alive from eels.

Rondelet (sixteenth century[4]) asserts that eels are born not only from putrefied matter, but also from eggs produced by the copulation of male and female eels.

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[1] *Aristotle: Περὶ ζώων ἱστορίας*, lib. iii, cap. 10, § 1; lib. v, cap. 3, § 2, and cap. 9, § 4; lib. vi, cap. 15, § 1-2, and cap. 16, § 6.

[2] *C. Plinii Secundi* Naturalis historiæ, lib. ix, cap. 51.

[3] *Albertus Magnus:* De animalibus libri viginti sex; written about the year 1254, and published at Venice 1495.

[4] *Rondeletii* Universæ aquatium historiæ pars altera. De piscibus fluviatilibus liber, p. 200, An. 1555.

Conrad Gesner (sixteenth century[1]) attributes the reproduction of eels to putrefying matter, and also to copulation.

Malpighi (seventeenth century[2]), a great anatomist and expert microscopist, declares that the ovaries not only of the eels but also of similar fish, such as the "grongo" and the "murena" (*Muræna helena*), are fatty productions, and calls them "*striæ adiposæ*."

Redi (toward the end of the seventeenth century[3]), who has dissected many eels and "murenas," (*Muræna helena*), and also illustrated as such the ovaries of the last-mentioned fish, nevertheless, does not recognize the ovaries of the eel.

He opposes the hypothesis that the eel can be reproduced from putrefying matter; he proves, moreover, that what are called young eels are nothing but intestinal worms, and that therefore eels are not viviparous animals, but are reproduced by means of eggs in the same manner as other fish.

Leeuwenhoek (toward the end of the seventeenth century[4]), who has occupied himself much with microscopic observations, and was the first who made known the infusoria, having found, in the urinary bladder of an eel, very small parasitic worms, mistook them for young eels, and the bladder itself for the uterus.

Georg Elsner[5] relates that a fish-vender showed him an eel whose uterus was full of young ones, which, to quote his own words, *hærebant in diversis membranis involutæ anguillæ.*

Vallisneri (beginning of the eighteenth century[6]) has given illustrations of the true ovaries of the eel, but, following Malpighi and Redi, calls them *vasi adiposi* [fatty vessels]; and, having accidentally found in an eel a pathologically-deformed swimming-bladder, announced with great joy to the Academy of Bologna and the whole scientific world that he had found the true ovary of the eel.

Linné[7] maintains that eels are viviparous.

Carlo Mundini,[8] professor of anatomy at the University of Bologna, was the first discoverer of the ovary of the eel, of which he gave a detailed description to the Academy of Bologna the 19th day of May, 1777, which, however, was not published till 1783.

Otto Müller[9] writes, in 1780, that he has found eggs in the fringed

[1] *Conradi Gesneri* Historiæ animalium liber iv. Tiguri 1558.

[2] Tetras epistolarum, &c. Dissertatio de Omento, 1665.

[3] Osservazioni intorno agli animali viventi che si trovano negli animali viventi. Florent. 1684.

[4] Arcana naturæ. Epistola 75. An. 1692.

[5] Acad. Cæs. Leopold. Miscellanea medico-physica. Observat. 119, p. 219.

[6] Prima raccolta d'osservazioni &c. Venice, 1710.—De ovario anguillarum. Ephemerides Acad. Nat. Curios. ad Centur. I et II appendix, p. 152, fig. *h*; An. 1712.—La terza volta lo stesso: Nuova scoperta delle nova, ovaje delle anguille &c. nelle opere Fisico-Mediche, raccolta del suo figliulo. An. 1733.

[7] Systema naturæ, 1750.

[8] De anguillæ ovariis. De Bononiensi Scientiarum et Artium Instituto atque Academia Commentarii. Vol. vi. 1783.

[9] Schriften der Berliner Gesellschaft naturforschender Freunde. Vol. i, p. 204. 1780.

bodies; but the description which he gives of them being in some respects inaccurate, pre-eminence must be accorded to that of Mundini.

Spallanzani,[1] a distinguished naturalist who lived toward the end of the eighteenth and in the beginning of the present century, basing his opinion on the examination of 497 eels, casts doubts on the discovery of Mundini, remarking "that not content with destroying, he wishes to erect on the Vallisnerian ruins a new edifice." These words, however, lead us to suppose that a certain animosity toward the anatomist Mundini, whom he possibly considered as an intruder among the zoologists, has led his judgment astray. In another place, moreover, he contradicts himself when he adds: "If the masses of little globules were eggs, and if they were found united with the fecundating semen, the eels would be true hermaphrodites."

Rathke,[2] who first, since Mundini, has in detail described (1824, 1838, and 1850) the ovaries of the eel, is considered by some to have recognized them; but this, however, is not true, the additions made by him to Mundini's description being to a great extent erroneous. It is not true that the transverse leaflets are wanting in the ovaries of the eel, as he asserts in his last work, contrary to his former description, which was probably based on the law of analogy, and that thereby they are distinguished from those of the salmon and sturgeon. It is not true, what Rathke likewise asserts, that the genital opening of the eel consists of two small canals, for I have invariably only found one, which opens in the urethra. Rathke has certainly described the eggs quite exactly, distinguishing the larger whitish ones, having a diameter of about one-fifteenth of a line, and the smaller transparent ones, with the germinal vesicle inside; but Mundini likewise says: "*innumeras sphærulas minimas, æquales, pellucidas, divisas tamen, quæ in centro maculam ostendebant ecc. vidi*", thus showing the true nature of the ovaries and the eggs, and contrasting them with the fatty formation and with the ovaries and eggs of other osseous fish.

If, as we have thus seen, it took more than two thousand years to find out, and this even inaccurately, the ovaries, which are much larger than the spermatic organs, it is but natural that it was no easy matter to find these, which resemble two rows of small lobes, about two to three millimeters large, and are of almost glassy appearance, starting from the same place where in the females the ovaries are found, and running both on the right and left side along the whole length of the abdominal cavity.

Mundini[3] and *Spallanzani* have sought the spermatic organs of the eel in vain.

[1] Due opuscoli sulle anguille. Appendice ai viaggi alle due Sicilie. Vol. vi. 1792.

[2] Beiträge zur Geschichte der Thierwelt. Halle, 1824.—Wiegmann's Archiv für Naturgeschichte. Vol. i. p. 299. 1838.—Müller's Archiv für Anatomie, Physiologie, &c. Vol. i, p. 203. 1850.

[3] Memoria autografa del Mundini, del 1788, in the possession of Mr. Gualtiero Sacchetti, engineer.

Hornbaum-Hornschuch,[1] who re-echoes Rathke's erroneous assertions, claims to have found in the fringed bodies of many eels, instead of eggs, round bodies inclosing small granules, and has declared that such eels are male individuals.

Schlüsser[2] was not able to confirm Hornbaum-Hornschuch's assertion. I have found only once, and that in an eel 390 millimeters long, dissected on the 5th July, in the fringed organs, besides eggs, the above-described small bodies in compartments similar to those of the testicles of eels and other fish.

The rare phenomenon of spermatic compartments and ovarian leaflets occurring side by side, I also found once in *Ophidium barbatum* and *Smaris alcedo*, where the compartments were interlarded with groups of eggs.

Professor Siebold,[3] after having passed in review the different hypotheses regarding the male organs of reproduction in the eel, and having reached a negative conclusion, says that eels may reproduce by means of parthenogenesis, or by being of different sex, or also by being hermaphrodites.

In 1872 was published a memoir,[4] accompanied by an illustrative plate, by Prof. G. B. Ercolani, in which the author distinguishes, as a rudimental testicle, the fat which is found attached to the swimming-bladder between the intestine and the right ovary and the intestine itself, while he calls "true testicle" a sac on the left side, formed exceptionally by the peritoneum, and found in the place which corresponds to the position of the fat on the right side. In the parietes of this sac, Professor Ercolani found fat and self-moving spermatozoa, which movements, however, seem to be nothing else but the molecular movement of the granules found so frequently in the tissues of the animal body. I have, instead of all this, found in the same place a fatty formation, resembling that of the right side, and only in two eels have I found a sac which could be inflated through the genital opening.

The so-called alveolar or proligenous cells of the testicle are, therefore, —as the illustration in Ercolani's article also shows—nothing else than the common and well-known alveolar vessels of the adipose tissue.

In the same year (1872) was published the results of researches by *G. Balsamo Crivelli* and *L. Maggi*,[5] professors at the University of Pavia, who, contrary to the assertions of Professor Ercolani, maintained that the fat on the right side was a well-developed testicle, and that of the left an atrophied testicle. They, too, have therein found, and also given illustrations of, spermatozoa.

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[1] De Anguillarum sexu ac generatione. Gryphiæ, 1842.

[2] De Petromyzontum et Anguillarum sexu. Dorpati, 1849.

[3] Die Süsswasserfische von Mittel-Europa, p. 348. Leipzig, 1863.

[4] Del perfetto ermafroditismo delle anguille. Memoria del Prof. Comm. G. B. Ercolani, nelle Memorie dell'Accademia delle Scienze dell'Istituto di Bologna. Serie iii, tomo i, fascicolo 4. Bologna, 1872.

[5] Intorno agli organi essenziali della riproduzione delle anguille &c. nelle Memorie del Reale Istituto Lombardo di Scienze e Lettere, vol. xii–xiii, della serie iii, fascicola 4. Milano, 1872.

I have found similar formations in almost all eels, usually more developed on the right side than on the left, sometimes fringed, as shown in the illustration accompanying Ercolani's article, or with long borders, as shown in Professor Maggi's illustration, but always of a structure which is, so to speak, typical of adipose tissues.

Recently there appeared in No. 7 for the year 1874, of the German periodical "*Die Gartenlaube*", an article, accompanied by an illustration, which represents a pseudo-embryo of an eel of the length of 24 millimeters, with the head and eyes very large, the belly swollen, and a yellow yolk-sac, described by Dr. Eberhard, of Rostock, who says that he received it in December last from a student, who again had got it from a woman who had found in the abdominal cavity of an eel a net-like sac containing about a thousand similar embryos. This story reminds one of that told more than a century ago by George Elsner.

With regard to this matter, Professor Grube, at a session of the Society of Natural History in Breslau (Prussia), expressed himself in the following manner:—

"The journals have recently brought us from Rostock the intelligence that an eel had given birth to living young ones. Similar statements have been made in former times, but afterward corrected, to the effect that the parasitic worms which are frequently found in the abdominal cavity or, in the urinary bladder, had been mistaken for young eels. The statement, however, which has come to us from Rostock owes its origin to the fact that a really viviparous fish, the *Zoarces viviparus*, has been mistaken for an eel, as was proved when the supposed young eel was sent to me by Professor Aubert. Young eels have never been found in the bodies of mother eels."

During the month of March or April of this year (1874), there appeared in the Miscellanea of the "Neue Freie Presse" of Vienna, a notice entitled "The reproduction of eels", where it is stated, "Not unfrequently persons ignorant of zoology believe that they have found in the bodies of eels young living eels, which, however—as was recently brought out strongly by Professor Münter, director of the Zoological Museum of Greifswald—when subjected to the critical examination of competent persons were found to be intestinal worms. The above-mentioned professor observes: 'It is not difficult to find in the eels of the Baltic Sea curled ovaries resembling a drapery; I myself [Münter] having invariably found ovaries in about 3,000 eels examined by me for that purpose. Unfortunately, my numerous observations have never yet been rewarded with the discovery of a male eel—*i. e.*, a milter; all the eels examined by me with all possible care for a number of years having turned out to be females. I must therefore admit that eels are reproduced by parthenogenesis, *i. e.*, from non-fecundated eggs, as is the case with some insects. In all probability, the eggs are deposited at the bottom of the Baltic Sea from the middle of March to the middle of April, and the young eels, one-half to two inches long, born from such eggs, migrate into fresh water about the beginning of May.'"

Thus but few results have been obtained with great difficulty in all the numerous researches, and the observations have frequently been erroneous. This historical review is also, from an anthropologic point of view, very instructive, showing that not only the masses of the people but also highly intelligent and cultivated men are liable to err.

I commenced my investigations on the 29th November last year (1873), and already in the second eel which I dissected on that day I found the testicles, and therefore a male individual of the eel. I sent in March of the following year (1874) to the Academy of Sciences in Vienna a preliminary communication, which was read at the public session held the 15th April, and printed in the Reports of the Academy.

Having in the course of my investigations met with similar errors regarding the female organs of reproduction in the descriptions hitherto given of them, with the view of rectifying and completing the details, and also for the purpose of comparison with the male organs, I determined to commence by describing the former, *i. e.*, female organs.

THE OVARIES OF THE EEL.

These organs (fig. 16), two in number, are ribbon-shaped, with leaflets on their outer face, and with transverse folds. In the natural position of the live fish, the one extends to the left and the other to the right of the alimentary tube, following most of its angles nearly the whole length of the abdominal cavity to the place where the dorsal parietes is confluent with the lateral.

The right ovary commences at a point nearly corresponding to that where on the outside the right pectoral fin ends, and the left ovary commences about two centimeters and ends three to four centimeters behind the former. They extend three to six centimeters back of the anus, into the caudal part of the animal's body; they do not, however, unite in a single body, as some have asserted, but both are toward the end inclosed in a peritoneal membrane, and are separated from each other by the union of these membranes, having each on their inner face an accessory ovary (*pars recurrens ovarii*). In rare cases is such an accessory ovary wanting either on the right or on the left side.

The ovaries in fully-grown eels are in the middle about two centimeters larger, and posteriorly terminate in a thread-like form. They are not smooth on both sides, but have, as was said above, on their outer side numerous transverse folds (fig. 17) full of eggs (fig. 18).

It is another of Rathke's erroneous assertions, likewise maintained by others, that the genital opening through which the eggs pass out from the abdominal cavity is formed by two holes, a right one and a left one. I have invariably found in all specimens examined a simple hole, which communicated with the right and left half of the abdominal cavity by means of a transverse fissure between the straight intestine and the urinary bladder (*fissura recto-vesicalis*) and opens in the urethra (fig. 19).

Fig. 16.

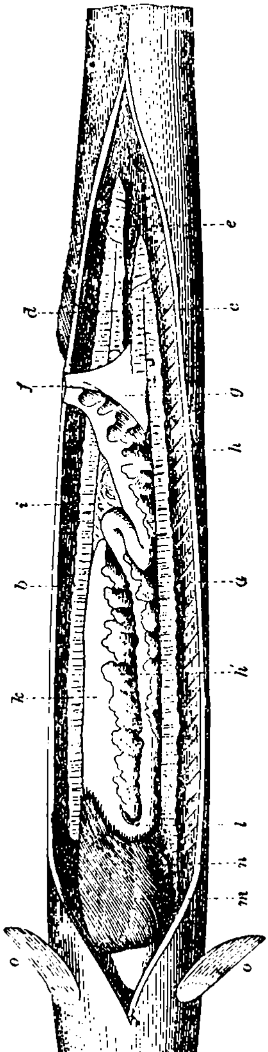

FIG. 16. *Female eel, longitudinal section of the abdomen; natural size.*

a. Right ovary.
b. Left ovary.
c. Accessory part of the right ovary.
d. Left accessory part.
e. Dividing membrane.
f. Anal depression.
g. Urinary bladder.
h. Fat on the right side erroneously taken for the testicles by some.
h'. Similar fat, covering the stomach.
i. Fat on the left side.
k. Stomach.
l. Pylorus.
m. Liver.
n. Gall-bladder.
oo. Pectoral fins

Fig. 17.

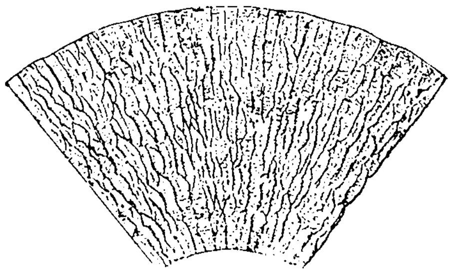

FIG. 17. *Piece of the ovary, twice its natural size, with ovarian leaflets arranged in transversal rows, on its outer surface.*
The shorter border attached to the dorsal wall of the abdominal cavity; the longer being free.

Fig. 18.

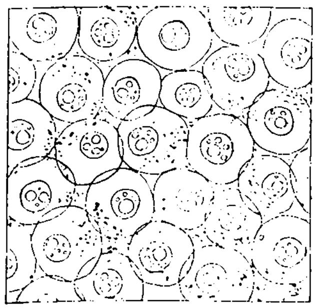

FIG. 18. *Piece of a somewhat developed ovary, one hundred times the natural size, showing the transparent eggs with the germinative vesicles and the germinative dots.*

Fig. 19.

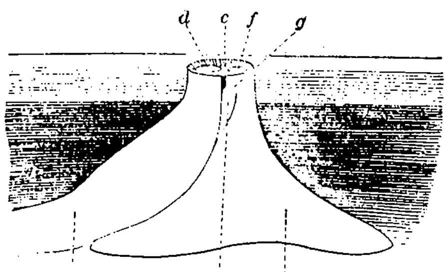

FIG. 19. *Anal part of a female eel, twice the natural size.*

a. Straight intestine.
b. *Fissura recto-vesicalis.*
c. Urinary bladder.
d. Anus.
e. Partition.
f. Uro-genital opening.
g. Outlet of the genital opening in the urethra.

It is generally admitted that the eggs, when loosened from the ovaries, fall indiscriminately into the abdominal cavity, but it is not said which w y they take in order to go out through the genital aperture. As I have invariably found that the fully-developed ovaries lean with their outer surface against the side of the abdominal cavity, and approach with their free edges the lower portion of this side, forming, so to speak, a furrow, I must conclude that the loosened eggs descend between the abdominal partition and the folds and leaflets of the ovary in the above-mentioned furrow, and from it pass to the genital aperture without scattering in the abdominal cavity.

As to the development which the ovaries undergo, I have observed, from the end of November till the beginning of March, in many adult eels, of the length of 530 millimeters and more, that the ovaries were of the breadth of 15 to 25 millimeters, and of a yellowish and sometimes reddish-white color, produced by the development of adipose tissues and of the blood-vessels, and not by the eggs filled with little globules of fat; the genital aperture and the *fissura recto-vesicalis* were open.

In other eels of a length sometimes of 600 millimeters and more, I found the ovaries less broad, with but little fat, and of a mucous and almost glassy appearance, so that I could discern the so-called vesicles and germinative dots (*nuclei* and *nucleoli*); the genital aperture and the *fissura recto-vesicalis* were closed.

The ovaries of young eels, of the length of about 500 millimeters, contained invariably but little fat, and the eggs were without globules. The gradual growth and enlargement of the ovaries go on simultaneously with the opening of the genital orifice. According to the quantity of fat contained in the ovaries, they have a mucous and glassy, or more or less opaque or white, appearance, or have small shining white dots.

From the end of March till October, I found in the majority of eels which I examined, measuring 600 to 700 millimeters in length, that the ovaries were scarcely white, and that the genital aperture was closed.

The number of eggs contained in both developed ovaries reaches, according to my calculation, five millions. The larger eggs measured by me had a diameter of one fourth to one-fifth millimeter, while the eggs of an adult "grongo" (*Conger*) had, accordingto my measurements, a diameter of one-third of a millimeter, and those of the "murena" (*Murœna helena*) almost one millimeter, which explains to me why the ovaries of the two last-mentioned species of fish have long since become known.

In an eel measuring 590 millimeters, examined on the 6th July, the left ovary was entirely wanting, and replaced by a mass of fat.

THE SPERMATIC ORGANS.

The position of these organs, (fig. 20), which are not ribbon-shaped like the ovaries, but represent two longitudinal rows each with about fifty lobules (fig. 21) of the width at most of three millimeters, and found only in eels not more than 430 millimeters long, corresponds entirely with that of the ovaries. In these organs are likewise found, toward the posterior end, the spermatic accessory organs (*partes recurrentes*), which, however, as is the case with the ovaries, are sometimes wanting.

The spermatic organs can be distinguished at the first glance from the ovaries of the adult eels and those of young eels, not only by their lobular form, but also by their shining glassy appearance, by the surface of the individual lobes, which is smooth and without leaflets, and by the much greater density of the tissue, so that with a pair of pincers one can take off a large portion of the organ, which could not possibly be done with a more developed ovary whose tissue is as tender as a cobweb, and is composed of small vessels formed of a thin membrane and filled with eggs and fat.

The fibrous tissue of the spermatic organs is composed of vascular compartments with thicker partitions, inclosing, according to the development of the organ, granular globules (fig. 22).

These compartments are joined toward the inside and the base of the lobes, which are united to a tube (*vas deferens*), which, cæcal at the commencement, runs along the entire length of the abdominal cavity, and opens near the straight intestine (*rectum*) in a triangular pouch, which likewise contains a *vas deferens* starting from the caudal part of the spermatic organ. This pouch has its outlet in the genital orifice, which opens in the urethra (fig. 23).

As regards the development of the spermatic organs, I have observed that the lobes of these organs in young eels, measuring not more than 200 to 300 millimeters in length, are not yet very distinct, forming two thin ribbons differing but little from ovaries of the female in their average size. In eels measring about 400 millimeters in length, the testicles can easily be distinguished from the ovaries. The former, much straighter, and with tissue, as has been already remarked, much more solid, are provided with

Fig. 20.

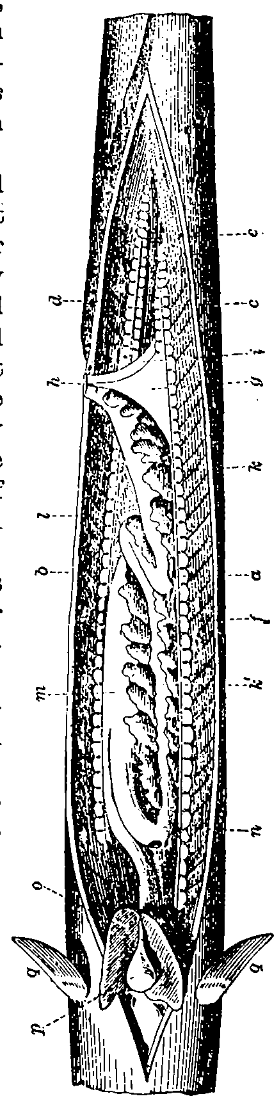

FIG. 20. *Male eel (natural size).*

a. Right testicle.
b. Left testicle.
c. Right accessory part.
d. Left accessory part.
e. Dividing membrane.
f. Deferent canal.
g. Seminal pouch.
h. Anal depression.
i. Urinary bladder, covered to a great extent by the seminal pouch.
k. Fat on the right side.
k'. Similar fat covering the stomach.
l. Fat on the left side.
m. Stomach.
n. Pylorus.
o. Liver, turned up to show the inner surface adhering to the œsophagus and the stomach.
p. Gall-bladder.
qq. Pectoral fins.

a much more developed net-work of vessels; their lobes are very distinct, and the deferent canals are usually open, while the ovaries present the appearance of two continuous ribbons, have a more delicate tissue,

Fig. 21.

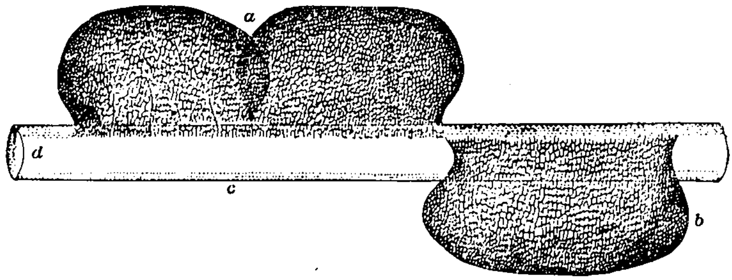

FIG. 21. *Three lobes of the right testicle, with the deferent canal (enlarged ten times).*

a. Lobes, seen from their outer surface.
b. Lobe, seen from its inner surface.
c. Deferent canal.
d. Anterior part of the same.

and an almost mucous appearance, and contain the eggs with the germinative vesicles.

The deferent canals and the genital orifice are closed in young eels of the male sex, and open simultaneously with the development of the lobes.

In the male eels examined by me from March to October, I have found individuals of 400 millimeters and more in length, whose genital orifice and deferent canals were invariably open, while in some of the smaller ones they were closed and in others open.

Fig. 22.

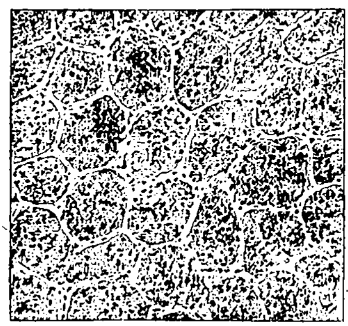

FIG. 22. *Piece of the testicle (one hundred and sixty times enlarged), showing the vascular tissue and the small granules.*

Fig. 23.

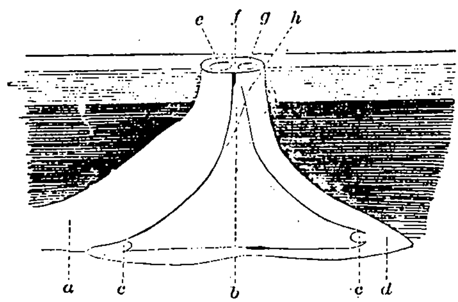

FIG. 23. *Anal part of the male eel, enlarged twice.*

a. Straight intestine.
b. *Fissura recto-vesicalis*, covered by the outside wall of the seminal pouch.
cc. Outlet of the anterior and posterior part of the deferent canal in the pouch.
d. Urinary bladder.

Of the 258 eels examined by me, the males and females were in about even proportion; the greatest length of the former was about 430 millimeters, while the latter were of all sizes up to 1,050 millimeters, which shows that the males are smaller than the females.

XXXIV.—THE FOOD AND MODE OF LIVING OF THE SALMON, THE TROUT, AND THE SHAD.

By D. Barfurth.*

PREFATORY NOTE.

A few preliminary remarks are demanded in explanation of this article. The question investigated is whether the catching of what is called "Rümpchen" in certain parts of Germany (and in this case in the vicinity of Bonn) is injurious in reference to the species of economical importance. As the investigation has reference to forms or combinations which have certain technical designations without exact English synonyms, those designations are retained in the translation. They may be explained as follows:

"Rümpchen" is the collective name for small fresh-water fishes in Western Germany, and under it are confounded small full-grown fishes as well as the young of larger species. There is no exact English equivalent for the term; the word "minnows" being restricted properly to small cyprinoids, while "fry," although sometimes used as a collective name for small fishes, is in intention applicable rather to the very young of various species.

It has been also deemed expedient to retain the German names of the several species in question. These, however, have exact English synonyms, viz:

The "Lutter-Rümpchen," or "Süsse Rümpchen," (*Cobitis barbatula*,) is the "loach" of the English.

The "Riedlingchen," or "Bitter-Rümpchen," (*Phoxinus lævis*,) is the "minnow" of the English.

The "Güwchen" (*Gobio fluviatilis*) is the "gudgeon" of the English.

The "Kaulkopf" (*Uranidea* or *Cottus gobio*) is the "miller's-thumb" of the English.

The word "Gesams" corresponds as nearly as may be with the English word "fry."

The species whose food has been especially examined have been named in accordance with the views of Siebold, and are respectively

* Ueber Nahrung und Lebensweise der Salme, Forellen und Maifische.—Inaugural-Dissertation zur Erlangung der Doctorwürde bei der philosophischen Facultät der Rheinischen Friedrich-Wilhelms-Universität zu Bonn eingereicht und mit den beigefügten Thesen vertheidigt am 19. December 1874 von D. Barfurth, stud. rer. nat. aus Dinslaken. . . . . Bonn, Druck von Carl Georgi. 1874. [8vo, 41 pp.]—Reprinted from Archiv für Naturgeschichte. Translated by O. Jacobson.

(1) the salmon, (2) the sea-trout, (3) the common river-trout of Europe, and (4) the Allice shad. These, in accordance with the nomenclature generally prevalent, are (1) *Salmo salar*, (2) *Salmo trutta*, (3) *Salmo fario*, and (4) *Alausa vulgaris*. The old genus *Salmo* has been differentiated by Siebold into two genera: (1) *Salmo*, including the charrs and hucho, distinguished by the vomer being abbreviated, the anterior short portion thereof alone armed with teeth, the hinder longer portion (shaft) being wholly toothless in the old as well as in the young; and (2) *Trutta*, including the salmon, sea-trout, river-trout, and related species, whose vomer is elongated, (the anterior short portion being with or without teeth,) and the hinder elongated portion (shaft) armed along its entire length with teeth, which, however, in the very old are more or less lost. These would respectively correspond to (1) *Salvelinus* Bon. emend. (=*Salmo* Siebold) and (2) *Salmo* Linn. Bon. emend. (=*Trutta* Siebold).

The "Maifische" of the Germans is the common shad or Allice shad of the English, (*Alosa vulgaris*,) and is very closely related to the shad of the American coast (*Alosa sapidissima*).

THEO. GILL.

INTRODUCTION.

In the year 1852, the Prussian government proposed to forbid the "Rümpchen-fishery," as it was believed that, in consequence of such fishery, species which when larger might be useful were destroyed. Professor Troschel, of Bonn, thereupon examined the young fish which, under the name of "Rümpchen," are brought to market, and found that the "Lutter-Rümpchen," or "Süsse Rumpchen," was the *Cobitis barbatula L.*, the "Riedlingchen" or "Bitter-Rümpchen," the *Phoxinus lævis Ag.*, the "Güwchen," the *Gobio fluviatilis C.*, and the "Kaulkopf," the *Cottus gobio L.* The "Rümpchen," brought to market under the name of "Gesams," consist, according to *Troschel*, of the young of all the fish living in the river Ahr; consequently, besides the young of the species mentioned, those of *Alburnus lucidus H.*, *Squalius cephalus L.*, *Leuciscus rutilus L.*, *Barbus fluviatilis Ag.*, and *Trutta fario Lin.*[1] (*Siebold.*) On the strength of these investigations,[2] *Troschel* declared that, as most of the "Rümpchen" are entirely worthless for fishery-purposes, they might be caught without any injury to the fisheries. But when this problem had been solved, the assertion was made that it would, nevertheless, be injurious to catch the "Rümpchen," because thereby the better kinds of fish were deprived of their necessary food,[3] and the philosophical faculty of the Friedrich-Wilhelms University of Bonn, during the year 1873–'74, proposed a prize for answering the following questions:

"It is asserted that the catching of 'Rümpchen,' although these fish are in themselves worthless, still proves injurious to the Rhine fisheries, because the larger fish, *Salmo salar*, *Salmo hamatus*, and *Salmo fario*, are thereby deprived of their most necessary food. The salmon go into the sea, where they feed on other fish, and only come into the rivers for the purpose of spawning. The trout always keep in the mountain-brooks. By examining the entrails of the above-mentioned fish at different seasons of the year, it is to be ascertained of what their food consists while in fresh water, in order to decide whether it is injurious to the fisheries to catch 'Rümpchen.' It is desired to extend these investigations to the 'Maifische,' (*Alausa vulgaris*,) as these likewise live in the sea and only ascend the rivers in May."

[1] *Salmo fario* of most authors, the common trout of Europe.

[2] Published in "Verhandlungen des naturhistorischen Vereins der Preussischen Rheinlande und Westphalens," 8 Jahrg., Bonn, 1851, p. 563.

[3] *Siebold*, Die Süsswasserfische von Mitteleuropa, Leipzig, 1863, p. 420.

With a view to answering the above questions as far as possible satisfactorily, I have made the following investigations:

I.

THE FOOD OF TRUTTA SALAR SIEBOLD, (*Salmo salar* AND *hamatus Val.*,) AND TRUTTA TRUTTA SIEBOLD (*Fario argenteus Val.*) IN THE RIVER RHINE.

The fishes belonging to the genus *Salmo* occurring in the Rhine are, by the fishermen, distinguished as "Salm," "Lachs," and "Lachsforelle." The Lachsforelle has been described as *Fario argenteus* by *Valenciennes*,[1] and as *Trutta trutta* by *Siebold*.[2] But, respecting the proper ichthyological definition of the species which are brought to market under the popular name of "Salm" and "Lachs," the views of zoologists still differ considerably. *Cuvier* was the first to distinguish two species, and *Valenciennes* described them at length as *Salmo salmo, le saumon commun*,[3] and *Salmo hamatus, le bécard*.[4] He was followed by *Heckel* and *Kner*,[5] *Troschel*,[6] and others; while *Agassiz* considered the *Salmo hamatus* as the old male of the *Salmo salar*, and recognized only this latter species. The same view was taken by *Siebold*,[7] *Günther*,[8] and many others.

Such a diversity of opinions seems surprising, as the question is about such valuable and well-known fishes. It must, however, be remarked that no other genus of fishes has given the ichthyologists so much trouble as the genus *Salmo*. Even such a thorough systematist as *Günther*[9] says: "There is no other group of fishes which offers so many difficulties to the ichthyologist with regard to the distinction of the species, as well as to certain points in their life-history, as this genus."

Although a critical examination of these different views, properly speaking, does not come within the reach of this treatise, and would lead us too far, the nature of the question demands that I take my part in this dispute.

After the investigations which I have made in this matter, I agree with *Agassiz* and *Siebold*; *i. e.*, I recognize only one species, viz, the *Salmo salar*. My reasons for this I will state in brief.

Valenciennes mentions the following chief distinguishing marks between *Salmo salar* and *Salmo hamatus*:

1. The *Salmo hamatus* has more pyloric cæca (*appendices pyloricæ*) than the *Salmo salar*.[10]

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[1] *Valenciennes*, Histoire naturelle des poissons, Paris, 1848, tome xxi, p. 294.

[2] *Siebold*, op. cit., p. 314.

[3] *Valenciennes*, op. cit., p. 169.

[4] *Valenciennes*, op. cit., p. 212.

[5] *Heckel* and *Kner*, Die Süsswasserfische der österreichischen Monarchie, Leipzig, 1858, pp. 273 and 276.

[6] *Troschel*, Handbuch der Zoologie, 7th ed., 1871, p. 266.

[7] *Siebold*, op. cit., p. 293.

[8] *Günther*, Catalogue of the fishes in the British Museum, London, 1866, vol. vi, p. 11.

[9] *Günther*, op. cit., p. 3.

[10] *Valenciennes*, op. cit., pp. 176 and 217.

2. The *Salmo hamatus* has invariably only one tooth on the front plate of the vomer, while the *Salmo salar* has several teeth.[1]

3. The *Salmo hamatus* has a reddish-gray back, the color becoming more lively on the lower portions of the sides; the color of the belly is a dull white. The *Salmo salar*, on the other hand, is slate-colored on the back, of a subdued silver-color on the sides, and of a silvery-white, shining like mother of pearl, on the belly.[2]

4. The flesh of the *Salmo hamatus* has much less color and is drier than that of the *Salmo salar*.[3]

5. The *Salmo hamatus* has at the end of the lower jaw a protuberance, ("*tubercule*,") which, when the mouth is closed, fits exactly into a considerable concavity ("*enfoncement considérable*") of the upper jaw.[4] The lower jaw thus forms a projecting hook, so that the upper and lower jaws cannot be pressed against each other. The *Salmo salar* does not have this hook.

With regard to the above assertions, the following remarks are to be made:

To 1: The number of pyloric cœca in one and the same species of salmons varies greatly.[5]

Valenciennes found in the *Salmo salar* 60 and in the *Salmo hamatus* 67 *appendices pyloricæ*. In the enumerations which I have made, I was led to the result that in the salmonoids which *Valenciennes* differentiated as two species, the number of cœca is no safe distinctive character, as it varied from 56 to 72, and was frequently larger in those which had no hook than in the so-called "hook-salmon." *Günther* states that the number of cœca varies from 53 to 77; *Richardson*,[6] from 63 to 68. *Kner*[7] has also shown that the number of cœca in one and the same species of salmonoids is extremely varying.

To 2: The arrangement of the teeth on the vomer has been erroneously described by *Valenciennes*, as has been shown by *Siebold*.[8] The short front plate (*chevron*) of the vomer of the *Salmo salar* (and the *S. hamatus*) is invariably toothless, and only the long point of the vomer has teeth. But, as the fish grows older, these teeth fall out gradually, and no new ones take their place, so that an entirely toothless vomer is frequently found in old fish. It is evident from this—as I also found in my investigations—that the number of vomerine teeth differs very much. In our Bonn Museum, there are two old specimens, labeled

[1] *Valenciennes*, op. cit., pp. 172 and 213.

[2] *Valenciennes*, op. cit., pp. 174 and 217.

[3] *Valenciennes*, op. cit., p. 222.

[4] *Valenciennes*, op. cit., p. 215.

[5] *Siebold*, op. cit., p. 314.

[6] *Günther*, op. cit., p. 13.

[7] *R. Kner*, Über die Verschiedenheiten der Blinddärme bei den Salmonen (in "Sitzungsberichte der mathem.-naturw. Classe der kaiserl. Akademie der Wissenschaften," vol. viii, 1852, p. 201).

[8] *Siebold*, op. cit., p. 301.

"*Salmo hamatus*," of which the one has only two teeth in the vomer, and the other none at all. A younger specimen, marked likewise *Salmo hamatus*, has four teeth in two rows, one behind the other; while another somewhat younger specimen, marked *Salmo salar*, has only two vomerine teeth.

It is not necessary to go into further details, as *Siebold* has explained this whole matter sufficiently, and has satisfactorily proved *Valenciennes's* errors.

To 3: "In none of our native fish is there such variety of color, according to the different influences of food, water, light, and temperature, as in the toothed salmons."[1] Günther likewise lays special stress on this change of color in the *Salmo salar*. Scientifically, we are scarcely justified in distinguishing two different species merely on account of this difference in color, when the other distinguishing marks cannot be sustained.[2]

To 4: *Bloch* has shown how much the color and quality of the flesh varies in one and the same species of salmonoids.[3] *Siebold* likewise, in several places,[4] has directed attention to this peculiar variation. It must also be borne in mind that in all species of animals the flesh of old ones[5] which have propagated for many years has become of an inferior quality. It is well known that the Rhine salmon is more savory than that of the Oder, the Weser, and the Vistula; but nobody ever entertained the idea that they were different species.

To 5: The projecting hook of the lower jaw in some specimens is so peculiar, that certain ichthyologists were thereby induced to distinguish a separate species—*Salmo hamatus*, *i.e.*, the hooked salmon. But *Bloch* had already proved that these hooks occur only in old male fish. *Agassiz*, all the modern English ichthyologists,[6] *Siebold*,[7] *Schlegel*,[8] and others are of the same opinion. The observations which I made on this point, and the information which I gathered from experienced fishermen, led to the same result: the hook is only found in male fishes, and—I must emphasize it—only in such as have milt nearly ready for impregnation. I have, by observing a large number of specimens, convinced myself that this hook gradually forms in the male fish as it is growing old and the milt is getting mature; fishermen, by this mark, distinguish even the young male from the young female. If, therefore, *Valenciennes* (p. 213)

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[1] *Siebold*, op. cit., p. 276.

[2] I may as well remark here that, according to my observations, this difference of color, which *Valenciennes* considered as a distinguishing mark of the species, can only serve as such for distinguishing the fruitful specimens of the *Salmo salar* from temporarily barren ones.

[3] *Bloch*, Oekonomische Naturgeschichte der Fische, Berlin, 1782, p. 139.

[4] *Siebold*, op. cit., pp. 276, 299, &c.

[5] It will be presently seen why I only speak of old animals.

[6] *Valenciennes*, op. cit., p. 224.

[7] *Siebold*, op. cit., p. 293.

[8] *Schlegel*, De Dieren van Nederland; Visschen, p. 127.

says that the female has just as strongly curved a hook, it must be considered an error. Why this peculiarity occurs only in the one sex and not in the other has not yet been explained. It has been said that too long a sojourn in fresh water, and swimming against the stream, had caused it; but there is no reason why the hook should not develop itself just as much in the female as in the male.

This hook occurs likewise in the lower jaw of the males of other species of salmonoids. Thus, *Wartmann*[1] has found it in *Trutta lacustris* (*Siebold*); *Heckel*,[2] in *Trutta fario* (*Siebold*); he also thinks that this peculiarity is found in most of the species of the salmonoids.

On the strength of these facts, I must presume that of the salmonoids belonging to the ocean only two species occur in the Rhine: 1. The "Lachsforelle," (sea-trout,) *Fario argenteus Val.; Trutta trutta* according to *Siebold*; 2. The "Salm," (salmon,) *Salmo salar Lin.; Trutta salar* according to *Siebold*. I cannot in this place refrain from making the remark that people have been induced to accept the two species, *Salmo salar* and *Salmo hamatus*, only by the occurrence together of fruitful and temporarily barren specimens of one and the same species of *Salmo salar*.

Henceforth, I shall exclusively use *Siebold's* nomenclature, as by his investigations the position of our salmonoids in the general system has been definitely settled.

I now turn to the investigation of the food of *Trutta trutta* and *Trutta salar* in fresh water—the Rhine.

The question, What is the food of our salmonoids in fresh water and in the ocean, is not only of scientific but also of great economical interest. It is, however, very strange that the ichthyological works contain scarcely any or wrong data regarding this point.

Valenciennes speaks only in one place of the food of *Trutta salar*:[3] "La nourriture consiste en poissons et l'on dit qu'il préfère l'ammodite—*Ammodytes tobianus*."[4] As the fish in question (Sard-launce) lives in the North Sea and in the Baltic, this fact would refer to the food of the fish while in the ocean; but nothing is said regarding its food in fresh water.

Figuier, on the other hand, says:[5] "On n'a pu faire jusqu'ici que des conjectures sur leur genre d'alimentation dans la mer, mais on est plus instruit de leur manière de vivre dans les eaux douces (?). Pendant leur premier âge, ils vivent d'insectes, de frai, et aussi de petits poissons, des qu'ils ont atteint une certaine taille. À l'état de grilse et à l'état

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[1] *Wartmann*, Von den Rheinanken oder Illanken, in "Schriften der Berlinischen Gesellschaft naturforschender Freunde," vol. iv, 1783, p. 55. (Quoted from *Siebold*, op. cit., p. 32.)

[2] *Heckel*, Bericht einer ichthyologischen Reise, in the "Sitzungsberichte der kaiserl. Akademie der Wissenchaften," vol. viii, 1852, p. 355.

[3] *Valenciennes*, op. cit., p. 197.

[4] Its food consists of fish, and it is said that it prefers the Sard-launce-*Ammodytes tobianus*.

[5] *Figuier*, La vie et les mœurs des animaux, Paris, 1868, p. 106.

adulte ils devorent une foule de poisson (?)."[1] *Bloch*[2] says that the salmon lives on small fish, aquatic insects, and worms, and that it could be enticed by dragon-flies, worms, and small fish if these were attached to the hook (?).

In *Heckel* and *Kner's* work,[3] I find, regarding the food of *Trutta trutta*, only the very general remark that "it is a powerful fish of prey." *Siebold's* excellent work[4] contains several observations regarding the food of our salmonoids while in fresh water.[5] The most important, and, as will be seen afterward, the most correct, (p. 246,) is the following: "I cannot in this place pass over in silence the fact that in observing and describing the digestive organs of the salmonoids, no attention whatever has been paid to the circumstance that these fishes do not eat anything before and during their spawning-season, but are merely intent upon spawning, during which process their empty stomach is unusually contracted; the '*appendices pyloricæ*' and the gut itself being filled only with the different secretions of the digestive organs." From the following, it will be seen whether and in how far the remarks of the above-quoted ichthyologists are correct.

On the 20th September, 1873, I examined the stomachs of the first two specimens of *Trutta salar*, which had been caught in the Rhine, in the neighborhood of Bonn. They were female spawn-salmon ("*Laichsalme*"); *i. e.*, salmon which had ascended the Rhine for the purpose of spawning. The eggs of both these specimens were of the size of a pea, and ripe for impregnation. The sides of the stomach were strongly contracted, and the pyloric cœca were exposed; *i. e.*, they were not covered with masses of fat, as is the case with other specimens—as I shall detail later—of the same species. The section of the whole digestive organs showed the following: The œsophagus and the stomach itself contained nothing but the secretion of the mucous membrane, a white and mostly very sticky mucus, which is always there, whether there is food in the stomach or not. At the place where the stomach proper joins the intestine, and where the "*appendices pyloricæ*" commence, this mucus increased in quantity, and at the same time assumed a yellowish-green

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[1] So far, we have only been able to to make conjectures regarding their food while in the ocean, but we are better informed regarding the mode of living while in fresh water (?). When quite young, they feed on insects, spawn, and small fish, until they have attained to a certain size. In their third year and when fully grown, they devour great quantities of fish (?).

[2] *Bloch*, Oekonomische Naturgeschichte der Fische, Berlin, 1782, pp. 135 and 137.

[3] *Heckel* and *Kner*, op. cit., p. 266.

[4] *Siebold*, op. cit., pp. 246, 276, 299, &c.

[5] After I had completed this treatise, there appeared in the "Acta Universitatis Lundensis," Lund, 1871–'72, a work by *P. Olsson*—Jakttagelser öfver skandinaviska Fiskar Föda—in which I find very valuable information regarding the food of *Trutta salar* and *Trutta trutta* while in the ocean. I shall again refer to this work. as this information has enabled me to give fuller details in one place.

color from the secretions of the "*appendices*," these themselves being filled with the same matter. Nearer to the anus, this mucus became darker, and finally assumed a reddish-black color. In no part of the whole digestive organ did I find anything which might lead to the supposition that any solid food had been taken. Near the pylorus, I found in one of the specimens several tapeworms (*tænia*) with their heads sticking in the appendices. In the tissues surrounding all these organs, but more especially in the pyloric cœca, I found a large number of entozoa.[1]

I have continued these investigations during the months of September, October, November, and December, and invariably with the same result.

The digestive organs of *Trutta trutta* likewise showed the characters detailed above. In both species, males as well as females, in such as had already propagated their kind and likewise in such as still contained roe or milt, the character of the stomach and intestine was exactly the same as that of the first two specimens of *Trutta salar* examined by me; and I never found any food or anything which might be considered as remnants of food. Three times I thought I had found a fishbone, but a closer examination showed it to be particles of wood or bast which had become enveloped in mucus, and stuck to the side of the stomach or gut. The thick or corky cellulose had withstood the digestive power, which at any rate had been reduced to a minimum, and no new food had been taken in through which these indigestible particles could have been carried out. Up to the beginning of January, 1874, I thus examined stomachs of forty-four such spawn-salmon ("*Laichsalme*")—*Trutta salar* and *Trutta trutta*—and never found any food. I must here state expressly that these investigations were made during the spawning-season proper of both species.[2]

In the following, only *Trutta salar* is spoken of, as *Trutta trutta* ascends the Rhine for the purpose of spawning only till the beginning of January. From January on, salmon (*Trutta salar*) are but rarely caught in the neighborhood of Bonn, while on the Lower Rhine (near Wesel) many are caught about this season. In Wesel, I succeeded in obtaining

[1] Regarding these, as well as the entozoa which I found in those species of fish which I examined later—*Trutta fario* and *Alausa vulgaris*—see *Gurlt's* "Verzeichniss der Thiere, bei welchen Entozoen gefunden worden sind" in *Wiegmann's* "Archiv für Naturgeschichte," XI Jahrg., vol. i, 1845, p. 223.

[2] The spawning-season of the salmon extends, according to *Valenciennes*, (p. 179,) from the end of May till the end of February; according to *Siebold*, (p. 299,) from May till November. According to the information which I gathered from experienced fishermen and my personal observations, a spawn-salmon is scarcely ever seen in the Rhine before the end of August. Those which show themselves in the Rhine at an earlier date do not ascend the river for the purpose of spawning. As I have never seen a spawn-salmon after the 10th January, I feel justified in assuming that the spawning-season proper extends from the beginning of September till the beginning of January. This explains the fact that the season when the Dutch are not permitted to fish for salmon lasts from September 15 till November 15.—(From information communicated by Mr. *Lisner*, a fish-merchant of Wesel.)

and examining stomachs of several specimens.[1] All these salmon, and also those which I saw in March, May, and June, showed a very striking difference from those which had been caught during the spawning-season proper. The fishermen call them "*Wintersalme*"[2] (winter-salmon). They are highly esteemed on account of their excellent flavor, which far exceeds that of the spawning-salmon, (at least during the spawning-season proper,) and the character of their inner parts likewise differs very much from that of the latter.

This winter-salmon is found in the river nearly all the year round, as well as during the spawning-season proper,[3] but is specially called "*Wintersalm*" by the fishermen during the winter-months, when its flesh is of the finest quality.

When I said before that the inner parts of these fish differ very much from those of the spawn-salmon, I referred to the sexual organs and the surroundings of the entrails. Of the former difference I shall speak later, and will confine myself here to the latter. The whole fish has a much better and fatter texture than the spawn-salmon, and its entrails are entirely overgrown with fat, so that the united appendages of the upper portion of the intestine (the *appendices pyloricæ*) resemble a lump of fat.[4] When I commenced to examine the stomach, I obtained nearly the same result as in my examination of the spawn-salmon; for in by far the majority of cases no trace of food could be discovered. In one stomach, I found parts of the hard covering and of the wing of a beetle; and in another, the skin of an insect-larva, which could not be satisfactorily identified. In a third specimen, I found, in the back part of the intestinal canal, the scale of a fish, seemingly a cycloid scale. It was lying behind one of the numerous ring-shaped lids, which are found all through the lower portion of the intestinal canal, and had not yet been expelled with the other excrements.

Besides these, I examined twenty-three stomachs, but found no remnants of food. The three fish in whose digestive organs I found some

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[1] Through the kindness of Mr. *Ridder*, of Wesel. In Bonn, I obtained the material for my investigations chiefly through Mr. *Brenner*, but in part from Mr. *Schumacher*. I must also thank the following-named gentlemen for much valuable information concerning the food of the Salmon: Messrs *Lisner* and *Ridder*, in Wesel; *Brenner*, in Bonn; *Josten*, in Dinslaken; and *Rennings*, in Ruhrort.

[2] In this and the following I make a distinction between *Wintersalme* and *Laichsalme*, although they both belong to the same species, viz, *Trutta salar*. I shall later characterize this distinction more exactly; but I may state here that by *Laichsalme* I mean those fish which, during the spawning-season, ascend the rivers for the purpose of spawning, while I call *Wintersalme* those which, from October on, appear nearly all the year round, and which do *not* come directly for the purpose of spawning, as their sexual organs are entirely undeveloped from October to May, and only begin to develop from the month of May.

[3] Mr. *Ridder*, of Wesel, got the first *Wintersalm* on the 3d October, and Mr. *Brenner*, of Bonn, on the 6th October, 1873.

[4] There are such large quantities of fat, that it is extracted by boiling, and used for various purposes.—(According to information received from Mr. *Lisner*, of Wesel.)

remnants of food had been caught near Wesel. The food may therefore have been taken partly in the mouth of the Rhine and partly in the ocean.

I will here mention an interesting observation, which was communicated to me by the Messrs. *Ridder* and *Lindner*. The Dutch fishermen have occasionally found in the stomachs of those salmon which were caught near the mouth of the Rhine remnants of fish which they said came from the herring (*Clupea harengus*). But, according to the unanimous testimony of the fishermen, there never were found remnants of fish or any other food in the stomachs of salmon which had ascended higher up the Rhine. This observation agrees in every particular with those made by me.

These investigations therefore lead me to the following result: *Trutta salar* and *Trutta trutta*, while in the Rhine, do not take food at any season of the year, which explains the fact that all attempts to keep salmon and raise them artificially in fresh water have proved failures.[1] There are artificial hatching-establishments (*e. g.*, in Hüningen, near Strasburg, and in Arnheim) where the ripe salmon-eggs are artificially impregnated and hatched, and where the young salmon, called *Sälmlinge*, [in English samlets,] obtained in this manner, are kept for some time (perhaps one to three years); but, if these fish are to become full-grown salmon, they must be let loose so that they can reach the ocean, there to feed and grow. A friend of mine communicated to me the following: The institution near Arnheim, on the Yssel, has, during this spring, artificially raised 300,000 young salmon and placed them in the Yssel. These are to go to the ocean, return to the Yssel[2] during the following years, and then be caught as salmon. The young salmon are fed in the water of the Yssel, which is pumped into reservoirs from the river, and then led through the tanks in which the fish are kept. They are not supplied with any food, but find it in the water (infusoria, larvæ, &c.) If these young salmon are to be sent away, they are placed in special boxes, and fed on calves' brain and worms.

The following observation, communicated by *Sander* in the "Naturforscher,"[3] is explained in the same manner: "A reliable fisherman kept young salmon for many years, and fed them—on what? Unfortunately, he did not inform me. He paid great attention to them, but found that

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[1] *Günther* says on this point, (p. 9:) "The question whether any of the migratory species (of the genus *Salmo*) can be retained in fresh water, and finally accommodate themselves to a permanent sojourn therein, must be negatived for the present."

[2] It may be considered as an established fact that the salmon return to the river in which they were born and raised. In Brittany, a dozen young salmon were marked with copper rings on the tail. Of these, five were caught in the following year, three in the second, and three in the third.—(*Cornelius*, Zug- and Wanderthiere, Berlin, 1865, p. 202.) During the summer of 1873, 500 young salmon, twenty-one months old, 5 to 6 inches long, were marked and placed in the Rhine, in order to ascertain whether they will return to the same river.—(From a newspaper.)

[3] Der Naturforscher, 15. Stück, 1781, p. 176.

not only did they not grow larger, remaining always the same size, but also that they did not increase at all in number."

Siebold has therefore come nearest the truth regarding the salmonoids found in the Rhine, (*Trutta salar* and *Trutta trutta*,) when he says that the salmon just before and after their spawning-season do not eat anything for weeks. I even go a little further, and maintain that these salmonoids do not eat at all as soon as they have entered the Rhine from the ocean.[1]

The circumstance that, as I mentioned above, I found remnants of food in the stomachs of three winter-salmon is not against, but rather in favor, of my assertion. These three salmon were caught below Wesel, therefore comparatively near the mouth of the Rhine. The food whose few undigested remnants I found might therefore have been taken in the ocean, or when the fish had not yet lived in fresh water for any length of time,[2] and the desire for food had not yet become quite extinct. The best proof of it is the fact that nothing was found in the stomachs of those salmon which had been caught farther up the Rhine. This likewise explains, in a very simple manner, the above-mentioned observation of the fishermen, that the stomachs of those salmon which are caught in Holland near the mouth of the Rhine occasionally contain parts of fish.

The result of this whole investigation is therefore the astonishing fact, that fish which stay in the Rhine a long time, and move about a great deal and in a very vigorous manner,[3] take no food at all.

Such a very astonishing fact might well awaken the belief among the common people that the salmon digests everything it eats in three minutes (!), although this is a physiological impossibility.[4] I myself for a moment entertained the thought that the salmon might be able to digest food taken after it had been caught, as it is frequently kept alive in the fish-tanks for some time. But the fact that most salmon are killed by the fishermen immediately after they are caught by being

[1] It certainly does not follow directly from my investigations that they do not eat anything at all in fresh water; but it is very probable that the facts are the same in the Oder, Elbe, Weser, Vistula, and other rivers frequented by the salmon. (Of the English rivers, I shall speak below.)

[2] This would apply to those two specimens in whose stomachs I found remnants of insects, as no insects live in the ocean.

[3] See, on this point, *Siebold*, op. cit., p. 297; *Valenciennes*, op. cit., pp. 194, 200, &c.

[4] *James G. Bertram* (The Harvest of the Sea, London, 1865) says "that one gentleman who writes on this subject accounts for the emptiness of the stomach by asserting that the salmon vomits at the moment of being taken" (p. 192). Independently of the fact that the fishermen know nothing of this strange act of vomiting, the salmon could not well empty its intestines in this manner But remnants of food are found neither in the intestines nor in the stomach. *Bertram*, whose book I unfortunately only got after I had finished my treatise, confesses that hundreds of fish had been examined, and that but rarely traces of food had been found. He likewise confesses that the salmon does not grow in fresh water, and still he asserts that it takes food when in fresh water. A recent publication will oblige me to refer once more to this point.

knocked on the head, and that their stomachs never contain remnants of food, militates against that supposition. All the fishermen whom I questioned assured me that they never had found food in the salmon even if cut open immediately after having been caught.

In view of this remarkable fact, two questions naturally arise: 1. How can the salmon live for a comparatively long time without food without (as is the case at least with the winter-salmon) growing visibly thinner? 2. How does it happen that the salmon does not eat any more after having entered fresh water? The first of these questions is less difficult to answer than the second. I shall now briefly examine the first.

It is well known that the change of matter (*Stoffwechsel*) and the heat of the animal body resulting from it reach their highest degree in birds and mammals, but that they are much less in amphibious animals and fishes, because the organs of respiration and of circulation are much less complete in those vertebrates than in the two higher classes. This also explains the well-known fact that amphibious animals and fishes can live without food for a much longer time than the higher vertebrates. This circumstance, however, does not yet sufficiently explain the fact that the salmon can live so long without food without growing visibly thinner, as the winter-salmon. One might feel tempted to think of the somewhat analogous winter-sleep of many animals, if this was not made impossible by the violent motions of the salmon. If the swimming and leaps of the salmon, like every motion of this kind, are nothing but a change from the molecular to the mass motion, and if this molecular motion can only be the result of a burning process, there must be some matter which makes such a burning process possible; and if this matter is not, as is usually the case, supplied by the taking of food, the body itself must furnish it; and this is actually the case with the salmon. As regards the winter-salmon, I have stated above that its stomach is surrounded by a very considerable mass of fat. This fat forms, so to speak, the reserve fund from which the expenses of this burning process are paid. This fund is large, and lasts long enough to make the winter-salmon during all the time of its sojourn in the Rhine (which is not as long as is generally supposed) a highly-esteemed fish.

The case is different with the spawn-salmon. When it ascends the Rhine, its eggs are already as large as pease, and the milt is almost ready for impregnating. Even while out in the ocean, the inner organs were chiefly engaged in developing the eggs and the milt. On entering the Rhine, it is well developed, but compared to the winter-salmon it has only a small reserve fund. This is considerably diminished by the very violent motions of the fish, and the remainder is so completely used up in fully forming the sexual organs that the quality of the flesh deteriorates considerably, and the fish becomes weak and miserable. It is, therefore, not astonishing to see these fish, after having finished spawning, utterly exhausted, "flottant à la surface de l'eau sans faire aucun mouvement; on peut les prendre alors facilement à la main."[1]

As regards the second question, how does it come that the salmon does not eat anything in fresh water, there are two ways of explaining this fact. Either the fresh water (the Rhine) does not offer any suitable food, so that it cannot eat anything, or the salmon on entering the fresh water loses all desire for food, so that it does not want to eat anything. Regarding the first point, it is well known that the Rhine at any rate does not offer much food for fish. The salmon, especially, finds but little of its favorite food in the Rhine. *P. Olsson*[2] has made observations regarding the food of different species of fish on the coast of Scandinavia, and has, among the rest, also examined twelve specimens of *Trutta salar*. He says, regarding the contents of the stomach: "It is often empty, or contains a yellow mucus, (from the fresh-water crustaceans?) small fishes, (in seven specimens,) especially *Ammodytes* and *Gasterosteus aculeatus*, (in twelve specimens,) young fish, likewise crustaceans, viz, small *decapoda macroura* and *isopoda*, and *Mysis vulgaris*, according to Lilljeborg, (K. Vetensk. Ak. Förh., 1852,) and, in one case, a large coleopterous insect (*carabus*)[3] was found." If we inquire into the place of sojourn of these animals, we find that the *Ammodytes* lives exclusively, and the above-mentioned crustaceans almost exclusively, in the sea. *Gasterosteus aculeatus* is frequently found in the region of the Rhine, "but prefers the small brooks flowing into the Rhine, Main, and Neckar," (*Siebold*, op. cit., p. 67,) and it would, therefore, be difficult for the salmon to get at it. The *carabus* must have been eaten in the neighborhood of the coast or the mouth of a river, as no insects are found in the ocean. As regards the mucus, *Olsson* would, on examining it microscopically, in all probability only have found torn epithelial cells, blood-atoms, &c. If, therefore, the absence of its favorite food would force the salmon to eat less while in the Rhine, it is very hard to believe that the salmon would not be able to find a substitute for its favorite food in the river. If it eats young fish while in the ocean, why should it not do the same while in the river, though, perhaps, the young of different species of fish? If in the ocean, or near the mouth of a river, it eats a *carabus*, why should it not hunt for insects while in the river? It seems to me that the want of suitable food is not the reason why it does not eat anything in the river. I am rather inclined to think that life in fresh water produces a certain morbid disgust with all food in the salmon; and not only in the spawning salmon, in which this peculiarity is not so striking, but also in the winter-salmon, which does not

[1] *Valenciennes*, op. cit., p. 179. (Floating motionless at the surface of the water; they may then easily be caught with the hand.)

[2] *Olsson*, Iakttagelser, &c., p. 6.

[3] *Olsson* examined two specimens of *Trutta trutta*; in the one, he found nothing, and, in the other, fourteen *Clupea sprattus* and three *Ammodytes*.

ascend the Rhine for the express purpose of spawning.[1] With regard to this winter-salmon, which I have mentioned so often, I have made some observations, up to this date, (October, 1874,) which I will give in this place.[2]

Till quite recently, the opinion was prevalent, that the *Trutta salar* spawned every year. An anonymous writer in Loudon's Magazine[3] was the first to show that this opinion is erroneous. This writer says: "Neither the salmon nor the trout spawns every year, for specimens of both kinds are frequently caught in January whose roe is smaller than mustard-seed, which, therefore, could not have spawned in that year; while, on the other hand, in the red fish, (spawn-fish,) which ascends the rivers in November and December, the spawn is almost ripe, and in March and April no trace of roe is found." This observation is correct. From September till May, specimens of *Trutta salar* appear in the Rhine whose sexual organs are entirely undeveloped. The fishermen call these "Wintersalme," (winter-salmon,) and esteem them very highly on account of their fat red flesh (Rhine salmon). It is absolutely certain that these fishes cannot have spawned in that one year, for they appear at the same time as the spawn-salmon, whose eggs have the size of pease.[4] The question is only whether this barrenness is permanent or temporary.

Siebold, who was the first to show that permanently barren individuals occur in several species of salmonoids,[4] is inclined likewise to consider these winter-salmon as permanently barren individuals;[5] and I thought at first that he was right, from reasons which I will proceed to give.

Siebold shows that, in *Trutta lacustris*, the barren ones are distinguished from the fruitful ones by some unimportant differences; the body of the barren ones is much more slender, and does not reach so large a weight as that of the fruitful ones; the mouth seems to be cleft deeper; the caudal fin does not so soon lose its emargination; no hook is formed on the lower jaw in old males; and, in their color, they differ much from the fruitful ones.

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[1] *Siebold*, Die Süsswasserfische, &c., p. 209.

[2] I will not deny that, in exceptional cases, the salmon, while in the Rhine, feels a desire for taking food, for this is quite natural. Thus *von dem Borne*, in his interesting "Handbuch der Angelfischerei," Berneuchen, 1875, says that an Englishman, Mr. *Sachs*, near Schaffhausen, caught a salmon, weighing 16¼ pounds, with an articficial *Squalius leuciscus*. According to *von dem Borne*, it seems that the salmon is more inclined to seek food in the English rivers than in the Rhine. It is true that he says, "While ascending the rivers, the salmon eats but little. *Buckland* has examined the entrails of hundreds of salmon, and always found them without food, and only containing entozoa;" but afterward he mentions various bait (insects, fish, &c.) with which the salmon is caught in England.

[3] *Loudon*, The Magazine of Natural History, vol. ii, 1834, p. 207, in an extract in *Wiegmann's* "Archiv für Naturgeschichte," 1835, vol. ii, p. 267.

[4] From Mr. *Ridder*, in Wesel, I received the entrails of the first *Wintersalm* during this period (1874) on September 24.

[5] *Siebold*, op. cit., pp. 276, 302, 321.

[6] *Siebold*, op. cit., p. 277.

I have likewise found that the lower jaw of the older male individuals of the winter-salmon never shows such a striking hook as the fruitful male of the salmon (the hooked salmon). There is also a difference in the color of the winter-salmon and spawn-salmon. The winter-salmon has a grayish-blue back and silver-white sides, while the spawn-salmon has a darker, frequently reddish-gray, color. The former has on the sides only a few black spots, and the latter has on the sides and the gill-covers numerous red spots. The urogenital papilla is scarcely noticeable in the winter-salmon, while it is large, protruding, and swollen on the edges in the spawn-salmon. The winter-salmon, on the other hand, generally reaches a greater weight than the spawn-salmon, and its flesh is redder and fatter. With regard to size and weight, therefore, the case seems here to be just the opposite to what *Siebold* has found in *Trutta lacustris.*[1]

All these facts, therefore, seem to be in favor of the supposition that the winter-salmon is the permanently barren variety of *Trutta salar.* But, in spite of this, I have arrived at the conviction that this barrenness is only temporary,[2] and that those fish which one autumn and winter appear as barren winter-salmon probably spawn as spawn-salmon during the next spawning-period.[3] After I had continued my observa-

[1] The opposite from the winter-salmon seems to be the case in the barren *Trutta lacustris,* also with regard to the quality of the flesh. *Siebold,* at least, says that, in the Lake of Constance, the thin and barren "Schwebforelle" is esteemed much less than the fruitful "Grundforelle," (p. 309.) The barren *Trutta fario,* (common trout,) on the other hand, has a better flesh than the fruitful one.

[2] *Günther* (op. cit., p. 8) says: *Siebold* "appears to have gone too far when he stated that this state of sterility extends over the whole period of existence of such individuals." In "Nya Bidrag till Kännedommen om Sveriges Salmonider," communicated in the "Kongl. Vetenskaps-Akademiens Förhandlingar," Stockholm, 1865, *Widegren* has shown in very young (one to three years' old) individuals of *Trutta trutta* and *Trutta salar* that this barrenness, which occurs in nearly one-half of all these fish, is only temporary. He mentions, as the chief difference between barren and fruitful fish, that in the barren ones the shorter middle ray of the caudal fin is not as much as, or, at most, not more than, half the length of the longest outer ray, while in the fruitful ones the shortest ray exceeds a little more than half the length of the longest one. This, in itself somewhat subtle distinguishing mark, (he gives, *e. g.*, the proportions of 19:40 mm. in the sterile against 20:38 mm. in the fertile, p. 290,) which is subject to exceptions (p. 280,) forms no criterion in the case of older individuals, as the caudal fin more and more loses its emargination as the fish grow old.—(See *Siebold,* p. 295.) *Widegren* then goes on to show that in the barren fish the sexual organs develop gradually; that the proportion between the longest and shortest ray of the caudal fin gradually becomes the same as in the fruitful ones; that the color changes, &c.

[3] *Widegren* thinks that several years may elapse before the barren ones become fruitful (p. 292). *William Brown,* on the other hand, ("Natural History of the Salmon by the Recent Experiments at Stormontfield," quoted from *Widegren,* p. 294,) says (p. 48) that of the young female fish which had been marked before going to the ocean, some returned in the autumn of the same year for the purpose of spawning, while others did not return till the autumn of the following year. *Von dem Borne* says (p. 339): "There are among the salmon some which spawn only every other year, just as there are among the young salmon some which only leave the fresh water after two years. (I must here remark that *von dem Borne* cites this fact from English sources, which were not accessible to me.) I, therefore, think that the same applies to those salmon whose home is the Rhine.

tions for more than a year, (from September, 1873, till October, 1874,) I became convinced that all the above-mentioned differences between the winter-salmon and the spawn-salmon disappear with the advancing season of the year and the progressing sexual development. From September till about May, the differences between the two are so striking that, without knowing the further development of the winter-salmon, they would forthwith be declared to be two different species. I am, therefore, not at all astonished that the spawn-salmon (*Salmo hamatus*) has been distinguished as a separate species from the winter-salmon (*Salmo salar*) when both were seen together, without knowing that the differences between the two were only temporary. From May onwards, the whole appearance of the winter-salmon changes, and gradually approaches that of the spawn-salmon. The spots become more numerous; besides the black ones, red ones make their appearance; the silver-white sides assume a dirty-white color, while the back changes from a slate blue to a dingy gray; the jaw of the male becomes elongated, and the hook is formed in the lower jaw; the cœca lose their fat; the flesh becomes paler and drier; the milt and the eggs become larger in proportion; and the edges of the urogenital papilla back of the anus swell and become more prominent. It is interesting to watch the growth of the ovaries. The ovary of the above-mentioned winter-salmon, caught near Wesel on the 22d September, weighed at that date 13 grams.[1] According to my observations of last winter, the weight of the ovaries increases very little up to April. The ovary of a winter-salmon, caught in April of this year, weighed 19 grams; of one caught in May, 22 grams; in June, 48; in July, 91; in August, 211; and the ripe ovary of a fish ready for spawning, (in November,) 800 to 1,000 grams.[2]

Two questions arise here: (1) Why does the winter-salmon ascend the Rhine long before it is able to spawn? and (2) How long does it remain in the river?

The first question is difficult to answer. In such cases, resort is had to an "obscure instinct." This would in this case be the desire for propagating, although this cannot as yet be realized. It is true that all salmons require a longer or shorter sojourn in fresh water for developing their sexual organs.[3] It is possible that, in the winter-salmon, a sojourn in fresh water, even if it be only temporary, gives the first impetus toward the formation of the sexual organs; this is, in fact, highly probable. While in the sea, the fish has fattened so much that, if it continued to take plenty of food, the milt and eggs would not develop at all—a physiological fact which has long since been observed in other animals. This development becomes possible by the fish's abstaining from food while in the Rhine.

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[1] 1 gram = 15.434 grains troy.

[2] In these figures, it must, of course, be taken into consideration that the fish from which the ovaries were taken were not absolutely equal in age, size, and weight; on an average, they weighed 9 kilograms, (1 kilogram = 2.205 pounds avoirdupois.)

[3] See *Siebold*, op. cit., p. 238.

In many cases, some outward cause may induce the fish to ascend the Rhine long before they are able to spawn. I will give the following observations on this point which I have made.

On the bodies of the winter-salmon I frequently found wounds caused by the teeth of other animals. These bites I found on different parts of the body; they were of different size, and most of them had healed over. The fishermen of the Rhine are well acquainted with this fact, and the Messrs. *Ridder* and *Lisner*, in Wesel, furnished me with the interesting information that a rich salmon-year (with regard to winter-salmon) might be expected if comparatively many fish appeared having such wounds. It is but natural to draw certain conclusions from these observations. Not only man but also other beings are eager for the fine flesh of the winter-salmon. The greatest enemy of the salmon are the seals (*Phoca vitulina* and *annellata*[1]). These nimble robbers pursue the salmon,[2] which seeks a place of refuge in the Rhine. If its enemies increase in number and their attacks become more violent, the winter-salmon in consequence appears in the Rhine more frequently, and the above-mentioned observation would thereby be explained. Regarding the second question, "How long does the winter-salmon remain in the Rhine," I think I can assert on the strength of my observations that from September till May it only makes a temporary sojourn in the Rhine,[3] and that it becomes permanent only from May.[4]

Of the temporarily barren salmon which occurs in the English rivers, *von dem Borne* says (p. 338) that it remains in the river nearly a whole year. This may be possible in the English rivers; but, as far as the Rhine is regarded, I must deny it emphatically, for the simple reason that the winter-salmon while in the Rhine eats next to nothing. The fishermen say that it gets into the Rhine only by "losing its way." It is a fact that near the mouth of the Rhine it is caught frequently all the year round; near Wesel quite frequently, but near Bonn only rarely, up to May. As the growth of the eggs—as I have remarked above—becomes considerable only from May, I believe that its sojourn in the Rhine becomes settled only from that time.

The results of the investigations which I have been able to make so far regarding the salmonoids occurring in the Rhine are briefly the following: In the Rhine, only two species are found, viz, *Trutta salar* and *Trutta trutta;* neither take any food while in the Rhine. Of *Trutta salar*, a

[1] See on this point *Bloch*, op. cit., p. 139.

[2] This probably takes place chiefly in winter, because the seal is at that season without any other food, and because the winter-salmon does not, like other fish, live deep in the water, but rather near the surface. Thus, *Mangold* (quoted after *Siebold*, p. 309) says that the barren *Trutta lacustris* lives near the surface, while the fruitful *Grundforelle* keeps near the bottom of the lake.

[3] The great strength of its muscles enables it to travel long distances in a very short time. According to *Cornelius*, (p. 199,) it can swim twenty-three to thirty English miles; according to *von dem Borne*, (p. 338,) it swims about 1,500 feet in one minute.

[4] *N. Loberg*, Norges Fiskerier, Christiania, 1864, p. 280, says of the Norwegian salmon that they stay in the rivers all summer.

fruitful variety (spawn-salmon) and a temporarily barren one (winter-salmon[1]) exist. The former ascends the Rhine for the purpose of spawning from September till November; the latter appears sporadically, and for a brief season from September till May, and probably remains in the Rhine for a longer time, or permanently from May till the spawning-season. These results answer—at least as far as the grown salmons are concerned—the question, Is it injurious to catch "Rümpchen" because thereby valuable fish are deprived of their food. As these salmons do not eat anything while in the Rhine, the catching of the "Rümpchen" cannot possibly deprive them of any food. The case will be somewhat different with the young "Sälmlinge," (salmon one to three years old, which have never yet made the journey to the sea.) Prof. *de La Valette St. George*, who is thoroughly acquainted with our native fishes, and occupies himself with artificial pisciculture, has informed me that he feeds his "Sälmlinge" (specimens of *Trutta trutta* and *Trutta lacustris* measuring on an average 8 inches in length) chiefly on "Rümpchen," and that they devour them eagerly. As this in all probability will also be the case in the Rhine, and as the young *Trutta trutta* certainly does not differ from the *Trutta salar* with regard to the taking of food, the catching of "Rümpchen" will deprive these young salmon of a considerable amount of food.[2]

I shall secondly examine the question whether the catching of "Rümpchen" deprives the trout (*Trutta fario*) to any extent of their food.

II.

The food of Trutta fario.

Next to the two above-mentioned species, the trout[3] is with us the most common salmonoid, and is highly esteemed on account of the delicate flavor of its flesh. It prefers small, rapidly-flowing, clear waters, and is therefore chiefly caught in small rivers and mountain-streams—the Ahr, Sieg, Roer, Wupper, Wied, and Anbach near Neuwied, and the Kyll near Gerolstein. But as the "Rümpchen" are likewise caught in these very waters, it is of special importance to ascertain whether the catching of the "Rümpchen" deprives the trout of food.

The first material for my investigations I obtained November 25, 1873, from Mr. Brenner in Bonn.[4] Among twenty-two fishes, I found four-

[1] This must be understood in this manner: that of those salmon which return to the sea from the Rhine after having done spawning, quite a number remain barren the next year, as probably the too rich food and the rapid accumulation of fat prevent the development of the sexual organs.

[2] I must, however, remark here that these young salmon go into the sea at a very early age—according to *Siebold* (p. 299) in their second year, when they are about 4 inches long; according to the recent observations of English naturalists, in their third year, when they are about 8 inches long—and that therefore the existence of the Rümpchen is no matter of life and death with them.

[3] As to the character of this kind, see *Siebold*, op. cit., and *Valenciennes*, op. cit., p. 320.

[4] To this gentleman I am also indebted for the material for all my later investigations; also those made on *Alausa vulgaris*.

teen females and eight males; in two of the females, the eggs were entirely undeveloped, and the same was the case with the milt in one male fish, while in the others the sexual organs were fully developed. The fins in these three fish were likewise much less developed, and the characteristic modification of the skin found in the trout during the spawning-season was wanting; in short, I recognized in these the barren variety of the trout. As Siebold[1] has proved with absolute certainty the existence of such barren varieties, and has accurately described their characteristic distinguishing marks, I will not enter further on this matter, but will only remark that since I have continually found specimens of barren trout. I will here add that there is no difference between barren and fruitful trout with regard to their food.

The section of the digestive organs showed immediately that their character was entirely different from those of *Trutta salar* and *Trutta trutta*. The œsophagus and stomach were not contracted, but in most cases considerably extended and showed symptoms of a—for the spawning-season—very considerable feeding activity. Nearly all the organs which play a part in digestion, from the œsophagus down to the anus, contained remnants of food. Among the twenty-two which I examined I only found one whose digestive organs contained no remnants of food whatever. Among the others there were several whose stomach contained no food-substance, but in the entrails I found the indigestible remnants of food.

I will now briefly state what I found in these twenty-one trout:[2]

1. Twenty-one wings of insects (mostly neuroptera).
2. Twenty-six parts of integuments, heads and wings of coleoptera and orthoptera, as well as crustaceans and myriopods.
3. Thirty-five tarsi and other portions of the legs of the same insects.
4. Twenty-six larvæ of *Phryganidæ* or their cases, composed of particles of quartz and plants.

What I looked for most eagerly—viz, remnants of fish—I did not find in any of these twenty-one trout. The stomach occasionally contained large connected parts of insects, and in some stomachs I found the tolerably well-preserved larvæ of *Sialis lutaria*. On one occasion, I found six cases of *Phryganidæ* in a fish, and several times three or four were packed closely together, so that they extended the stomach and could be seen from outside. In some cases, the larvæ of these cases were well-preserved. I found no lime in these cases, and in bringing them in contact with muriatic acid they did not effervesce. It was surprising to me that in three fishes I found large portions of the bast of a plant (perhaps

[1] *Siebold*, op. cit., p. 233.

[2] Any one occupied with similar observations will know that in most cases it is almost impossible to draw any conclusion, as to genus and species of the animals which have been devoured, from the half-digested and torn fragments which are found. Although in most cases the accurate definition of these animals is of no practical value, it is of great interest to the zoologist to get as near the truth as possible. I have, therefore, attempted a definition wherever it was possible.

Juncus or *Carex*) folded together, and measuring from one to four inches in length. It is not possible that the trout had taken this as food, and I explain its occurrence in the following manner: On these plants, some insect or larva had settled, the trout had eagerly rushed toward it,[1] and had seized the insect with the plant or portion of it. I was likewise surprised to find in the stomachs of some individuals ripe eggs of the size of pease, which, on closer examination, completely resembled the eggs of the trout. I thought at first that these eggs had got in accidentally while the fish was being dissected,[2] but I soon changed my opinion. These eggs occurred, as I found later, in other specimens, not only in the stomach but also in the entrails of trout, but when in the entrails always deprived of their contents by having been digested, the empty shells being folded together. This circumstance proves that this voracious fish devours the spawn of its own species.

Similar contents of stomach and entrails I found in ten other trout, which I examined on the 6th December. In the entrails of one I found besides, remnants of fish—vertebræ and bones enveloped in the reddish mucus of the entrails. It was, of course, impossible to ascertain to what species this fish belonged.

On the 14th December, I received fifteen, and on the 16th, eight trout-stomachs. In examining these, I was at once struck by the fact that the remnants of food had considerably diminished. I found a large quantity of partly-digested trout-eggs and a number of phryganid cases, but very few parts of other insects. The cause of this striking diminution of food was, no doubt, the change in the weather. Till the 13th of December we had had mild sunny weather, but from that date there had been considerable frosts. Two explanations of this diminution of food now became possible. The insects, larvæ, &c., had either sought a refuge from the severity of the weather in hidden nooks where they were safe from the persecutions of the trout, or the lower temperature had diminished the liveliness of the trout and their desire for food. The most probable explanation is that the two circumstances combined in diminishing the quantity of food-taken. On the 7th January, 1874, I examined the last thirteen trout. The result, on the whole, was the same as in the first instance. The weather had again become somewhat milder, and the remnants of food had consequently increased. In two of these trout, I at last found distinct remains of a fish. In one, I found scales, bones, and barbels; in the other, the tolerably well-preserved skeleton of a small fish. In this latter, the whole vertebral column, with portions of the bones and of the head, with three barbels, had been preserved; the total length of the skeleton was about four inches. The trout in which I found this fish was about ten inches long,

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1 It is well known that the trout, when rushing toward the bait, also devours the hook. *Valenciennes*, op. cit., p. 330.

2 In dissecting the entrails, it occasionally happens that fresh scales of the same or other fish get in the œsophagus.

and the larger portion of the fish stuck in the lower half of the œsophagus,[1] as there was no room for it in the stomach. From the character of the skeleton, I feel justified in inferring that the fish was a *Cobitis barbatula*, which, like the trout, loves clear running water.

Quite recently, (10th June, 1874,) I succeeded, through the kindness of a friend, in getting six stomachs of trout which had been caught in the Kyll near Gerolstein. The examination of the stomach and entrails showed entirely different results from those of trout which had been caught during the spawning-season. In the first, I found four cases of *Phryganidæ*, which were shorter and thinner than those which I had obtained in winter; in the second, I found one hundred and thirty-six such cases, one insect, (half digested,) one dragon-fly's wing, and the remains of a fish; in the third, five hundred and eighty-five (!) cases, one insect, and the scale of a fish; in the fourth, one hundred and sixteen cases, one insect, and the remains of a fish; in the fifth, one hundred and eighty-six cases and the flower of a graminaceous plant; in the sixth, one hundred and fifteen cases, a small caterpillar, a number of fish-eggs, and the lower half of a small fish about four inches in length. The cases of the Phryganidæ were found in all the stomachs, and also in the entrails; in one, the intestinal canal as far as the anus was completely stuffed with these cases. I should expressly state that all these six fishes were well fed.

It follows from this that the trout takes much more food before than during the spawning-season, but that even during that season its chief food does not consist of small fish but of insects and their larvæ. I draw from this the further conclusion that the quality of the flesh of the trout does not deteriorate by this insect-diet, but that the delicacy of its flavor is heightened.

The results of these investigations therefore in general agree with the statements of other authors. Günther[2] says: "The trout is a very voracious fish, and its food consists, besides insects, their larvæ, and worms, particularly (?) of young fish." *Valenciennes*,[3] *Heckel*[4] and *Kner* make similar statements.

If from these investigations I now draw a conclusion as to whether the fishing for "Rümpchen" is injurious or not, I find that among the fifty-three trout which had been caught during the spawning-season there were three which had eaten fish, and among the six caught before the spawning-season there were four whose stomachs contained remains of fish. The fish, at any rate, formed but a very small portion of the food. If I now assume as highly probable that these fish belonged to

[1] "This part of the digestive organs lying immediately in front of the first curvature takes the part of a stomach, and digestion in it becomes far advanced."—*Kner*, "Ueber die Mägen und Blinddärme der Salmoniden," in the "Sitzungsberichte der Kaiserlichen Akademie der Wissenschaften," vol. viii, 1852, p. 203.

[2] *Günther*, Die Fische des Neckars, Stuttgart, 1853, p. 116.

[3] *Valenciennes*, op. cit., p. 330.

[4] *Heckel* and *Kner*, op. cit., p. 252.

the genera *Cobitis*, *Phoxinus*, *Leuciscus*, or some other of the "Rümpchen" kind, the catching of these fish would in the worst case only deprive the trout of a comparatively small amount of food. And as the trout are flourishing, even if they feed almost exclusively on insects, it follows that they can live without any fish-food, and that no particular harm is done by the catching of the "Rümpchen." In conclusion, I will give the result of investigations which I have made regarding the food of the "Maifisch," (*Alausa vulgaris*,) so as to enable us to pass a final judgment on the fishing of "Rümpchen."

III.

THE FOOD OF ALAUSA VULGARIS WHILE IN THE RHINE.

The three species spoken of above belong to the family of the Salmonoids, while the *Alausa vulgaris* is a representative of the Clupeoid family.[1] The "Maifisch" takes its German name from the month during which it ascends the Rhine for the purpose of spawning, and during which it is mostly caught. It is not so highly esteemed as an article of food as the salmon, but its flesh still forms a favorite and valuable food, so that the question whether by the catching of the "Rümpchen" it is deprived of food well deserves an answer based on scientific investigations. Till quite recently, the "Maifisch" (*Alausa vulgaris*) was identified with the "Finte" (*Alausa finta*)—even by *Heckel* and *Kner*. *Cuvier*[2] and other ichthyologists had tried to show certain differences between the two, but *Valenciennes*[3] had showed these to be untenable, and therefore declared that both fish were one and the same species, viz, *Alausa vulgaris*. But since *Troschel*[4] has examined these fish more thoroughly, and has shown the actual differences between them, it has become possible to distinguish them. The chief difference is in the gills; *Alausa vulgaris* has, on the first branchial arch, 99 to 118 long, slender, and thin lamellæ; on the second, 96 to 112; on the third, 74 to 88; and on the fourth, 56 to 65; while *Alausa finta* has, on the first and second arch, only 39 to 43 short and thick protuberances; on the third, 33 to 34; and on the fourth, 23 to 27.

The flesh of the *Alausa finta* has a bad odor, and is not nearly as fat and delicately-flavored as that of *Alausa vulgaris*,[5] so that the fishermen

[1] As to the family and specific characters, see *Heckel* and *Kner*, p. 228; *Siebold*, p. 328; *Valenciennes*, vol. xx, 1847, p. 391.

[2] *Cuvier*, Règne animal, tome ii, 1829, p. 319.

[3] *Valenciennes*, op. cit., p. 403.

[4] *Troschel*, in *Wiegmann's* "Archiv für Naturgeschichte," 1852, vol. i, p. 228, and "Lehrbuch der Zoologie," 1859, p. 229; 7th ed., 1871, p. 268.

[5] *Siebold*, op. cit., p. 334, erroneously doubts whether the difference in flavor between *Alausa vulgaris* and *Alausa finta* has anything to do with the specific differences of the fishes. Not only after the spawing, but also during the whole time of their sojourn in the Rhine, (therefore, also, at a time when they have not yet become worthless through spawning,) the *Alausa finta* has poor flesh, so that many fish-dealers do not keep it at all.

do not esteem it at all. As the *Alausa finta*, consequently, does not come within the scope of my observations,[1] I have confined myself to the examination of the food of *Alausa vulgaris*.

In the above-mentioned authors, I find no statement regarding the food of *Alausa vulgaris*. Only *Günther* (who, however, had not been able to examine any of those which occur in the Neckar, p. 121) says, (p. 124:) "The food of the 'Maifisch' consists chiefly of worms and insects. It is said, however, that it can also be caught with boiled pease." It will be seen from the following in how far he is right.

The first two stomachs of *Alausa vulgaris* I received on the 3d May; later I gradually got eighteen more, so that the total number of specimens which I examined was twenty. The result was, on the whole, the same in all. In most of them, I found that the stomach had some contents; only in a few I found little or nothing. The examination of the contents showed the following: Inside the stomach proper, which was strongly contracted, there was a cylindrical mass, pointed at the lower end, toward the pylorus; it seemed to consist of a stringy, white mucus, and showed the impression of the folds of the stomach. By a longitudinal section, the inside was laid open, and it became evident that the mucus only formed an outer covering, enveloping a reddish or gray grained substance. The microscopic examination of this substance showed a large number of remnants of diminutive animal organs and well-developed cell-like formations. As regards the former, I recognized tarsi, antennæ, &c., of microscopic entomostracans and other crustaceans. Occasionally, I found larger connected parts of these diminutive animals. It is possible that these tarsi, &c., belonged to insects; but I have never been able to find wings or parts of the skeleton, &c., of an insect. I must also state that I have not found remains of fish in any of the specimens which I examined.

Among the cell-like formations which I found in the stomach of *Alausa vulgaris*, there were (as shown by a microscopic examination) two varieties, a ball-shaped one and a tube-shaped one. In the ball-shaped ones, I recognized animal eggs (probably of *Ascaris adunca*, which is found in large quantities in the stomach of the "Maifisch"); the tube-shaped ones seemed to be encysted embryos of nematoids. But as I could not bring my investigations of this point to a final conclusion, and as its further discussion goes beyond the aim of this treatise, I confine myself to what has been said above.

CONCLUSION.

Nothing remains but to give a brief *résumé* of these investigations and their results, so as to definitely answer the question whether or not the catching of "Rümpchen" is injurious to other fishes.

[1] In examining the question as to whether the catching of the "Rümpchen" is injurious to other fish, only such fish can be spoken of which exceed the "Rümpchen" in quality; for one certainly would not think of sparing the "Rümpchen," *e. g.*, for the pike.

Of the valuable fishes which, coming from the sea, ascend the Rhine and its tributaries, (*Trutta salar*, *Trutta trutta*, and *Alausa vulgaris*,) the two first-mentioned species do not eat anything, and the third only crustaceans and insects. The young salmon living in the Rhine seem to show a preference for the "Rümpchen" as an article of food; but they only spend that part of their life in fresh water when they are too small to hunt for "Rümpchen." The food of *Trutta fario* consists chiefly of insects and their larvæ, and only to a small extent of small fish which must be classed with the "Rümpchen." By the catching of the "Rümpchen," only a small portion therefore of the young salmon and the trout are to a limited extent deprived of food. Since, therefore, as *Troschel* has shown, no valuable young fish are destroyed by the fishing of "Rümpchen," since thereby the more valuable large fish are not deprived of any absolutely necessary food, and since, finally, the "Rümpchen" form a good and well-flavored article of food, thus amply making up for the damage which their being fished may do to the great fisheries, *I must declare the fishing of "Rümpchen" to be entirely harmless.*

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