

GREAT INTERNATIONAL FISHERIES EXHIBITION.

LONDON, 1883.

UNITED STATES OF AMERICA.

L.

CATALOGUE

OF THE

FISH-CULTURAL EXHIBIT

OF THE

UNITED STATES FISH COMMISSION.

BY

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A.—INTRODUCTION.

HISTORICAL SKETCH OF FISH-CULTURE IN THE UNITED STATES.

As the United States is the acknowledged leader among nations in all questions relating to fish-culture, it seems proper, in presenting the catalogue of the fish-cultural exhibit at the London Fisheries Exhibition, to give a brief outline of the origin and growth of the science in this country and of the more important changes in methods and improvements in apparatus that have taken place from time to time.

The first attempt at artificial fish-culture in the United States was made in 1851, when Dr. Theodatus Garlick, of Cleveland, Ohio, took and impregnated eggs of the brook trout, *Salvelinus fontinalis*, which he placed in a wooden trough, the bottom of which was covered with gravel. This trough was supplied with pure, cold spring-water, and the eggs placed upon the gravel, where they were allowed to remain until hatched. When the news of Dr. Garlick's success became known considerable interest in the subject sprang up in many quarters, and numerous experiments were made with eggs of the trout and other species. In 1856 public sentiment had developed sufficiently to warrant the Massachusetts legislature in establishing a Board of Commissioners for investigating subjects relating to the fisheries and considering the practicability of the artificial propagation of fish at the expense of the State. In 1865 another board was appointed to report upon the obstructions to the ascent of fish in the Connecticut River. Private individuals also interested themselves in similar investigations, and numerous experiments were made in the hatching and rearing of young fish, but these were for the most part limited and of little commercial importance.

The era of practical fish-culture was inaugurated in 1864 by Mr. Seth Green, who built a hatchery and engaged extensively in the artificial propagation of several species. A year later the New Hampshire fish commission was formed, and an attempt was made, at the expense of the State, to restock the salmon rivers, this being the first appropriation of public money for fish-cultural purposes. The same year a fish commission was established in the neighboring State of Vermont, and a permanent commission was formed in Massachusetts, together with similar commissions in Connecticut and Pennsylvania. Other States soon followed the example of those already mentioned, Maine establishing its commission in 1867, followed by New York and Rhode Island in 1868, and by New Jersey and the distant State of California in 1870.

The reports of several of the commissions already established pointed to a rapid diminution in the fish supply of New England, owing to immoderate fishing, the obstruction of river channels by dams and the pollution of the waters by the manufacturing establishments along their

banks. These reports were widely circulated and caused general public interest in the matter, Congress being called upon to investigate the subject. As a result, the United States Fish Commission was established in 1871, with Prof. Spencer F. Baird, then Assistant Secretary of the Smithsonian Institution, at its head, with instructions to investigate the question of the alleged decrease and report whether any protective measures were advisable. The establishment of this Commission marks a new era in the fish-culture of the country, and its operations, which have been increasing from year to year, are more extensive than those of any other similar organization in the world.

The same year Alabama and Utah established fish commissions, and in 1873 commissions were formed in Michigan, Ohio, and Wisconsin. In 1874, the legislatures of Iowa, Maryland, Minnesota, and Virginia were induced to create commissions in their respective States. Illinois followed their example in 1875, and Arkansas, Georgia, and Kentucky a year later. The year 1877 was a remarkable one in the history of State fish commissions, as it witnessed the organization of eight new ones, namely, those of Colorado, Kansas, Missouri, Nevada, North Carolina, Tennessee, Washington Territory, and West Virginia. In 1878 a State commission of fisheries was organized in South Carolina, and similar ones were formed in Nebraska, Wyoming, and Texas in 1879, in Oregon, in 1880, and in Arizona, Delaware, and Indiana in 1881.

The present public interest in the subject is indicated by the fact that only seven States and Territories of our entire number are now without commissions. A better test of public confidence is found in the annually increasing appropriations which are made for fish-cultural work by the General Government and by the governments of the several States. Below are tables showing the annual appropriations for the several State commissions and for the United States Commission:

Appropriations for the work of the State fish commissions from their origin down to, and including, the year 1882.

State.	Years for which appropriations were made.	Amount appropriated to 1882, inclusive.	State.	Years for which appropriations were made.	Amount appropriated to 1882, inclusive.
Alabama			New Hampshire	1866-1882	\$26, 463
Arizona	1881, 1882	\$500	New Jersey	1872-1881	33, 500
Arkansas			New York	1868-1882	210, 000
California	1870-1882	52, 000	North Carolina	1881-1882	11, 226
Colorado	1877-1882	11, 650	Ohio	1873-1882†	39, 000
Connecticut	1868-1882	53, 300	Oregon		
Delaware	1881-1882	300	Pennsylvania	1873-1882	114, 630
Georgia	1876-1882	3, 500	Rhode Island	1870-1882‡	11, 500
Illinois	1880-1882	5, 500	South Carolina	1879-1882§	6, 242
Indiana	1881-1882	2, 000	Tennessee		
Iowa	1874-1882	32, 450	Texas	1882	5, 000
Kansas	1877-1882*	3, 000	Utah	1882	850
Kentucky	1876-1882	13, 500	Vermont	1867-1882	10, 800
Maine	1867-1882†	46, 975	Virginia	1875-1882	21, 500
Maryland	1874-1882	96, 500	Washington		
Massachusetts	1866-1882	95, 500	West Virginia	1877-1882	8, 100
Michigan	1873-1882	68, 500	Wisconsin	1873-1882	52, 860
Minnesota	1874-1882	32, 500	Wyoming	1880-1882	2, 350
Missouri	1877-1882	14, 000			
Nebraska	1879-1882	8, 400	Total		1, 101, 996
Nevada	1877-1882	7, 000			

* Except 1881.

† Except 1879.

‡ Except 1877, 1878, 1879, and 1882.

§ Except 1880.

Appropriations for the work of the United States Fish Commission, 1871-'83.

Fiscal year.	Inquiry.	Propaga- tion.	Hatcheries and ponds.	Steam vessels.	Miscella- neous.	Total.
1871-'72	\$8, 500					\$8, 500 00
1872-'73	5, 000	\$25, 000			\$500	30, 500 00
1873-'74	5, 000	32, 500			1, 000	38, 500 00
1874-'75	5, 000	17, 500			1, 000	23, 500 00
1875-'76	5, 000	65, 000			1, 000	71, 000 00
1876-'77	5, 000	30, 045			1, 000	36, 045 00
1877-'78		67, 500	\$2, 200 00		1, 000	70, 700 00
1878-'79		70, 000	5, 000 00		1, 000	76, 000 00
1879-'80	3, 500	90, 000	5, 000 00	\$57, 500	1, 000	157, 000 00
1880-'81	3, 500	85, 000	17, 000 00	15, 000	1, 000	121, 500 00
1881-'82	3, 560	130, 000	20, 001 45	172, 709	2, 500	328, 710 45
1882-'83	3, 500	115, 000	30, 000 00	70, 000	10, 500	229, 000 00
Total	47, 500	727, 545	79, 201 45	315, 209	21, 500	1, 190, 955 45

An examination of these tables shows a total of \$2,292,051.45 of public money appropriated for fish-cultural work since 1865. This, by no means, represents the entire amount of money expended in fish-cultural work, as private funds are invested in fish-culture in many localities and large sums are expended annually in establishing and maintaining hatcheries and in preparing ponds for the reception of carp and other species, which are now being raised for sale in the markets.

The work of the different commissions is by no means limited to the artificial propagation of food-fishes, a wiser and broader policy having been adopted, including a thorough investigation of the waters and their inhabitants, together with kindred subjects that have a practical bearing on the food and habits of fish life. The success of fish-culture in the United States is largely due to the fact that it is under the direction of men of acknowledged scientific ability, who are not contented with any superficial investigations, and will not be satisfied until they have reached the bottom facts.

As the United States Fish Commission has been the leader in the fish-culture of America, a somewhat full description of its aims and methods seems desirable. No better statement of these can be found than that given by Mr. G. Brown Goode, in his paper on the fishery industries of the United States, read before the conference of the London Fisheries Exhibition.*

"On the 9th of February, 1871, Congress passed a joint resolution which authorized the appointment of a Commissioner of Fish and Fisheries. The duties of the Commissioner were thus defined: 'To prosecute investigations on the subject [of the diminution of valuable fishes] with the view of ascertaining whether any and what diminution in the number

* A Review | of the | Fishery Industries | of | the United States | and the Works of the U. S. Fish Commission | by | G. Brown Goode, M. A. | Assistant Director of the United States National Museum | and | Commissioner to the International Fisheries | Exhibition, London, 1883 | — | Read at a conference of the International Fisheries | Exhibition, June 25, 1883 | His Excellency James Russell Lowell in the chair | — | London | William Clowes and Sons, Limited | International Fisheries Exhibition | and 13 Charing Cross, S. W. | 1883.

of the food-fishes of the coast and the lakes of the United States has taken place; and, if so, to what causes the same is due; and also whether any and what protection, prohibitory or precautionary measures should be adopted in the premises, and to report upon the same to Congress.'

"The resolution establishing the office of Commissioner of Fisheries required that the person to be appointed should be a civil officer of the Government, of proved scientific and practical acquaintance with the fishes of the coast, to serve without additional salary. The choice was thus practically limited to a single man for whom, in fact, the office had been created. Prof. Spencer F. Baird was appointed and entered at once upon his duties.

"I think I may say without fear of challenge that very much of the improvement in the condition of our fisheries has been due to the wise and energetic management of our Commissioner. Himself an eminent man of science, for forty years in the front rank of biological investigation, the author of several hundred scientific memoirs, no one could realize more thoroughly the importance of a scientific foundation for the proposed work.

"His position as the head of that most influential scientific organization, the Smithsonian Institution, given by an Englishman to the United States 'for the increase and diffusion of knowledge among men,' enabled him to secure at once the aid of a body of trained specialists.

"Pure and applied science have labored together always in the service of the Fish Commission, their representatives working side by side in the same laboratories; indeed, much of the best work both in the investigation of the fisheries and in the artificial culture of fishes has been performed by men eminent as zoologists.

* * * * *

"The work of the Commission is naturally divided into three sections:

"1. The systematic investigation of the waters of the United States and the biological and physical problems which they present. The scientific studies of the Commission are based upon a liberal and philosophical interpretation of the law. In making his original plans the Commissioner insisted that to study only the food-fishes would be of little importance, and that useful conclusions must needs rest upon a broad foundation of investigations purely scientific in character. The life history of species of economic value should be understood from beginning to end, but no less requisite is it to know the histories of the animals and plants upon which they feed or upon which their food is nourished; the histories of their enemies and friends, and the friends and foes of their enemies and friends, as well as the currents, temperatures, and other physical phenomena of the waters in relation to migration, reproduction, and growth. A necessary accompaniment to this division is the amassing of material for research to be stored in the National and other museums for future use.

"2. The investigation of the methods of fisheries, past and present, and the statistics of production and commerce of fishery products. Man being one of the chief destroyers of fish, his influence upon their abundance must be studied. Fishery methods and apparatus must be examined and compared with those of other lands, that the use of those which threaten the destruction of useful fishes may be discouraged, and that those which are inefficient may be replaced by others more serviceable. Statistics of industry and trade must be secured for the use of Congress in making treaties or imposing tariffs, to show to producers the best markets and to consumers where and with what their needs may be supplied.

"3. The introduction and multiplication of useful food-fishes throughout the country, especially in waters under the jurisdiction of the General Government, or those common to several States, none of which might feel willing to make expenditures for the benefit of the others. This work, which was not contemplated when the Commission was established, was first undertaken at the instance of the American Fish-Cultural Association, whose representatives induced Congress to make a special appropriation for the purpose. This appropriation has since been renewed every year on an increasingly bountiful scale, and the propagation of fish is at present by far the most extensive branch of the work of the Commission, both in respect to number of men employed and quantity of money expended.

* * * * *

"Since the important sea-fisheries are located along the North Atlantic, the coast of this district has been the seat of the most active operations in marine research. For twelve years the Commissioner, with a party of specialists, has devoted the summer season to work at the shore, at various stations along the coast from North Carolina to Nova Scotia.

"A suitable place having been selected, a temporary laboratory is fitted up with the necessary appliances for collection and study. In this are placed from ten to twenty tables, each occupied by an investigator—either an officer of the Commission or a volunteer.

"The regular routine of operations at a summer station includes all the various forms of activity known to naturalists—collecting along the shore, seining upon the beaches, setting traps for animals not otherwise to be obtained, and scraping with dredge and trawl the bottom of the sea, at depths as great as can be reached by a steamer in a trip of three days. In the laboratory are carried on the usual structural and systematic studies, the preparation of museum specimens and of reports.

"The permanent headquarters are located at Wood's Holl, Mass., where wharves are being built for the accommodation of the fleet of the Commission, and a house for use as scientific and fish-cultural lab-

oratories, and where the propagation of sea-fishes will be continued on a larger scale than heretofore.

“In addition to what has been done at the summer station, more or less exhaustive investigations have been carried on by smaller parties in every important position of the coast and interior waters.

“For several years steamers were lent for the work by the Secretary of the Navy and the Coast Survey and Revenue Services.

“In 1880, however, a steamer of 450 tons, the *Fish Hawk*, was built for the Commission. This being needed for fish-hatching purposes, another larger steamer, of 1,000 tons, the *Albatross*, has just been built and put into commission. She has already, since April, made two successful deep-sea explorations, and has been supplied with every means for work of this kind.

“The general practical results of this part of the work cannot be satisfactorily summed up on account of the number of important investigations still in progress.

“One of the important features of the work has been the preparation of life histories of the principal fishes, great quantities of material having been accumulated relating to almost every species. A portion of this has been published, biographical monographs having been published on the bluefish, the scup, the menhaden, the salmon, the whitefish, the shad, the mackerel, the swordfish; and others are being printed.

“Similar monographs upon the lobster, oyster, and other invertebrates are also ready.

“In connection with the work of fish-culture much attention has been paid to embryology. The breeding times and habits of nearly all of our fishes have been studied, and their relations to water temperatures. The embryological history of a number of species, such as the eod, shad, alewife, salmon, smelt, Spanish mackerel, striped bass, white perch, the silver gars, the clam, and the oyster, have been obtained under the auspices of the Commission.

“Many other problems have been worked out by specialists for the Commission, the details of which are described in the reports. One of these, for instance, has been the determination of the cause of the reddening of salt codfish, so injurious to commerce. Professor Farlow found this to be due to the presence of a species of alga in the kind of salt in common use, and gave instructions by which the plague has been greatly lessened.

“An investigation into the chemical composition and nutritive value of fish as compared with other food is still in progress, and all American food-fishes are being analysed by Professor Atwater.

“The temperature of the water in its relation to the movements of fish, has from the first received special attention. Observations are made regularly during the summer work and at the various hatching stations. At the instance of the Commissioner an extensive series of observations have for several years been made under the direction of

the Chief Signal-Officer of the Army at light-houses, light-ships, life-saving and signal stations, carefully chosen, along the whole coast. A number of fishing schooners and steamers have kept similar records. One practical result of the study of these observations has been the demonstration of the cause of the failure of the menhaden fisheries on the coast of Maine in 1879; a failure on account of which nearly 2,000 persons were thrown out of employment.

"A most remarkable series of contributions have been received from the fishermen of Cape Ann. When the Fish Commission had its headquarters at Gloucester, in 1878, a general interest in the zoological work sprang up among the crews of the fishing vessels, and since that time they have been vying with each other in efforts to find new animals. Their activity has been stimulated by the publication of lists of their donations in the local papers; and the number of separate lots of specimens received to the present time exceeds eight hundred. Many of these lots are large, consisting of collecting-tanks full of alcoholic specimens. At least thirty fishing-vessels were carrying collecting-tanks on every trip, until it became necessary to recall them because no more specimens were required, and many of the fishermen, with characteristic superstition, had the idea that it insured good luck to have a tank on board, and would not go to sea without one. The number of specimens acquired in this manner is at least fifty or sixty thousand, most of them belonging to species otherwise unattainable. Each halibut vessel sets once or twice daily, lines from 10 to 14 miles in length, with hooks upon them 15 feet apart, in water 1,200 to 1,800 feet in depth, and the quantity of living forms brought up in this manner, and which had never hitherto been saved, is very astonishing. Over thirty species of fishes have thus been added to the fauna of North America, and Professor Verrill informs me that the number of new and extra limitai forms thus placed upon the list of invertebrates cannot be less than fifty.

"The investigation of the statistics and history of the fisheries has perhaps assumed greater proportions than was at first contemplated. One of the immediate causes of the establishment of the Commission was the dissension between the line and net fishermen of Southern New England with reference to laws for the protection of the deteriorating fisheries of that region. The first work of Professor Baird as Commissioner was to investigate the causes of this deterioration.

"Each year increasing attention has been paid to this subject. The Commissioner has never advised any legislation on the part of the General Government, each State Government having control over the fisheries in its own waters.

* * * * *

"The statutes of the various States contain numerous laws for the protection of fish and fishermen generally worse than useless, though there are many definitions of close time which appear to be beneficial.

To enforce these laws would, however, render necessary a large force of fish wardens.

“The policy of the United States Commissioner has been to carry out the idea that it is better to expend a small amount of public money in making fish so abundant that they can be caught without restriction and serve as cheap food for the people at large, rather than to expend a much larger amount in preventing the people from catching the few that still remain after generations of improvidence.”

The first experiments in fish-culture by Dr. Garlick were conducted in an ordinary trough filled with running water, the bottom being covered with gravel, so that the conditions might approximate as nearly as possible to the natural conditions of the river bed. As fish-culture has become more extensive experiments have been made in the artificial propagation of numerous other species, which have necessitated the invention of apparatus of an entirely different character.

The eggs thus far hatched may be referred to one of four classes, viz: (1) heavy eggs, (2) semi buoyant eggs, (3) adhesive eggs, and (4) floating eggs. Each of these classes requires apparatus adapted to itself, and that suited to one is frequently entirely unfit for another.

The apparatus for heavy eggs has numerous modifications, depending upon the direction of the current through the eggs. All of the older forms required a horizontal current, but the more recent ones have the eggs arranged in trays, one above the other, with the current passing either upward or downward through them.

Apparatus for semi-buoyant eggs has undergone considerable change. They were for a time hatched with fair success on trays with a downward current of water, but the use of this apparatus is now entirely discontinued. The present forms are floating boxes for utilizing river currents, submerged boxes for utilizing wave action, closed vessels for utilizing head or hydrant pressure, and mechanical apparatus. The third named is unquestionably the most satisfactory, as it is more economical and more convenient than the others. This form has undergone numerous modifications to make it automatic, and is now perfected so that the dead eggs pass off with the waste water and the young fish are collected in aquarium receivers.

Several forms of apparatus have been invented for adhesive eggs. The first were copied from Sweden, consisting of wooden boxes, protected by wire netting, containing twigs covered with eggs and placed in the open streams. The most important form consists of a wooden trough with glass plates placed transversely and extending entirely across it, fitting in grooves at the side, each alternate one being a little above the bottom of the trough, so that the current passes over the first, under the second, over the third, &c., on its way through the trough, thus furnishing a constant current around each plate. The eggs are placed upon the glass plates, which can be easily removed to be cleaned of any sediment that may have gathered upon them. No apparatus has

yet been invented for floating eggs that proves entirely satisfactory, though several forms are used with fair results. These are the floating box, arranged to utilize the action of the waves, a cylindrical hatching-can, made to revolve by means of machinery, and a modified form of the Clark hatching-trough.

Formerly, the work of any fish-cultural establishment was limited to the quantity of eggs obtained in the immediate vicinity, which were usually secured from fish kept in the ponds of the hatchery, or from those taken in the adjacent river. Later, boats were employed to enable the spawn-takers to go out among the net-fishermen, and, later still, steam-launches were introduced to enable them to visit more distant localities. Another plan, which has considerably reduced the expense of artificial propagation, has been the building of floating hatcheries, which can be towed to any given locality, and after the spawning season is over these can again be taken in tow and carried to a more northern fishing center to continue the work; thus the same hatchery and equipment can be employed in hatching eggs of the shad in Florida waters in January and February, on the Carolina coast in March and April, in the rivers of Maryland in May and June, and on the New England coast later in the season.

Within the past few years satisfactory experiments have been made in securing eggs and shipping them either by rail or steamer to hatching stations quite remote from the fishing grounds. This plan has long been applied to the eggs of certain species of *Salmonidae*, but it is only recently that it has been employed with the eggs of the shad. Men are now sent with a camping and collecting outfit to the different fishing stations along the river banks, with rations to last them during the fishing season, their duty being to examine the fish at each haul of the seine, secure such eggs as may be obtained, and put them on board the river steamer for shipment to the hatching station. In this way the expense of the work has been greatly reduced. Another plan of increasing the quantity of eggs for any particular hatchery is to build pens capable of holding considerable numbers of fish. For some years the practice of the U. S. Fish Commission was to visit the nets of the fishermen and take the eggs from such females as chanced to be in proper condition, a very large proportion of the fish being either spent or too immature to enable the eggs to be impregnated. Numbers of eggs were lost in this way, and it was found expedient to collect the fish and pen them until they should ripen, when the eggs could be secured. Different plans are adopted to accomplish this purpose. At Grand Lake Stream, where the land-locked salmon are hatched, net basins are constructed along the bank and netting is stretched across the stream when the salmon ascend to spawn. These nets or wings turn them into the basins, where they are retained until the spawning season arrives, when they can be examined from day to day and all the ripe eggs secured. In California the same end is ac-

complished by placing a dam across the river which prevents the fish from proceeding further. The fish thus remain in the vicinity of the dam until ripe, when they are secured by seines hauled by employés of the hatchery. At the whitefish hatcheries on the Great Lakes pounds have been constructed along the shore in which the fish have been retained for a few days until ripe, so that the entire number of eggs, or a large percentage of them, can be impregnated. The penning of fish, especially in summer, often results in great loss, as some species are so restless when in confinement that they soon kill themselves by rushing against the barriers, or become so bruised that they fall an easy prey to fungus, which destroys great numbers of them. At one of the hatcheries in Canada the plan is adopted of penning the fish in salt water, which entirely does away with the danger from the fungus, as it never makes its appearance in salt water.

The spawning season of any particular species in a given locality usually lasts but a few weeks, and for this reason a large force of men has been required for a short time in taking and caring for the eggs and distributing the fish, after which the hatchery is closed for want of eggs. The plan of retarding eggs by means of refrigerators, in which they can be stored, promises to give good results. Mr. F. N. Clark, the superintendent of the Northville hatchery, informs me that his hatchery will accommodate scarcely more than a hundred millions of eggs; but as it is found desirable to hatch out larger quantities, a refrigerator is being erected, with an ice-chamber at the top and pipes running down to convey the air into the chamber beneath, which is to contain the eggs. These are to be spread on trays, placed one above another, with air-spaces between them. Here they will be kept until room occurs for them in the hatchery, one lot being taken from the refrigerator and hatched, while the rest remain to await their turn. He hopes to increase the capacity of his hatchery in this way from one hundred to five hundred millions, and believes that he will be enabled to distribute fish during at least four months, and to extend the hatching period by at least three months beyond its natural limit.

In the early stages of fish-culture in this country considerable difficulty was experienced in transporting fry from one locality to another, and the expense of such transportation was a serious item. The fry were usually placed in large cans, carried in the baggage-cars of passenger trains, two assistants usually accompanying every shipment, to change the water and keep it at a proper temperature. Cars constructed expressly for the purpose, with hotel accommodations for the messengers, are now employed by the United States Fish Commission. These are fitted with refrigerators, tanks, and water-pipes. Their use greatly reduces the difficulty and cost of transportation, as a car-load can now be taken as easily as a half dozen cans by the old method.

Fish-culture was for some years confined wholly to a few species, but of late the number has been considerably extended.

Until 1878 the work of the United States Commission was confined wholly to fresh-water and anadromous species. In this year, however, a station was established at Gloucester, Mass., for the propagation of marine species; and cod, herring, and haddock were successfully hatched. In 1880 successful experiments were made with several food-fishes from our southern seaboard. The following is a list of the principal species artificially hatched in the United States, with the date when, and the person by whom, the experiments were first made:

1. Brook trout, *Salvelinus fontinalis*, by Dr. T. Garlick in 1851.
2. White-fish, *Coregonus clupeiformis*, by Müller and Brown in 1857.
3. Lake trout, *Salvelinus namaycush*, by Müller and Brown in 1857.
4. Pike perch, *Stizostedium americanum*, by Müller and Brown in 1857.
5. Atlantic salmon, *Salmo salar*, by J. B. Johnston in 1864.
6. Land-locked salmon, *Salmo salar*, subsp. *sebago*, by Robinson and Hoyt in 1867.
7. Shad, *Clupea sapidissima*, by Seth Green in 1867.
8. California salmon, *Oncorhynchus chouicha*, by Livingston Stone in 1872.
9. Striped bass, *Roccus striatus*, by M. G. Holton in 1873.
10. Oquassa trout, *Salvelinus oquassa*, by C. G. Atkins in 1874.
11. Sea bass, *Centropristis nigricans*, by Fred Mather in 1874.
12. Grayling, *Thymallus tricolor*, by Fred Mather in 1875.
13. Sturgeon, *Acipenser sturio*, by Seth Green in 1875.
14. Smelt, *Osmerus mordax*, by James Ricardo in 1876.
15. Herring, *Clupea harengus*, by Vinal N. Edwards in 1877.
16. Alewife, *Clupea vernalis*, by T. B. Ferguson in 1877.
17. Oyster, *Ostrea virginica*, by W. K. Brooks in 1877.
18. Cod, *Gadus morrhua*, by James W. Milner in 1878.
19. Haddock, *Melanogrammus aeglefinus*, by R. Edward Earll in 1879.
20. Carp, *Cyprinus carpio*, by Rudolph Hessel in 1879.
21. Spanish mackerel, *Scomberomorus maculatus*, by R. Edward Earll in 1880.
22. Cero, *Scomberomorus regalis*, by R. Edward Earll in 1880.
23. Moon-fish, *Chaetodipterus faber*, by R. Edward Earll in 1880.
24. Silver gar, *Tylosurus marinus*, by Marshall McDonald in 1881.
25. Gold-fish, *Carassius auratus*, by Rudolph Hessel in 1881.
26. Tench, *Tinca vulgaris*, by Rudolph Hessel in 1881.
27. Soft-shelled clam, *Mya arenaria*, by J. A. Ryder in 1881.

As the operations of the Commission have increased, and the propagation of additional species has been undertaken, it has been found desirable to increase the number of hatching stations. These are of two kinds, known as collecting and distributing stations. The former are located near the spawning grounds of those species for which they are especially intended. The eggs are secured at these stations, and enough having been reserved to stock the waters of that region, the remainder

are sent to distributing stations, usually located at some central point, to be hatched and shipped to the waters for which they are intended.

The following is a list of the hatching stations operated by the U. S. Fish Commission in 1883 :

1. Grand Lake Stream, Maine, station for collecting eggs of the Schoodic salmon (*Salmo salar*, subsp. *sebago*).
2. Bucksport, Me., station for collecting and hatching eggs of the Atlantic salmon (*Salmo salar*), and for hatchings eggs of whitefish (*Coregonus clupeiformis*) to be distributed in the waters of the State.
3. Wood's Holl, Mass. Permanent coast station, which serves as a base of operations for the scientific investigations of the Commission, and as a hatching station for eggs of the cod (*Gadus morrhua*) and other sea-fishes.
4. Cold Spring Harbor, Long Island, New York. Station for hatching eggs of various species of *Salmonidæ* for distribution in New York and vicinity.
5. Havre de Grace, Md. Station located on Battery Island, in the Susquehanna River, for the purpose of collecting and hatching eggs of the shad (*Clupea sapidissima*).
6. Washington, D. C.
 - a. National Carp ponds. Ponds for the propagation of the three varieties of the carp (*Cyprinus carpio*), and the goldfish (*Carassius auratus*), the golden ide (*Idus melanotus*, var. *auratus*), and the tench (*Tinca vulgaris*).
 - b. Arsenal ponds. Ponds for the propagation of carp (*Cyprinus carpio*).
 - c. Navy-yard. Station for collecting and hatching eggs of the shad (*Clupea sapidissima*).
 - d. Central hatching station. A station fully equipped for scientific experiments connected with propagation of fishes. The station is also provided with apparatus for hatching the eggs of all of the more important species, including light, heavy, and adhesive eggs. It is the principal distributing station of the Fish Commission, for both eggs and young fish, to all portions of the United States.
7. Wytheville, Va. A station for hatching eggs of brook-trout (*Salvelinus fontinalis*) and California trout (*Salmo irideus*).
8. Saint Jerome's Creek, Point Lookout, Maryland. A station for the artificial propagation of the oyster (*Ostrea virginica*), the Spanish mackerel (*Scomberomorus maculatus*), and the banded porgy (*Chatodipterus faber*).
9. Avoca, N. C. A station on Albemarle Sound, at the junction of Roanoke and Chowan Rivers, for collecting, hatching, and distributing eggs of the shad (*Clupea sapidissima*), alewife (*Clupea vernalis* and *C. aestivalis*), and striped bass (*Roccus striatus*).

10. Northville, Mich. A hatching station for the development and distribution of eggs of the whitefish (*Coregonus clupeiformis*). This station is also provided with tanks and ponds for the spawning, hatching, and rearing of brook-trout (*Salvelinus fontinalis*) and California trout (*Salmo irideus*).
11. Alpena, Mich. A station for the collection and development of the eggs of the white-fish (*Coregonus clupeiformis*).
12. Baird, Cal.
 - a. Salmon station. A station on the McCloud River for the development and distribution of eggs of the California salmon (*Oncorhynchus chowicha*).
 - b. Trout ponds. A station near Baird, for collecting, developing, and distributing eggs of the California trout (*Salmo irideus*).
13. Clackamas River, Oregon. A station on Columbia River for collecting and hatching eggs of the California salmon (*Oncorhynchus chowicha*).

To enable the public to form some idea of the extent of public fish-culture within the limits of the United States, a brief description of the operations of several of the larger stations operated by the U. S. Fish Commission is given.

The hatchery at Northville, Mich., under the direction of Mr. Frank N. Clark, passed into the hands of the U. S. Fish Commission in 1880, and is now one of the most important stations for salmonidæ in the world. It is provided with natural and artificial ponds in which brook-trout, rainbow-trout, land-locked salmon and lake-trout, are kept for breeding purposes. In addition to the eggs obtained from these ponds, many millions of eggs of the whitefish, lake-trout, and wall-eyed pike are obtained in the waters of Lake Erie, and forwarded to Northville to be hatched and distributed. During the season of 1882-'83, 70,950,000 eggs of the salmonidæ were handled at this hatchery, a large percentage of which were hatched and distributed to different waters. A large refrigerator is being put in readiness for next season's work, when it is expected that fully 500,000,000 eggs of the whitefish alone will be hatched.

The hatcheries at Bucksport and Grand Lake Stream are both under the superintendence of Mr. Charles G. Atkins. The former of these is provided with ponds in which salmon, purchased from the fishermen of the Penobscot River, in May, are confined till November, at which time the eggs are taken and the fish liberated. At Grand Lake Stream, where the land-locked salmon are hatched, the eggs are obtained from the wild fish which, when attempting to ascend to their natural spawning grounds, are turned aside into inclosures of netting, where they are retained until all of the eggs have been secured. There were secured at these two stations, during the past season, 3,675,000 eggs of these species for distribution to different parts of the United States.

The hatchery on the McCloud River in California was established in 1872, under the superintendence of Mr. Livingston Stone, who has secured large quantities of eggs of the California salmon annually. The eggs have been taken from the wild salmon, which have been prevented from ascending to their natural spawning grounds by a dam which he has caused to be thrown across the river just above the hatchery. Eggs of the rainbow-trout also have been secured in considerable numbers.

Owing to the lateness of the appropriation, little was done at the hatchery last year, only 4,000,000 salmon and 337,500 trout eggs being secured. Most of these were hatched and planted in the waters of the Sacramento River. Mr. Stone gives the following comprehensive statement of the work accomplished since the establishment of the hatchery.

In the eleven years since the salmon-breeding station has been in operation, 67,000,000 eggs have been taken, most of which have been distributed in the various States of the Union. Several millions, however, have been sent to foreign countries, including Germany, France, Great Britain, Denmark, Russia, Belgium, Holland, Canada, New Zealand, Australia, and the Sandwich Islands. About 15,000,000 have been hatched at the station, and the young fish placed in the McCloud and other tributaries of the Sacramento River. So great have been the benefits of this restocking of the Sacramento that the statistics of the salmon fisheries on the Sacramento show that the annual salmon catch of the river has increased 5,000,000 pounds during the last few years.

The shad stations at Washington, D. C., and Havre de Grace, Md., have been recently enlarged, and are now capable of holding immense numbers of eggs. At one of the Washington stations alone nearly 50,000,000 of eggs were received. An estimate of those for the other stations gives a total of over 70,000,000 eggs of this species.

The work of the Commission has been by no means confined to the replenishing of depleted waters, but an effort has been made to introduce desirable species into localities where they had not previously existed; American fishes have been sent abroad, and foreign fishes have been introduced into American waters. The experiments in acclimatization, as would naturally be expected, have not always been successful, but in some cases they have been remarkably so. The shad has been introduced into the tributaries of the Gulf of Mexico and of the Pacific coast, and large shad are now not uncommon in the California markets. Glowing accounts are given of the introduction of the California salmon into Australian waters, and the Atlantic salmon and California trout are reported to be thriving well in the waters of Continental Europe, especially in those of Germany and the Netherlands. The last-named species has been introduced into small streams and ponds east of the Mississippi, and seems destined to become one of the important fishes of this region. Attempts have also been made to introduce the Lake whitefish into numerous inland waters, but sufficient time has not

yet elapsed to warrant a statement regarding the success or failure of the experiment.

The most satisfactory results thus far in acclimatization have been obtained from the introduction of German carp. A desirable food-fish was needed for the inland waters of our Western and Southern States, and the German carp was found to meet this want. The first carp were imported into this country by the United States Fish Commission in 1877, ponds being prepared for them at Baltimore and Washington. In 1880, the distribution of fry began, and by January 1, 1883, they had been planted in not less than 17,860 localities, covering nearly every State and Territory. They proved to be especially adapted to our waters, and in some localities grew with surprising rapidity reaching more than twice the weight attained in the same time in German waters. An instance is cited where a carp 4 inches long placed in the waters of Texas was found to have increased to 20½ inches in length in eleven months, at which time it weighed 4 pounds 11 ounces. Arrangements are being made by the Fish Commission to continue the distribution of carp upon a larger scale than heretofore.

Owing to the existence of so many private fish-cultural establishments, and the fact that the statistics of the work of some of the State commissions are inaccessible, it is hardly practicable to attempt to furnish statistics of the extent of fish-culture within the United States. The following table, however, shows the statistics for the six principal species hatched by the United States Fish Commission, from its origin to the present time:

*Table of the principal hatching operations of the United States Fish Commission from 1872 to 1883.**

Year.	Number of young fish hatched and planted in open waters.						
	Shad.	California salmon.	Schoodic salmon.	Penobscot salmon.	Whitefish.	California trout.	Total.
1872	859,000	6,000	.....	10,000	25,000	.....	900,000
1873	3,003,000	1,511,230	4,000	437,797	25,000	.....	4,981,027
1874	3,561,000	2,531,500	7,250	1,174,918	.....	.....	7,274,668
1875	12,055,550	4,538,039	731,600	953,900	120,000	.....	18,401,089
1876	6,330,400	4,663,031	341,950	765,000	2,370,000	.....	14,470,381
1877	11,183,300	5,127,875	1,295,925	97,500	300,000	.....	18,001,600
1878	16,165,500	7,821,057	1,304,278	.....	.....	.....	25,290,835
1879	15,589,500	4,558,576	525,300	20,574	655,000	.....	21,248,950
1880	28,626,000	3,165,652	2,068,500	81,729	200,000	44,002	34,185,883
1881	†70,035,000	3,650,000	†860,000	†2,611,000	†19,500,000	†261,000	96,917,000
1882	†50,000,000	†4,000,000	†1,490,000	†2,100,000	†50,000,000	†337,500	107,933,500
Total.	217,408,250	41,572,960	8,634,803	8,254,418	73,195,000	642,502	349,707,933

* Other species have been hatched for distribution, but only in limited numbers, no organized and continuous efforts having been made for the propagation of any except those named.

† Including both those produced at the local hatchery and eggs sent to other hatching establishments to be hatched there.

‡ Estimated.

B.—INVESTIGATION.

I.—COMMISSIONS AND SOCIETIES ENGAGED IN THE INVESTIGATION OF QUESTIONS PERTAINING TO FISH-CULTURE.

1. PORTRAITS AND PHOTOGRAPHS OF PROMINENT FISH-CULTURISTS.

UNITED STATES FISH COMMISSIONER.

CRAYON PORTRAIT.

A crayon portrait of Spencer F. Baird, United States Commissioner of Fish and Fisheries. Size, 22 by 28 inches. Washington, 1883. L. Moeller, artist.

STATE FISH COMMISSIONERS.

PHOTOGRAPHS (mostly cabinet size).

- J. J. Gosper, Prescott, Ariz.
- Richard Rule, Tombstone, Ariz.
- J. H. Taggart, Yuma, Ariz.
- J. H. Hornibrook, Little Rock, Ark.
- John E. Reardon, Little Rock, Ark.
- H. H. Rottaken, Little Rock, Ark.
- S. R. Throckmorton, San Francisco, Cal.
- W. E. Sisty, Denver, Colo.
- Dr. Wm. M. Hudson, Hartford, Conn.
- Robert G. Pike, Middletown, Conn.
- G. N. Woodruff, Sherman, Conn.
- Enoch Moore, Wilmington, Del.
- J. T. Henderson, Atlanta, Ga.
- S. P. Bartlett, Quincy, Ill.
- N. K. Fairbank, Chicago, Ill.
- S. P. McDoel, Aurora, Ill.
- Calvin Fletcher, Spencer, Ind.
- A. A. Mosher, Spirit Lake, Iowa.
- D. B. Long, Ellsworth, Kans.
- P. H. Darby, Louisville, Ky.
- Wm. Griffith, Louisville, Ky.
- W. C. Price, Danville, Ky.
- H. O. Stanley, Dixfield, Me.
- G. W. Delawder, Oakland, Md.
- Thomas Hughlett, Easton, Md.
- F. W. Putnam, Cambridge, Mass.
- A. J. Kellogg, Detroit, Mich.

PHOTOGRAPHS—Continued.

Daniel Cameron, La Crescent, Minn.
 R. Ormsby Sweeney, Saint Paul, Minn.
 J. S. Logan, Saint Joseph, Mo.
 B. E. B. Kennedy, Omaha, Nebr.
 R. R. Livingston, Plattsmouth, Nebr.
 W. L. May, Fremont, Nebr.
 Dr. Edward Spalding, Nashua, N. H.
 Benjamin P. Howell, Woodbury, N. J.
 Eugene G. Blackford, New York City, N. Y.
 Richard U. Sherman, New Hartford, N. Y.
 Edward Meigs Smith, Rochester, N. Y.
 L. A. Harris, Cincinnati, Ohio.
 H. C. Post, Sandusky, Ohio.
 Robert Dalzell, Pittsburg, Pa.
 Ben. L. Hewit, Hollidaysburg, Pa.
 John Hummel, Selinsgrove, Pa.
 A. P. Butler, Columbia, S. C.
 C. J. Huske, Columbia, S. C.
 H. H. Sneed, Chattanooga, Tenn.
 Herbert Brainard, Saint Albans, Vt.
 Hiram A. Cutting, Lunenburg, Vt.
 Col. M. McDonald, Washington, D. C.
 N. M. Lowery, Hinton, W. Va.
 Henry B. Miller, Wheeling, W. Va.
 John F. Antisdell, Milwaukee, Wis.
 Mark Douglas, Melrose, Wis.

MEMBERS OF AMERICAN FISH-CULTURAL ASSOCIATION.

PHOTOGRAPHS (mostly cabinet size).

James Annin, jr., Caledonia, N. Y.
 Perry Belmont, New York City, N. Y.
 W. H. Butler, New York City, N. Y.
 Oscar Comstock, New York City, N. Y.
 W. A. Conklin, Central Park, N. Y.
 H. P. Dwight, Toronto, Ont.
 Charles B. Evarts, Windsor, Vt.
 Seth Green, Rochester, N. Y.
 Frederick Habershaw, New York City, N. Y.
 Charles Hallock, New York City, N. Y.
 W. B. Hopson, Baltimore, Md.
 Benjamin P. Howell, jr., Woodbury, N. J.
 Charles M. Hutchinson, Utica, N. Y.
 S. M. Johnson, Boston, Mass.
 C. A. Kingsbury, M. D., Philadelphia, Pa.

PHOTOGRAPHS—Continued.

George N. Lawrence, New York City, N. Y.
 Theodore Lyman, Brookline, Mass.
 H. D. McGovern, Brooklyn, N. Y.
 Fred Mather, New York City, N. Y.
 S. B. Miller, New York City, N. Y.
 Theodore Marford, New York City, N. Y.
 Charles Pease, Cleveland, Ohio.
 Thomas E. Porter, Coventry, Conn.
 Herman P. Schuyler, Troy, N. Y.
 G. H. Shaffer, Brooklyn, N. Y.
 Charles W. Smiley, Washington, D. C.
 Elisha Sterling, Cleveland, Ohio.
 Livingston Stone, Charlestown, N. H.
 H. H. Thompson, Brooklyn, N. Y.
 John H. Thompson, Bristol, Mass.
 J. S. W. Thompson, New Hope, Pa.
 C. Van Brunt, New York City, N. Y.

PRIVATE FISH-CULTURISTS.

(Not mentioned in this section.)

II.—RESULTS OF INQUIRY.

2. PUBLICATIONS.

PUBLICATIONS OF U. S. FISH COMMISSION.

CIRCULARS, REPORTS, &C.

1. Circular regarding tagged fish in Lake Michigan, 1871.
2. Memoranda of inquiry. 1872.
3. Questions; food-fishes. 1872.
4. Circular to accompany No. 3. 1872.
5. Statistics; menhaden fisheries; circular, 1873.
6. Report. Part I. 1873.
7. Report. Part I, with supplement. United States Commission of Fish and Fisheries. Part 1.— | Report | on the | condition of the sea fisheries | of the south coast of New England | in | 1871 and 1872, | by | Spencer F. Baird, Commissioner. | — | With supplementary papers. | — | Washington: | Government Printing Office. | 1873. [8vo. pp. xlvii, 852, plates xxxviii, with 38 leaves explanatory to plates, 2 maps.]

The report of the Commissioner, without supplementary papers, pp. xlvii, was issued separately in advance. Title page the same.

CIRCULARS, REPORTS, &C.—Continued.

8. Report. Part II. 1874.

9. Report. Part II, with supplement.

United States Commission of Fish and Fisheries. | Part II. |
Report | of | the Commissioner | for | 1872 and 1873. | — |
A.—Inquiry into the decrease of the food-fishes. | B.—
The propagation of food-fishes in the waters | of the United
States. | — | With supplementary papers. | Washington:
| Government Printing Office. | 1874. [8vo. pp. CII, 808,
pls. xxxvii, 4 maps.]

10. Statistics of fishery marine. Circular. 1875.

11. Blank tables to accompany No. 10. 1875.

12. Circular asking statistics. Menhaden fisheries. 1875.

13. Report. Part 3. 1876.

14. Report. Part 3. With supplement. 1876.

United States Commission of Fish and Fisheries. | Part III. |
Report | of | the Commissioner | for | 1873-'74 and 1874-
'75. | — | A.—Inquiry into the decrease of the food-fishes. |
B.—The propagation of food-fishes in the waters | of the
United States. | — | Washington: | Government Printing
Office. | 1876. [8vo., pp. LII, 777.]

15. Questions; food-fishes. 2d ed. 1877.

16. Circular. Statistics; mackerel, &c. To accompany 15. 1877.

17. Circular. Statistics; cod fishing, &c. To accompany 15. 1877.

18. Circular. Statistics; mullet fishing, &c. To accompany 15.
1877.

19. Circular. Statistics of coast and river fisheries. 1877.

20. New York market blanks. 1877.

21. Statistics of the whale-fishery; census blanks.

22. (a) Propagation series.

23. (b) Propagation series.

24. (c) Propagation series.

25. Record of collection of eggs.

26. Report. Part IV. 1878.

27. Report. Part IV, with supplement.

United States Commission of Fish and Fisheries. | — |
Part IV. | — | Report | of | the Commissioner | for |
1875-1876. | — | A.—Inquiry into the decrease of the
food-fishes. | B.—The propagation of food-fishes in the
waters of the United States. | — | Washington: | Gov-
ernment Printing Office. | 1878. [8vo., pp. ix, 50*,
1029, plates vi (Hist. of Whale Fishery.)]

28. Circular. Questions; cod fishing. 1878.

29. Circular. Questions; alewife fisheries. 1878.

30. Circular. Questions; smelt fisheries. 1878.

31. Blank. Statistics New England fish markets. 1878.

CIRCULARS, REPORTS, &C.—Continued.

32. Questions; mackerel fisheries. 1879, January.
33. Acknowledgment of response. 1879, May.
34. Circular to accompany mackerel circular. 1879, January.
35. Ocean temperature blanks. 1878.
36. Application for fish. 1879, April.
37. Report. Part V. 1879, October.
38. Report. Part V, with supplement. 1879, October.
 United States Commission of Fish and Fisheries. | — |
 Part V. | — | Report | of | the Commissioner | for
 | 1877. | — | A.—Inquiry into the decrease of food-
 fishes. | B.—The propagation of food-fishes in the |
 waters of the United States. | — | Washington: | Gov-
 ernment Printing Office. | 1879. | [8 vo., pp. 48, 972.]
39. Record of dredging stations (blank). 1879, September.
40. Circular inviting co-operation. F. C. & Census. 1879, July.
41. Returns for 40. 1879, July.
42. Circular relating to fish trade. 1879, July.
43. Returns for 42. 1879, July.
44. Prospectus of investigation. 1879, August.
45. Note-book for statistics of fishery marine. 1879, September.
46. Fishery marine blanks. 2d ed. 1879, September.
47. Letter to persons interested in fish culture. 1879, October.
48. Questions to accompany 47. 1879, October.
49. Circular to practical fish culturists. 1879, October.
50. Fixtures for salmon hatching. F. C. Report, Part 6. 1879,
 October.
51. Coast town index. 1879, October.
52. Hektograph letter to Rhode Island postmasters. 1879, No-
 vember.
53. The river fisheries. 1879, October.
54. Letter of the Postmaster-General to postmasters. 1879, Oc-
 tober.
55. 43 revised. Postmasters upon fish consumption. 1879, October.
56. Property record. 1879, October.
57. Measurements of fishes, old.
58. Property receipts, old No. 3179.
59. Questions relating to the menhaden (hektograph) (two forms).
 1879, November.
60. Scale for fish measure. 1879, December.
61. Record of observations at hatching stations, old.
62. Record of operations at hatching stations, old.
63. ———.
64. Record of distribution, old.
65. Book record of collection of eggs, old.
66. Ingersoll's oyster circular (two forms). 1880, January.

CIRCULARS, REPORTS, &C.—Continued.

67. Record of river fisheries to accompany 68 (hektograph). 1880, February.
68. Book record of river fisheries. 1880, February.
69. Record of ocean temperatures for use on mackerel and menhaden vessels. 1880, February.
70. Edmonds' circular to Maryland oyster dealers and Baltimore fish dealers (two forms). 1880, February.
71. Hektograph letter to postmasters about imperfect returns. 1879, December.
72. Supplement to 41 (hektograph). 1879, December.
73. Fish-guano letter to postmasters (hektograph). 1879, December.
74. Inquiry for coast town addresses (hektograph). 1880, January.
75. Inquiry for coast towns (hektograph). 1880, February.
76. Blank form; expenses tenth census of the United States; statistics of the fisheries.
77. Menhaden fishery marine (two forms). 1880, February.
78. Berlin shipping list. 1880, February 20.
79. Letter in regard to Berlin exhibits. 1880, February 25.
80. Letter in regard to New York markets (Phillips). 1880, February.
81. Railroad circular. 1880, February.
82. Manufacturers' circular. 1880, February.
83. Report. Part VI. 1880.
84. Report. Part VI, with supplement. 1880.
 United States Commission of Fish and Fisheries. | — |
 Part VI. | — | Report | of | the Commissioner | for |
 1878. | — | A.—Inquiry into the decrease of food-
 fishes. | B.—The propagation of food-fishes in the |
 waters of the United States. | — | Washington: | Gov-
 ernment Printing Office. | 1880. | [8 vo, pp. LXIV, 988,
 pl. XVI.]
85. Report. Part VII. 1879.
86. Report. Part VII, with supplement, 1879.
 United States Commission of Fish and Fisheries. | — |
 Part VII. | — | Report | of | the Commissioner | for |
 1879. | — | A.—Inquiry into the decrease of food-
 fishes. | B.—The propagation of food-fishes in the |
 waters of the United States. | — | Washington: | Gov-
 ernment Printing Office. | 1882. | [8 vo, pp. LII, 846,
 pl. XLVI.]
87. Bulletin. Vol. I. 1882.
 Bulletin | of | the United States Fish Commission. | Vol.
 I, | for 1881. | — | Washington: | Government Print-
 ing Office. | 1882. | [8 vo, pp. 466, pl. XXI.]

CIRCULARS, REPORTS, &C.—Continued.

88. Bulletin. Vol. II. 1883.

Bulletin | of the | United States Fish Commission. | Vol.
 II, | for 1882. | — | Washington: | Government Print-
 ing Office. | 1883. | [8 vo, pp. 468, fig. 28.]

PUBLICATIONS OF STATE FISH COMMISSIONS.*

ALABAMA.

- (1) Preliminary report and memorial, Dec. 13, 1870: 4 pp. 1870.
- (2) R. of Cs. to the governor, January 26, 1872, Jan. 26, 1872: 7 pp. 1872.

CALIFORNIA.

- (1) [First Biennial] R. of Cs. for 1870 and 1871, Dec. 31, 1871?: 24 pp. 1872.
- (2) [Second Biennial] R. of Cs. for 1872 and 1873, Dec. 31, 1873?: 18 pp. 1873.
- (3) [2d Biennial] R. of Cs. for 1872 and 1873 [Repr.], Dec. 31, 1873?: 28 pp. 1874.
- (4) [Third Biennial] R. of Cs. for 1874 and 1875, Dec. 31, 1875?: 36 pp. 1875.
- (5) [Fourth Biennial] R. of Cs. for 1876 and 1877, Nov. 10, 1877: 30 pp. 1877.
- (6) [Fifth Biennial] R. of Cs. for 1878 and 1879, Nov. 1, 1879: 63 pp. 1879.
- (7) [Sixth] R. of Cs. for 1880, Jan., 1881?: 70 pp. 1881.
- (8) [Seventh] R. of Cs. for 1881 and 1882, Jan., 1883: 31 pp. 1883.

COLORADO.

- (1) [First and second reports.] [Unpublished?] Dec. 1, 1878? Unpublished?
- (2) [3d and 4th reps.] Biennial R. of C. for 1879-'80, Dec. 1, 1880: 34 pp. 1881.
- (3) [Fifth report] Biennial R. of C. for 1881 and 1882, Dec. 1, 1882: 11 pp. 1882.

CONNECTICUT.

- (1) [First] R. of Cs. to Gen. Assem., May sess., 1867, May, 1867: 27 pp. 1867.

* List prepared by Charles W. Smiley, at the request of Professor Baird, for the London Fisheries Exhibition.

The date of publication is placed at the extreme right, and is preceded by the number of pages contained in the issue. This is preceded by the date when the report was officially made if known; otherwise the date at which the report seems to close is inserted with a query (?). The number on the left refers to the bibliography of reports; the number in brackets to the State series. Words in brackets do not occur on the title-pages of the reports. R. of C. is used as an abbreviation for Report of Commissioner; Cn. for Commission; Cs. for Commissioners.

CONNECTICUT—Continued.

- (2) [Second] R. of Cs. to Gen. Assem., May sess., 1868, May, 1868: 28 pp. 1868.
- (3) [Third] R. of Cs. to Gen. Assem., May sess., 1869, May, 1869: 18 pp. 1869.
- (4) Fourth R. of Cs. to Gen. Assem., May sess., 1870, May 7, 1870: 37 pp. 1870.
- (5) Fifth R. of Cs. to Gen. Assem., May sess., 1871, May 12, 1871: 46 pp. 1871.
- (6) Sixth R. of Cs. to Gen. Assem., May sess., 1872, Apr. 26, 1872: 36 pp. 1872.
- (7) Seventh R. of Cs. to Gen. Assem., May sess., 1873, May 1, 1873: 48 pp. 1873.
- (8) Eighth R. of Cs. to Gen. Assem., May sess., 1874, Apr. 30, 1874: 36 pp. 1874.
- (9) Ninth R. of Cs. to Gen. Assem., May sess., 1875, May 1, 1875: 32 pp. 1875.
- (10) Tenth R. of Cs. to Gen. Assem., May, 1876, May 17, 1876: 34 pp. 1876.
- (11) Eleventh R. of Cs. to Gen. Assem., Jan., 1877, Jan. 1, 1877: 33 pp. 1877.
- (12) Twelfth R. of Cs. to Gen. Assem., Jan., 1878, Jan. 1, 1878: 24 pp. 1878.
- (13) Thirteenth R. of Cs. to Gen. Assem., Jan., 1879, Jan. 1, 1879: 34 pp. 1879.
- (14) Fourteenth R. of Cs. to Gen. Assem., Jan., 1880, Jan. 1, 1880: 23 pp. 1880.
- (15) Fifteenth R. of Cs. to Gen. Assem., Jan., 1881, Jan. 1, 1881: 32 pp. 1881.
- (16) Sixteenth R. of Cs. to Gen. Assem., Jan., 1882, Dec. 1, 1881: 33 pp. 1881.
- (17.) 1st R. of Shell-fish Cs. to Gen. Assem., Jan., 1882, Dec. 1, 1881: 99 pp. 1882. In same cover with (16).
- (18) 2d R. of Shell-fish Cs. to Gen. Assem., Jan., 1883, Nov. 30, 1882: 44 pp. 1883.
- (19) Seventeenth R. of Cs. to Gen. Assem., Jan., 1883, Dec. 1, 1882: 28 pp. 1883.

DELAWARE.

- (1) First Biennial R. of C. for years 1881-'82, Jan., 1883?: 14 pp. 1883.

GEORGIA.

- (1) R. of C. of Agriculture for the year 1876, Dec. 31, 1876?: pp. 6, 7, 1877.
- (2) R. of C. of Agriculture for the year 1877, Dec. 31, 1877?: pp. 29, 30. 1878.

GEORGIA—Continued.

- (3) [First Biennial] R. of Supt. of Fisheries, Oct. 15, 1880: pp. 33-38. 1880. [In R. of C. of Agr., for 1879-'80.]
- (4) [Second Biennial] R. of Supt. of Fisheries, Oct. 15, 1882: pp. 37-44. 1882. [In R. of C. of Agr., years 1881-'82.]

ILLINOIS.

- (1) [First] R. of C. from July 1, 1879 to Sept. 30, 1880, Oct. 1, 1880: 14 pp. 1880.
- (2) [Second] R. of Cn. from July 1, 1879 to Sept. 30, '82, Oct. 1, 1882: 33 pp. 1883.

INDIANA.

- (1) First Annual R. of C. to General Assembly, Jan., 1883: 103 pp. 1883.

IOWA.

- (1) First R. of Cs. for years 1874 and 1875, Oct. 27, 1875?: 40 pp. 1876.
- (2) 2d Biennial R. of Cn. for 1875-'76, 1876-'77, Oct. 13, 1877: 31 pp. 1877.
- (3) Third Biennial R. of Cn. for 1877-'78, 1878-'79, Oct. 1, 1879: 54 pp. 1880.
- (4) Fourth Biennial R. of Cn. for 1879-'80, 1880-'81, Oct. 31, 1881: 38 pp. 1882.

KANSAS.

- (1) First Biennial R. of C. for years 1877-'78, June 30, 1878: 20 pp. 1878.
- (2) Supplemental R. for December, 1878. Jan. 25, 1879: 3 pp. 1879.
- (3) Second Biennial R. of C. [for years 1879-'80], June 30, 1880: 19 pp. 1880.
- (4) Third Biennial R. of C. for years 1881-'82, June 30, 1882: 69 pp. 1883.

KENTUCKY.

- (1) First R. of Cs. for year ending Nov. 1, 1877, Nov. 1, 1877: 22 pp. 1878.
- (2) Second Biennial R. of Cn. for 1877-'78, 1878-'79, Nov. 1, 1879: 30 pp. 1879.
- (3) Third Biennial R. of Cn. for 1879-'80, 1880-'81, Oct. 10, 1881: 26 pp. 1882.

MAINE.

- (1) First R. of Cs. for the year 1867, Jan. 16, 1868: 96 pp. 1869.
- (2) Second R. of Cs. for the year 1868, Dec. 31, 1868: 45 pp. 1869. In same cover with (1).

MAINE--Continued.

- (3) Third R. of C. for the year 1869, Dec. 31, 1869: 48 pp. 1870.
- (4) Fourth R. of C. for the year 1870, Dec. 31, 1870: 56 pp. 1870.
- (5) Fifth R. of C. for the year 1871, Dec. 31, 1871: 31 pp. 1872.
- (6) Sixth R. of Cs. for the year 1872, Dec. 31, 1872?: 16 pp. 1873.
- (7) Seventh R. of Cs. for the year 1873, Dec. 31, 1873?: 39 pp. 1873.
- (8) Eighth R. of Cs. for the year 1874, Nov. 30, 1874: 32 pp. 1874.
- (9) Ninth R. of Cs. for the year 1875, Dec. 9, 1875?: 40 pp. 1875.
- (10) Tenth R. of Cs. for the year 1876, Dec. 9, 1876?: 31 pp. 1876.
- (11) Eleventh R. of Cs. for the year 1877, Nov. 31, 1877?: 30 pp. 1877.
- (12) Twelfth R. of Cs. for the year 1878, Dec. 31, 1878?: 26 pp. 1878.
- (13) [Thirteenth] R. of C. for the year 1879, Dec. 31, 1879?: 35 pp. 1879.
- (14) [Fourteenth] R. of C. for the year 1880, Dec. 31, 1880?: 55 pp. 1880.
- (15) [Fifteenth] R. of C. for the year 1881, Dec. 31, 1881: 31 pp. 1882.
- (16) [Sixteenth] R. of C. for the year 1882, Dec. 1, 1882: 38 pp. 1882.

MARYLAND.

- (1) R. upon oyster resources in Maryland, Oct., 1869: 20 pp. 1870.
- (2) R. on oyster fisheries, shad and herring fisheries, &c., Jan., 1872: 48 pp. 1872.
- (3) R. of Commander of oyster fisheries, &c., Jan. 1, 1872: 11 pp. 1874.
- (4) R. of Cs. to General Assembly, Jan. 1, 1876, Jan. 1, 1876: 239 pp. 1876.
- (5) R. of a C., January 1877, Jan. 1, 1877?: 108 pp. 1877.
- (6) R. of a C., January, 1878, Jan. 1, 1878?: 156 pp. 1878.
- (7) R. of Cs., January, 1879, Jan. 1, 1879?: 56 pp. 1879.
- (8) R. of Cs., January, 1880, Jan. 1, 1880?: 355 pp. 1880.
- (9) R. of T. B. Ferguson, a C., January, 1881, Jan. 1, 1881?: 294 pp. 1881.
- (10) R. of Thomas Hughlett, a C., January, 1881, Jan. 1, 1881?: Unpublished.
- (11) R. of Thomas Hughlett, a C., January, 1882, Jan. 1, 1882?: 32 pp. 1882.
- (12) R. of Cs., January, 1883, Dec. 19, 1882: 31 pp. 1883.

MASSACHUSETTS.

- (1) R. of Cs., appointed 1856; Chap. 58, May 5, 1857: 54 pp. 1857.
- (2) [First] R. of Cs., under resolve of May 3, 1865, Dec. 1, 1865: 77 pp. 1866?

MASSACHUSETTS—Continued.

- (3) [Second] R. of Cs. for year ending Jan. 1, 1868, Jan., 1868: 50 pp. 1868.
- (4) [Third] R. of Cs. for year ending Jan. 1, 1869, Jan., 1869: 71 pp. 1869.
- (5) [Fourth] R. of Cs. for year ending Jan. 1, 1870, Jan., 1870: 67 pp. 1870.
- (6) Fifth R. of Cs. [for year ending], January, 1871, Jan., 1871: 77 pp. 1871.
- (7) Sixth R. of Cs. for year ending Jan. 1, 1872, Jan., 1872: 270 pp. 1872.
- (8) Seventh R. of Cs. for year ending Jan. 1, 1873, Jan., 1873: 35 pp. 1872.
- (9) Eighth R. of Cs. for year ending Jan. 1, 1874, Dec. 1, 1873: 63 pp. 1874.
- (10) Ninth R. of Cs. for year ending Jan. 1, 1875, Dec. 1, 1874: 57 pp. 1875.
- (11) Tenth R. of Cs. for year ending Jan. 1, 1876, Dec. 15, 1875?: 72 pp. 1876.
- (12) Eleventh R. of Cs. for year ending Jan. 1, 1877, Dec. 31, 1876?: 50 pp. 1877.
- (13) Twelfth R. of Cs. for year ending Jan. 1, 1878, Dec. 1, 1877?: 68 pp. 1878.
- (14) Thirteenth R. of Cs. for year ending Sept. 30, 1878, Oct., 1878?: 63 pp. 1879.
- (15) Fourteenth R. of Cs. for year ending Sept. 30, 1879, Oct., 1879?: 50 pp. 1880.
- (16) Fifteenth R. of Cs. for year ending Sept. 30, 1880, Oct., 1880?: 77 pp. 1881.
- (17) Sixteenth R. of Cs. for year ending Sept. 30, 1881, Oct., 1881?: 62 pp. 1882.
- (18) Seventeenth R. of Cs. year ending Dec. 31, 1882, Dec., 1882?: 58 pp. 1883.

MICHIGAN.

- (1) First [Biennial] R. of Cs. and Supt. for 1873-'74, ending Dec. 1, 1874, Dec. 1, 1874: 67 pp. 1875.
- (2) Second [Biennial] R. of Cs. and Supt. for 1875-'76, ending Dec. 20, 1876, Dec. 20, 1876?: 67 pp. 1876.
- (3) Third [Biennial] R. of Supt. for 1877-'78, ending Dec. 20, 1878, Dec. 20, 1878?: 96 pp. 1879.
- (4) Fourth [Biennial] R. of Cs. and Supt. for 1879-'80, ending Dec. 1, 1880, Dec. 1, 1880: 52 pp. 1881.
- (5) Fifth Biennial R. of Supt. for 1881-'82, ending Dec. 1, 1882, Dec. 1, 1882: 26 pp. 1883.

MINNESOTA.

- (1) First R. of Cs. [for year ending Dec. 31, 1874], Feb. 20, 1875: 30 pp. 1875.
- (2) Second R. of Cs. [for year ending Dec. 31, 1875], Dec., 1875?: 19 pp. 1876.
- (3) Third R. of Cs. for year ending Dec. 31, 1876, Dec., 1876?: 14 pp. 1877.
- (4) Fourth R. of Cs. for year ending Dec. 31, 1877, Dec., 1877?: 34 pp. 1878.
- (5) Fifth R. of Cs. for year ending Dec. 31, 1878, Dec. 1878?: 22 pp. 1879.
- (6) Sixth and seventh R. of Cn. for 1879 and 1880, Jan., 1881?: 32 pp. 1881.
- (7) Eighth [and ninth] R. of Cn. for 1881-'82, Dec. 1, 1882: 84 pp. 1883.

MISSOURI.

- (1) [First] R. of Cs. [for 1880], Jan. 27, 1881: 42 pp. 1881.
- (2) [Second] R. of Cn. for the years 1881 and 1882, Jan. 26, 1883: 62 pp. 1883.

NEBRASKA.

- (1) [First] R. of Cs. for the year 1879, Jan. 1, 1880?: 16 pp. 1880.
- (2) Second R. of Cs. [for year ending] Dec. 31, 1880, Dec. 31, 1880: 19 pp. 1881.
- (3) Third R. of Cs. [for year ending] Dec. 31, 1882, Dec. 31, 1882: 13 pp. 1883.
- (4) Fourth R. of Cs. [for year ending] Dec. 31, 1882, Dec. 31, 1882: 22 pp. 1883. In same cover with (3).

NEVADA.

- (1) First Biennial R. of C. for years 1877 and 1878, Dec. 28, 1878: 7 pp. 1879.
- (2) Second Biennial R. of C. for years 1879 and 1880, Dec. 31, 1880: 10 pp. 1881.
- (3) [Third] Biennial R. of C. for years 1881 and 1882, Jan. 4, 1883: 11 pp. 1883.

NEW HAMPSHIRE.

- (1) R. of select committee, June session, 1865, July 1, 1865: 8 pp. 1865.
- (2) R. of Cs., June session, 1866, June 1, 1866: 16 pp. 1866.
- (3) R. of Cs., June session, 1867, July 5, 1867: 17 pp. ms. c.
- (4) R. of Cs., June session, 1868, June 18, 1868: 8 pp. 1868.
- (5) R. of Cs., June session, 1869, June 21, 1869: 10 pp. 1869.
- (6) R. of Cs., June session, 1870, June 10, 1870: 15 pp. 1870.
- (7) R. of Cs., June session, 1871, May 29, 1871: 11 pp. 1871.

NEW HAMPSHIRE—Continued.

- (8) R. of Cs., June session, 1872, May 27, 1872 : 15 pp. 1872.
- (9) R. of Cs., June session, 1873, May 30, 1873 : 13 pp. 1873.
- (10) R. of Cs., June session, 1874, May 20, 1874 : 15 pp. 1874.
- (11) R. of Cs., June session, 1875, Feb. 20, 1875 : 16 pp. 1875.
- (12) R. of Cs., June session, 1876, Mar. 2, 1876 : 16 pp. 1876.
- (13) R. of Cs., June session, 1877, May 19, 1877 ? : 45 pp. 1877.
- (14) R. of Cs., June session, 1878, April 1, 1878 ? : 75 pp. 1878.
- (15) R. of Cs., June session, 1879, May 1, 1879 ? : 51 pp. 1879.
- (16) R. of Cs., June [session], 1880, June 1, 1880 ? : 61 pp. 1880.
- (17) R. of Cs., June session, 1881, June 1, 1881 ? : 90 pp. 1881.
- (18) R. of Fish and Game Cs., 1881-'82, June 1, 1882 ? : 47 pp. 1882.

NEW JERSEY.

- (1) First R. of Cs. [for the year 1870], 1871, Dec., 1870 ? : 25 pp. 1871.
- (2) Second R. of Cs. [for the year 1871], 1872, Dec., 1871 ? : 22 pp. 1872.
- (3) Third R. of Cs. for the year 1872, Dec., 1872 ? : 28 pp. 1872.
- (4) Fourth R. of Cs. for the year 1873, Dec., 1873 ? : 32 pp. 1873.
- (5) Fifth R. of Cs. for the year 1874, Nov. 14, 1874 ? : 62 pp. 1874.
- (6) Sixth R. of Cs. for the year 1875, Nov. 14, 1875 ? : 29 pp. 1875.
- (7) Seventh R. of Cs. for the year 1876, Nov. 14, 1876 ? : 47 pp. 1876.
- (8) Eighth R. of Cs. for the year 1877, Dec. 5, 1877 ? : 65 pp. 1877.
- (9) [Ninth] R. of Cs. for the year 1878, Dec 31, 1879 : 33 pp. 1878.

NEW YORK.

- (1) [First] R. of Cs. to legislature, March 9, 1869, Mar. 9, 1869 : 75 pp. 1869.
- (2) [Second R. of Cs. to legislature, March 11, 1870, Mar. 11, 1870 : 20 pp. 1870.
- (3) [Third] R. of Cs. to legislature, Feb. 28, 1871, Feb. 1, 1871 : 32 pp. 1871.
- (4) Fourth R. of Cs. to legislature, March 19, 1872, Mar. 19, 1872 ? : 34 pp. 1872.
- (5) [Fifth] R. of Cs. to legislature, Feb. 12, 1873, Jan., 1873 : 32 pp. 1873.
- (6) [Sixth] R. of Cs. to legislature, Feb, 5, 1874. Jan., 1874 : 41 pp. 1874.
- (7) Seventh R. of Cs. to legislature, Feb. 1, 1875, Jan., 1875 : 61 pp. 1875.
- (8) Eighth R. of Cs. for year ending Dec. 31, 1875, Feb., 1876 : 59 pp. 1876.

NEW YORK—Continued.

- (9) Ninth R. of Cs. for year ending Dec. 31, 1876, Feb., 1877: 20 pp. 1877.
- (10) Tenth R. of Cs. for year 1877, Feb. 1878: 50 pp. 1878.
- (11) Eleventh R. of Cs. for 2 years ending Dec. 31, 1879, April 1, 1880: 45 pp. 1880?
- (12) [Twelfth] R. of Cs. for the year 1881, April 1, 1882: 83 pp. 1882.

NORTH CAROLINA.

- (1) Third Qr. of C., January 15, 1878, Jan. 15, 1878: pp. 10-14. 1877.
- (2) Second Qr. of C. of Agric. for the year 1878, Oct. 15, 1878: pp. 5-8. 1878.
- (3) R. of Supt. [in R. of C. of Agric., 1877-'78], Jan. 6, 1879: 7-15 pp. 1879?
- (4) Fish Culture in North Carolina, 1879, April 1, 1879: 26 pp. 1879.
- (5) R. of Supt. [in R. of C. of Agric., 1879-'80], Dec. 31, 1880?: pp. 25-51. 1881.
- (6) Second Biennial R. of Supt., 1881-'82, Dec. 31, 1882: pp. 62-81. 1883. [In R. of C. of Agric., 1883.]

OHIO.

- (1) R. of Cs. for year ending December, 1873, Feb. 23, 1874: 40 pp. 1874.
- (2) First R. of Cn. for years 1875 and 1876, Jan. 13, 1877: 96 pp. 1877.
- (3) Second R. of Cn. for year 1877, April 9, 1878: 116 pp. 1878.
- (4) Third R. of Cn. for year 1878, Jan. 14, 1879: 22 pp. 1879.
- (5) Fourth R. of Cn. for year 1879, Jan. 15, 1880: 35 pp. 1880.
- (6) Fifth R. of Cn. for year 1880, Jan. 20, 1881: 34 pp. 1881.
- (7) Sixth R. of Cn. for year 1881, Jan. 23, 1882: 19 pp. 1882.
- (8) Seventh R. of Cn. for year 1882, Jan. 29, 1883: 14 pp. 1882.

PENNSYLVANIA.

- (1) R. of C. for the year 1870, Jan. 23, 1871: 48 pp. 1871.
- (2) R. of C. for the year 1871, Jan. 16, 1872: 24 pp. 1872.
- (3) R. of Cs. for the year 1873, Dec. 31, 1873?: 32 pp. 1874.
- (4) R. of Cs. for the year 1874, Dec. 31, 1875?: 29 pp. 1875.
- (5) R. of Cs. for the years 1875 and 1876, Feb. 7, 1877: 28 pp. 1877.
- (6) R. of Special Committee, Dec. 1877?: 20 pp. 1878.
- (7) R. of Cs. for the year 1877, Feb. 11, 1878: 38 pp. 1878.
- (8) R. of Cs. for the year 1878, Feb. 20, 1879: 44 pp. 1879.
- (9) R. of Cs. for the years 1879 and 1880, Feb. 15, 1881: 151 pp. 1881.

RHODE ISLAND.

- (1) R. of Cs. to General Assembly, Jan., 1869, Feb. 15, 1869: 36 pp. 1869?
- (2) R. of Com. [to Genl. Assem.], Jan. sess., 1870, Jan. —, 1870: 9 pp. 1870.
- (3) R. of Com. of Genl. Assembly, May sess., 1870, June 15, 1870: 159 pp. 1870.
- (4) [First] R. of Cs. [to G. A.], Jan. sess., 1870, Jan. 25, 1871: 4 pp. 1871?
- (5) [Second] R. of Cs. [to G. A.], Jan. sess., 1872, Feb. 23, 1872; 16 pp. 1872.
- (6) Third R. of Cs. to G. A., Jan. sess., 1873, Feb. 24, 1873: 12 pp. 1873.
- (7) Fourth R. of Cs. to G. A., Jan. sess., 1873, Feb. 19, 1874: 10 pp. 1874.
- (8) Fifth R. of Cs. to G. A., Jan. sess., 1875, Jan. 30, 1875: 20 pp. 1875.
- (9) [Sixth] R. of Cs. to G. A., Jan. sess., 1876, Feb. 29, 1876: 11 pp. 1876.
- (10) [Seventh] R. of Cs. to G. A., Jan. sess., 1877, Jan. 1, 1877: 11 pp. 1877.
- (11) Eighth R. of Cs. to G. A., Jan. sess., 1878, Apr. 9, 1878: 19 pp. 1878.
- (12) Ninth R. of Cs. to G. A., Jan. sess., 1880, Apr. 9, 1880?: 19 pp. 1880.
- (13) Tenth R. of Cs. to G. A., Jan. sess., 1881, Feb. —, 1881: 32 pp. 1881.
- (14) Eleventh R. of Cs. to G. A., Jan. sess., 1882, Jan. 5, 1882: 10 pp. 1882.

SOUTH CAROLINA.

- (1) R. on Fish, of Agr. and Mech. Soc. Nov. 10, 1869: pp. 21-26 and 45-47. 1869.
- (2) [First] R. of C. for the year 1879, Oct. 31, 1879?: pp. 569-582. 1880?
- (3) [Second] R. of Supt. [R. of C. of Agr., 1880], Oct. 23, 1880: pp. 12-17. 1880.
- (4) [Third] R. of Supt. [R. of C. of Agr., 1881], Oct. 31, 1881: pp. 28-42, 95. 1881.

TENNESSEE.

- (1) Bienn. R. of C. to Gen. Assem., Jan. 3, 1881, Jan. 3, 1881: 13 pp. 1881.
- (2) [Second] R. of Cs. for 1881-'82, Jan. (?), 1883: 24 pp. 1883.

TEXAS.

- (1) First R. of C. for the year 1880, Dec. 1, 1880: 26 pp. 1880.
- (2) R. of C. for the year 1882, Jan. 1, 1883: 13 pp. 1883.

UTAH.

- (1) R. of Deseret Agr. and Mfg. Soc. for 1872-'73, Jan. 1, 1874: pp. 5-7. 1874?
- (2) R. of Deseret Agr. and Mfg. Soc. for 1875, Feb. 14, 1876: pp. 8-9. 1876.
- (3) R. of Supt. of Zion's Fish Assoc'n, 1871-'77, Jan. 1, 1878: 14 pp. 1878?

VERMONT.

- (1) R. on propagation of fish, Oct. 22, 1857: 64 pp. 1857.
- (2) R. of Cs. to annual session, 1866, Oct. 11, 1866: 35 pp. 1866.
- (3) R. of Cs. for the year 1867, Oct. 25, 1867: 25 pp. 1867.
- (4) R. of Cs. for the year 1869, Oct. 25, 1869: 16 pp. 1869.
- (5) [Biennial] R. of Cs. for the years 1871-'72, Oct. 29, 1872: 20 pp. 1872.
- (6) [Biennial] R. of Cs. for the years 1873-'74, Oct. 27, 1874: 80 pp. 1874.
- (7) [Biennial] R. of Cs. for [the years] 1875-'76, Oct. —, 1876?: 16 pp. 1876.
- (8) Biennial R. of Cs. for 1877-'78, Oct. —, 1878: 24 pp. 1878.
- (9) Biennial R. of Cs. for 1879-'80, Oct. 26, 1880: 10 pp. 1880.
- (10) Biennial R. of Cs. for 1881-'82, Nov. 15, 1882: 23 pp. 1882.

VIRGINIA.

- (1) Report to the Auditor on the oyster beds, &c., Oct. 1, 1871: 21 pp. 1872.
- (2) R. of Cs. for the 1875, Dec., 31, 1875?: 34 pp. 1875.
- (3) R. of Cs. for the year 1876, Nov. 30, 1876: 13 pp. 1876.
- (4) R. of C. for the year 1877, Nov. 20, 1877: 60 pp. 1877.
- (5) R. of C. for the year 1878, Nov. 5, 1878: 25 pp. 1878?
- (6) R. of C. for the year 1879, Nov. 1, 1879: 23 pp. 1879.
- (7) R. of C. on fisheries and oysters, Jan. 28, 1880: 20 pp. 1880.
- (8) R. of C. [for three years ending Oct. 1], 1882, Feb. 24, 1883: 31 pp. 1882.

WASHINGTON.

- (1) R. of C. [for the year] 1879, Oct. 1, 1879: 4 pp. 1879.

WEST VIRGINIA.

- (1) R. of Cs. for the years 1877-'78, Nov. 22, 1878: 28 pp. 1879.
- (2) R. of Cs. for the years 1879-'80, Dec. 31, 1880: 16 pp. 1881.
- (3) R. of Cs. for the year 1881, Jan. 26, 1882?: 37 pp. 1882.

WISCONSIN.

- (1) First R. of Cs. [for year ending Dec. 31, 1874], Dec. —, 1874: 8 pp. 1875.
- (2) Second R. of Cs. [for year ending Dec. 31, 1875], Dec. —, 1875: 15 pp. 1875.
- (3) Third R. of Cs. for year [ending Dec. 31], 1876, Dec. 21, 1876: 23 pp. 1876.
- (4) Fourth R. of Cs. for year ending Sept. 30, 1877, Nov. —, 1877: 23 pp. 1877.
- (5) Fifth R. of Cs. for year ending Dec. 31, 1878, Dec. 29, 1878: 46 pp. 1879.
- (6) Sixth R. of Cs. for year ending Dec. 31, 1879, Dec. 31, 1879?: 36 pp. 1880.
- (7) Seventh R. of Cs. for year ending Dec. 31, 1880, Dec. 29, 1880: 44 pp. 1881.
- (8) Eighth R. of Cs. for year ending Dec. 31, 1881, Dec. 31, 1881: 54 pp. 1882.
- (9) Ninth R. of Cs. for year ending Dec. 31, 1882, Dec. 31, 1882: 52 pp. 1883.

PUBLICATIONS OF THE AMERICAN FISH-CULTURAL ASSOCIATION.

PROCEEDINGS.

Proceedings | of the | American Fish Culturists' Association. | —
| Organized December 20, 1870. | — Albany: | The Argus Com-
pany, Printers. | 1872. |

Proceedings | of the | American Fish Culturists' Association | at
its Second Annual Meeting, February 11th, 1873. | — | Al-
bany: | The Argus Company, Printers. | 1873. |

Proceedings | of the | American Fish Culturists' Association | at its
Third Annual Meeting, | February 10, 1874. | — | Rochester,
N. Y. | Evening Express Printing and Engraving Company. |
1874. |

Proceedings | of the | American | Fish Culturists' Association, | at
its Fourth Annual Meeting, | February 9 & 10, 1875. | —
| Rochester, N. Y. | Evening Express Printing and Engraving
Company. | 1875. |

TRANSACTIONS.

Transactions | of the | American | Fish Culturists' Association, |
at its Fifth Annual Meeting, | February 8th, 1876. | — | Rut-
land: | Tuttle and Company, Printers. | 1876. |

Transactions | - | of the | - | American | Fish Culturists' Associa-
tion. | Special Meeting | Held at the Centennial Exhibition,
Philadelphia, October 6th, 1876. | Sixth Annual Meeting, | Feb-
ruary 14th and 15th, 1877. | *Seal.* | New York: | John M. Davis,
Printer, 40 Fulton Street. | — | 1877. |

TRANSACTIONS—Continued.

Transactions | - | of the | - | American | Fish Cultural Association. | Seventh Annual Meeting, | February 27th and 28th, 1878. | *Held at the Directors' Rooms of the Fulton Market Fish Mongers' Association.* | Seal. | New York: | *John M. Davis, Typographer, No. 40 Fulton Street.* | 1878. |

Transactions | - | of the | - | American Fish Cultural Association. | Eighth Annual Meeting. | *Held at the Directors' Rooms of the Fulton Market Fish Mongers' Association, in the City of New York.* | February 25th and 26th, 1879. | Seal. | New York: | *John M. Davis, Typographer, No. 40 Fulton Street.* | —1879. |

Transactions | - | of the | - | American | Fish Cultural Association. | Ninth Annual Meeting, | Held at the Directors' Rooms of the Fulton Market Fish-Mongers' Association, in the City of New York. | May 30th and 31st, 1880. | Seal. | New York. | — | 1880. | [*John M. Davis, Typographer, No. 40 Fulton Street.*] |

Transactions | - | of the | - | American | Fish Cultural Association. | Tenth Annual Meeting, | Held at the Directors' Rooms of the Fulton Market Fish Mongers' Association, in the City of New York. | March 30th and 31st, 1881. | Seal. | New York. | — | 1881. | [*John M. Davis, Typographer, No. 40 Fulton Street.*] |

Transactions | — of the — | American | Fish-Cultural Association. | Eleventh Annual Meeting, | Held at the Directors' Rooms of the Fulton Market Fish-Mongers' Association, in the City of New York. | April 3d and 4th, 1882. | Seal. | — | New York. | 1882. | [*John M. Davis, Typographer, No. 40 Fulton Street.*] |

PUBLICATIONS OF PRIVATE FISH-CULTURISTS.

BOOKS AND PAMPHLETS.

A large number of books and pamphlets by scientists from all portions of the United States, giving results of their observation of aquatic animals, plants, temperatures, tides, currents, and the character of the ocean bottom. (See also supplements to Report of U. S. Commissioner of Fish and Fisheries, reports of State fish commissioners, and practical works on fish culture.)

3. COLLECTIONS.

SPERMARIES AND OVARIES.

(Illustrating the time and place of breeding of important food-fishes.)

SPERMARIES.

HERRING.—*Clupea harengus* Linn.

Spermaries, south head of Grand Manan Island, N. B., Sept. 24, 1872. 10,458. Prof. Spencer F. Baird.

WHITEFISH.—*Coregonus clupeiformis* (Mitch.) Milner.

Spermaries (specimen from a fish weighing 2 pounds). Ecorse, Mich.,
Nov. 15, 1872. 15,216. J. W. Milner.

MENHADEN.—*Brevoortia tyrannus* (Latrobe) Goode.

Spermaries. Noank, Conn., Aug. 24, 1874. 15,217. U. S. Fish
Commission.

SWORD-FISH.—*Xiphias gladius* Linn.

Spermaries. Fulton Market, N. Y., July 17, 1874. 16,222. E. G.
Blackford. It is doubtful whether this species spawns in
American waters, as fish of less than fifty pounds weight are
seldom seen on our coast. A "sword" about one inch long
was found imbedded in the flesh of a shark taken off Gloucester,
Mass., in 1878, but what distance the latter had traveled
since it had been attacked by the sword-fish is uncertain.

BONITO.—*Sarda mediterranea* (Schn.) J. & G.

Spermaries. Wood's Holl, Mass., August 4, 1874. 16,312.

HAKE.—*Phycis chuss* (Walb.) Gill.

Spermaries. (Taken from a fish weighing 8 pounds; weight of
specimen 8 ounces.) Gloucester, Mass., September 3, 1878.
25,144. R. Edward Earll.

SQUIRREL FISH.—*Diplectrum fasciculare* (C. & V.).

Spermaries. Charleston, S. C., April 2, 1880. 25,426. R. Edward
Earll.

HAKE.—*Phycis tenuis* (Mitch.) DeKay.

Spermaries. Off Newport, R. I., August, 1880. U. S. Fish Com-
mission.

OVARIES.

HADDOCK.—*Melanogrammus aeglefinus* (Linn.) Gill.

Ovaries. Eastport, Me., 1872. 10,475. U. S. Fish Commission.
The haddock spawns along various portions of the New Eng-
land coast in May. It was first artificially hatched at Glou-
cester, Mass., in the spring of 1880.

GOOSE FISH.—*Lophius piscatorius* Linn.

Spent ovaries. Eastport, Me., September 6, 1872. 10,476. Prof.
Spencer F. Baird.

WHITEFISH.—*Coregonus clupeiformis* Le S.

Ovaries, with a few free eggs. This specimen was taken from a
fish weighing $2\frac{3}{4}$ pounds, and is estimated to contain 28,500
eggs. Ecorse, Mich. 10,487. J. W. Milner. The whitefish

WHITEFISH.—*Coregonus clupeiformis* Le S.—Continued.

abounds in all of the Great Lakes, and its spawning-grounds are quite generally distributed. The spawning season lasts from October to January. A 5-pound female is estimated to yield 25,000 to 30,000 eggs. Not less than 50,000,000 were hatched by the U. S. Fish Commission in the spring of 1883.

WHITEFISH.—*Coregonus clupeiformis* Le S.

Spent ovaries. Ecorse, Mich. 10,489. J. W. Milner.

SISCOWET TROUT.—*Salvelinus namaycush*, var. *siscowet* Ag.

Fragments of ovaries. Specimen estimated to contain 2,796 eggs in a well developed condition. Outer Islands, Lake Superior. 10,493. This species spawns in the shore-waters of the Great Lakes, Lake Superior containing the most important spawning-grounds.

MACKINAW TROUT.—*Salvelinus namaycush* (Penn.) Goode.

Ovaries. This specimen, which is estimated to contain 14,943 eggs, was taken from a fish weighing 24 pounds. Shoal Islands, Lake Superior. 10,495. James W. Milner. This species breeds in the waters of the Great Lakes where it is quite abundant. The spawning season begins in October and lasts till the middle of November. Fish of average size will yield from 2,000 to 10,000 eggs, which, in water of 38° Fahr., will hatch in 70 to 80 days.

MUMMICHOG.—*Fundulus pisculentus* (Mitch.) Val.

Ovaries. Wood's Holl, Mass., June 5, 1872. 10,505.

TAUTOG.—*Tautoga onitis* (Linn.) Günther.

Ovaries. Wood's Holl, Mass., July 5, 1872. 10,516. Vinal N. Edwards. This species spawns on the rocky ledges off the coast of Southern New England and New Jersey during the summer months.

STRIPED SEA-ROBIN.—*Prionotus evolans* (Linn.) Gill.

Ovaries. Wood's Holl, Mass., May 25, 1872. 10,530. Vinal N. Edwards. This species spawns in various portions of the Atlantic coast, between Cape Cod and Florida, in summer.

SCUP, or SCUPPAUG.—*Stenotomus chrysops* (L.) Bean.

Ovaries. Wood's Holl, Mass., June, 1872. 10,531. Vinal N. Edwards. The principal spawning grounds of this species are along the coast of Southern New England.

SEA-BASS.—*Centropristis nigricans*.

Ovaries. Wood's Holl, Mass., May 26, 1872. 10,532. Vinal N. Edwards. This species spawns on the coral banks and rocky ledges of the Atlantic coast, some miles from shore, in spring. The spawning grounds extend from the Carolinas to Cape Cod.

SPRING ALEWIFE.—*Clupea vernalis* Wilson.

Ovaries. Wood's Holl, Mass., April, 1871. 10,615. Vinal N. Edwards. Immense schools of this species ascend the larger rivers of the Atlantic coast in springs for the purpose of spawning. The principal spawning-grounds are in the tributaries of Delaware and Chesapeake Bays, and Albemarle and Pamlico Sounds.

COD.—*Gadus morrhua* Linn.

Ovaries. Wood's Holl, Mass., April 20, 1871. 10,616. Vinal N. Edwards. The spawning-grounds of the codfish off our own coast extend as far south as Central New Jersey. The principal spawning-grounds are off the coasts of Maine and Massachusetts and on the more distant fishing banks. Ripe fish may be seen at any time between September and the following May, though the height of the spawning season occurs in mid-winter. The number of eggs in a fish varies with the size of the parent—a 75-pound female containing about 9 millions. The eggs hatch in from 13 to 50 days, according to the temperature of the water. They are $\frac{1}{10}$ of an inch in diameter, and have a specific gravity slightly less than that of sea-water.

COMMON FLOUNDER.—*Pleuronectes americanus* Walbaum.

Ovaries. Wood's Holl, Mass., April 3-5, 1876. 15,186. U. S. Fish Commission. The spawning-grounds for this species on the coast extend from Maine to Cape May, or perhaps even farther south. The spawning season occurs during the summer months.

SAND FLOUNDER.—*Bothus maculatus* (Mitch.) J. & G.

Ovaries. Wood's Holl, Mass., June. 15,187. Vinal N. Edwards. This species spawns in summer along the coast of Southern New England and New Jersey.

TOMCOD.—*Microgadus tomcod* (Walb.) Gill.

Ovaries. Wood's Holl, Mass., January 10, 1874. 15,191. U. S. Fish Commission. This species spawns in the salt and brackish waters of the New England coast in mid-winter.

SEA-RAVEN.—*Hemitripterus hispidus* (Schn.) Goode.

Ovaries. Caseo Bay, Me., August 25, 1872. 15,203. U. S. Fish Commission. This species spawns in the shoal waters of New England in the fall.

MACKEREL.—*Scomber scombrus* Linn.

Ovaries. Wood's Holl, Mass., May 20, 1875. 15,205. U. S. Fish Commission. This species spawns off the New Jersey and New England coast in spring and early summer.

BONITO.—*Sarda mediterranea* (Schn.) J. & G.

Ovaries. Noank, Conn., July 25, 1874. 15,208. U. S. Fish Commission. The fishermen of Sandy Hook report that the bonito spawns in that locality during the summer months, as ripe fish are often taken by them at that season.

BLUEFISH.—*Pomatomus saltatrix* (Linn.) Gill.

Ovaries. Wood's Holl, Mass., June 18, 1874. 15,209. U. S. Fish Commission. The New Jersey fishermen, as well as those of Southern New England, report ripe fish of this species occasionally taken by them during the summer months. The young occur almost everywhere along the coast between Cape Cod and Florida. From these facts it seems probable that the bluefish spawn a considerable distance from the shore during the summer months.

BUTTERFISH.—*Stromateus triacanthus* (Peck.) J. & G.

Ovaries. Wood's Holl, Mass., May 20 to June 8. 15,210. Vinal N. Edwards. This species spawns along the outer shores and in the salt-water bays lying between Cape Cod and Cape Hennen, the more important spawning-grounds being along the coast of Southern New England.

KINGFISH.—*Menticirrus nebulosus* (Mitch.) Gill.

Ovaries. Wood's Holl, Mass., May 25, 1874. 15,211. Vinal N. Edwards. The principal spawning-grounds for this species are off the coast of Southern New England and New Jersey, although the species undoubtedly spawns as far south as the Carolinas. The spawning season occurs in summer.

SQUETEAGUE.—*Cynoscion regalis* (Bloch.) Gill.

Ovaries. Wood's Holl, June 7-10, 1875. 15,212. Vinal N. Edwards. This species spawns in the salt and brackish water sounds and bays, and along the outer shore of the Atlantic coast, between Cape Cod and Florida, from April to July.

HERRING.—*Clupea harengus* Linn.

Ovaries. Wood's Holl, Mass., Oct., 1872. 15,221. Vinal N. Edwards. The principal spawning-grounds for this species within the limits of the United States are Passamaquoddy Bay, Boishubert Island, Penobscot Bay, and Wood Island, off the coast of Maine; and near Cape Ann, on the Massachusetts coast. The spawning season varies greatly with the locality.

SHARP-NOSED STURGEON.—*Acipenser oxyrhynchus* Mitch.

Ovaries. Block Island, August 2, 1874. 15,224. U. S. Fish Commission. This species spawns in the larger rivers of the Atlantic slope during the spring and early summer. During the spawning season great numbers of them are taken by the fishermen, who fish for them exclusively during several months.

SHORT-NOSED STURGEON.—*Acipenser brevirostris* Le S.

Ovaries. Noank, Conn., July 25, 1874. 15,225. U. S. Fish Commission. This species visits the larger rivers tributary to the Atlantic between Cape Cod and Florida for the purpose of spawning. The spawning season begins in March in the south and closes about the 1st of August in Southern New England.

GAR-PIKE—*Lepidosteus osseus* (Linn.) Ag.

Ovaries. Potomac River, Washington, D. C., May 20, 1875. 15,461. J. W. Milner. This species has a wide geographical range, and probably spawns in all of the larger rivers of the Mississippi basin, as well as those of the Atlantic coast.

GOOSE-FISH.—*Lophius piscatorius* Linn.

Ovaries. Wood's Holl, Mass., July 2, 1875. 16,104. Gelatinous masses, 20 to 30 feet long and 2 or 3 feet wide, in which are imbedded the eggs of this species, are found floating at the surface of the New England waters in midsummer.

DRUM.—*Pogonias chromis* La Cép.

Spent ovaries. Fulton Market, N. Y., July 23. 16,221. E. G. Blackford. The principal spawning grounds for this species occur in the salt and brackish waters of the coast between Maryland and Georgia, although the species undoubtedly breeds beyond these limits.

COBIA, OR CRAB-EATER.—*Elacate canada* (Linn.) Gill.

Fragment of ovary. New York Market, July 30, 1875. 16,283. E. G. Blackford. A number of females with the eggs well advanced were taken in Chesapeake Bay June 30, 1880. The species probably spawns along the coast from New Jersey to South Carolina in summer.

MUD-FISH.—*Amia calva* Linn.

Ovaries. September 30, 1875. 20,527. The mud-fish spawns in the fall in the fresh-water streams of many portions of the United States.

BURBOT.—*Lota maculosa* (Le S.) Rich.

Ovaries. Seneca Falls, N. Y., Nov., 1877. 20,847. E. G. Blackford. This species is said to spawn in the great lakes and their tributaries in the fall.

SMOOTH FLOUNDER.—*Pleuronectes glaber* (Stor.) Gill.

Ovaries. Portland, Me., December 15, 1877. 20,873. Dr. Tarleton H. Bean. This fish spawns in midwinter off the New England coast.

SILVER HAKE.—*Merluccius bilinearis* (Mitch.) Gill.

Ovaries. Halifax, Nova Scotia, September 8, 1877. 21,016. U. S. Fish Commission.

COW-NOSED RAY.—*Rhinoptera quadriloba* (Le S.) Cuv.

Uterus after young has been removed. Pensacola, Fla., April. 21,221. Silas Stearns. This ovoviviparous species breeds along the Southern Atlantic coast and in Gulf of Mexico, in the spring and early summer.

MENHADEN.—*Brevoortia tyrannus* (Latrobe) Goode.

Ovaries. August 18, 1878. 25,133. Until recently little or nothing was known regarding the spawning habits of this species. August 18, 1878, several ripe females were taken off the coast of Rhode Island. It is claimed by the fishermen of Virginia and the Carolinas that the species spawns off that portion of the coast from December to March. Young menhaden, an inch or more in length, are very abundant in the shore waters between Sandy Hook and Cape Cod in midsummer.

POLLOCK.—*Pollachius virens* (Linn.)

Ovaries. Noman's Land, November 21, 1877. 25,137. Vinal N. Edwards. The spawning grounds of this species off our coast extends from Cape Cod to New Brunswick. The spawning season begins about the middle of May and lasts till the middle or last of November.

ROCK.—*Roccus striatus* Mitchill.

Wood's Holl, Mass., 1876. 25,139. Ovaries. Vinal N. Edwards. This species spawns in spring in the bays and lower river-courses of the Atlantic coast.

TOAD-FISH.—*Batrachus tau* Linn.

Ovaries. Wood's Holl, Mass. 25,142. Vinal N. Edwards. Ripe toad-fish were taken in Chesapeake Bay, June 1, 1880. It is probable that the species spawns along all portions of the Atlantic coast during the summer months.

SWELL-FISH.—*Tetrodon turgidus* Mitchill.

Ovaries. Wood's Holl, Mass., July 1, 1877. 25,147. Vinal N. Edwards. This species spawns along the outer Atlantic coast in the spring and early summer. Ripe females are frequently taken in Virginia in June, and in the Long Island region in July.

WHITING.—*Menticirrhus alburnus* (Linn.) Gill.

Ovaries. (Specimen taken from a fish 12 inches long.) Charleston, S. C., May 26, 1880. 25,420. R. Edward Earll. This species spawns in the bays and along the outer shore between Cape Hatteras and Florida. The height of the spawning season at Charleston, S. C., occurs in April and May.

SQUIRREL-FISH.—*Diplectrum fasciculare* (C. & V.).

Ovaries. Charleston, S. C., April 2, 1880. 25,426. R. Edward Earll. This species spawns on the coral banks off the South Carolina coast in May. Not found elsewhere in our waters in any considerable numbers.

“BASTARD SNAPPER.”—*Sparus pagrus* L.

Ovaries. (Specimen taken from an immature female weighing 3½ pounds and measuring 18 inches to end of tail.) Charleston, S. C., April 2, 1880. 25,427. R. Edward Earll. Spawning grounds for this species occur off the Carolina coast, this being the only locality within our borders where the bastard snapper is taken. The season for spawning lasts from April to June. The eggs when impregnated are about one twenty-fourth of an inch in diameter.

SILVERY HAIR-TAIL.—*Trichiurus lepturus* Linn.

Ovary. Charleston, S. C., April 2, 1880. 25,428. R. Edward Earll. This species spawns off the Carolinas in April and May. Ripe females are frequently seen at Charleston, S. C., during the month of April.

BLACK-TAILED PORGY.—*Diplodus holbrookii* (Bean).

Ovaries. (Specimen from a fish weighing three-fourths of a pound.) Charleston, S. C., March 29, 1880. 25,522. This species spawns in April on the coral-banks off the Carolina and Georgia coasts, where it is more abundant than in any other locality.

EEL-POUT.—*Zoarces anguillaris* (Peck) Storer.

Ovaries. Gloucester, Mass., August 1, 1878. U. S. Fish Commission. This species spawns off the New England coast in August and September.

HAKE.—*Phycis chuss* (Walb.) Gill.

Ovaries. (Specimen from a fish 17 inches long.) Newport, R. I., September, 1880. U. S. Fish Commission. This species spawns off the coast of Maine and Massachusetts in September and October.

HAKE.—*Phycis tenuis* (Mitch.) DeKay.

Ovaries. Off Newport, R. I., 1880. U. S. Fish Commission. This species spawns in September and October off the New England coast.

HALIBUT.—*Hippoglossus vulgaris* Fleming.

Fragment of ovary. (Weight of specimen, one-half pound, Troy. Taken from a 175-pound fish, the entire ovaries of which weighed 17 pounds 2 ounces avoirdupois.) Grand Banks, September 17, 1878. Capt. Joseph W. Collins. Little is known of the spawning habits of this species, but from the observations of the fishermen it is supposed to spawn on the rocky bottom of the more important fishing banks north of latitude 44° N., in from 75 to 100 fathoms of water, in the fall and early winter. The eggs are thought to be adhesive, though there is still some doubt on the subject. The number of eggs in a fish varies with the size of the latter. The one from which this specimen was taken was estimated to contain about 2,250,000 eggs.

LAMPREY.—*Petromyzon marinus* Linn.

Ovaries. May 15, 1872. This species is said to spawn off the New England coast in spring; but little is known regarding its spawning habits.

MOON-FISH.—*Chatodipterus faber* (Cuv.) Jor. & Gilb.

Ovary. Crisfield, Md., July 1, 1880. R. Edward Earll. Important spawning grounds for this species are located in Chesapeake Bay, where ripe fish are taken in great numbers during the summer months. It probably spawns in various other localities between Cape Cod and Florida, as well as in the Gulf of Mexico. The eggs are one twenty-eighth of an inch in diameter, and in water of 80° Fahr. hatch in less than twenty-four hours.

SHAD.—*Clupea sapidissima* Wilson.

Ovaries. (This specimen taken from a fish 20 inches long, weighing 4½ pounds.) Winyah Bay, Georgetown, S. C., March 29, 1880. R. Edward Earll. The shad is one of the most important food-fishes of the United States. It spawns in all of the larger rivers of the Atlantic coast, the principal spawning-grounds being located near their headwaters. The fish make their appearance in Florida about the 1st of January. They enter the North Carolina rivers in March, and reach southern New England about the middle of May. The spawning season depends largely on the temperature of the water. In Florida the height of the season is in the month of February. In North Carolina the ripe fish are seen in greatest numbers in April. In New England the season begins about the last of May and continues till the middle of July.

SPANISH MACKEREL.—*Scomberomorus maculatus* (Mitch.) J. & G.

Ovaries. (Specimen taken from a fish 19½ inches long, weighing 34 ounces.) Crisfield, Md., June 28, 1880. R. Edward Earll. This species is known to spawn in the coastal waters between Long Island Sound and North Carolina in summer, and it is probable that it breeds as far south as the Gulf of Mexico. The principal spawning grounds are in the vicinity of Sandy Hook, N. J., and in Chesapeake Bay. The eggs average about one twenty-eighth of an inch in diameter, and in water of 80° Fahr. hatch in eighteen to twenty hours. Their specific gravity is slightly less than that of salt water. An average sized female produces during the season from 500,000 to 750,000 eggs, though as these are deposited at intervals during several months, the number that can be taken at one time for hatching purposes seldom exceeds 100,000.

SPOTTED SQUETEAGUE.—*Cynoscion maculatum* (Mitch.) Gill.

Ovaries. (Specimen taken from female 18 inches long, weighing 2 pounds 1 ounce.) Crisfield, Md., June 30, 1880. R. Edward Earll. This species spawns in the shoal water of the brackish sounds and bays along the Carolina coasts in May and June, and in the upper portions of Chesapeake Bay in June and July. The principal spawning grounds are on the Carolina coast.

PLAICE.—*Paralichthys dentatus* (Linn.) J. & G.

Ovaries. Wood's Holl, Mass., January 15, 1874. 14,140. Collected by Vinal N. Edwards. This species spawns along the New England coast and northward in winter.

GRAY PIKE.—*Stizostedium canadense* (Smith) Jordan.

Ovaries. Memphis, Tenn.

COMMON SMELT.—*Osmerus mordax* (Mitch.) Gill.

Fish showing ovaries in position. Raritan River, N. J., April 6, 1875. 15,232. J. R. Shotwell. This species enters the fresh and brackish waters of the New England coast in the fall and early winter for the purpose of spawning, the principal spawning-grounds being along the coast of Maine and Massachusetts.

LUMP-FISH.—*Cyclopterus lumpus*, Linn.

Spent ovaries. Eastport, Me., September 13, 1872. 10,471. The lump-fish spawns among the rocky ledges and algæ beds of the New England coast during the winter months. The eggs are adhesive, and bunches of them weighing a pound or more are often washed upon the beach during heavy gales. Bunches of naturally impregnated eggs have been taken and hatched out in floating boxes by the U. S. Fish Commission.

C.—PROTECTION.

III.—LEGISLATION.

4. FISHERY LAWS. (See Reports.)

IV.—ASSISTANCE TO FISH IN REACHING SPAWNING-GROUNDS.

5. FISH-WAYS.

POOL FISH-WAYS.

(Ascent made by alternate rapid currents and pools, the latter serving as resting-places for the fish).

a. POOLS FORMED BY NATURAL IRREGULARITIES OF THE CHANNEL.

DUNCANNON FISH-WAY.

Model of fish-way built at Duncannon, Pa., in which the velocity of the current is retarded by means of rocks and bowlders so arranged as to form a series of pools at different points in the sluice. Designed by J. T. Rothe, Duncannon, Pa. 25,701.

b. POOLS CONSISTING OF A SERIES OF PONDS OR COMPARTMENTS.

SHAW'S SPIRAL FISH-WAY.

In this fish-way the water passes by a series of vertical falls through openings in the several rectangular compartments on its way to the lower level. The width of the opening is about one-fourth of the longer side of the box. The extent of the fall varies with the number of compartments and the height of the dam. The compartments are arranged spirally. A gate at the top (not shown in the model) regulates the quantity of water used. Each compartment is provided with an opening at the bottom to admit of drainage in winter. Designed by B. F. Shaw, of Anamosa, Iowa. 39,497.

c. POOLS FORMED BY PARTITIONS PLACED AT AN ANGLE WITH THE SIDE OF THE SLUICE.

SWAZEY'S OBLIQUE FISH-WAY.

Old style. In this fish-way the partitions extend alternately from either side, sloping upward at an angle of 45° to a point slightly beyond the center of the sluice to form pockets or pools, which serve as resting-places for the fish. In passing through the way the water is caught in the angle formed by

SWAZEY'S OBLIQUE FISH-WAY—Continued.

the partition and the side of the chute and turned backward in its course. By this arrangement the velocity of the current is greatly reduced. Scale: One fourth of an inch to the foot ($\frac{1}{4}$). Invented by Alfred Swazey, of Bucksport, Me., in 1874. 29,289. Model by C. G. Atkins.

SWAZEY'S OBLIQUE FISH-WAY.

New style. Model of an inclined-plane fish-way in which the partitions, which extend entirely across to the chute at right angles to it, are placed at an angle with the perpendicular, thus forming a pocket or pool which retards the velocity of the current. The tops of these partitions slope downward, the lower end of the adjoining ones being on opposite sides of the sluice, so that the water in descending is made to travel back and forth across the way as many times as there are separate compartments. Scale: One-fourth of an inch to the foot ($\frac{1}{4}$). Designed by Alfred Swazey, of Bucksport, Me., in 1876. 29,288. Model by C. G. Atkins.

d. POOLS FORMED BY EDDIES IN THE CURRENT.**WORRALL'S EXPANDING-SLUICE FISH-WAY.**

Model of fish-way built in the Susquehanna River at Columbia, Pa., in 1866, showing the arrangement by which the floor or channel is widened, the object being to create eddies to serve as resting-places for the fish. This fish-way, which is 45 feet long, is set into the masonry of the dam so that its base is in line with the dam wall. It is 20 feet wide at the top, gradually increasing to 40 feet at the bottom. The dam is 6 feet high, and the velocity acquired by the current in descending the sluice is said to be less than 10 miles per hour. Scale: One-eighth of an inch to the foot ($\frac{1}{8}$). Designed by James Worrall, of Pennsylvania. 29,284. Model by C. G. Atkins.

CHUTE OR TROUGH FISH-WAYS.

(In which the ascent is so gradual that the fish succeed in overcoming the current).

WORRALL'S CHUTE FISH-WAY.

Model of fish-way built in the Susquehanna River, at Columbia, Pa., in 1873. It consists of a straight sluice-way, 120 feet long and 60 feet wide, made of crib-work and filled with stone. The fall is about 1 foot in 35, and the velocity acquired in the descent is said to be less than 10 miles per hour. Scale: One-eighth of an inch to the foot ($\frac{1}{8}$). Designed by James Worrall, of Pennsylvania. 29,284 (?). Model by C. G. Atkins.

DEFLECTED CURRENT FISH-WAYS.

(In which the current is retarded by being made to travel through a distance equal to many times the length of the way in descending, being frequently interrupted by objects placed in the course, causing a change in its direction).

a. ZIGZAG-CURRENT FISH-WAYS.**BREWER'S SINGLE-GROOVE FISH-WAY.**

This fish-way consists of a straight chute with a series of equilateral triangles extending transversely from either side along the bottom, the spaces between them forming a zigzag channel through which the water passes to the lower level. The angular turns, which change the direction of the current, serve to retard the downward movement of the water. This fish-way evidently works best when there is little more than enough water to fill the groove. Patented April 30, 1872, by James D. Brewer, of Muncy, Pa. Model by James D. Brewer. 15,355.

STECK'S DOUBLE-GROOVE FISH-WAY.

This fish-way consists of a straight chute, with irregularly sloping floors, which serve to retard the water in its descent. The floors are so arranged that the main current at the center is repeatedly broken up to form two smaller ones, which, after being deflected toward the sides, are brought together again at a lower point. Patented by Daniel Steck, of Pennsylvania. 26,107.

b. TRANSVERSE-PARTITION FISH-WAYS.**STECK'S FISH-WAY.**

In this fish-way the velocity of the water is retarded by transverse partitions extending alternately from either side four-fifths of the distance across the sluice. The descent is made by means of transverse sloping floors. By this arrangement the fish-way is practically cut up into a series of straight open sluices, the upper end of one being on a level with the lower end of the next preceding one. The length of the fish-way is greatly reduced by the parallel arrangement of the sluices. Designed and patented by Daniel Steck, of Pennsylvania. 26,108. Model by James D. Brewer.

SMITH'S INCLINE-PLANE RETURN FISH-WAY.

In this fish-way the water is carried through half of the perpendicular height in an ordinary sluice or chute, leaving a level floor with steps at regular intervals. In descending through the sluice the water acquires considerable velocity, which is overcome by a series of rectangular compartments, the partitions

SMITH'S INCLINE-PLANE RETURN FISH-WAY—Continued.

of which interrupt the current and turn it in its course. The floor of each alternate compartment is paved with stones, to render them more attractive to the fish, and to afford resting places while descending the fish-way. Scale: Three-eighths of an inch to the foot ($\frac{3}{8}$). Designed by Everett Smith, Portland, Me. 42,944. U. S. Fish Commission.

LAWRENCE FISH-WAY.

Model of Brackett's patent rectangular compartment fish-way on the inclined-plane system, built in the Merrimac River at Lawrence, Mass. Scale: One-eighth of an inch to the foot ($\frac{1}{8}$). Designed and patented by E. A. Brackett, of Massachusetts. Model by C. G. Atkins. 26,939. The first section of this fish-way is so arranged that it can be raised, thus entirely shutting off the water at time of freshets or at seasons when the way is not needed.

HOLYOKE FISH-WAY.

Model of fish-way built in the Connecticut River at Holyoke, Mass. This is a rectangular compartment fish-way on the inclined plane system, the peculiarity of this way being the submerged piece of cob-work placed in the river to direct the fish to the foot of the fish-way. Scale: One-eighth of an inch to the foot ($\frac{1}{8}$). Patented by E. A. Brackett, of Winchester, Mass. 26,937. Model by C. G. Atkins. The dam at Holyoke is 30 feet high. The total height of the fish-way is 440 feet, giving a fall of 1 foot in 15. It is said to carry a column of water 2 feet wide and 2 feet deep through the entire distance without perceptible increase in velocity, the current at the lower end being less than 10 miles per hour.

EVERLETH'S SELF-ADJUSTING FISH-WAY.

This is an ordinary rectangular compartment fish-way on the inclined plane system, the upper end of which is provided with a movable float that rises and falls with the fluctuations of the river. By this arrangement the entrance of the fish-way is always kept at the proper height to admit the required quantity of water. Scale: One-fourth of an inch to the foot ($\frac{1}{4}$). Designed by Dr. F. M. Everleth, of Waldoborough, Me. 26,930. Model furnished by C. G. Atkins.

ATKINS'S INCLINE-PLANE RETURN FISH-WAY.

In this model is shown the modification of the incline-plane fish-way for delivering the water at the foot of the dam. It is provided with gates for regulating the supply of water, and shows the

ATKINS'S INCLINE-PLANE RETURN FISH-WAY.—Continued.

arrangement of partitions in the rectangular compartments for preventing an increase in velocity. Scale: One-half inch to the foot ($\frac{1}{24}$). Designed by Charles G. Atkins, Bucksport, Me. 29,291.

PIKE'S SPIRAL FISH-WAY.

This is the first spiral fish-way invented in America. In it the compartments are modified into long and narrow sluices. The floors are level, the descent being by means of short vertical falls or steps which occur at regular intervals. The velocity of the water is retarded by frequent changes in the direction of the current and by the contracting of the sluices, which are much narrower at their lower than at their upper ends. In making one circuit of the way the water traverses seven sluices, or a total of 68 feet, passing over fourteen steps, which give a total of 42 inches for each current. Scale: One-half inch to the foot ($\frac{1}{24}$). 26,931. Great economy of space and material is effected by the spiral arrangement, and the outlet of the fish-way naturally comes at the foot of the dam, where the fish can readily find it.

ATKINS'S SPIRAL FISH-WAY.

Model of rectangular compartment fish-way on the inclined-plane system, in spiral arrangement, in imitation of Pike's spiral fish-way. Scale: One-half inch to the foot ($\frac{1}{24}$). Designed by C. G. Atkins, of Bucksport, Me. 26,949. U. S. Fish Commission. This fish-way, which is provided with sluices of different heights, can be worked satisfactorily at all seasons, as the river water of any level can be utilized. Each sluice is provided with gates by means of which the quantity of water can be easily regulated. In this model the sides of the fish-way are made of glass, in order that the interior may be more readily seen.

BANGOR FISH-WAY.

(Model of the fish-way in the Penobscot River at Bangor, Me.) This is a rectangular compartment fish-way on the inclined-plane system, spirally arranged. Its peculiarities are: A large supply-trough, provided with numerous gates, by means of which water, at different levels, can be utilized, and the arrangement of the partitions for retarding the velocity of the current. The abutments which protect it from the ice are also very effective. Height of dam, 16 feet. Scale: Three-eighths of an inch to the foot ($\frac{1}{32}$). Designed by Charles G. Atkins, of Bucksport, Me. 39,306. Built by the city of Bangor, in 1877, at a cost of \$6,000.

COUNTER-CURRENT FISH-WAYS.

THE McDONALD FISH-WAY.

Working model. Scale, one-twelfth. This fish-way, invented by Col. Marshall McDonald, of the U. S. Fish Commission, in 1878 (patented September 24, 1878, August 5, 1879), differs in principle from all previously invented or used, the water being delivered down a straight sluice-way, inclined at an angle of 30° , and without acceleration of velocity. "This is accomplished by compelling each particle of water to traverse a constrained path, the final direction being against gravity, the retardation by friction bringing the particle to rest at a lower level in the way. A reference to the model will show the mechanical means by which this is accomplished. The bottom of the way is hollow; each of the center openings communicates with the openings on each side corresponding to the fourth side-intervals below. A particle of water entering any one of the middle openings passes under the hollow floor and returns to the surface of way through the fourth opening below, its final direction being up the slope and against gravity, which soon brings the particle to rest, when it falls again towards the middle of the way, sinks into one of the center openings and traverses a similar circuit; this is repeated again and again until finally the particle of water reaches the bottom of the way with no greater acceleration than it received in its first circuit. It is evident, then, that the maximum velocity of the current of water in the fish-way can never be as great as the maximum velocity of each particle of water that makes the current. The maximum velocity of each individual particle is under absolute control, being in proportion to the difference of level between its consecutive points of rest; we may therefore deliver the water down the way with a uniform velocity which shall not exceed any maximum limit desired. The fish-way is sheltered from floods and floating ice or timber by being placed behind the abutment of a dam. Water is brought from the dam to the head of the fish-way by a conduit of boards supported by trestling; this conduit may, however, be built of masonry or of iron. This represents only one of a number of designs that may be adopted to suit best the varying conditions of locality. To test the fish-way practically, turn on, at the head, enough water to keep the box full. Place young trout in the pool at the foot of the fish-way, and after they have become accustomed to their surroundings, they will swim readily up the way, moving as quickly as the eye can follow them. For details of construction, see working-drawings of design for James River fish-ways."—*M. McDonald.*

McDONALD FISH-WAY.

Photograph of the falls at Fredericksburg, Va., showing the McDonald fish-way in position behind the abutment. Size, 8 by 10 inches. Fredericksburg, Va., 1882. 2,244. U. S. Fish Commission.

McDONALD FISH-WAY.

A photograph of the Falls at Fredericksburg, Va., showing the McDonald fish-way in position behind the abutment. Size, 30 by 40 inches. Enlarged by electric light from an 8 by 10 negative. Fredericksburg, Va., 1882. 2,244. U. S. Fish Commission.

V.—PURIFICATION OF STREAMS.

6. CLEANSING RESIDUUM FROM MANUFACTURING ESTABLISHMENTS,
ETC., BEFORE IT ENTERS THE RIVERS.

GAS-WORKS.

Drawings illustrating the method of purifying the residuum of gas-works before allowing it to pass off into the river. Description of apparatus, with letter of explanation to Prof. S. F. Baird, by J. R. Shotwell.

D.—ARTIFICIAL PROPAGATION.

VI.—APPARATUS FOR THE MANIPULATION OF EGGS AND YOUNG FISH.

7. HATCHING APPARATUS AND ACCESSORIES.

APPARATUS FOR HEAVY EGGS—TROUGH APPARATUS.

a. APPARATUS WITH A HORIZONTAL CURRENT.

GARLICK'S HATCHING-BOX.

A simple trough, the bottom of which is covered with pebbles, on which the eggs remain until hatched, the water entering through a spout above and passing out through an opening protected by wire cloth at the lower end. Length, 18 inches; width, 9 inches; depth, $6\frac{1}{2}$ inches. Invented by Theodatus Garlick, Cleveland, Ohio, 1851. Presented by Theodatus Garlick. 39,498. This is the first form of hatching apparatus used in the United States. It was adopted by Dr. Garlick, who may justly be called the father of fish-culture in America. Though simple, the results obtained by its use were very satisfactory.

SLACK'S HATCHING-GRILL.

A series of rectangular boxes arranged in flights so that the water passes readily from the highest through the intervening ones to the lowest. Each box is provided with a tray composed of glass tubings incased in a wooden frame, which contains the eggs. Length, 21 inches; width, 7 inches; depth, $4\frac{1}{2}$ inches. Designed by J. H. Slack, of Bloomsbury, N. J., in imitation of Coste's hatching-grill. U. S. Fish Commission. 57,158. The water enters from the top near one corner, and after passing through the box, goes out through the spout at the opposite diagonal corner. The glass tubes are advantageously employed in hatching, as by their use the eggs are less liable to be injured from fungus or sediment.

STONE'S PARLOR HATCHING-TROUGH.

A rectangular box with a glass cover, inclosing a smaller box with a double bottom. The inner box contains three screens, two of which are covered with cloth to serve as filters, the other being of wire cloth for keeping the fish from escaping through the outflow pipe. Outer box, 18 inches long, 5 inches wide, and 5 inches deep. Devised by Livingston Stone, of Charleston, N. H. Presented by Livingston Stone. 39,463. The up-

STONE'S PARLOR HATCHING TROUGH.—Continued.

per and lower bottoms slope in opposite directions. The water enters through an opening in the glass, passing over the cleats, which serve as resting places for the fish, to the lower end, and after passing through a small hole, follows the lower bottom to the opposite end, where it escapes through the outflow pipe.

BUCKSPORT HATCHING-TROUGH.

A section of hatching-trough showing two compartments complete, with nests of trays. Each compartment contains a frame which is closed when in use, but can be opened for convenience in removing them. Length, 31 inches; width, 15 inches; depth, 17 inches. Employed by Charles G. Atkins, of Bucksport, Me., for hatching eggs of various species of salmonidæ. Charles G. Atkins. 26,936.

ATKINS'S HATCHING-TRAY.

Photograph showing a nest of hatching-trays, devised by Charles G. Atkins, for use in hatching eggs of the Atlantic salmon. These trays are placed in troughs and a current of water is allowed to pass through them horizontally. Size, 8 by 10 inches. Bucksport, Me., 1882. (762). 2,221. U. S. Fish Commission.

HATCHING-APPARATUS.

Photograph of the apparatus employed in hatching eggs of the Atlantic salmon at the hatchery of the U. S. Fish Commission at Bucksport. Size, 8 by 10 inches. Bucksport, Me., 1882. (753) 2,214. U. S. Fish Commission.

ATKINS'S HATCHING-CRATE.

A frame of metal and wood, with hinged cover, which incloses a nest of nine egg-trays. Length, 12 inches; width, 12 inches; depth, 7 inches. Designed by Charles G. Atkins, of Bucksport, Me. Presented by Charles G. Atkins. 26,935. This crate is used chiefly for hatching eggs of the salmonidæ. The trays are provided with corner strips of wood, which separate them slightly from each other to allow free circulation of water, though the spaces are not large enough to allow the escape of eggs. These crates can be placed either in the open stream or in ordinary troughs.

b. APPARATUS WITH AN UPWARD CURRENT.

HOLTON HATCHING-BOX.

A square wooden box, with a tin bottom sloping downward and inward toward the center, where the inflow opening is situated.

HOLTON HATCHING-BOX—Continued.

Just above this is a rectangular piece of tin, against which the water impinges as it enters, thus being deflected toward the sides. The box is provided with eleven trays of wire cloth, each separated from the other by the wooden frame to which it is attached. Eighteen inches square and 12 inches deep; outside measurement, including base and waste trough, 22 inches square and 20 inches deep. Patented by Marcellus G. Holton, Rochester, N. Y., March 18, 1873. U. S. Fish Commission. 57,159. The water enters the buckets through a tube which extends from the top around the side to the inflow opening at the bottom center, from which it passes up through the trays of eggs into a trough at the top, which conducts it to the outflow spout. This is one of the first forms of apparatus by which an upward current of water is utilized, and the inventor claims for it many advantages over other systems. These boxes are often so arranged that the water passes through a series of twenty or more, each box being a trifle lower than the preceding one, and the outflow of the first communicating with the feed-pipe of the second.

STONE'S SALMON-BASKET.

This apparatus consists of a Williamson trough provided with wire baskets, suspended from frames, for holding the eggs. Designed by Livingston Stone, Charleston, N. H., 1874. Livingston Stone. 26,956. In this apparatus a double partition separates each compartment, the first, or upper one, extending to the bottom, while the second one is placed a little way above it. The water falls over the first partition and passes under the second into the compartment, then upward through the basket of eggs and over between the next partitions. This was one of the first forms of apparatus for bulk hatching in the United States, and, according to Mr. Stone, the eggs were often placed 12 to 15 layers deep without injury.

FERGUSON HATCHING-JAR.

A cylindrical jar of glass, with a contraction near the base, which serves as a support to the 7 wire-cloth egg-trays which it contains. It has two circular openings on opposite sides; one at the bottom for admitting the water, which passes upward through the eggs and out through the second opening, which is situated at the top. Height, 12 inches; diameter, 8 inches. Invented by T. B. Ferguson in 1876. U. S. Fish Commission. 26,998. For economy of water, the outflow opening of one jar is connected with the inflow pipe of the next by means of rubber tubing. By this means the water passes through an entire

FERGUSON HATCHING-JAR—Continued.

series of jars before it finally escapes. The jar is used chiefly for hatching eggs of the salmonidæ. It holds about 4,000 salmon eggs or 6,000 trout eggs.

c. APPARATUS WITH A DOWNWARD CURRENT.

CLARK'S HATCHING-TROUGH.

Model. A section of the Clark hatching-trough, supported on wooden standards, showing two compartments complete. Each compartment contains a hatching-box, the bottom of which is perforated with holes and raised slightly above the bottom of the trough by means of wooden standards to allow the escape of water from beneath. Each hatching-box contains 12 trays of wire cloth, on which the eggs remain during their development. Compartments, 15 inches long, 12 inches wide, 12 inches deep—inside measurement. Hatching-boxes, 13½ inches long, 12 inches deep, and 11 inches wide—outside measurement. Trays, 12 inches long, 9 inches wide, and $\frac{3}{4}$ of an inch deep. Patented by Nelson W. Clark, Clarkston, Mich., March 3, 1874. Presented by Frank W. Clark. 42,812. A Clark trough usually contains 10 to 20 compartments, each being separated from the adjoining one by means of a partition, which is notched at the center and provided with a tin spout for conducting the water. The trough is placed at a slight incline and the water, entering the first compartment, passes down through the trays of eggs, out at the bottom of the hatching-box, and up around its sides and ends on its way to the second compartment, all of the water passing through each box before it finally leaves the trough.

APPARATUS FOR SEMI-BUOYANT EGGS.

a. APPARATUS UTILIZING RIVER CURRENTS.

BRACKETT'S HATCHING-BOX.

A rectangular box of wood, the front end of which slopes inward at an angle of 45° for the purpose of deflecting the current. The bottom is covered with wire cloth and the water is forced through it by means of a tide-strip attached to its further edge. Length, 22 inches; width, 20 inches; depth, 12 inches. Patented by Edward A. Brackett, Winchester, Mass., February 8, 1876. 26,904. Presented by Edward A. Brackett.

GREEN'S HATCHING-BOX.

The original box in which Seth Green made his first experiments in hatching eggs of the shad. 26,903. Patented by Seth Green, Rochester, N. Y. Gift of Seth Green.

GREEN'S HATCHING-BOX.

A small model of the Green hatching-box. 26,997. Gift of Seth Green.

b. APPARATUS UTILIZING WAVE-ACTION.**WRIGHT'S SUBMERGED HATCHING-BOX.**

A cubical box, with a hinge cover of wire cloth, the sides being of galvanized iron; the bottom, which is of the same material, being provided with circular openings an inch in diameter, each covered with valves opening upward to admit water from beneath. In the interior of the box, an inch above the valves, is a wire tray upon which the egg are allowed to rest, and through which the water can readily pass. The sides of the box are prolonged downward to form an expanding rim. The whole is suspended from a float and held in position by means of a small weight fastened to the bottom. The float is lifted upon the crest of the waves drawing the box through an equal distance, and as it descends into the hollow the valves open allowing the water to rush up through the opening and among the eggs, closing again to prevent suction as the box rises. Length, 10 inches; width, 10 inches; depth, 12 inches. Patented by Isaac H. Wright, of Baltimore, Md., August 20, 1878. Gift of Isaac H. Wright. 39,462. This box was invented for hatching eggs of the shad. It is claimed to be suitable for exposed streams where the current is slight but where the waves are of considerable size.

c. APPARATUS REQUIRING HEAD OR HYDRANT PRESSURE.**CHASE'S HATCHING-JAR.**

A cylindrical jar of glass, with a metal rim notched at one side and provided with a wire screen for retaining the fish. The water is introduced through a glass tube at the bottom and passes upward through the eggs. Height, 16 inches; diameter, 6 inches. Invented by Oren M. Chase, Detroit, Mich. 39,142. This jar is extensively used for hatching eggs of the whitefish. When the embryos are developing, the outflow gate remains open, and through it any dead eggs which are carried upward by the current escapes, thus preventing the injurious effects which arises from fungus and dead eggs.

CLARK'S HATCHING-JAR.

Old style. A cylindrical jar of glass, with a metal rim notched at one side, and provided with a movable wire screen, which is open while the embryo are developing, to allow the escape of dead eggs, but closed when the hatching begins, to prevent the escape of the fish. The water is introduced through an open-

CLARK'S HATCHING-JAR—Continued.

ing at the bottom, passing upward through the eggs and out at the top. Height, 16 inches; diameter, 6 inches. Invented by Frank N. Clark, of Northville, Mich. 57,187. Presented by Frank N. Clark. Formerly extensively used for hatching eggs of the whitefish.

CLARK HATCHING-JAR. (Intermediate form.)

A cylindrical jar of glass, with a metal rim, having a spout on one side, through which the surplus water escapes. The water is introduced at the bottom through a tin tube with a funnel shaped opening, and passes upward through the eggs on its way to the outflow spout. Height, 16 inches; diameter, 6 inches. Designed by Frank N. Clark, Northville, Mich. 57,188. Presented by Frank N. Clark. Extensively employed for hatching eggs of the whitefish at the Fish Commission hatching station at Northville, Mich.

CLARK HATCHING-JAR. (New style.)

A cylindrical jar of glass, with a metal rim, having a spout at one side, from which the surplus water escapes. The bottom of the jar is provided with a metal cone corresponding with the funnel-shaped end of the supply tube, which is prevented from coming in contact with it by means of slight projections on its inner surface. Height, 18 inches; diameter, 6 inches. Designed by Frank N. Clark, Northville, Mich. 57,189. Presented by Frank N. Clark. This jar is coming into favor for hatching eggs of the whitefish, and is now used extensively at the Northville hatchery.

SHAD-HATCHING CONE.

With screen at the bottom. Devised by Charles F. Bell and Fred. Mather. 26,995. U. S. Fish Commission.

FERGUSON'S IMPROVED CONICAL HATCHER.

With removable top, used to prevent splashing; also arrangement for easily removing bottom screen. Valve used when bottom screen is to be removed or eggs and young fish to be transferred. Furnished also with hook for lifting vessel from frame. T. B. Ferguson. U. S. Fish Commission.

SECTION OF V-SHAPED HATCHING-TROUGH.

A simple trough, with false sides sloping downward from the top toward the center, leaving the space of one-eighth of an inch, covered with wire cloth, between their lower edges. The upper part of the trough is surrounded by perforated tin, through which the water passes into a sluiceway and thence to the

SECTION OF V-SHAPED HATCHING TROUGH—Continued.

escape pipes, which occur at short intervals. The water enters the apartment between the vertical and sloping sides with the hydrant pressure, and is forced up through the opening and out through the strainer at the top. The eggs, being heavy, tend to sink to the bottom, where they are caught by the current and carried upward and outward toward the sides; as the current weakens they gradually drop back toward the center, where they are again caught and carried through the same circuit. 57,178. Devised by Seymour Bower, Northville, Mich. U. S. Fish Commission.

McDONALD'S Y-SHAPED HATCHING-BOX.

A wooden box, with glass ends and sloping sides, for eggs. Length, 12 inches; width, 24 inches; depth, 15 inches. Invented by Marshall McDonald, for use in the U. S. Fish Commission work at Gunston, Va., in April, 1881. U. S. Fish Commission. 57,154. The sides of the box slope toward the bottom center until they come within an inch of each other. Below this opening is a space 3 or 4 inches deep for the introduction of water. This opening is nearly closed by means of an adjustable square wooden bar, one of the angles of which enters the center of the opening, the sides of the bar thus being parallel with those of the box. By this means the current is divided so that the water is deflected along either side of the box toward the surface, carrying the eggs with it and causing them to pass in toward the center and fall again to the bottom, where they are again caught by the current and carried through the same circuit. The outlet is protected by a triangular trough running across the top center from side to side. This is placed a little below the top of the box, so that the water shall flow over its side and out through the openings. The current introduced is sufficiently strong to carry away the dead eggs into this trough, thus allowing them to escape, but is not strong enough to carry away the good eggs, which, being heavier than the dead ones, drop before reaching the trough. Great care must be taken to see that the flow of water is properly adjusted; otherwise many of the dead eggs may be retained or the good ones may be lost.

McDONALD'S UNIVERSAL HATCHING-JAR.

A glass jar, with metal cap, containing two circular openings. Through one of these, which is situated in the center, a glass tube for the introduction of water passes to within a short distance of the bottom of the jar. The other, situated near one side, contains a shorter glass tube, which serves as an outflow pipe. Height,

MCDONALD'S UNIVERSAL HATCHING-JAR—Continued.

15 inches; diameter, 6 inches; capacity, 5 quarts. Patented by Marshall McDonald, Washington, D. C., in 1882. U. S. Fish Commission. 57,186. The McDonald jar is successfully employed in the hatching of various species of heavy eggs. The water in entering is thrown against the bottom with considerable force, and is deflected upward around the sides of the jar. The eggs, which tend to settle to the bottom, are carried upward along the sides, thence inward toward the center, from which point they again sink to the bottom. The current is regulated to give the desired motion to the eggs. With heavy eggs like those of the salmon there is no motion, but the water coming from beneath tends to buoy the eggs upward, thus preventing any injurious pressure on the lower ones by the mass above. The outflow pipe is movable, and can be lowered to a point where the dead eggs, which are lighter than the good ones, come in contact with it and are carried off. By this means the eggs are kept comparatively free from the injurious effects of fungous growth or decaying eggs. The jar can be filled two-thirds full of eggs with very satisfactory results. Sixty thousand shad eggs are considered a fair quantity.

MCDONALD HATCHING JARS.

Photograph showing a nest of hatching-jars on the deck of steamer Lookout employed by the U. S. Fish Commission in shad-hatching in the Maryland and North Carolina waters. Size, 8 by 10 inches. Washington, D. C., 1882. 2,282. U. S. Fish Commission.

MCDONALD HATCHING-JARS.

Photograph showing a nest of hatching-jars on the deck of steamer Lookout employed by the U. S. Fish Commission in shad-hatching in the Maryland and North Carolina waters. Size, 30 by 40 inches. Enlarged by electric light from an 8 by 10 negative. Washington, D. C., 1882. 2,282. U. S. Fish Commission.

d. MECHANICAL APPARATUS.

PARKER'S ROTATING HATCHER.

A windlass connected with a system of cog-wheels, which communicate motion to the hatching-cylinder by means of an endless chain. The cylinder is made of perforated tin and wire cloth, to admit of a free circulation of water. On the inside, suspended from the axis, is the small basket or trough which contains the eggs. Diameter of hatching-cylinder, 10 inches;

PARKER'S ROTATING HATCHER—Continued.

width, 4 inches. Invented by Joel C. Parker, Grand Rapids, Mich. 39,470. Presented by Joel C. Parker. The motion is communicated to the windlass, and thence through the clock-work to the hatching cylinder, by means of a weight which is suspended from the end of the windlass rope. The weight is raised by means of a crank attached to the windlass, and the distance through which it falls is considerably shortened by the use of compound pulleys.

FERGUSON'S SUBMERGED PLUNGING BUCKET.

A cylindrical brass frame, the top and sides of which are covered with nickel-plated wire cloth of fine mesh. The top is movable, being fastened by bolts and thumb-screws. Diameter, 14 inches; length, 20 inches. Invented by T. B. Ferguson, in 1880. 57,156. U. S. Fish Commission. This bucket is suspended from the end of a lever, which is worked by machinery. It is submerged to the depth of several feet, a vertical motion being imparted by the lever to facilitate the change of water. It has been used for hatching both heavy and floating eggs.

FERGUSON'S PLUNGING BUCKET.

A cylinder of block-tin, with a movable wire-cloth bottom; 24 inches long and $18\frac{1}{2}$ inches in diameter. Invented by T. B. Ferguson, in 1877. U. S. Fish Commission. This bucket is suspended from the end of a lever so that the lower half or two-thirds is submerged. The motion of the lever is so adjusted as to give a quick drop and slow rise, the upward and downward movement being about 6 inches. A bucket as above described will hold 200,000 shad-eggs.

"HANGER," "CAM," AND "GUIDES."

For Ferguson's improvement in fish-hatching apparatus. In use on the U. S. steamer Fish Hawk for imparting a vertical motion to the hatching cans. Designed by T. B. Ferguson. 39,107. U. S. Fish Commission.

APPARATUS FOR ADHESIVE EGGS.**RICARDO'S SMELT-HATCHING BOX.**

A rectangular box, with a hinge-cover and perforated ends, covered with wire cloth. The inside of the box is filled with twigs, to which the adhesive eggs of the smelt are attached. Devised by George Ricardo, Hackensack, N. J. 39,102. U. S. Fish Commission. This box is placed in the river where the current

RICARDO'S SMELT-HATCHING BOX—Continued.

is strong, the water entering and escaping through the circular opening at the end.

APPARATUS FOR FLOATING EGGS.

a. APPARATUS FOR UTILIZING WAVE ACTION.

WAVE HATCHING BOX.

A rectangular box, with a wire cloth bottom and openings covered with the same material on the sides. Just below these, on the outside of the box, are wooden strips which serve as floats for holding the box in the proper position in the water. Length, 32 inches; width, 17 inches; depth, 16 inches; float, 3 inches wide. Invented by H. C. Chester, Noank, Conn., 1878. 57,161. U. S. Fish Commission. This box is employed in open streams for utilizing currents caused by the action of the waves. The box when placed in the water sinks to such a depth that the floats which extend around its exterior rest upon its surface. The upper portions of these floats make a slight angle with the surface, so that each wave as it comes in contact with the float runs up a slight incline, and after reaching the highest point passes down into the box, thus giving a constant circulation and the best possible motion to floating eggs.

b. APPARATUS REQUIRING RUNNING WATER.

CLARK'S ADHESIVE EGG APPARATUS.

c. MECHANICAL APPARATUS.

CHESTER'S SEMI-ROTATING HATCHER.

A cylindrical can, with five rectangular openings of wire cloth on the side and a bottom of the same material, to admit a circulation of water and to prevent the loss of eggs or the escape of fish after they have been hatched. Beneath the wire cloth bottom are four strips of tin radiating from the center and placed at such an angle that the rotation of the cylinder upon a vertical axis forces the water against them and up through the bottom. Invented by H. C. Chester, of Noank, Conn., in 1878. Presented by H. C. Chester. 57,160. Several of these are placed in a trough containing running water. Each bucket turns on a pivot, the power being applied from the engine by means of a horizontal arm fixed to its axis, and is kept constantly turning backward and forward through an arc of 30 degrees, thus creating a free circulation of water, which gives a motion to the eggs. Used chiefly for floating eggs like those of the cod.

HATCHING AND REARING ESTABLISHMENTS.

a. A LIST OF U. S. FISH COMMISSION HATCHING STATIONS.

The following is a list of the hatching stations operated by the U. S. Fish Commission in 1883:

1. Grand Lake Stream, Me. Station for collecting eggs of the Schoodic salmon (*Salmo salar* subsp. *sebago*).
2. Bucksport, Me. Station for collecting and hatching eggs of the Atlantic salmon (*Salmo salar*), and for hatching eggs of white-fish (*Coregonus clupeiformis*), to be distributed in the waters of the State.
3. Wood's Holl, Mass. Permanent coast station, which serves as a basis of operation for the scientific investigations of the Commission, and as a hatching station for eggs of the cod (*Gadus morrhua*) and other sea-fishes.
4. Cold Spring Harbor, Long Island, New York. Station for hatching eggs of various species of Salmonidæ for distribution in New York and vicinity.
5. Havre de Grace, Md. Station located on Battery Island, in the Susquehanna River, for the purpose of collecting and hatching eggs of the shad (*Clupea sapidissima*).
6. Washington, D. C.
 - a. National carp ponds. Ponds for the propagation of the three varieties of the carp (*Cyprinus carpio*), and the gold-fish (*Carassius auratus*), the golden ide (*Idus melanotus* var. *auratus*), and the tench (*Tinca vulgaris*).
 - b. Arsenal ponds. Ponds for the propagation of carp (*Cyprinus carpio*).
 - c. Navy-yard. Station for collecting and hatching eggs of the shad (*Clupea sapidissima*).
 - d. Central hatching station. A station fully equipped for scientific experiments connected with the propagation of fishes. The station is also provided with apparatus for hatching the eggs of all of the more important species, including light, heavy, and adhesive eggs. It is the principal distributing station of the Fish Commission for both eggs and young fish to all portions of the United States.
7. Wytheville, Va. A station for hatching eggs of brook-trout (*Salvelinus fontinalis*) and California trout (*Salmo irideus*).
8. Saint Jerome's Creek, Point Lookout, Md. A station for the artificial propagation of the oyster (*Ostrea virginica*), the Spanish mackerel (*Scomberomorus maculatus*), and the banded porgy (*Chatodipterus faber*).

9. Avoca, N. C. A station on Albemarle Sound, at the junction of Roanoke and Chowan Rivers, for collecting, hatching, and distributing eggs of the shad (*Clupea sapidissima*), alewife (*Clupea vernalis* and *estivalis*), and striped bass (*Roccus saxatilis*).
10. Northville, Mich. A hatching station for the development and distribution of eggs of the whitefish (*Coregonus clupeiformis*). This station is also provided with tanks and ponds for the spawning, hatching, and rearing of brook-trout (*Salvelinus fontinalis*) and California trout (*Salmo irideus*).
11. Alpena, Mich. A station for the collection and development of the eggs of the whitefish (*Coregonus clupeiformis*).
12. Baird, Cal.
 - a. Salmon station. A station on the McCloud River for the development and distribution of eggs of the California salmon (*Oncorhynchus chouicha*).
 - b. Trout ponds. A station near Baird for collecting, developing, and distributing eggs of the California trout (*Salmo irideus*).
13. Clackamas River, Oregon. A station on Columbia River for collecting and hatching eggs of the California salmon (*Oncorhynchus chouicha*).

b. MODELS OF HATCHING HOUSES.

DRUID HILL HATCHERY.

Model of hatching house built at Druid Hill Park, Baltimore, Md., in 1875, under the direction of Maj. T. B. Ferguson, then State commissioner of fisheries. The interior of this model is fitted up with miniature hatching apparatus, showing the arrangements for actual work. It contains Ferguson hatching jars, flights of Coste trays, Williamson hatching troughs, Clark hatching troughs, Holton hatching box, Green hatching box, aquaria, and reservoir tank, provided with filters and porcelain-lined sinks.

BUCKSPORT HATCHERY.

Model of hatching house at United States salmon-breeding station at Bucksport, Me., built under the direction of Mr. Charles G. Atkins, with movable roof for showing the interior, which is provided with troughs for hatching eggs of the salmon. The water enters the troughs through a feed trough along the side of the room and escapes by pipes through the floor.

NORTHVILLE HATCHING-HOUSE.

Model; scale, 1 inch to the foot. This model, which represents one of the most important hatching houses of the U. S. Fish Commission, shows the interior arrangement of the hatchery, the

NORTHVILLE HATCHING-HOUSE—Continued.

various kinds of apparatus, consisting of Clark troughs, hatching jars, nursery tanks, and sorting and packing tables, being represented. Frank N. Clark, superintendent. 57,168. U. S. Fish Commission. This hatchery was established by N. W. Clark for the propagation of brook-trout, but for some years it has been used by the U. S. Fish Commission as a collecting and developing station for eggs of the whitefish (*Coregonus clupeiformis*), and during the past season (1882-'83) not less than 50,000,000 eggs have been handled here. These were shipped to various localities in the United States and Europe.

THE UNITED STATES FISH-HATCHERY, ALPENA, MICH.

This hatchery was built in the fall of 1882. It is a one-story frame building, 30 feet wide by 60 feet long, having front and rear entrances, and amply lighted by 14 windows. The main floor includes the hatching room, and an office and sleeping apartment, 10 feet wide by 18 feet long, the space between this office and the opposite side being conveniently utilized for storage of tools, cans, egg-cases, &c. The hatchery is arranged and equipped with especial reference to the manipulation of the embryos and minnows of whitefish (*Coregonus clupeiformis*), the most valuable commercial and food species of the Great Lakes. Its nominal capacity is 100,000,000 eggs. The water is furnished by the Holly Water Works Company, of Alpena, being forced through wooden mains from Thunder Bay, an arm of Lake Huron. A 2-inch stream, under an average pressure of 20 pounds to the square inch, connects with the hatchery, the discharge being regulated by globe valves and ball cocks. The inlet pipe is laid underneath the building, near the front, and is tapped by four perpendicular arms, each discharging into the top tank of the four systems of tanks for operating the hatching vessels. Each system comprises a series of four rows of tanks, one row above the other. There are 2 tanks to each row, making 8 tanks to the series, or 32 in all, each of which is 15 feet long by 12 inches wide by 10 inches deep. One series is the exact counterpart of another. A row of faucets on either side of the top tank, into which the water first enters, supplies two rows of hatching jars or incubators, which rest on shelves placed across the second tank below and discharge into the tank between, which in turn feeds a second series of jars, and so on. In this way the four rows of a series operate three double rows of jars, the water being used three times over. Overflows are provided at the ends of the tanks which discharge into the next below. These series of tanks all connect with larger storage tanks for the minnows. Into these the current carries the minnows as

THE UNITED STATES FISH-HATCHERY, ALPENA, MICH.—Cont'd.

soon as hatched, and to prevent their escape the tanks are provided with overflows of finely perforated tin, in the shape of a box of sufficient dimensions to keep the minnows away from the strong current at the point of overflow. There are ten of these tanks provided for the reception of the minnows, the aggregate capacity being 7,000 gallons.

U. S. FISH COMMISSION STEAMER FISH HAWK.

A model of the U. S. Fish Commission steamer Fish Hawk, built by Pusey & Jones, of Wilmington, Del.

U. S. FISH COMMISSION STEAMER FISH HAWK.

Sectional model of the U. S. Fish Commission steamer Fish Hawk, on a scale of 2 inches to the foot, showing the hatching deck properly equipped with fish-hatching apparatus and the arrangement of hatching boxes on the outer side.

c. PHOTOGRAPHS OF HATCHING HOUSES AND PONDS.

Fixed hatcheries.

SCHOODIC HATCHERY.

Photographic view of the station of the U. S. Fish Commission for hatching eggs of the land-locked salmon. Size, 8 by 10 inches. Grand Lake Stream, Me., 1882. (770) 2,228. U. S. Fish Commission.

SCHOODIC HATCHERY.

Photographic view of the hatching station of the U. S. Fish Commission, used for hatching eggs of the land-locked salmon. (Looking northwest.) Size, 8 by 10 inches. Grand Lake Stream, Me., 1882. (773) 2,231. U. S. Fish Commission.

SCHOODIC HATCHING STATION.

Photographic view of the principal buildings at the station of the U. S. Fish Commission, where eggs of the land-locked salmon are taken and hatched. (Looking southwest.) Size, 8 by 10 inches. Grand Lake Stream, Me., 1882. (774) 2,232. U. S. Fish Commission.

SCHOODIC HATCHING STATION.

A general photographic view of the fish inclosures, spawning-house, and watch-house at the U. S. Fish Commission hatchery. Size, 30 by 40 inches. Enlarged by electric light from an 8 by 10 negative. Grand Lake Stream, Me., 1882. (771) 2,229. U. S. Fish Commission.

SCHOODIC HATCHING STATION.

A general photographic view of the fish inclosures, spawning-house, and watch house at the U. S. Fish Commission hatchery. Size, 8 by 10 inches. Grand Lake Stream, Me., 1882. (771) 2,229. U. S. Fish Commission.

SCHOODIC HATCHERY.

A photographic view of the lower floor of the U. S. Fish Commission hatchery, showing the apparatus employed in hatching eggs of the land-locked salmon. Size, 8 by 10 inches. Grand Lake Stream, Me., 1882. (775) 2,233. U. S. Fish Commission.

SCHOODIC HATCHERY.

A photographic view of the interior second story of the U. S. Fish Commission hatchery for salmon at Grand Lake Stream. Size, 8 by 10 inches. Grand Lake Stream, Me., 1882. (760) 2,220. U. S. Fish Commission.

SCHOODIC HATCHERY.

A photographic view of the lower floor of the U. S. Fish Commission hatchery, showing the apparatus employed in hatching eggs of the land-locked salmon. Size, 30 by 40 inches. Enlarged by electric light from an 8 by 10 negative. Grand Lake Stream, Me., 1882. (775) 2,233. U. S. Fish Commission.

FISH INCLOSURE.

Photograph of the lower barrier of the inclosure built at Bucksport for retaining the unripe salmon until the eggs have matured. Size, 8 by 10 inches. Bucksport, Me., 1882. (755) 2,216. U. S. Fish Commission.

FISH INCLOSURE.

Photograph of the lower barrier of the inclosure built at Bucksport for retaining the unripe salmon until the eggs have matured. Size, 30 by 40 inches. Enlarged by electric light from an 8 by 10 negative. Bucksport, Me., 1882. (755) 2,216. U. S. Fish Commission.

SALMON HATCHERY.

Photographic view of the hatching house used by the U. S. Fish Commission in the propagation of the California salmon on the McCloud River. Size, 8 by 10 inches. Baird, Cal., 1882. (687) 2,163. U. S. Fish Commission.

HATCHING STATION.

Photograph showing the mess-house for use of the employés at the U. S. salmon hatchery on the McCloud River, as seen from Rattlesnake Bar. Size, 8 by 10 inches. Baird, Cal., 1882. (696) 2,170. U. S. Fish Commission.

SALMON STREAM.

Photographic view of the McCloud River, Cal., as seen from Colchoolooloo's Rancheria (near United States salmon-hatching station), looking down stream. Size, 8 by 10 inches. Baird, Cal., 1882. (684) 2,160. U. S. Fish Commission.

TROUT PONDS.

Photographic view of the buildings and ponds used by the U. S. Fish Commission in the artificial propagation of California trout. Size, 8 by 10 inches. Near Baird, Cal., 1882. (700) 2,172. U. S. Fish Commission.

SALMON HATCHERY.

Photograph of the hatching house used by the U. S. Fish Commission in the propagation of the California salmon on the McCloud River. Size, 30 by 40 inches. Enlarged by electric light from an 8 by 10 negative. Baird, Cal., 1882. (687) 2,163. U. S. Fish Commission.

SALMON STREAM.

Photographic view of McCloud River, Cal., as seen from Colchoolooloo's Rancheria, near United States hatching station, looking down stream. Size, 30 by 40 inches. Enlarged by electric light from an 8 by 10 negative. Baird, Cal., 1882. (684) 2,160. U. S. Fish Commission.

SALMON SPAWNING-GROUNDS.

Photograph showing an enormous school of salmon ascending the river on their way to their spawning-grounds. Size, 30 by 40 inches. Enlarged by electric light from an 8 by 10 inch negative. Pacific coast, 1882. U. S. Fish Commission.

SALMON SPAWNING-GROUNDS.

Photographic view of McCloud River from "Lone Rock," near U. S. salmon hatchery. Size, 8 by 10 inches. Baird, Cal., 1882. (705) 2,175. U. S. Fish Commission.

HAVRE DE GRACE HATCHING STATION.

Photograph of buildings employed by the U. S. Fish Commission for hatching eggs of the shad, and the breakwater which has been built to prevent the floating hatcheries and steamers from being damaged while lying at the hatchery. Size, 8 by 10 inches. Havre de Grace, Md., 1882. (667) 2,152. U. S. Fish Commission.

HAVRE DE GRACE HATCHING STATION.

Near photographic view of the buildings used by the U. S. Fish Commission for hatching shad. Size, 8 by 10 inches. Havre de Grace, Md., 1882. (674) 2,151. U. S. Fish Commission.

HAVRE DE GRACE HATCHING STATION.

Distant photographic view of the buildings used by the U. S. Fish Commission for hatching shad. Size, 8 by 10 inches. Havre de Grace, Md., 1882. (665) 2,150. U. S. Fish Commission.

HATCHING STATION.

Photograph showing the boats employed at the U. S. Fish Commission shad station, with a view of the locality where the fish are taken in the background. Size, 8 by 10 inches. Havre de Grace, Md., 1882. (670) 2,154. U. S. Fish Commission.

SHAD INCLOSURE.

Photograph of the harbor or pond at the hatching station of the U. S. Fish Commission for penning unripe shad until their eggs are sufficiently developed to enable them to be utilized for hatching purposes. Size, 8 by 10 inches. Havre de Grace, Md., 1882. (669) 2,153. U. S. Fish Commission.

SHAD INCLOSURE.

Photograph showing the harbor or pond at the hatching station of the U. S. Fish Commission for penning unripe shad until their eggs are sufficiently developed to enable them to be utilized for hatching purposes. Size, 30 by 40 inches. Enlarged by electric light from an 8 by 10 negative. Havre de Grace, Md., 1882. (669) 2,153. U. S. Fish Commission.

CENTRAL HATCHING STATION.

Photograph of the interior of the U. S. Fish Commission hatchery, showing the room fitted with McDonald jars for hatching eggs of the shad. Size, 8 by 10 inches. Washington, D. C., 1882. 2,240. U. S. Fish Commission.

CENTRAL HATCHING STATION.

Photograph of the interior of the U. S. Fish Commission hatchery, showing the room fitted with McDonald jars for hatching eggs of the shad. Size, 30 by 40 inches. Enlarged by electric light from an 8 by 10 negative. Washington, D. C., 1882. 2,240. U. S. Fish Commission.

CARP PONDS.

General photographic view of the U. S. Fish Commission carp ponds. Taken from an elevation near the Washington Monument. Size, 8 by 10 inches. Washington, D. C., 1882. (620) 2,127. U. S. Fish Commission.

CARP PONDS.

General photographic view of U. S. Fish Commission carp ponds. Similar to (620) 2,127, but from a different point. Size, 8 by 10 inches. Washington, D. C., 1882. (621) 2,128. U. S. Fish Commission.

CARP PONDS.

Photograph showing several of the smaller ponds and principal buildings at the U. S. Fish Commission carp ponds, as seen from an elevation. Size, 8 by 10 inches. Washington, D. C., 1882. (628) 2,131. U. S. Fish Commission.

CARP PONDS.

General photographic view of the U. S. Fish Commission carp ponds, looking north with a wide-angle lens. Size, 8 by 10 inches. Washington, D. C., 1882. (619) 2,126. U. S. Fish Commission.

CARP PONDS.

General photographic view of the U. S. Fish Commission carp ponds. Taken from an elevation near the Washington Monument. Size, 30 by 40 inches. Enlarged by electric light from an 8 by 10 negative. Washington, D. C., 1882. (620) 2,127. U. S. Fish Commission.

NORTHVILLE HATCHING STATION.

A photographic view of the right side of the Northville hatchery, used by the U. S. Fish Commission for hatching eggs of the whitefish, and, to a limited extent, for salmon eggs sent from California, and for eggs of grayling and trout taken from fish kept in the ponds at the hatchery. Size, 8 by 10 inches. Northville, Mich., 1882. (730) 2,194. U. S. Fish Commission.

NORTHVILLE HATCHING STATION.

A photographic view of the left side of the Northville hatchery, used by the U. S. Fish Commission for hatching eggs of the whitefish, and, to a limited extent, for salmon eggs sent from California, and for eggs of grayling and trout taken from fish kept in the ponds at the hatchery. Size, 8 by 10 inches. Northville, Mich., 1882. (731) 2,195. U. S. Fish Commission.

NORTHVILLE HATCHERY.

Photograph of the interior of the U. S. Fish Commission hatchery at Northville, showing the apparatus employed in hatching the whitefish and other species. Size, 8 by 10 inches. Northville, Mich., 1882. (736) 2,200. U. S. Fish Commission.

NORTHVILLE HATCHING STATION.

A photographic view of the right side of the Northville hatchery, used by the U. S. Fish Commission for hatching eggs of the whitefish, and, to a limited extent, for salmon eggs sent from California, and for eggs of grayling and trout taken from fish kept in the ponds at the hatchery. Size, 30 by 40 inches. Enlarged by electric light from an 8 by 10 negative. Northville, Mich., 1882. (730) 2,194. U. S. Fish Commission.

NORTHVILLE HATCHING STATION.

Photographic view of the left side of the Northville hatchery, used by the U. S. Fish Commission for hatching eggs of the whitefish, and, to a limited extent, for salmon eggs sent from California, and for eggs of grayling and trout taken from fish kept in the ponds at the hatchery. Size, 30 by 40 inches. Enlarged by electric light from an 8 by 10 negative. Northville, Mich., 1882. (731) 2,195. U. S. Fish Commission.

NORTHVILLE HATCHERY.

Photograph of the interior of the U. S. Fish Commission hatchery at Northville, showing the apparatus employed in hatching the whitefish and other species. Size, 30 by 40 inches. Enlarged by electric light from an 8 by 10 negative. Northville, Mich., 1882. (736) 2,200. U. S. Fish Commission.

ALPENA HATCHERY.

Photograph of the interior of the U. S. Fish Commission whitefish hatchery, showing the apparatus employed in hatching eggs of that species. Size, 8 by 10 inches. Alpena, Mich., 1882. (781) 2,236. U. S. Fish Commission.

SANDUSKY HATCHERY.

Photograph of the interior of the whitefish hatchery belonging to the Ohio Fish Commission, showing the apparatus employed in hatching eggs of the whitefish. Size, 8 by 10 inches. Sandusky, Ohio, 1882. (735) 2,199. U. S. Fish Commission.

SANDUSKY HATCHERY.

Photograph of the interior of the whitefish hatchery belonging to the Ohio Fish Commission, showing the apparatus employed in hatching eggs of the whitefish. Size, 30 by 40 inches. Enlarged by electric light from an 8 by 10 negative. Sandusky, Ohio, 1882. (735) 2,199. U. S. Fish Commission.

Movable hatcheries.

FLOATING HATCHERY.

Photograph of the hatching barge and steamer Fish Hawk belonging to the U. S. Fish Commission, and employed in hatching shad and other species of food-fishes. Size, 8 by 10 inches. Havre de Grace, Md., 1882. (664) 2,149. U. S. Fish Commission.

HATCHING BARGE.

Photograph of the interior of U. S. Fish Commission hatching barge employed in the shad-work in Maryland, Virginia, and North Carolina. The barge is a floating hatchery, being pre-

HATCHING BARGE—Continued.

ferred to a stationary one, as it can be towed to different localities during the height of the spawning season, thus obviating the necessity of having several outfits of hatching apparatus, the one sufficing for the entire work. The barge is fitted with Bell and Mather cones, formerly extensively used in hatching shad eggs. Size, 8 by 10 inches. Avoca, N. C., 1877. 2,249. U. S. Fish Commission.

HATCHING BARGE.

Photograph of the interior of U. S. Fish Commission hatching barge, employed in the shad-work in Maryland, Virginia, and North Carolina. The barge is a floating hatchery, being preferred to a stationary one, as it can be towed to different localities during the height of the spawning season, thus obviating the necessity of having several outfits of hatching apparatus, the one sufficing for the entire work. The barge is fitted with Bell and Mather cones, formerly extensively used in hatching shad eggs. Size, 30 by 40 inches. Enlarged by electric light from an 8 by 10 negative. Avoca, N. C., 1877. 2,249. U. S. Fish Commission.

HATCHING STEAMER FISH HAWK.

Photograph of the steamer Fish Hawk, employed by the U. S. Fish Commission for scientific investigations and for hatching purposes. The steamer is fitted with hatching apparatus employed in hatching eggs of the shad, in the waters of Maryland and North Carolina, during a portion of the year. Size, 8 by 10 inches. Washington, D. C., 1882. 2,255. U. S. Fish Commission.

HATCHING STEAMER FISH HAWK.

Photograph of the steamer Fish Hawk, employed by the U. S. Fish Commission for scientific investigation and for hatching purposes. The steamer is fitted with hatching apparatus, employed in hatching eggs of the shad, in the waters of Maryland and North Carolina during a portion of the year. Size, 30 by 40 inches. Enlarged by electric light from an 8 by 10 negative. Washington, D. C. 2,255. U. S. Fish Commission.

d. FISH-REARING ESTABLISHMENTS.

STONE & HOOPER'S TROUT NURSERY.

A trough, or sluice-way, covered with lattice-work to admit the light. The upper end, through which the water enters, is covered with wire cloth to prevent the escape of the fish, and the outflow-spout at the lower end is similarly protected. Designed by Stone & Hooper. 29,380. Collected by Livingston Stone.

e. MAPS SHOWING TOPOGRAPHY OF GROUNDS ADJACENT TO FISH-CULTURAL ESTABLISHMENTS.

SCHOODIC SALMON-BREEDING STATION.

Plan No. 2, showing hatching-park, fishing-grounds, and principal buildings. Scale, 1 inch = 60 feet.

SCHOODIC SALMON BREEDING STATION.

Plan 4, embracing plan of hatchery No. 3. Scale, 1 inch = 2 feet.

PENOBSCOT SALMON-BREEDING STATION.

Hatchery and watchman's room, plan and elevation. Scale, 1 inch = 2 feet.

PENOBSCOT SALMON-BREEDING STATION.

Plan of inclosure for parent salmon. Scale, 1 inch = 50 feet.

CARP PONDS AT WASHINGTON, D. C.

Plan of west and north pond; gives elevation, bench-marks, and areas. Surveyed by C. Junken, September, 1882. Scale, 1 inch = 30 feet.

GREAT FALLS, MARYLAND SIDE, POTOMAC RIVER.

Survey by Eugene Ellicott, November 25, 1882, to January 10, 1883, for U. S. Fish Commission. Scale, 1 inch = 50 feet.

SAINT JEROME CREEK.

West shore of Chesapeake Bay, Point Lookout to Point No-Point; surveyed between 1848 and 1856; copied from U. S. Coast and Geodetic Survey Office for U. S. Fish Commission January 4, 1882. Scale, $\frac{1}{20000}$.

MCCLLOUD RIVER TROUT PONDS.

General plan of ponds, buildings, &c., with dimensions. Scale, 1 inch = 30 feet.

ACCESSORIES TO HATCHING APPARATUS.

AINSWORTH'S SPAWNING-RACE.

Model of natural spawning-race, invented by Stephen H. Ainsworth, West Bloomfield, N. Y. Not patented. This device consists of two sets of frames, covered with wire cloth, placed in two layers; the upper one has meshes coarse enough to allow the eggs to pass through, and is covered with coarse gravel, in which the fish make nests and spawn. The upper screens are then lifted and the ova taken from the lower ones. 42,936. Gift of S. H. Ainsworth.

COLLINS'S SPAWNING-RACE.

Model of spawning-race similar to the Ainsworth spawning-race, but with an endless revolving wire cloth apron in place of the lower trays, and a movable pan, which receives the eggs. The advantages of this spawning-race are saving of time and labor, and convenience of manipulation, as the men are not obliged to go into the water in order to secure the eggs. Patented by A. S. Collins, U. S. Fish Commission.

MARBLEIZED SPAWNING-PANS.

Pans of marbleized iron of various sizes. U. S. Fish Commission. 57,155. Used for receiving and impregnating eggs of different species. These pans can be advantageously used in salt water, as they are not liable to rust.

COMMON SPAWNING PANS.

Ordinary tin pans with flaring sides, used in the manipulation of eggs of fresh-water fishes. 12 inches in diameter and 3 inches deep. U. S. Fish Commission. 39,116.

EGG-DIPPER.

A seamless tin dipper. Diameter of bowl, 5 inches; depth of bowl, $2\frac{1}{2}$ inches; length of handle, 10 inches. U. S. Fish Commission. 42,938. Used in changing water on eggs while *en route* for the hatchery.

WOODEN NIPPERS FOR REMOVING DEAD EGGS.

Devised by F. Mather. 26,915. U. S. Fish Commission.

WOODEN NIPPERS, WITH WIRE LOOPS, FOR REMOVING DEAD EGGS.

Devised by M. A. Green. 39,113. New York Fish Commission.

SHAD SKIMMING-NET.

A rectangular frame of galvanized iron, covered with coarse-mesh netting, and provided with a wooden handle, for removing dead shad eggs from hatching-boxes and cones. Net, 6 inches long and 5 inches wide; handle, 6 inches long. Devised by M. A. Green, Rochester, N. Y. 39,114 (a). Presented by the New York Fish Commission.

TROUGH-NET.

A semicircular galvanized iron frame covered with fine-meshed netting, and provided with a wooden handle, for removing young salmon and other smaller fish from the hatching and feeding troughs. Presented by T. B. Ferguson, Baltimore, Md. 39,115. U. S. Fish Commission.

TROUGH-NET.

A semicircular galvanized-iron frame covered with cloth, and provided with a wooden handle, for removing young salmon and other smaller fish from the hatching and feeding troughs. Presented by T. B. Ferguson, Baltimore, Md. U. S. Fish Commission.

CLEANING-NET.

A piece of fine-mesh netting stretched upon a rectangular wire frame and provided with a wooden handle. Frame, $5\frac{1}{2}$ inches long and $4\frac{1}{2}$ inches wide; handle, 13 inches long. In general use. 39,114. U. S. Fish Commission.

REFLECTOR LANTERN.

A patent tubular lantern, provided with a movable reflector of tin. Frame of lantern, 15 inches high; diameter of reflector, 16 inches. 39,118. U. S. Fish Commission. This lantern is extensively used by the United States Fish Commission when collecting and impregnating eggs of the shad and other species at the fishing shores, and from the boats of the gill-netters at night. It is occasionally employed at the hatchery when manipulating the eggs. The reflector is movable and can be taken off when not needed. It is provided with grooves at the sides, to correspond with the lantern tubes, which hold it in position.

WATER-WHEEL.

Photograph of the wheel which supplies the U. S. salmon-breeding station on the McCloud River with water. Also, of the dam which furnishes the current for turning the wheel. Size, 8 by 10 inches. Baird, Cal., 1882. (680) 2,157. U. S. Fish Commission.

WATER-WHEEL.

Photograph of the wheel which supplies the U. S. salmon-breeding station on the McCloud River with water. Also, of the dam which furnishes the current for turning the wheel. Size, 30 by 40 inches. Enlarged by electric light from an 8 by 10 negative. Baird, Cal., 1882. (680) 2,157. U. S. Fish Commission.

EGG REFRIGERATOR.

Drawing of a prospective refrigerator building, to be constructed at the Northville hatchery of the U. S. Fish Commission, for storing eggs of the whitefish to retard their development for several months, or until such time as room can be made for them in the hatching house. Size, 30 by 40 inches. Washington, D. C., 1882. Henry W. Elliott.

8. TRANSPORTATION APPARATUS AND ACCESSORIES.

a. APPARATUS FOR TRANSPORTING FRY.

FISH COMMISSION TRANSPORTATION CAN.

A cylindrical can of block-tin, the top of which is contracted and provided with a cover to prevent splashing of water while in transit. Height, 24 inches; diameter, 14 inches; capacity, 12 gallons. U. S. Fish Commission. 26,911. This can is more extensively used than any other kind for the transportation of young shad, and proves very satisfactory. The contraction of the neck, giving only a limited free surface, prevents any violent agitation of the water.

CLARK'S FISH-TRANSPORTATION CAN.

A cylindrical tin can with 20 circular trays of perforated tin. Diameter, 6 inches; height, 9 inches. Designed by Frank N. Clark, Northville, Mich. 57,165. U.S. Fish Commission. The trays rest one upon the other, a tube, which extends from the top to the bottom of the can, passing through the center of each. The water is introduced through this tube, passes to the bottom and up through the eggs on its way to the outlet near the top of the can. Each tray will accommodate one thousand salmon.

FERGUSON'S TRANSPORTATION CAN.

A cylinder of block-tin, with movable top fitted with a rubber rim and thumb-screws for rendering it water-tight. 24 inches high and 14 inches in diameter. Capacity, 12 gallons. This can is provided with nipple attachments by means of which several can be connected so that a current of water will flow from one to another, thus giving a circulation during transit. This can carries from 15,000 to 30,000 shad.

STONE'S CONICAL TRANSPORTATION BOX.

Model. A truncated cone of tin with perforated cover, capable of holding ice for reducing temperature of water in can. Height, 12 inches; diameter, 11 inches at base and 6 inches at top. Designed by Livingston Stone. 29,379. Presented by Livingston Stone. This can is used in the transportation of various species of salmonidæ. Its principal advantages are derived from its peculiar shape, which, according to the inventor, facilitates the aeration of water. Cans of similar shape with the cone produced into a long funnel-shaped cover are frequently used.

ROGERS'S TRANSPORTATION CAN.

A cylindrical tin can provided with a false bottom one inch above the other. In the center of the upper bottom is a circular open-

ROGERS'S TRANSPORTATION CAN—Continued.

ing covered with wire cloth to admit of circulation of the water. On either side of the can is a tube of tin extending through the upper bottom. One of these has a funnel-shaped top and serves as a feed-tube for introducing fresh water; the other is provided with a pump by means of which stale water can be removed. Diameter, $9\frac{1}{2}$ inches; height, 10 inches. Invented by Charles W. Rogers, Waukegan, Ill. 26,281. Presented by Charles W. Rogers.

AUTOMATIC TRANSPORTATION CAN.

A cylindrical can of copper, with contracting neck to prevent splashing, and a movable cover, the center of which contains a brass plate with tubular openings, through which the water enters and escapes. Height, 18 inches; diameter, 14 inches. U. S. Fish Commission. 57,175. To the inner end of the outflow-pipe is attached a wire frame, covered with cloth, which serves as a strainer to prevent the escape of the fish. The outer end of the other tube communicates with a reservoir of water by means of rubber tubing. When several cans are fed by the same reservoir they are placed side by side and so connected that the water passes readily from one to the other.

AUTOMATIC TRANSPORTATION CAN.

A cylinder of tin, strengthened by a heavy brass frame. The can is provided with a movable cover, the center of which contains a brass plate with tubular openings, through which the water enters and escapes. Height, 13 inches; diameter, 14 inches. U. S. Fish Commission. 57,174. To the inner end of the outflow-pipe is attached a wire frame, covered with cloth, which serves as a strainer to prevent the escape of the fish. The outer end of the other tube communicates with a reservoir of water by means of rubber tubing. When several cans are fed by the same reservoir they are placed side by side and so connected that the water passes readily from one to the other. Cans of this size hold about 20,000 shad.

CARP TRANSPORTATION CAN.

A cylindrical tin can, incased in wood, with the top slightly contracted to prevent splashing. Diameter, 12 inches; height, 18 inches; capacity, 10 gallons. U. S. Fish Commission. 57,172. This can holds from 30 to 50 carp 3 inches in length. It was formerly extensively used in the transportation of this species, but it is now seldom employed, as small pails are found more convenient, less expensive, and equally satisfactory.

CARP TRANSPORTATION CAN.

A cylindrical tin can, incased in wood, with the top slightly contracted to prevent splashing. Diameter, 10 inches; height, 13½ inches; capacity, 6 gallons. U. S. Fish Commission. 57,171. This can holds 10 three-inch carp. It was formerly extensively used in the transportation of this species, but it is now seldom employed, as small pails are found more convenient, less expensive, and equally satisfactory.

CARP TRANSPORTATION CRATE.

A wooden crate, provided with 16 two-quart tin pails, arranged in two tiers, separated by a wooden partition. Length, 32 inches; width, 18 inches; depth, 14 inches. Designed by Marshall McDonald in February, 1881. U. S. Fish Commission. 57,173. This crate has now almost wholly superseded the more cumbersome and expensive cans. In shipping, cans intended for different persons in the same section are placed together in the same crate, each being provided with a tag bearing the name of the consignee. On its arrival at the proper railroad center the crate is opened by the employés of the express company and the cans reshipped to the parties for whom they are intended.

b. PHOTOGRAPHS ILLUSTRATIVE OF THE METHOD OF TRANSPORTING FRY.

SHIPPING FISH.

Photograph showing a number of transportation cans, containing young shad, at central hatchery of U. S. Fish Commission. Two men are engaged in removing stale water by means of a siphon and supplying fresh water, while others are employed in loading the fish into a wagon for delivery to the railway authorities. Size, 8 by 10 inches. Washington, D. C., 1882 2,241. U. S. Fish Commission.

SHIPPING SHAD.

Photograph of the employés of the U. S. Fish Commission at work loading cans of young shad on a steam-launch which carries them to the river landings for shipment. The launches are also employed in distributing the men at the different fisheries and bringing them with their take of eggs to the hatchery after their seines have been hauled. Size, 8 by 10 inches. Avoca, N. C., 1877. 2,246. U. S. Fish Commission.

PLANTING SHAD.

Photograph of the employés of the U. S. Fish Commission turning young shad that have been artificially hatched into the waters of Albemarle Sound. Size, 8 by 10 inches. Avoca, N. C., 1877. 2,247. U. S. Fish Commission.

SHIPPING CARP.

A photograph of the U. S. Fish Commission car, employed in distributing young fish to all portions of the United States, showing men engaged in loading it with carp at the central hatching station. Size, 8 by 10 inches. Washington, D. C., 1882. 2,242. U. S. Fish Commission.

FISH TRANSPORTATION CANS.

Photograph showing a wagon-load of empty cans on their way to the United States carp ponds, to be filled with young carp for shipment to the rivers of the interior. Size, 8 by 10 inches. Washington, D. C., 1882. (618) 2,125. U. S. Fish Commission.

CLEANING TRANSPORTATION CANS.

Photograph of the employés of the U. S. Fish Commission at the Avocashad station, cleaning cans before filling them with young shad, which are to be sent by rail to the interior of the country. Fish cans are carefully cleaned after each trip to remove all slime, dirt, and rust that may have collected. Size, 8 by 10 inches. Avoca, N. C., 1877. 2,245. U. S. Fish Commission.

STEAM LAUNCH.

Photograph of a small launch employed by the U. S. Fish Commission, at its Avoca hatchery, for collecting eggs and carrying young fish. Size, 8 by 10 inches. Avoca, N. C., 1877. 2,248. U. S. Fish Commission.

SHIPPING FISH.

Photograph showing a number of transportation cans containing young shad, at central hatchery of the U. S. Fish Commission. Two men are engaged in removing stale water by means of a siphon, and supplying fresh water, while others are employed in loading the fish into a wagon for delivery to the railway authorities. Size, 30 by 40 inches. Enlarged by electric light from an 8 by 10 negative. Washington, D. C., 1882. 2,241. U. S. Fish Commission.

SHIPPING CARP.

Photographic view of the U. S. Fish Commission car, employed in distributing young fish to all portions of the United States. Showing men engaged in loading it with carp at the central hatching station. Size, 30 by 40 inches. Enlarged by electric light from an 8 by 10 negative. Washington, D. C., 1882. 2,242. U. S. Fish Commission.

FISH TRANSPORTATION CANS.

Photograph showing a wagon load of empty cans on their way to the United States carp ponds, to be filled with young carp for

FISH TRANSPORTATION CANS—Continued.

shipment to the rivers of the interior. Size, 30 by 40 inches. Enlarged by electric light from an 8 by 10 negative. Washington, D. C., 1882. (618) 2125. U. S. Fish Commission.

c. APPARATUS FOR TRANSPORTING SPAWNING FISH.

TOURING CAR.

Model. A car employed at the Gloucester hatching station of the U. S. Fish Commission for transporting spawning codfish alive from the fishing-grounds to the hatchery. Length, 9 inches; breadth, 3 inches; depth, $\frac{3}{4}$ inch. 22,221. U. S. Fish Commission.

SALMON DORY-CAR.

Model. A fishing-dory, the central portion of which is partitioned off and covered with netting for retaining the fish while in transit to the breeding-pens. Just in front of the partition, which is made of slats, are two large circular openings provided with wooden slides for admitting fresh water. In the rear of the compartment are other openings similarly arranged. Designed by Charles G. Atkins, of Bucksport, Me. 57,162. U. S. Fish Commission. This live-car is employed at the Penobscot breeding-station for conducting the salmon from the weirs to the hatchery, a distance of several miles, and is frequently used as a pen for the salmon for several days or weeks.

SALMON CAR.

Model, scale 4 inches to the foot ($\frac{1}{3}$). A water-tight box provided with a sliding-cover and handles for carrying fish overland from the fishing shores to the hatchery. Designed by C. G. Atkins, Bucksport, Me. 26,932. Presented by C. G. Atkins. This box is filled with water and the salmon placed in it, after which it is carted a distance of several miles, the salmon usually arriving in good condition.

FISH CARS.

Photograph showing a group of dories made into live-cars for transporting spawning salmon and for retaining them for a few days during the hatching season until the eggs are in condition to be taken. Size, 8 by 10 inches. Bucksport, Me., 1882. (757) 2,218. U. S. Fish Commission.

SALMON CAR.

Photograph of a towing-car used by the employés of the Bucksport hatching station for transporting unripe salmon from the fishing weirs in the Penobscot River to the inclosures at the

SALMON CAR—Continued.

hatchery, where they are to be retained until the eggs are sufficiently developed for hatching purposes. Size, 8 by 10 inches. Bucksport, Me., 1882. (754) 2,215. U. S. Fish Commission.

FISH CARS.

Photographic view of a group of dories made into live-cars for transporting salmon and for retaining them for a few days during the hatching season until the eggs are in condition to be taken. Size, 30 by 40 inches. Enlarged by electric light from an 8 by 10 negative. Bucksport, Me., 1882. (757) 2,218. U. S. Fish Commission.

SALMON CAR.

Photographic view of a towing-car used by the employés of the Bucksport hatching station for transporting unripe salmon from the fishing weirs in the Penobscot River to the inclosures at the hatchery, where they are to be retained until the eggs are sufficiently developed for hatching purposes. Size, 30 by 40 inches. Enlarged by electric light from an 8 by 10 negative. Bucksport, Me., 1882. (754) 2,215. U. S. Fish Commission.

d. APPARATUS FOR CARRYING EGGS.

TRANSPORTATION BUCKET.

A tin bucket with flaring sides, into which impregnated eggs are introduced, for convenience in carrying. Diameter at top, 11 inches; at bottom, 6 inches; depth, 9 inches; capacity, 2 gallons. U. S. Fish Commission. 1,785.

WROTEN BUCKET.

A tin bucket having spouts which communicate with a closed chamber extending entirely around the bottom. Invented by William H. Wroten, June, 1877. U. S. Fish Commission. 39,119. Diameter at top, 15 inches; at bottom, $11\frac{1}{4}$ inches; height, 11 inches. The water is introduced through the spouts at the sides, passing to the bottom and into the interior of the bucket; thence upward through the eggs and out through the perforated tin which surrounds the top. This bucket was invented for convenience in changing the water and handling the eggs while carrying them from the fishing-shore to the hatchery. Eggs have occasionally been allowed to remain in it until hatched, though it is more successful as a transportation bucket than a hatching can.

HAMLIN'S EGG-TRANSPORTATION CAN.

Height, $19\frac{1}{2}$ inches; diameter, 13 inches. Devised by William H. Hamlin. Baltimore, Md., 1879. 57,151. U. S. Fish Com-

HAMLIN'S EGG-TRANSPORTATION CAN.—Continued.

mission. This apparatus consists of a cylindrical tin can, the bottom part of which has sloping sides, the top being provided with a wire-cloth strainer and tin spout, to enable the water to be more easily poured. It has handles for convenience in carrying. Designed for use in boats when carrying shad-eggs across rough water, the sides being high to prevent slopping.

TAYLOR'S EGG-TRANSPORTATION CAN.

Height, 19½ inches; diameter, 13 inches. Invented by Thomas Taylor. Newberne, N. C., 1878. 57,153. U. S. Fish Commission. The can is provided with pans or trays for holding the eggs. In the center of the can, extending from top to bottom, is a supply tube, an inch in diameter, with holes opposite each tray. This tube extends upward between the tray and cover, water being introduced at the top by means of a funnel passing out through the jets upon the eggs, and dripping through the different trays to the bottom of the can, where it escapes through numerous small openings around the sides. This apparatus has been successfully used in the transportation of shad-eggs from distant fishing-shores to the hatchery. It marks the transition period between the old, or wet, and the new, or dry, method of transportation; for by it water was thrown upon the eggs at frequent intervals, though they were not at any time immersed in it.

MCDONALD'S EGG-TRANSPORTATION CRATE.

A crate containing eighteen shallow trays or wooden frames, with wire-cloth bottoms, incased in canvas, and secured by frames connected by leather straps. Length, 16 inches; height, 15 inches; width, 14 inches. Invented by Marshall McDonald, May, 1881. U. S. Fish Commission. 57,150. This crate is used for transporting the eggs of the shad for a distance of 50 to 100 miles. The bottoms of the trays are covered with wet cloths, upon which the eggs are spread. Each tray holds from 10,000 to 15,000 shad eggs. When filled, they are incased in the cloth cover, securely strapped together, and shipped by boat or rail to the hatchery. This apparatus marks the beginning of the dry transportation of shad eggs, and has been successfully used in the work of the U. S. Fish Commission for the past two years.

CLARK'S WHITEFISH CRATE.

Model, scale 3 inches to the foot. A box containing a crate of ten trays, surrounded by sawdust to prevent sudden change of temperature. Designed by Frank N. Clark, Northville, Mich. U. S.

CLARK'S WHITEFISH CRATE—Continued.

Fish Commission. 57,167. This crate is used only for short distances, and chiefly for sending eggs from the fishing shores to the hatchery, a distance of 20 to 50 miles. The trays are provided with canton-flannel bottoms, upon which the eggs are placed; these in turn are covered with a layer of cloth, the remaining space in the tray being filled with wet moss.

MCDONALD'S EGG-REEL.

A simple contrivance by means of which adhesive eggs are attached to cotton cord, to facilitate hatching and transporting. Frame: height, 23 inches; width, 14 inches; length of reel, 12 inches; breadth of reel, 10 inches; diameter of funnel, 6 inches. Invented by Marshall McDonald. 1882. 57,152. U. S. Fish Commission. To be used in transporting eggs of the alewife and perch. The square box at the bottom contains a ball of twine, the end of which passes up through the opening in the funnel and is fastened to the reel. The eggs are placed with water in the funnel, and, as the cord is drawn through them by means of the crank and reel, quantities of them adhere to it and are reeled upon the frame. When a frame has been filled it is transported, in a crate holding twelve of them, to the hatchery, where the strings with the eggs are removed and suspended in the proper hatching apparatus. If desirable, the entire frame with its contents can be placed in the hatching apparatus.

CLARK'S EGG-TRANSPORTATION CASE.

Model, scale 4 inches to the foot. A wooden case containing twenty trays, each consisting of a piece of canton-flannel stretched across a wooden frame. Patented by Nelson W. Clark, of Charleston, Mich., March 31, 1874. 57,166. This case is used chiefly for transportation of eggs of the whitefish (*Coregonus clupeiformis*), though it is often successfully used for salmonoids and other fishes.

ATKINS'S TRANSPORTATION BOX.

Scale, 6 inches to the foot. A wooden box containing four smaller boxes, in each of which 15,000 salmon eggs are placed upon layers of muslin. Devised by Charles G. Atkins, Bucksport, Me. The space between the larger and smaller boxes is filled with hay to prevent an unhealthy change of temperature, and the layers of eggs are separated from each other by wet moss. Eggs packed in this way can be sent several thousand miles with very satisfactory results.

MODEL OF ANNIN'S EGG-TRANSPORTATION BOX.

This apparatus consists of an outer case which contains a smaller one, surrounded by sawdust to prevent loss of eggs from sudden change of temperature. The inner case is provided with eight trays, with canton-flannel bottoms, for holding the eggs. The tops and bottoms of both the inner and outer boxes have small openings by means of which the eggs can be kept moist, the water being thrown upon the top of the box and allowed to trickle through the eggs on its way to the bottom. There is a small ice-chamber between the tops of the outer and inner boxes, and the bottom of the outer box is provided with wooden strips to prevent its coming in contact with the surface on which it rests, which would prevent drainage. Devised by James Annin, jr. Caledonia, N. Y. 39,121. Boxes of this patent have been used by Mr. Annin for sending eggs of the brook trout to Europe.

GREEN'S TRANSPORTATION BOX.

Model. A wooden box containing 8 canton-flannel trays for holding the eggs. Nine and one-half inches square; height, 11 inches. Trays, 7 inches square, inside measurement. Devised by M. A. Green. 39,120. Presented by the New York Fish Commission. In imitation of Clark's transportation box.

MATHER'S TRANSPORTATION CRATE.

A wooden box, with a grating of the same material separating it into two compartments, the upper serving as an ice-chamber, while the lower contains 13 canton-flannel egg-trays. The ends of the four pieces which compose the frame of the tray extend an inch beyond the point of intersection to form an air-chamber on each of the four sides of the box, thus giving a free circulation. There is also a slight space between each tray, and a larger one at the bottom. Designed by Fred. Mather, Jersey City, N. J. 39,311. U. S. Fish Commission. A box similar to this one was used in sending salmon-eggs from America to Europe.

PACKING SALMON EGGS.

Photograph showing the method employed in packing eggs of the land-locked salmon for shipment to other hatcheries at a considerable distance. Size, 8 by 10 inches. Grand Lake Stream, Me., 1882. (766) 2,225. U. S. Fish Commission.

e. ACCESSORIES USED IN TRANSPORTING EGGS AND LIVE FISH.**SIPHON-TUBE.**

A piece of five-eighths inch rubber tubing, the lower end of which is incased in a perforated tin tube to prevent the escape of fish

SIPHON-TUBE—Continued.

in removing stale water while in transit. U. S. Fish Commission. 57,156.

SIPHON-TUBE.

A piece of five-eighths inch rubber tubing, 4 feet long, used in connection with the siphon-strainer for removing stale water from cans containing young fish. U. S. Fish Commission. 26,912.

SIPHON-STRAINER.

A tin tube, with funnel-shaped top and perforated tin bottom, 25 inches long and 3 inches in diameter. U. S. Fish Commission. This tube is used when changing the water on young shad, or other species, while in transit. It is placed in the can of fish, the water passing through the strainer before being drawn off by the siphon, the end of which is introduced into it.

STILLWELL'S AERATING PUMP.

A tin tube the lower end of which is incased in perforated tin to prevent the fish from being drawn into it. The spout is also provided with a covering of perforated tin, and the water which is forced through is broken into a great number of minute streams or jets, thus giving complete aeration. Invented by E. M. Stillwell, Bucksport, Me. Presented by E. M. Stillwell. 57,157. This pump is used in aerating the water in which fish are transported, when it is not convenient to procure a fresh supply. In aerating, the pump is inserted in the mouth of the can and the water is pumped up and forced through the perforated tin spout, falling back again into the can.

WATER-BUCKET.

A cylindrical bucket of block tin, provided with a bail and strengthened by iron hoops. Depth, 14 inches; diameter, 12 inches. U. S. Fish Commission. 57,170. This bucket is used in connection with the siphon tubes for changing the water on the young fish while in transit.

9. MODELS AND PHOTOGRAPHS ILLUSTRATING THE HISTORY AND METHODS OF FISH-CULTURE.

HATCHING-TABLE.

In three parts, showing small sized models of the various kinds of hatching apparatus used in the United States, in actual working order, the water being supplied by means of a gas pumping engine which forces it into closed pipes with a pressure of 15 pounds to the square inch. Stop-cocks are placed at frequent intervals in these pipes and are connected with the hatching apparatus by means of rubber tubing. The apparatus is

HATCHING-TABLE—Continued.

supplied with natural and artificial eggs to illustrate better its working. The first compartment contains the closed apparatus, the next the trough and other apparatus requiring running water, while the third is arranged as a basin or artificial lake for showing the floating apparatus and other kinds used in open streams. A McDonald fish-way is placed at the end of the trough to conduct the waste water to the tank below, from which it is again carried to the pump.

TAKING EGGS.

A plaster cast representing a man in the act of taking eggs from an Atlantic salmon in a pan in which they are to be impregnated. By his side are casts of a ripe male and female salmon with the abdominal walls removed to show the ovaries and spermaries in position.

HAULING SHAD-SEINE.

Photograph of employes of the U. S. Fish Commission hauling the seine for shad at the Havre de Grace hatching station, for obtaining ripe fish from which eggs can be supplied to the hatchery. Size, 30 by 40 inches. Havre de Grace, Md., 1882. (660) 2,146. U. S. Fish Commission.

SEINING SALMON.

Photographic view of a portion of the McCloud River, showing the employes of the U. S. salmon hatching station hauling the seine for securing spawning salmon to provide eggs for the hatchery. Size, 8 by 10 inches. Baird, Cal., 1882. (723) 2,189. U. S. Fish Commission.

SEINING SALMON.

Photograph of employes of the U. S. Fish Commission engaged in seining the spawning salmon from the inclosures in which they have been kept till the eggs are sufficiently developed for hatching purposes. Size, 8 by 10 inches. Grand Lake Stream, Maine, 1882. (772) 2,230. U. S. Fish Commission.

HANDLING SALMON.

Photograph of men engaged in transferring salmon from the towing cars in which they have been brought from the fishing-grounds to the inclosure, where they are allowed to remain until ripe. Size, 8 by 10 inches. Bucksport, Me., 1882. (758) 2,219. U. S. Fish Commission.

FISH-CULTURAL OPERATIONS.

Photograph showing a group of men at work salmon fishing, and taking, impregnating, and washing eggs before placing them

FISH-CULTURAL OPERATIONS—Continued.

in the apparatus in the hatchery. Size, 8 by 10 inches. Grand Lake Stream, Me., 1882. (769) 2,223. U. S. Fish Commission.

TAKING SHAD EGGS.

Photograph of employés of the U. S. Fish Commission engaged in stripping shad at the Sutton Beach Fishery, in Albemarle Sound. Size, 8 by 10 inches. Avoca, N. C., 1877. 2,254. U. S. Fish Commission.

RIPE SALMON.

Photograph of a landlocked salmon with eggs fully matured. Size, 8 by 10 inches. Grand Lake Stream, Me., 1882. (763) 2,222. U. S. Fish Commission.

TAKING SALMON EGGS.

Photograph of the U. S. Fish Commission spawn-takers engaged in stripping salmon to secure eggs for hatching purposes. Size, 8 by 10 inches. Washington, D. C., 1882. (634) 2,132. U. S. Fish Commission.

TAGGING SALMON.

Photograph of a man fastening a small numbered platinum tag to the dorsal fin of a salmon from which eggs have been taken before returning the fish to the river. This method of tagging is practiced by Mr. C. G. Atkins to give a clue to the movements of the fish that have passed through his hands. Before the salmon is liberated, its length and weight, together with the date, are accurately recorded, and when it is recaptured the same facts are noted, thus giving the growth, and something of the movements, in a known period. Size, 8 by 10 inches. Bucksport, Me., 1882. (756) 2,217. U. S. Fish Commission.

WORK AT CENTRAL HATCHING STATION.

Photograph of employés of the U. S. Fish Commission receiving shad eggs that have been transported from the fishing stations 20 miles distant on the McDonald egg-crates. One man is engaged in unstrapping the crates, another in removing the eggs to hatching jars, while still another is dipping young shad into a can for shipment. Size, 8 by 10 inches. Washington, D. C., 1882. 2,239. U. S. Fish Commission.

PICKING SALMON EGGS.

Photograph of a man at work removing the dead eggs from the hatching trays at Grand Lake stream. It is necessary that the bad eggs should be removed daily, or at intervals of a few days, in order that the adjoining good eggs may not be injured by

PICKING SALMON EGGS—Continued.

contact with them. Size, 8 by 10 inches. Grand Lake Stream, Me., 1882. (767) 2,226. U. S. Fish Commission.

TAGGING SALMON.

Photograph showing the mode of weighing, measuring, and tagging salmon after stripping, in order that a record can be made before turning them loose in the river. Size, 8 by 10 inches. Bucksport, Me., 1882. (765) 2,224. U. S. Fish Commission.

SEINING CARP.

Photograph of men at work seining small carp from the shipping tanks in which they remain after the ponds are drawn off until such time when they can be distributed. Size, 8 by 10 inches. Washington, D. C., 1882. (622) 2,129. U. S. Fish Commission.

SEINING CARP.

Photograph of employes of the U. S. Fish Commission removing the fish from the Government carp ponds for stocking inland waters. The ponds are made lower at one end than at the other, and have several deep trenches leading into a small reservoir where the fish collect and can be readily taken after the water has been drawn off from the ponds. Size, 8 by 10 inches. Washington, D. C., 1882. 2,243. U. S. Fish Commission.

SORTING AND COUNTING CARP.

Photograph of men at work separating the several varieties of small carp and removing the minnows that chance to be found among them. The men are obliged to ascertain the number of each variety of carp while sorting. Size, 8 by 10 inches. Washington, D. C., 1882. (626) 2,130. U. S. Fish Commission.

HAULING SHAD-SEINE.

Photograph of employes of the U. S. Fish Commission hauling the seine for shad at the Havre de Grace hatching station, for obtaining ripe fish from which eggs can be supplied to the hatchery. Size, 30 by 40 inches. Enlarged by electric light from an 8 by 10 negative. Havre de Grace, Md., 1882. (660) 2,146. U. S. Fish Commission.

SEINING SALMON.

Photograph of employes of the U. S. Fish Commission engaged in seining the spawning salmon from the inclosures in which they have been kept till the eggs are sufficiently developed for hatching purposes. Size, 30 by 40 inches. Enlarged by electric light from an 8 by 10 negative. Grand Lake Stream, Me., 1882. (772) 2,230. U. S. Fish Commission.

EXAMINING SPAWNING SALMON.

Photograph showing employés of the U. S. Fish Commission at the McCloud River hatching station examining the live cars to see if any salmon are sufficiently advanced for spawning purposes. Size, 30 by 40 inches. Enlarged by electric light from an 8 by 10 negative. Baird, Cal., 1882. U. S. Fish Commission.

FISH-CULTURAL OPERATIONS.

Photograph showing a group of men fishing for salmon, and taking, impregnating, and washing eggs before placing them in the apparatus in the hatchery. Size, 30 by 40 inches. Enlarged by electric light from an 8 by 10 negative. Grand Lake Stream, Me., 1882. (769) 2,233. U. S. Fish Commission.

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TAKING SHAD EGGS.

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WORK AT CENTRAL HATCHING STATION.

Photograph of employés of the U. S. Fish Commission receiving shad eggs that have been transported from the fishery stations 20 miles distant, on the McDonald crates. One man is engaged in unstrapping the crates, another in removing the eggs to hatch-

WORK AT CENTRAL HATCHING STATION—Continued.

ing-jars, while still another is dipping young shad into a can for shipment. Size, 30 by 40 inches. Enlarged by electric light from an 8 by 10 negative. Washington, D. C., 1882. 2,239. U. S. Fish Commission.

SEINING CARP.

Photograph of employés of the U. S. Fish Commission removing the fish from the Government carp ponds for stocking inland waters. The ponds are made lower at one end than at the other, and have several deep trenches, leading into a small reservoir, where the fish collect, and can be readily taken after the water has been drawn off from the ponds. Size, 30 by 40 inches. Enlarged by electric light from an 8 by 10 negative. Washington, D. C., 1882. 2,243. U. S. Fish Commission.

SORTING AND COUNTING CARP.

Photograph showing men at work separating the several varieties of small carp and removing the minnows that chance to be found among them. The men are obliged to ascertain the number of each variety of carp while sorting. Size, 30 by 40 inches. Enlarged by electric light from an 8 by 10 negative. Washington, D. C., 1882. (626) 2,130. U. S. Fish Commission.

VII.—RESULTS OF FISH-CULTURE.

10. COLLECTIONS ILLUSTRATING THE GROWTH OF FISH.

EGGS SHOWING THE GROWTH OF THE EMBRYOS.

ATLANTIC SALMON.—*Salmo salar*, Linn.

Ova. Prepared at the U. S. Salmon-Breeding Station at Bucksport, Me. Charles G. Atkins, superintendent. A series of eggs in alcohol, showing daily development of the embryo for one hundred and eighteen days, beginning with the unimpregnated egg.

BROOK TROUT.—*Salvelinus fontinalis* (Mitchill), Gill & Jordan.

Ova. Eggs taken from the U. S. Fish Commission trout ponds at Northville, Mich., and shipped to the central hatching station at Washington, D. C., where the series was prepared. U. S. Fish Commission. A series of eggs in glycerine, showing the development of the embryo at regular intervals of two days from a month after the impregnation of the egg to the time of hatching, covering a period of fifty days.

WHITEFISH.—*Coregonus clupeiformis* (Mitch.) Milner.

Ova. Eggs taken in Lake Erie, near Detroit, Mich., and shipped to central hatching station, Washington, D. C., where the series

WHITEFISH.—*Coregonus clupeiformis* (Mitch.) Milner—Continued.

was prepared. U. S. Fish Commission. A series of eggs in glycerine, showing daily development of the embryo from a month after the impregnation of the egg to the time of hatching, covering a period of eighty-three days.

LAKE TROUT.—*Salvelinus namaycush* (Penn.) Goode.

Ova. Eggs taken in Lake Erie, near Detroit, Mich., and shipped to central hatching station, Washington, D. C., where the series was put up. U. S. Fish Commission. A series of eggs in glycerine, showing daily development of the embryo from a month after impregnation to the time of hatching, covering a period of fifty days.

FISH ILLUSTRATING THE GROWTH OF THE FRY.

BROOK TROUT.—*Salvelinus fontinalis* (Mitchill), Gill & Jordan.

Reared at U. S. trout ponds at Northville, Mich. Frank N. Clark, superintendent. A series showing the growth of the young at intervals from the newly hatched fish to the three-year-old trout.

RAINBOW TROUT.—*Salmo irideus*, Gibbons.

Reared at U. S. trout ponds at Northville, Mich. Frank N. Clark, superintendent. A series showing the growth of the young at intervals from the newly hatched fish to the trout two years and a half old.

SCHOODIC SALMON.—*Salmo salar*, Linn. subsp. *sebago*.

Reared at U. S. trout ponds at Northville, Mich. Frank N. Clark, superintendent. A series showing the monthly growth of the young for nine months.

SALMON.—*Salmo salar*, Linn.

Fish probably a year old. New York Fish Commission, Seth Green, superintendent.

COMMON EEL.—*Anguilla rostrata*, (Le S.) De Kay.

Young. October 17, 1877. 20,684. U. S. Fish Commission. This species has a wide geographical range. It spawns in most of the larger streams and in the brackish waters along the coast in the fall, the young eels being seen in immense numbers the following spring.

HERRING.—*Clupea harengus*, Linn.

Young, two days old. Grand Manan Island, N. B. 10,470.

HERRING.—*Clupea harengus*, Linn.

Young, three days old. Grand Manan Island, N. B. 10,461.

HYBRID FISHES.

HYBRID.

Cross between the salmon trout and the brook trout (*Salvelinus fontinalis*). New York Fish Commission, Seth Green, superintendent. This specimen is about a year old.

HYBRID.

Cross between the California salmon (*Oncorhynchus chouicha*) and the brook trout (*Salvelinus fontinalis*). New York Fish Commission, Seth Green, superintendent.

HYBRIDS AND YOUNG FISHES.

A set of five test tubes containing the following specimens:

- a. Eggs of shad, *Clupea sapidissima* Wilson, which have been impregnated with the milt of striped bass, *Roccus striatus* Mich. 31,504.
- b. Hybrids hatched from eggs similar to those in a, two and one-half days old. 31,505.
- c. The same, nine days old. 31,506.
- d. Shad, seven days old, eating dead ones of the same age. 31,507.
- e. Shad, four days old. 31,508.

ACCLIMATIZATION OF FISHES.

Numerous specimens of shad, Atlantic salmon, California salmon, trout, grayling, and carp, which have been reared in waters where, prior to their introduction by fish-culturists, they did not exist.

11. STATISTICS OF FISH-CULTURE.

LOCATIONS OF HATCHING STATIONS, ETC.

A map showing the operations of the U. S. Fish Commission from 1871 to 1883, the location of the hatching stations belonging to the U. S. Fish Commission, and to the fish commissions of the several States, and the dates of the establishment of the State commissions. It shows the locations where young fish have been planted, each species being designated by a peculiar symbol. The number of shad introduced into the different river basins during the years 1880, 1881, and 1882, and the number of applications for carp from each State that have been supplied, are also indicated by colored figures. (See also reports of U. S. Fish Commission and of the various state commissions for statistics of eggs taken and fish hatched.)

12. LITERATURE OF FISH-CULTURE.

NORRIS, THADDEUS. 39,129.

American | Fish-culture | embracing all the details of | artificial breeding and rearing of trout; | the culture of salmon, shad

NORRIS, THADDEUS—Continued.

and other | fishes. | By Thaddeus Norris, | Author of "The American Angler's Book." | Illustrated. | [Seal of the publishers.] | Philadelphia : | Porter & Coates. | London: Sampson Low, Son & Co. | 1874.

GREEN, SETH. 39,130.

Trout Culture | by | Seth Green. | — | Published by Seth Green and A. S. Collins, | Caledonia, N. Y. | — | Rochester, N. Y.: | Press of Curtis, Morey & Co., Union and Advertiser Office. | 1870.

GREEN, SETH, and ROOSEVELT, R. B. 39,133.

Fish Hatching, | —and— | Fish Catching. | — | — | by— | R. Barnwell Roosevelt, | Commissioner of Fisheries of the State of New York, | Author of | Game Fish, etc., etc., | and | Seth Green, | Superintendent of Fisheries of the State of New York. | — | Rochester, N. Y. : | Union and Advertiser Co.'s Book and Job Print. | 1879.

SLACK, J. H. 39,132.

Practical | Trout Culture. | By | J. H. Slack, M. D., | Commissioner of Fisheries, N. J.; Natural History Editor of "Turf, | Field, and Farm," N. Y.; Proprietor of Troutdale Ponds, near Bloomsbury, N. J. | — | "We speak what we do know, and testify what we have seen." | — | New York: | Geo. E. Woodward. | — | Orange Judd & Co., | 245 Broadway. | 1872.

GARLICK, THEODATUS. 39,128.

A Treatise | on the | Artificial Propagation | of | certain kinds of Fish, | with the | description and habits of such kinds as are the most | suitable for pisciculture. | — | By Theodatus Garlick, M. D., | Vice President of Cleveland Academy of Natural Science. | — | Giving the author's first experiments contained in a paper read | before the Cleveland Academy of Natural Science. | Also, | directions | for the most successful modes of angling for such kinds of | fish as are herein described. | — | Cleveland: | Tho. Brown, Publisher, Ohio Farmer Office. | 1857.

STONE, LIVINGSTON. 39,131.

Domesticated Trout. | How to Breed and Grow them. | By Livingston Stone, | United States Deputy Fish Commissioner, in charge of the United States Salmon Breeding Station on the Pacific Coast; etc., etc. | "*Purpurisque Salare stellatus tergora guttis.*" | Ausonius, Idyl Tenth. | "Make assurance doubly sure." | Macbeth, Act IV., Scene 1. | Third Edition, | Revised and Enlarged. | [Cut of fish.] | Charlestown, N. H. | For sale at the Cold Spring Trout Ponds. | 1877.

ATKINS, CHARLES G. 39,144.

U. S. Fish Commission. | — | Cheap Fixtures | for the | Hatching
of Salmon. | By | Charles G. Atkins, | Assistant, U. S. Fish Com-
mission. | — | Washington: | Government Printing Office. |
1879.

WILSON, SIR SAMUEL.

The | Californian Salmon | with an account of its | Introduction into
Victoria. | By | Sir Samuel Wilson | Member of the Legislative
Council of Victoria, | — | Melbourne: | Sands & McDougall,
| Printers, Collins Street, West. | 1878.

(See also Reports of the various Fish Commissions and Fishery So-
cieties.)

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