A Remarkable Southerner

By John Trotwood Moore

Col. T. T. Wright, of Nashville, is known as the father of the Columbia arsenal. He first suggested it to Senator Whitthorne, enthused him and stood by him until the bill was passed and signed by the President.

Colonel Wright is also known as the founder of the Scotch-Irish Congress, which assembled at Columbia, Tenn., its object being to gather data for a history of the race which gave us a Patrick Henry and the real founders of this government.

Governor Bloxham, of Florida, refers to Colonel Wright as the most aggressive creative intellect in America.

Col. A. K. McClure, the Nestor of American journalism, states: "I cannot recall a single important advancement made in the South during the last quarter of a century that was not of Colonel Wright's conception and largely of his execution."

Governor Johnston, of Alabama, says: "Colonel Wright did more educational work for the Nicaragua Canal than any living man. His great National Nicaraguan Canal Convention, held at New Orleans, was designed to aid the noble Alabama Senator, John T. Morgan, in his heroic work for this canal.

Col. T. T. Wright

That memorable convention first awakened the masses to the importance of Senator Morgan's plea for a canal to unite the Atlantic with the Pacific. Possibly that convention represented the most intelligent body of strictly business men that has ever assembled in the South. The New York Chamber of Commerce was represented by a liberal delegation; the San Francisco Chamber of Commerce sent thirty-one delegates—every State in the Union sent representatives; six hundred and two delegates were assembled in thirty-one days from date of the call. The New York Herald referred to this as a remarkable feat, as it certainly was. Senator Morgan spoke for three hours. It was a revelation to the New York and California delegates, who pronounced it the greatest speech they had ever heard. Fate has sent that canal to Panama, yet but for the lifework of Senator Morgan and the loyal educational aid given him by the National Nicaraguan Canal Convention, which first awakened the masses for Senator Morgan's inter-ocean canal, the Panama scheme never would have materialized.

We regret our inability to note all of Colonel Wright's prominent works. We will name but a few of his creations:

He assembled the first forestry congress in the world in Florida twenty-two years ago.

Also the National Harbor Defense Congress, which resulted in placing many of our seaport cities in a proper state of defense.

The National Military Congress also he originated, its object being to reorganize the National Guard and place it on a modern, up-to-date plane. The national government has adopted the measures formulated by this congress for the government of the National Guard. A feature of this National Military Congress was the advocacy of compulsory military drill in our public schools to turn our city boys from cigarettes and nerves to muscle and stamina. To demonstrate what the military drill will do for boys, Colonel Wright brought a company of cadets from Toronto, Canada. Chancellor McCracken, of the New York University, delivered the leading address in favor of compulsory military drill in schools to check the cigarette habit, causing moral and physical degeneracy of our city boys. The Governors of thirty States sent staff officers to this military congress, as did President Diaz, of Mexico.

Possibly one of Colonel Wright's most important creations was the International Fishery Congress, which he assembled at Tampa. The leading governments of the world, including China, sent delegates to this congress. Its second session was held at Paris; its third, at St. Petersburg, under the auspices of the Russian government; the fourth session, at Vienna; and its next session will assemble at Washington, in 1908. The government of the United States published two large editions of the proceedings of this first congress. This valuable publication is now out of print.

Colonel Wright has advocated a friendly unification of the English-speaking family in this interest, and during the last years of Queen Victoria's life he commemorated her birthday with great popular celebrations at Tampa. The last one was a memorable event. Lord Salisbury sent him a British fleet, as did our own government. Twenty thousand Americans assembled to participate in the ceremonies of this celebration. Cables and message greetings came to him from notables of the Old World and our own country. That great Irishman, the late Lord Dufferin, sent him a phonographic voice greeting from Ireland, as did Cardinal Vaughan, from London. The Queen cabled her thanks, and President Roosevelt, then Governor of New York, touched a button at the State capitol, Albany, unveiling a picture of Queen Victoria, with the following message:

"I congratulate you, and through you the citizens of Florida, on your action in celebrating the eightieth birthday of the Queen and Empress. All Americans who hold their country dear and who realize the essential brotherhood of the English-speaking people, must join you in sending the heartiest greetings to the sovereign herself, and to the mighty nation over which she reigns. Last year gave us striking proofs of her friendship at a time when her friendship meant much to us, and if we are true to ourselves, we shall always keep the fact in mind. Let us also realize how vital it is to the well-being of English-speaking people throughout the earth, and, therefore, to the cause of civilization and humanity throughout the earth, that every effort be made now and hereafter to draw closer the bonds of friendship between England and America, and let all men, and especially all public men, keep this at heart and do whatever in them lies to see that there is no relaxation in the present bond of cordial good will.

(Signed.)

"THEODORE ROOSEVELT,
"Governor of New York."

President Roosevelt's reference to England's friendship at a critical time meant the episode at Manila, when Germany tried to bluff Admiral Dewey.

Col. Wright, twenty years ago, through the New Orleans Times-Democrat, first advocated organizing a National Naval Reserve, and continued to agitate this matter until it materialized. He was one of the first to urge the necessity for a strong national quarantine law to protect us from the yellow fever plague, local state grafts with their often brutal shot-gun terror. He also advocated holding nations responsible for the spread of epidemic diseases, as was England for the depredations of the Alabama on our commerce. That Cuba had no more right to send us yellow fever than a band of pirates to devastate our coasts, hence nations must keep their sea ports clean, or pay damages for transmitting preventable diseases from same. Mr. Gladstone brought this subject to the attention of the British Parliament, and stated that the time is coming when all civilized nations would jointly unite in framing legislation to secure this measure.

Colonel Wright is not a politician—has never held public office, and never will; his mission is to turn our people from politics to industrialism.

Editorial - Nashville Banner

INTERNATIONAL FISHERY.

The next meeting of the International Fishery Congress will be held at Washington, D. C., in 1908. This is an association of the world's most eminent scientific fish culturists which has enlisted the interest and cooperation of all civilized governments and has steadily grown in importance as the scope of its work has extended. This association owes its origin to the energy and enterprise of a well-known and estemmed citizen of Nashville, Mr. T. T. Wright, who founded it in 1898, at Tampa, Fla., where its first session was held, the delegates representing European countries and China. The United States Government published the proceedings of that Congress in two large third session was held at St. Petersburg in 1902 and the last at Vienna in 1904. The purpose of the Congress is to study and promote the fishing interests in the many ways that can be made practical by international co-operation. A number of governments now employ vessels of their navies to map out food producing water farms and make investigations to increase and improve the supply of the best fish for the benefit of mankind.

U. S. COMMISSION OF FISH AND FISHERIES,

GEORGE M. BOWERS, Commissioner.

PROCEEDINGS AND PAPERS

OF THE

NATIONAL FISHERY CONGRESS,

HELD AT

TAMPA, FLORIDA, JANUARY 19-24, 1898.

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F. C. B. 1897—10

CONTENTS.

PREFATORY NOTE.

U. S. COMMISSION OF FISH AND FISHERIES,
Washington, D. C., February 23, 1898.

The National Fishery Congress, which convened at Tampa, Florida, in January, 1898, pursuant to the call of the governor of Florida, was attended by a large number of persons prominently connected with the fisheries, fish-cultural work, scientific research, and general economic pursuits from all parts of the United States. Papers covering a wide range of subjects were presented, and some of them evoked considerable discussion. A number of special topics of timely importance were brought up, some of which formed the basis for formal resolutions. Of scarcely less consequence than the regular proceedings of the Congress was the opportunity afforded the delegates for the personal interchange of opinions and experiences.

In order that a permanent record may be made of the work of the Congress, the Commission has undertaken the publication of the papers and an abstract of the proceedings, but in so doing assumes no responsibility for any opinions expressed.

For the purpose of expediting the issuance of this report, it has been deemed advisable to utilize the Bulletin for 1897, although the proceedings more properly belong in the Bulletin for 1898, the printing of which will not begin for some months.

GEORGE M. BOWERS,
Commissioner.

8.—PROCEEDINGS OF THE NATIONAL FISHERY CONGRESS, HELD AT TAMPA, FLORIDA, JANUARY 19-24, 1898.

WEDNESDAY, *January 19.*

The convention met at noon in the casino of the Tampa Bay Hotel and was called to order by Hon. M. E. Gillett, mayor of Tampa.

On motion of Hon. S. G. McLendon, of Georgia, Mr. Gillett was made temporary chairman, and on motion of Maj. A. A. Wiley, of Alabama, Mr. H. Cunningham, secretary of the Tampa Board of Trade, was elected temporary secretary.

On motion of Mr. William E. Meehan, of Pennsylvania, the chair appointed the following committee on credentials and permanent organization, the chairman being subsequently added to the committee: Mr. W. E. Meehan, of Pennsylvania, chairman; Hon. S. G. McLendon, of Georgia; Maj. A. A. Wiley, of Alabama; Dr. H. M. Smith, of Washington; Mr. F. Q. Brown, of Massachusetts, and Gen. Patrick Houston, of Florida.

On motion of Major Wiley the following resolution was adopted:

Resolved, That no resolution will be considered by this Congress that is not germane to the call of Governor Bloxham, and that all resolutions shall be referred, without debate, to the committee on resolutions, when duly raised by this Congress.

The chairman announced that it was expected that at this morning's session Governor Bloxham would deliver an address of welcome and that the work of the convention would begin, but owing to the fact that a great many delegates, who expected to be here, were en route and would arrive on incoming trains, it was thought best to defer further action until to-morrow.

The Congress then adjourned until 11 o'clock a. m., January 20.

THURSDAY, *January 20.*

The Congress was called to order by Temporary Chairman Gillett. The secretary then read the following call of Governor Bloxham for the Congress:

EXECUTIVE MANSION, *Tallahassee, Fla., April 14, 1897.*

Impressed with the importance of propagating and protecting the fish in the waters of the United States, and the necessity of devising means and formulating methods to save from total extinction many varieties of valuable food-fish, we have deemed it proper to issue a call for a National Fishery Congress to assemble at Tampa, Fla., on the 19th day of January, 1898.

The National Fishery Commission of the United States will take a prominent part in the proceedings of this assembly.

We respectfully request the governors of the various States of the Union, and the fishery commissioners of the same, to appoint delegates to this Congress, which should command the earnest attention of all good citizens of the United States. In this interest we commend the words of Hon. T. T. Wright, who says:

"The water farms of the United States, oceans, lakes, and rivers, are neglected and but half developed. Let us turn on them the search-light of science to reveal their treasures and possibilities, and thereby increase openings for new fields of labor and a larger supply of food for mankind."

Trusting that this Congress will receive the consideration it deserves, and that its deliberations may prove beneficial to the citizens of the United States and the world at large,

W. D. BLOXHAM,
Governor of Florida.

Mr. Gillett then addressed the meeting, welcoming the delegates in behalf of the city of Tampa, after which he introduced Governor Bloxham, who spoke as follows:

The assembling of this Fishery Congress is the result of the suggestion of Col. T. T. Wright, one of the most progressive intellects of the South. His presentation of the possibilities of such a meeting was the prompting cause of my issuing the call, and he organized the movement so well executed by Tampa's board of trade and Dr. H. M. Smith of the United States Commission of Fish and Fisheries. Tampa's representative will bid you welcome to this city; and I have been requested to welcome you not only to this progressive and prosperous city, but to Florida. I take pleasure in performing the task, feeling that in doing so I but voice the sentiments of our entire people.

I welcome you to a State whose history is the most romantic in the annals of America. When familiar with the raiment with which nature has clothed her—the richest that a tropical luxuriance could furnish so captivating a figure—with her limpid streams glistening like sheens of silver under a semitropical sun; with deep-bedded rocks reflecting with a dazzling brilliancy God's great orb of light, and penciled fringings of the richest foliage adding a halo to their unsurpassed beauty, can we wonder that fable's persuasive tongue invested her with treasures surpassing the famed El Dorado? Are we surprised that imagination's "weird sisters" pictured her waters as holding by divine right the most precious of Hygeia's elixir to restore honorable but tottering infirmities to the freshness and vigor of robust manhood, and that the hope of this famed fabled physical regeneration should have served as an irresistible stimulant to Spain's lion-hearted cavalier, Ponce de Leon?

You meet here upon historic ground, where the footprints of some of Spain's greatest cavaliers and America's noblest captains can be traced. While it is not my intention to recur to their heroic deeds, or to offer you a cup filled with the ambrosia of ancient story, yet there is one romance, based upon historic fact, associated with this very spot, that I feel you will kindly indulge should a brief reference thereto be made.

Wherever the history of America is read, there the story of Pocahontas is known. The romance is most captivating, and some of Virginia's most honored sons trace back a lineage to this daughter of the forest. But the historic fact that a similar scene was enacted on this very spot, three-quarters of a century before the name of Pocahontas was ever lisped by English lips, is unknown even to many Floridians.

It was here, in 1528, twelve years before De Soto landed upon Tampa's Bay, that Juan Ortez, a Spanish youth of eighteen, having been captured at Clearwater, was brought before Hirrihugua, the stern Indian chief, in whose breast was rankling a vengeance born of ill treatment of his mother by the followers of the ill-fated Narvaez. Ortez was young and fair, but the cruel chief had given orders, and here was erected a gridiron of poles, faggots were prepared, and young Ortez was bound and stretched to meet the demands for a human sacrifice. The torch was being applied, the crackling flames began to gather strength for a human holocaust, when the stern chief's daughter threw herself at her father's feet and interposed in Ortez's behalf. Her beauty rivaled that of the historic dame "whose heavenly charms kept Troy and Greece ten years in arms." The soft language of her soul flowed from her never-silent eyes as she looked up through her tears of sympathy, imploring the life of the young Spaniard. Those tears, the ever-ready weapon of a woman's weakness, touched the heart of even the savage chief, and Ortez was for a time spared.

But the demon of evil in a few months again took possession of Hirrihugua, and his daughter saw that even her entreaties would be unavailing. She was betrothed to Mucoso, the young chief of a neighboring tribe. Their love had been plighted—that God-given love that rules the savage breast as—

"It rules the court, the camp, the grove,
And men below, and saints above."

Her loving heart told her that Ortez would be safe in Mucoso's keeping. At the dead hour of night she accompanied him beyond danger, and placed in his hands such tokens as Mucoso would recognize. She acted none too soon. As the sun rose over this spot its rays fell upon the maddened chief, calling in vain for the intended victim of his revenge. His rage was such that it dried up the wellsprings of parental affection, and he refused the marriage of his daughter unless Ortez was surrendered. But that Indian girl, although it broke the heartstrings of hope, sacrificed her love to humanity; and Mucoso sacrificed his bride upon the altar of honor. Ortez lived to welcome De Soto.

Tell me, aye, tell the world, where a brighter example of noble virtue was ever recorded. Where in history do you find more genuine and more touching illustrations of "love, charity, and forgiveness"—the very trinity of earthly virtues and the brightest jewels of the Christian heaven? What a captivating theme this Florida Pocahontas should present to the pen of imagination picturing this spot, then and to-day associated with romance rich in historic lore!

But I am here to welcome you to this National Fisheries Congress; and what location more fitting for such a congress than the shores of this western Mediterranean, the Gulf of Mexico.

Mathew Maury, that great intellect and writer on the currents of the oceans, that great map-maker of the air that circles above Old Ocean's waves, states it as a physico-commercial fact that "the area of all the valleys which are drained by the rivers of Europe that empty into the Atlantic, of all the valleys that are drained by the rivers of Asia that empty into the Indian Ocean, of all the valleys that are drained by the rivers of Africa and Europe that empty into the Mediterranean, does not cover an extent of territory as great or as fertile as that included in the valleys drained by the American rivers alone, which discharge themselves into this our central sea."

Those vast valleys furnish waste organic matter that is brought into this inland sea, furnishing abundant food for animal life. The temperature of the waters of the Gulf of Mexico and the Caribbean Sea is most favorable to the development of the lower orders of animal life; and the animalcula and small fish feed upon this abundant supply of food, and in turn become food for larger fish. The Gulf Stream, originating in the Caribbean Sea, sweeping through the Gulf of Mexico and around the entire coast of Florida, helps to bring to our very doors this vast food supply, and gives us the best of feeding-grounds, many times the area of our State.

What State, then, more suitable in which to organize a national fishery congress than Florida? Stimulated by the erroneous sentiment that America's fishery resources, on account of the great area and capabilities of her waters, are practically inexhaustible, improvidence has led, in many States, to useless and wasteful destruction that tends strongly to the depletion of their waters.

The valleys drained into the Gulf of Mexico and the Caribbean Sea range through all the producing latitudes of the world and embrace every agricultural climate under the sun. Upon their green bosom rests the throne of the vegetable kingdom; and in the near future, when the waters of the Atlantic and Pacific shall be allowed to commingle through a canal across Central America, the commerce of the world will here hold its court.

Public sentiment is becoming largely directed and educated up to a full comprehension of the importance of the industry, and the General Government is lending its powerful aid to the dissemination of information and the propagation of valuable species of food-fish. With such earnest and intelligent workers as are now in the Government employ and at the head of this great work, with the various States cooperating, we may confidently look to a cessation of useless improvidence and an increase in the supply of desirable food-producing fish. And what efforts more commanding and deserving greater consideration than the suggesting of new fields of labor looking to increasing the food supply of mankind? And where can we look more confidently for such increase than in the water farms of America?

This Congress is really in the interest of the highest civilization, for no questions are of more moment than the increase or diminution of a wholesome food supply for mankind.

But, Mr. Chairman, I am not here to discuss any of the phases of the many questions that may be brought to the attention of this Congress. That will be the work of specialists and experts. I am here simply to give you a cordial welcome, and in the name and on behalf of the good people of Florida,

"I will welcome thee and wish thee long."

Hon. A. Nelson Cheney, of New York, was then presented and made the following response to the governor's address of welcome:

Your Excellency, Ladies, and Gentlemen: On behalf of the delegates of the National Fishery Congress I desire to thank you, and also the people of Florida, for your most gracious welcome. As you have said, the food problem is a most important one to this country and all countries, and the fish food is not the least important.

Called upon unexpectedly, as I have been, I thought that I could do no better than to state to you the beginning of fish propagation, leading back some centuries. It is said in the encyclopedias that China and Egypt practiced fish-culture. If they did it is not probable that they practiced the fish-culture that we know to-day. The history of our fish-culture has never been written, and I regret that I must trust to my memory as to dates. It is recorded that a French marquis hatched fish in 1420. By those best informed it is believed that he did not do more than to transport the fertilized eggs of fish from one water to another. The real father of fish-culture was Stephen L. Jacobi, a German fish-breeder, who announced the discovery in 1761. He practiced it for some twenty years before that date. His observations were conducted in a little wooden trough, and he himself or his sons continued the work for thirty or forty years. He is undoubtedly the father of fish-culture, as we understand fish-culture to-day. His methods were translated into French, Italian, and English, and George III granted him a life pension.

Down to 1848 there is little or no record of fish-cultural work. Two French fishermen, Remy and Gehin, discovered, as they claimed, the process of hatching fish artificially, and were brought to Paris and there conducted a number of experiments, which happened to be witnessed by Dr. E. S. Sterling, from Cleveland, Ohio, who had as a classmate in Cleveland a Dr. Garlick. Dr. Sterling went abroad to complete his studies, and there witnessed the experiments. In 1853 Dr. Garlick brought trout from Lake Superior to a stream or pond near Cleveland, took the eggs of trout, artificially fertilized them, and hatched them in 1854. Those were the first fish to be hatched artificially in the United States. Dr. Sterling was then in Cleveland and knew nothing about this experiment until he was called on by Dr. Garlick to look at the trout. Dr. Sterling is credited as being the author of the experiments as practiced by Dr. Garlick. Soon after these experiments were made known, as they were in a paper before the Cleveland Academy of Science, it was claimed that the fish had been hatched artificially in 1804 in this country, but this was found to be a mistake.

The first act of any State legislature looking to the propagation of fishes was a resolution passed by the legislature of Massachusetts in 1856. The States formed fish commissions from that date, and in 1872 the United States Fish Commission was organized—largely at the instigation of the American Fisheries Society, as it is now called; it was formerly the American Fish-Cultural Association. One of the first acts of the society was to appoint delegates to go to Washington and recommend the creation of a United States Fish Commission. We all know the workings of the United States Fish Commission and the State fish commissions, because almost every State in the Union has a commission now.

The following telegrams were read:

WASHINGTON, D. C., *January 20.*

The Secretary of State of the United States has the pleasure to extend cordial greetings to the National Fishery Congress now assembled at Tampa, in the hope that its deliberations and results will further the important objects proposed to be attained.

JOHN SHERMAN.

LONDON, ENGLAND, *January 20.*

The world will be benefited by your Fishery Congress. Success to it.

R. MILLER ARNOLD.

DUSSELDORF, GERMANY, *January 19.*

Accept my hearty congratulations for the great movement you have inaugurated. May success attend your deliberations. The International Fishery Congress which you propose to organize is destined to benefit the whole world.

PETER LIEBER.

WASHINGTON, D. C., *January 19, 1898.*

Accept my best wishes for success of National Fishery Congress.

THEODORE ROOSEVELT.

INDIANAPOLIS, IND., *January 19, 1898.*

May the National Fishery Congress be a success is the wish of your Indiana friends.

ALBERT LIEBER.

CHICAGO, ILL., *January 18, 1898.*

Regret exceedingly can not attend Fishery Congress. Sincerely hope meeting will result in greater protection to one of our greatest industries.

H. H. KOHLSAAT.

CHICAGO, ILL., *January 19, 1898.*

Regret extremely inability to attend. Noble industrial enterprise.

THOMAS B. BRYAN.

CHICAGO, ILL., *January 19, 1898.*

Please express to Governor Bloxham and to the Fisheries Congress my regret at being unable to accept his and their very kind invitation, and be good enough to tender my best wishes for the success of the Congress; also present my regards to my old and valued friend, H. B. Plant, whose hospitality I am sure you are all enjoying.

STUYVESANT FISH.

Letters were read from President McKinley, expressing the sincere hope that the Congress would accomplish all that it was assembled for, and from United States Fish Commissioner Brice, conveying his best wishes for the success of the meeting.

In response to calls from the audience Mr. H. B. Plant spoke in part as follows:

I am not a public speaker, and am rarely called upon to make any address, and especially to such an intelligent set of people as I see before me now. It is a pleasure, however, to be here, in the presence of gentlemen who are devoting their time for the benefit of mankind in an effort to promote the propagation and preservation of that excellent food for man—fish. And I thank you, sir, Governor Bloxham, for calling the attention of the American people—not only the American people, but the people of the world generally—to the fact that fish must be protected. It is not an easy matter to protect the fishes of this country, whether it be the fish that swims in the water or the fish that is hidden away in the sands.

You have done well, sir, to call this convention. You have done better, perhaps, than you thought to bring it to the attention of the whole country, as well as to the countries represented here, and to whom invitations have been sent by the Secretary of State of the United States. It is to be regretted that so few foreign delegates have been able to attend. I know, sir, that it was the intention of the Emperor of Japan, through his cabinet, to have sent a delegate here, and I am informed that the occasion for not sending is, as you have announced, a change in the official cabinet of the Emperor. I had the assurance of the prime minister that there was no subject that could be brought to the attention of the Emperor and the cabinet that they felt a greater interest in than that of preserving the fish industry. The Japanese are a great fish-eating people. Fish is their principal article of diet, together with rice, and I am sure that country will regret that it was not able to be represented here.

In response to calls Col. A. A. Wiley, of Montgomery, Ala., made a stirring address.

Mr. W. E. Meehan, of Pennsylvania, from the committee on credentials and permanent organization, announced the list of delegates and made the following report, which was adopted:

We recommend that Mr. A. N. Cheney, of New York, be selected as president of this Congress, and that Dr. H. M. Smith, of Washington, D. C., be selected as secretary of this Congress.

We further recommend that five vice-presidents be hereafter appointed by the president, to preside over the deliberations of this Congress at his invitation.

We further recommend that a committee on resolutions, consisting of one from each State, shall be appointed by the president of this Congress on the nomination of such delegates as may be selected respectively by the representatives from said States.

Mr. Cheney, on taking the chair, made the following address:

Gentlemen of the Congress: I thank you for the honor you have paid me by my selection to preside over your deliberations. I am often asked the question, How many fish arrive at the age that we call adult fish? That is a difficult question to answer; but there is this known: That during a drought in the rivers of Canada, salmon rivers especially, the hatchery men of the State of New York went to the head of one river and secured some salmon eggs. They found that only 2 per cent of the eggs were impregnated. If that, or anything near it, holds true of the salmon family, probably less than 1 per cent is hatched. In all artificial propagation of the salmon family about 95 per cent of all good eggs are hatched. That is a long step forward in fish propagation. We also rear a large percentage of other fish.

But there is still another step, and, as I believe, a most important one, that now deserves attention. Fish-breeders have very little to do with the enacting of laws to protect fish; but it is incumbent upon them to discover some means to feed the fish that are planted in the waters in such large numbers. The State of New York alone last year hatched and planted of various kinds of fish 216,000,000, and the United States Fish Commission, for the year ending June 30, 1897, hatched and planted 586,000,000 fish of various kinds and ages.

Of the value of artificial fish propagation I will only refer you to one item. About 1880 the shad resorts of the Atlantic coast were in a deplorable condition. The shad had fallen off, and something had to be done to restock them, and they were restocked by artificial processes. At that time the catch was 5,162,000 shad. In 1896 the catch was 13,000,000 shad, an increase of 7,900,000 fish, or an increase in the value of the shad product of $1,580,000, on the basis of 20 cents each to the consumer. That will show the benefit derived from artificial fish propagation.

Pursuant to the recommendations of the committee, the chair announced the following as vice-presidents: Hon. Thomas H. Watts, of Alabama; Hon. Eugene G. Blackford, of New York; Hon. George F. Peabody, of Wisconsin; Hon. P. J. Berckmans, of Georgia; Hon. D. P. Corwin, of Pennsylvania.

The Congress then took a recess until 3 p. m.

The Congress reassembled at 3.30 p. m.

The committee on resolutions, as selected by the respective States, was announced as follows: Alabama, W. K. Pelzer; Florida, John G. Ruge; Georgia, T. B. Felder; Illinois, S. E. Meek; Iowa, A. Holland; Kansas, Albert Finger; Kentucky, Jule Plummer; Louisiana, W. Edgar Taylor; Maine, Henry O. Stanley; Massachusetts, F. Q. Brown; Michigan, Col. Hiram F. Hale; Minnesota, Frank Bruen; Missouri, J. A. Sherman; New Jersey, George L. Smith; New York, Edward Thompson; North Carolina, W. R. Capehart; Pennsylvania, W. E. Meehan; Rhode Island, C. W. Willard; Tennessee, A. J. McIntosh; Vermont, J. W. Titcomb; Wisconsin, Calvert Spensley.

The reading of papers was then taken up, and Mr. W. E. Meehan was called on to present his paper on "The relations between the State fish commissions and the commercial fishermen." The paper was discussed by Messrs. Blackford, of New York; Corwin, of Pennsylvania; Peabody, of Wisconsin; Spensley, of Wisconsin; Cheney, of New York, and Meehan.

The paper of Prof. Jacob Reighard on "Methods of estimating plankton and their value for practical purposes," was read by the secretary.

Prof. W. Edgar Taylor then read his paper on "The establishment of a marine biological station on the Gulf of Mexico."

The paper of Mr. R. M. Munroe, on "The green turtle and the possibilities of its protection and consequent increase on the Florida coast," was read by the secretary.

The Congress then adjourned to meet at 9.30 a. m. January 21.

FRIDAY, *January 21.*

On the assembling of the Congress the chair asked Hon. L. T. Carleton, of Maine, to speak in connection with the discussion of Mr. Meehan's paper of the previous day, especially the matter of the money expended in Maine each season by anglers. Mr. Carleton said:

I did not expect to take any active part in these proceedings. The printed program as distributed does not call for any paper or speech from any of the Maine delegates, and, sir, I am taken very much by surprise to be called upon this morning to make an address upon any subject connected with the deliberations of this Congress. I have been more than content to be a silent listener to the exceedingly interesting papers that have been read and the timely and lively discussions thereon. I count myself indeed fortunate that I was privileged yesterday to listen to the stirring address of welcome of his honor the mayor of this metropolitan city of south Florida, and that I was permitted to sit here as a delegate and hear the wonderfully eloquent speech of his excellency Governor Bloxham, the chief magistrate of this great and powerful and prosperous Commonwealth. To a person coming as I do from the frozen North to this sunny Southland, the voices of these eloquent and distinguished citizens were sweet music to my ears, more charming, I assure you, than "the voices of many waters." And, sir, I feel that I express the sentiments, the feelings, of delegates from the North, from the West, and, in fact, of all the representatives here assembled, when I declare that we are charmed with the cordiality of the people of this State, greatly pleased with your city and State, and are enjoying ourselves to the fullest extent.

Coming as I do to Florida for the second time only—my first visit was in 1861–62—the patriotic words of Governor Bloxham, when, pointing to the Star-Spangled Banner, the emblem of our national unity and liberty, he declared "that for all time we are one and indivisible, and that we have one flag and one country and one destiny," thrilled me through and through. We are indeed, sir, gathered here from every State in the American Union with unity of purpose, unity of interest to do as best we may to advance the great and important fish and game interests of the nation, as citizens of the best country on God's green earth, under the best government ever yet devised by mortal man. Maine sends geeting to the earnest, patriotic, and brave people of the South, and rejoices in your marvelous prosperity, the evidences of which are seen on every hand.

But I am reminded, Mr. President, that I am expected to say something about the fish and game of the old Pine Tree State—the State of Maine. You will pardon me, sir, when I declare to you that Maine in this respect, as in many others, leads the world. In her limitless forests roam countless numbers of the monarch of the forest, the gigantic moose, the bounding caribou, and the graceful, beautiful Virginia deer. In her more than 2,000 inland seas and lakes are found in greater abundance than elsewhere the square-tailed trout and the landlocked salmon. The great dailies and sporting papers of the American continent are in the habit of referring to Maine as the "Paradise of the sportsman," and this is a very appropriate title, as nowhere else is there such sport to be had for either rod or rifle. We have an area of about 30,000 square miles in extent, and from the nature of the soil and climate, affording food and cover for numberless herds of deer, caribou, and moose, not to speak of the countless flocks of birds, both resident and migratory, including the ruffed grouse, woodcock, snipe, wild geese, black duck and wood duck, and an endless variety of sea birds—and the whole world is fast learning of our advantages in this respect. In her majestic rivers, those great highways from the mountains to the sea, is found in increasing numbers the best fish that swims the ocean blue, the Atlantic salmon. Wise, well-considered laws we have and an enlightened public sentiment.

Ten thousand citizens of other States during the open season last year, now just closed, came to Maine to fish and hunt, employed our 1,300 registered guides, skilled guides, and spent $4,000,000 among our people and killed 10,000 deer, 250 moose, 230 caribou, and 160 bears, while $6,000,000 more were spent there by non-residents last year, by visitors to our seashore and inland summer resorts, making $10,000,000 expended in Maine last year by non-residents for pleasure.

Do you wonder that the people of Maine are marvelously interested in fish and fisheries? We follow the example of the great Apostle Peter, we go a fishing, and invite everybody to come and do likewise. We have a health-giving, invigorating climate, wondrously charming and enchanting scenery. There is not a poisonous reptile, nor ravenous beast, nor poisonous insect in all her borders; and in her mountain streams, numerous as the sands of the seashore, are the protected nurseries of our lakes, wherein are millions of speckled beauties, the brook trout, and these feeders are so numerous, so well protected and restocked by artificial propagation as to give assurance that fishing in Maine will be better and still better as the years go and come.

Something has been said here about the constitutional right of a State to enact restrictive or protective laws regulating the times in which and the circumstances under which inland fish and game may be taken. That question has fortunately been settled for all time in the United States. The United States Supreme Court in a late decision has declared that the people of a State, in their sovereign capacity, own the fish and the game within its borders, and may say through its legislature how, when, and where the game and the fish may be taken and disposed of; in other words, the legislature may give a qualified property right or ownership to fish and game lawfully taken. We have found by experience that protective laws are necessary, and that these laws must be enforced. Why, do you know that down in Maine if a person is shot by another while hunting it is called an accident, but if a person shoots a moose or a caribou unlawfully we imprison him four months "without the benefit of clergy."

As true disciples of Isaak Walton we propagate artificially the trout and the salmon, and, aided greatly by the United States Fish Commission, we are constantly making the fishing better, and the multitude is constantly growing larger who come among us, and let me say, though I am no prophet, or the son of a prophet, but only a down-east Yankee, that in these times of wages growing less and still less, and the army of the unemployed constantly being augmented, the Congress of the United States can display wise statesmanship by giving earnest attention to the improvement of fishing, better fishing to those who go down to the sea in ships, better opportunity to secure this good, wholesome food, greater opportunity to willing hands to engage in this great industry. Dollar wheat may be a blessing to the farmers of the West, but it means dearer bread to the toiling millions, but better than dollar wheat would be a greater abundance of fish and game and enlarged opportunities to our laboring people to engage in this great, important, and growing industry.

The committee on resolutions reported organization by the election of Hon. H. O. Stanley, of Maine, as chairman, Hon. Edward Thompson, of New York, as vice-chairman, and Mr. W. E. Meehan, of Pennsylvania, as secretary. The committee also presented a resolution calling for a statement at each session of the program for the next session, which was adopted.

The secretary gave notice of a complimentary excursion to the Manatee River provided for the delegates by the Tampa Board of Trade on Saturday, January 22, on the steamer *Margaret;* also a trip on the U. S. Fish Commission steamer *Fish Hawk* on Tampa Bay, for exhibiting the methods of deep-sea dredging, etc.

The following telegram was read:

OMAHA, NEBR., *January 20, 1898.*

Unable to be present at meeting of Congress, but send greeting and invite all members to visit Trans-Mississippi and International Exposition at Omaha during meeting of American Fisheries Society third Wednesday in July, current year.

W. L. MAY,
President American Fisheries Society.

The following letter from Mr. A. Milton Musser, of Salt Lake City, Utah, was read by the secretary and discussed by Mr. Edward Thompson, of New York:

It would give me great pleasure to attend the Fishery Congress, were it possible for me to do so.

For the information of the managers I will give brief data respecting the Utah fish industry. The native fishes consist of mountain trout, Williamson's whitefish (both very choice), suckers, chubs, and mullets; more suckers than all others put together.

During my labors for the Territory and the State as fish and game commissioner, I introduced from the East and West and planted in our public waters some 11,000,000 of choice fishes. Most of these were gifts from the general government, and consisted of whitefish, shad, black bass, rock bass, perch, crappie, sunfish, speckled, rainbow, and lake trout, catfish, eels, carp, etc. We hope soon to have an abundant supply of the best of these fishes for home consumption and sale to our neighbors. We have not yet attempted to increase our supplies by artificial means. Our legislators thus far have refused to appropriate funds for a public hatchery. Long ago I came to the conclusion that the only way to keep our mountain streams stocked with trout would be by turning into them a few million fry every year from a local hatchery. The basses, etc., need no artificial manipulation. They multiply very rapidly, and, as a rule, find suitable places to spawn in the waters in which they are planted.

The salinity of Great Salt Lake is too great for the propagation of fishes. Nothing larger than the brine shrimp is found in its waters. At different periods since the year 1850 the following densities have been observed by different persons: 22.28, 14.99, 16.716, 19.557, and 22.

As has been suggested, I hope your Congress will find some process for drying fish when taken from the water, so that they can be shipped as hay, cotton, etc., are shipped to the marts. This would indeed be a grand consummation, especially if it is comparatively inexpensive.

I have all along contended that an acre of water can be made more remunerative than an acre of land, and when the comparative labor and expense bestowed upon their respective cultivation is considered, the force of the conclusion is irresistible. Our large lakes have never been thoroughly prospected. Only a very limited area has been seined, and we do not know what might be found in the great areas not yet seined.

Under the pressure brought to bear on our legislators by selfish men, an abnormal and no doubt unconstitutional provision was put in the fish and game law of the State, which obliges seiners to hire and pay the warden for his presence during the seining. The provision reads:

"Provided, that before any person shall use a seine * * * such person shall secure the presence of either the county warden or his deputy, who shall be paid not to exceed $2 per day by the party drawing the seine."

I would be surprised to find any such provision in the fish law of any other State in the Union. To discriminate against fishermen alone is class legislation, and to oblige them to pay a second party to keep them from breaking the law is, indeed, to say the very least, remarkable legislation. The result is that nearly all the seiners are forced out of the business. Another source of evil, which nearly amounts to a crime, is that carp, suckers, etc., are permitted to multiply prodigiously and prey upon the spawn and fry of the good fish and to occupy the waters largely to their exclusion. Further, the poor people who can not afford to pay from 15 to 30 cents per pound for bass, trout, etc., are barred from purchasing the commoner kinds, which by this lawless law virtually prevents their being caught.

The president, having called Vice-president Corwin to the chair, presented his paper, "The Hudson as a salmon stream." In the discussion which followed Messrs. Meehan, Corwin, Titcomb, Thompson, Spensley, Peabody, and Cheney participated.

Dr. H. C. Bumpus, of the Rhode Island Fish Commission, then read his paper on "The importance of extended scientific investigation." In discussing the paper Hon. E. G. Blackford, of New York, said:

The point emphasized by Professor Bumpus as to the proper handling of fish is a very important one, especially to the fishermen of Florida. Some ten years ago, when the first shipment of fresh fish was made to New York from the State of Florida, they were thrown into large casks, indiscriminately, and chunks of ice weighing 15 pounds each were put upon top of the fish, then another layer of fish was thrown upon the ice, and again another layer of broken ice, and the whole put under a canvas cover on the steamer. These were Spanish mackerel. On the arrival of the steamer at New York the entire shipment had to be thrown away, as a large portion of the fish were spoiled by decomposition, and the remainder were so badly bruised as to be unfit for market purposes. This was a costly experiment for the shipper; yet year by year experience has demonstrated to the shippers of fish the importance of careful handling and packing, so that now mackerel, pompano, sheepshead, and other fish are sent from the most remote parts of Florida to the New York market in perfect condition, and bring a fair and remunerative price to the producer.

As an example of the increased returns to the shippers from careful handling, I call the attention of the convention to the fact that certain shipments of shad, going to the New York market from North Carolina, bring from 25 per cent to 40 per cent more than other shad from the same locality. For instance, a certain shipper from Albemarle Sound, North Carolina, pursues the following method: His shad are carefully taken from the nets and placed in a cold room until thoroughly chilled, then packed in boxes; first a layer of fine ice, broken into lumps no larger than chestnuts, is placed in the bottom of the box; then the shad are placed in rows, lying on their backs, making a complete layer on the ice; then a layer of fine ice is spread over the bellies of the shad, and on this layer is another row of shad; all the shad are packed in a similar way; then the top of the box is filled with fine ice and the cover nailed securely on. These shad reach the New York market in a perfect condition, and so well known has this shipper's mark or brand become that the buyers are always on the lookout for this particular brand, and these shad are the first that are sold and bring the highest prices. On arriving in New York the fish have not moved from their position in the box, the ice is still intact, and on opening the box we find all the fish to be in a perfect condition, each scale undisturbed, and the whole presenting the appearance of a glistening jewel just taken from a casket.

As I said before, these fish bring a very much greater price than other fish shipped from the same locality; the latter have been packed in a careless and slovenly way, and the packages when opened in the New York market do not look inviting, and, as a result, are not sought for and can only be sold by marking down the price.

What I wish to impress upon the shippers and fishermen is that for every dollar invested in labor and ice in packing the fish they will receive $10 in return.

Mr. J. M. Willson, jr., of Kissimmee, Fla., read a paper on "Florida fur-farming," relating to the breeding of otters in captivity, which was briefly discussed by Mr. Blackford.

A pair of live otters raised in captivity were exhibited.

Col. F. C. Zacharie, of Louisiana, brought up the subject of crayfishes in the Mississippi levees, showing the damage done by a certain species, which appeared only during high water. Dr. H. C. Bumpus, Dr. H. F. Moore, and Mr. C. H. Townsend made remarks on the subject.

A recess was then taken until 6 p. m.

On the reassembling of the Congress, the president called Vice-president Peabody to the chair.

The afternoon session was occupied in the reading of papers and discussions thereon.

Prof. H. A. Smeltz, of Tarpon Springs, Fla., delivered a paper on the "Florida oyster-bars, their depletion and restoration," and exhibited specimens of live oysters attached to various objects, from the vicinity of Tarpon Springs. Mr. Blackford, Dr. Moore, and Colonel Zacharie spoke on the subject.

In the discussion of the paper Mr. Blackford said:

One point as to the oyster question brought forward so very interestingly by Professor Smeltz, in speaking of the efforts that should be made to obtain legislation: He seems to lay a great deal of force upon the fact that a revenue might be obtained from the leasing or selling of these grounds for oyster-culture. I think that is the wrong end of it. I think that the terms should be such as to invite oyster-culture, to protect the industry by giving the man the right, by lease or selling the ground outright, on such terms as would encourage him to go into the business. There is no reason why a revenue should be sought from the oyster-cultivator for the purpose of lowering the tax upon the farmer who occupies the upland. I think this the wrong way to go at it. I think we should make legislation so as to encourage and promote oyster-farming, to obtain such an immense product that it would bring a large business to the State, and consequently wealth, but not particularly for the purpose of raising a revenue for the State and thereby reducing the taxes of other people.

Dr. Moore said:

I have given the subject of oyster-culture some attention during the last year or more. I have been interested in it more or less for a number of years, and I have given particular attention to the facts which Mr. Blackford has just brought up. I am inclined to agree with what he has said. I think the main unfortunate feature of our oyster legislation heretofore has been the effort to get a large income. The prospects of acquiring a large revenue to the State have been held out. The income to be derived from oyster-culture has been very much magnified by those who have given the subject attention, and legislatures have become imbued with an entirely erroneous idea concerning the matter. Their aim has, therefore, been to secure as large an amount of the revenue as possible, and in many cases this has resulted in the enactment of laws which were practically prohibitory, so far as oyster-culture is concerned. This is the case in the State of Virginia. They have there an enactment allowing the leasing of the land. The annual rental was at first 25 cents per acre. The legislators from the interior of the State of Virginia believed that vast revenues were being derived from these oyster-bars, and it immediately became their aim to secure a larger share of this revenue for the State. The consequence has been that the annual rental has been raised, to the detriment of oyster-culture.

Col. F. C. Zacharie, in discussing the subject, spoke as follows:

As a member of the bar, as a lawyer, I desire to say something in regard to the laws which we have in the State of Louisiana, supplementary to the comments of Mr. Blackford and Dr. Moore. I am not familiar enough with the oyster laws of the other States to say what their provisions are, or what is the principle upon which the oyster tax is based. One of the chief difficulties which we have had in Louisiana has been that oyster-culture is looked upon by a large portion of our legislators as an experiment, and people from the interior are very ill-disposed toward making any experiments which increase taxation upon them. The theory of taxation is that it is a correlative and corresponding duty between the citizens and the government; that the government shall give him protection in life, liberty, and property, and that the tax which is levied on him is simply a correlative duty from the taxpayer to pay his proportionate share toward that protection.

Now, in view of this, we have sought in Louisiana not to derive any revenue for the State beyond the needs of the regulation and protection of the oyster fishery, and so we have held out for very small taxation or fishing licenses, and have a tax upon planted oysters—a very small tax, for the purpose of meeting the expenses of the particular production and regulation of that particular industry—so that we have not sought to make the oyster industries of the State a source of general revenue. This is a tentative process or principle, because we look forward to the day, or at least some of us do, when these industries will become very much developed and very valuable, and of course as they become more valuable and remunerative and the protective system is more detailed and complicated, then will be the time for the State to tax that property, as it does all other property, in proportion to its value.

I believe I make myself clear in announcing that the policy of my State has been not to derive a revenue from the oyster industry as a matter of general revenue, but merely to attempt to raise a revenue sufficient to regulate and protect the industry, and when we placed it on that basis we found that the people from north Louisiana and the interior middle district of Louisiana were perfectly willing to pass any legislation which they thought productive of good in regard to the oyster industry, providing it did not cost them anything.

Mr. Meehan read the paper by Dr. Bushrod W. James, of Philadelphia, on "International protection for the denizens of the seas and waterways."

Mr. J. F. Welborne, of Sanford, Fla., read a paper by Mr. George W. Scobie, of Titusville, Fla., entitled "The fishing industry on the east coast."

Dr. H. F. Moore read an article by Dr. J. P. Moore, of Philadelphia, on "The utility and methods of mackerel propagation."

Adjournment was then taken until Monday morning, January 24.

SATURDAY, *January 22.*

In the evening, in the music hall of the Tampa Bay Hotel, Mr. Charles H. Townsend, of the United States Fish Commission, gave a lecture on "The world's seal fisheries, with special reference to the American fur-seal." The lecture was illustrated by lantern slides.

MONDAY, *January 24.*

The meeting was called to order by President Cheney. He presented a letter he had received from Mr. Stevison, of New York, relative to a close season for tarpon in Florida, and asked any persons who were informed on the subject of the spawning time of the tarpon to report at the afternoon session.

The president introduced Mr. Chow Tsz-chi, who made the following response in behalf of the Chinese Government:

Mr. President and Gentlemen of the National Fishery Congress: I thank you for your kind reference to my Government and also for honoring the Government of China with an invitation to be represented at this important gathering of learned and distinguished gentlemen who have assembled here in the interest of a work which is destined to benefit mankind and all the nations of the earth. How I long for words in your language to express the feelings of my heart for the many kind attentions extended to me! I came to you a stranger; I leave you as a brother. Governor Bloxham in eloquent words referred to the early pioneers of Florida; I would write in words of gold the deeds of Henry B. Plant, the modern Christopher Columbus, who rediscovered Florida and built the palace which now shelters us. I will ever remember you, kind friends; my heart goes out to you in thanks unspeakable.

May peace, prosperity, and happiness be with you and the people of the United States forever!

The president presented Capt. E. N. del Arbol, of the Spanish navy, who said:

I wish to congratulate you on the interest you are taking in such an important matter to you and to the world at large as that which pertains to fish and fisheries; to congratulate you, too, on the numerous and valuable papers that are being read here; to thank you in behalf of my country for the courtesy in inviting it to participate in this Congress, and for the kindness you have shown to its delegate; and allow me to express my desire that in some time to come all the navies of the world, to one of which I belong, may be a large police force whose principal duty may be to protect fish and fisheries for the benefit of mankind and to enforce the wise laws enacted for this purpose.

The committee on resolutions reported the following, which were adopted:

Whereas it is the opinion of this Congress that every State should have a well-organized and active board of fish commissioners, whose duty it should be to foster the fishery interests of their respective States; to advise the legislatures in all matters pertaining to fishery legislation; and to secure by protective, fish-cultural, and educational methods the preservation and increase of useful water products: Therefore, be it

Resolved, That this Congress recommends to those States having no fish commission the appointment of such at the earliest practical date.

Resolved, That at least one member of each commission should be a man of scientific attainments, competent to intelligently deal with the biological phases of fish commission work.

Resolved, That a copy of these resolutions be sent to the governor of each State having no fish commission, requesting him to bring the matter to the attention of the legislature; and that a copy also be sent to the governors of those States which now have such commissions.

The following resolutions were also reported and adopted:

Whereas, recognizing the great extent of the Gulf coast line and the fact that this section possesses excellent food fishes in greater abundance than elsewhere; that her superior oyster facilities are being rapidly depleted by lack of proper protection and investigation; that this section possesses shrimp and other resources of great interest, with the possibility of development of still other industries as yet untried; that climatic conditions being different from other sections of our country renders it necessary that the fauna of this region be given individual study; and, furthermore, wishing in every reasonable way to stimulate and encourage each and all of the States of the Gulf region to a more active interest in our fisheries: Therefore, be it

Resolved, That this Congress express itself as favoring the location and equipment of a national fish-hatchery and laboratory at some central and suitable location on the Gulf coast, to be under the control and direction of the United States Commission of Fish and Fisheries.

Resolved, That this Congress appoint a committee of five, one from each of the States bordering the Gulf, whose duty it shall be to urge upon the United States Congress the necessity for making an appropriation for carrying on this hatchery and laboratory.

The committee appointed in pursuance of this resolution was later announced, as follows: Florida, Mr. John G. Ruge; Alabama, Maj. A. A. Wiley; Mississippi, Mr. Frank Howard; Louisiana, Prof. H. A. Morgan; Texas, Prof. W. W. Norman.

In acknowledgment of the telegram from Mr. W. L. May, president of the American Fisheries Society, the following resolution was adopted:

Resolved, That the National Fishery Congress now assembled in Tampa, Fla., accepts the greeting and invitation of the American Fisheries Society, and hereby expresses the hope that the purpose and result of this Congress may, with their aid and approval, become an international one in full effect.

Resolved, further, That the secretary of this Congress transmit a copy of this resolution to the President of the American Fisheries Society.

A resolution was also adopted providing that in the presentation of papers preference be given to those accompanied by their authors, and another recommending that the proceedings of the Congress be terminated on this date.

Dr. H. F. Moore, in referring to the resolution relative to the establishment of a biological station on the Gulf coast, called attention to the large prawns found in the waters of Tampa Bay by the *Fish Hawk* while engaged in experimental trawling, and their prospective importance to the State.

Col. F. C. Zacharie discussed the resolution relative to fish-commission boards, and asked for information relative to the organization of such boards. He gave notice of the calling of a proposed meeting of the people of Louisiana interested in fishery matters, and announced that later there would be a convention of the Gulf States for the purpose of securing uniform legislation and interstate cooperation.

Mr. Meehan referred to the valuable aid rendered the Pennsylvania Fish Commission by fish-protective associations, and the financial assistance given the commission after the failure of the legislature to make any apppropriation for the current year.

The president then yielded the chair to Hon. E. G. Blackford, vice-president, who spoke briefly on the oyster question, and presented Dr. H. F. Moore, who delivered a paper on "Some factors in the oyster problem."

Mr. Edward Thompson, shellfish commissioner of New York, spoke on the extent of the oyster-planting business. His remarks, in substance, were as follows:

The sensible oysterman leaves natural grounds alone. After Mr. Blackford had secured a law to permit the use of barren bottoms in New York, the business increased rapidly. The great importance of liberal laws, the prohibition of poaching, and the taking up of barren grounds should be emphasized. The business is almost certain to be successful. The fifteen-year lease is a failure, as five years may be required to get a set. There should be a perpetual lease. I am a successful grower, and give the credit of it to Mr. Blackford, the gentleman in the chair. The present law ought to give place to the old Blackford law, which is good enough for all. All the members should go home and secure the enactment of liberal planting laws, where none exist. I once got a lease of 200 acres of bottom in Long Island Sound, spending $9,000 in cleaning the grounds, and planted 45,000 bushels of shells and 1,500 bushels of large oysters thereon. In a year I sold out my half interest for $30,000 and bought it back in two years for $50,500 at public auction.

Mr. John G. Ruge, of Apalachicola, Fla., then read a paper on "The oysters and oyster-grounds of Florida."

In response to an inquiry of Mr. Blackford as to whether any delegate could present information on the subject of raising seed oysters in claires or ponds according to the French system, Colonel Zacharie spoke as follows:

I know of no such experiment having been tried in the Gulf States or indeed anywhere in this country. I may add, however, that members of the Bayou Cook Fish and Oyster Company have discussed the feasibility of an experiment in that direction on a small scale on their property, as it could be tried at trifling expense. The current in Bayou Cook, like that in nearly all the salt or brackish bayous, while bringing down the finest food for the fattening of planted oysters, prevents to a great degree the satisfactory "fixing of spat," as the spawn is carried out, in large part, into Bastian Bay or the Gulf, into which Bayou Cook empties, where it is nearly entirely lost. The reckless and wasteful fishing of the natural reefs in that neighborhood has denuded and destroyed them, so that planters in the bayou now have to go over 60 miles to the westward, mainly to Timbalier Bay, to get seed or young oysters for planting. The Timbalier natural reefs are being rapidly exhausted from the same causes as the eastward, and fishing in a few years will be entirely exhausted unless the matter is regulated by stringent legislation and execution of the laws. The planters, and indeed the fishers for market, will be forced to go farther west still when the Timbalier fisheries are destroyed.

It is therefore contemplated for the company to raise its own seed in the following manner: The soil on the banks of the bayou being soft and marshy, an area of a quarter or half an acre can be readily excavated by spading to the depth of from 4 to 6 feet. An inlet, say 10 feet wide, can be cut in from the bayou so as to admit the waters thereof, and a similar outlet can be made into the bay, through which the water can be partially discharged into the sea at low tide, the reverse flow taking place at high tide. These openings may be closed by close-meshed nettings of galvanized wire or other suitable material, so as to protect the breeding oysters and spawn in the pond to a great extent at least from drumfish, starfish, boxers, conchs, crabs, and other enemies of the oyster. Benches of poles can then be erected in the "claire" or pond, and on them will be placed earthenware tiles, or half tiles, previously limed. These tiles or half tiles can be procured from a tile factory a few miles above on the Mississippi River at a nominal price for the broken or damaged unsalable half tiles which would answer the purpose.

The pond or "claire" can then be stocked with breeding oysters, carefully selected from prime stock. Indeed, by importation from northern and eastern quarters, crosses could be experimented with by interbreeding with the native bivalve. In the spawning season the ova of the female and the milt of the male would, in this comparatively still water, more readily coalesce with their "affinities" of the opposite sex, and a larger product of the embryo oyster be furnished This embryo or "spat" would readily "fix" on the tiles. When this spat is sufficiently developed in size to plant, the wire-netting screens can be removed and small flatboats or shallops introduced into the "claires," the tiles covered with spat removed from the benches and loaded on the flatboats. These being carried out into the bayou, the young plants can be scaled off the tiles with trowels or similar instruments, and dropped into and on the plant or growing beds, there to fatten, grow, and mature until ready for market. The tiles being then relimed may be placed back in the "claires" ready for the "fixing" of the next season's spat. In other words, the "claires" would be used as nurseries for the raising and growing of spat, which might be perhaps further improved and developed by artificial feeding.

The system is called the "French," but is in fact the old Roman method, as frequent mention is made in the old Latin writers of "oyster ponds." The French, it is said by French writers, have also made use of these "claires" as "écoles des huitres," by which they profess to be able to teach the oysters, by gradually increasing the length of time during which the oyster is without water, to take in an extra supply of water like a camel about to cross a desert, so as to last through transportation on long voyages and keep the mollusks in good condition. It is not definitely known that this last method has ever been tried in America, although it is believed that it has been—and that successfully. American biologists (humorously styled here "oyster sharps") are, however, skeptical on the subject. The French governmental reports seem to substantiate the practicability of the method.

In case the idea is adopted, when the Bayou Cook Company gets into operation it will report progress and results to the United States Fish Commission. If successful, each oyster-culturist will be independent of the natural reefs, can obtain all the necessary seed or spat in his own inclosure, and vastly improve the poorer species of the native oyster by interbreeding with other and choicer varieties, besides improving much the preservation of oysters in shipment in their full excellence when delivered to the consumer at far distant points. If successful, it could be conducted on a very large scale, and it would be profitable for some planters to embark in the business of raising and selling the young plants exclusively as a special branch of the trade. It would produce a revolution in oyster-culture.

In reference to the opposition of oystermen to the enactment of oyster-planting laws, Mr. Blackford referred to meetings at which the oyster fishermen had had their opposition allayed by being shown that they would have more regular and remunerative employment on planted grounds than if they worked on the natural grounds.

Mr. John Y. Detwiler, of New Smyrna, Fla., read a paper on "Experimental oyster-culture."

A recess was then taken until 3 p. m.

At the opening of the afternoon session a paper entitled "The Florida commercial sponges: their nature, protection, and cultivation," was read by Dr. Hugh M. Smith and discussed by Professor Smeltz and the author.

The committee on resolutions reported the following, which were adopted by a rising vote:

Resolved, That the National Fishery Congress acknowledges the call of his excellency W. D. Bloxham for the existence of this Congress, as well as the inception of the idea to Col. T. T. Wright, and hereby gives an expression of appreciation and grateful thanks to Mr. H. B. Plant, not only for his general interest in the purpose of this Congress, but for his liberal hospitality in furnishing the use of the hall for the Congress, the excursion by train and steamer; and in thus manifesting our appreciation we also gratefully acknowledge the courtesy of his honor M. E. Gillett, mayor of Tampa, as also of Mr. H. Cunningham, the efficient secretary of the Board of Trade of Tampa, for their cordial greeting; be it further

Resolved, That we extend our thanks to Lieut. Franklin Swift for the pleasant trip on the United States Fish Commission steamer *Fish Hawk*; be it still further

Resolved, That the secretary of the Congress furnish a copy of these resolutions to those above mentioned.

The question of publishing the proceedings of the Congress being under consideration, the following resolution was passed, and pursuant thereto Dr. H. M. Smith and Mr. W. E. Meehan were selected by the chair to constitute, with himself, the committee on publication:

Resolved, That the president of this Congress appoint two persons, who, with himself, shall constitute a committee on publication, with powers to arrange for the editing, printing, and distribution of the papers here presented.

Col. F. C. Zacharie, of New Orleans, presented his paper on "The oyster industry of Louisiana," which was discussed by Mr. Blackford and Colonel Zacharie.

Dr. S. E. Meek, of Chicago, read a paper entitled "The utility of a biological station on the Florida coast in its relation to the commercial fisheries."

Dr. H. C. Bumpus brought up a topic which had been referred to in the paper of Professor Smeltz read on January 21, namely, the alternating sexuality of the oyster. He asked the author to state the basis for his remark that the sex of the common Eastern oyster changes from season to season, and requested an outline of the experiments on which the statement was founded. Professor Smeltz said he had had about 400 oysters under observation, and about 2 per cent of them apparently exhibited the condition stated. Dr. Bumpus, Dr. Moore, and Mr. Blackford referred to the great liability of error in the experiments and observations, and thought Professor Smeltz should not make a positive statement until crucial tests had been applied.

Owing to the fixing of an earlier date for final adjournment than had been anticipated, a number of papers could not be read. These were read by title by the secretary, who outlined their scope.

The following are the titles of the papers:

Possibilities of an increased development of Florida's fishery resources. By John N. Cobb.
The fish fauna of Florida. By Prof. B. W. Evermann.
A plea for the development and protection of Florida fish and fisheries. By Dr. James A. Henshall.
The protection of the lobster fishery. By Prof. Francis H. Herrick.
Oysters and oyster-culture in Texas. By I. P. Kibbe.
Parasitism among fishes considered from an economic standpoint. By Prof. Edwin Linton.
The black bass in Utah. By John Sharp.
Some notes on American shipworms. By Dr. Charles P. Sigerfoos.
The restricted inland range of the shad due to artificial obstructions, and its effect on natural reproduction. By Charles H. Stevenson.
Some brief reminiscences of the early days of fish-culture in the United States. By Livingston Stone.
The methods, limitations, and results of whitefish culture in Lake Erie. By J. J. Stranahan.
The lampreys of central New York. By H. A. Surface.
The oyster-grounds of the west coast of Florida: Their extent, condition, and peculiarities. By Lieut. Franklin Swift.
The past, present, and future of the red-snapper fishery in the Gulf of Mexico. By A. F. Warren.
The feasibility of propagating sponges from the egg. By Prof. H. V. Wilson.

A motion of thanks to the officers of the Congress was adopted by a rising vote. The Congress then, at 5.30 p. m., adjourned sine die.

In the evening, in the music hall of the Tampa Bay Hotel, Mr. George F. Kunz, of New York, delivered an address on the fresh-water pearl fisheries of the United States, and exhibited some choice specimens of pearls and pearl-bearing mussel shells.

HUGH M. SMITH,
Secretary of National Fishery Congress.

LIST OF DELEGATES IN ATTENDANCE AT THE NATIONAL FISHERY CONGRESS.

ALABAMA:
- Joel C. Barnett, Montgomery.
- R. F. Ligon, jr., Montgomery.
- W. K. Pelzer, Montgomery.
- W. F. Spurlin, Camden.
- Alexander Troy, Montgomery.
- T. H. Watts, Montgomery.
- A. A. Wiley, colonel, chief of ordnance, governor's staff, Montgomery.

FLORIDA:
- W. H. Bigelow, Tarpon Springs.
- F. G. Bunker, Cedar Keys.
- J. S. Castaing, mayor, Tarpon Springs.
- W. W. K. Decker, Tarpon Springs.
- John Y. Detwiler, New Smyrna.
- J. A. Enslow, jr., Board of Trade, St. Augustine.
- John Fiernally, Orlando.
- Frank Hyers, Palmetto.
- John W. Jackson, Palmetto.
- Raymond D. Knight, mayor, Jacksonville.
- W. T. McCreary, Cedar Keys.
- William Macleod, St. Petersburg.
- C. E. McNeil, Palmetto.

FLORIDA—Continued.
- H. E. Mills, Tampa.
- W. A. Rawls, State chemist, Tallahassee.
- John G. Ruge, Apalachicola.
- George W. Scobie, Titusville.
- Henry A. Smeltz, Tarpon Springs.
- H. D. Stratton, Board of Trade, Jacksonville.
- S. Stringer, mayor, Brooksville.
- Dr. C. B. Sweeting, Key West.
- W. S. Ware, Board of Trade, Jacksonville.
- J. F. Welborne, Sanford.
- J. M. Willson, jr., Kissimmee.

GEORGIA:
- A. H. Adams, Macon.
- J. H. Alexander, Augusta.
- P. J. Berckmans, Augusta
- E. P. Black, Atlanta.
- H. H. Cabaniss, Atlanta.
- H. F. Emery, Atlanta.
- T. B. Felder, jr., Atlanta.
- V. L. McLendon, Atlanta.
- S. G. McLendon, Thomasville.
- H. L. Mershon, Brunswick.

GEORGIA—Continued.
- C. W. Parrott, Atlanta.
- J. J. Spaulding, Atlanta.
- R. D. Spaulding, Atlanta.

ILLINOIS:
- August Hirth, Chicago.
- Dr. S. E. Meek, assistant curator of zoology, Field Columbian Museum, Chicago.

IOWA:
- A. Holland, Des Moines.

KANSAS:
- Judge Albert Finger, Girard.

KENTUCKY:
- Dr. H. Garman, professor of zoology, State University, Lexington.
- R. P. Jacobs, Danville.
- Jule Plummer, Newport.

LOUISIANA:
- H. A. Morgan, representative Louisiana Society of Naturalists; professor of zoology, State University, Baton Rouge.
- W. Edgar Taylor, professor of biology, Louisiana Industrial Institute, Ruston.
- C. J. Wenck, New Orleans.
- F. C. Zacharie, New Orleans.

MAINE:
- L. T. Carleton, chairman Maine Fish and Game Commission, Augusta.
- Charles E. Oak, member Maine Fish and Game Commission, Caribou.
- H. O. Stanley, member Maine Fish and Game Commission, Dixfield.

MASSACHUSETTS:
- F. Q. Brown, Boston.

MICHIGAN:
- C. E. Brewster, Grand Rapids.
- Hiram F. Hale, Battle Creek.

MINNESOTA:
- A. J. Boardman, Minneapolis.
- Frank Bruen, Minneapolis.

MISSOURI:
- John A. Sherman, St. Louis.

NEW HAMPSHIRE:
- O. L. Frisbee, Portsmouth.

NEW JERSEY:
- George L. Smith, member New Jersey Fish and Game Commission, Newark.

NEW YORK:
- Eugene G. Blackford, New York.
- A. Nelson Cheney, State fish-culturist, New York Fish Commission, Glens Falls.
- Warren N. Goddard, New York.
- G. E. Jennings, publisher The Fishing Gazette, New York.
- George F. Kunz, New York.
- C. L. MacArthur, editor The Troy Budget, Troy.
- Edward Thompson, New York shellfish commissioner, Northport.

NORTH CAROLINA:
- Dr. W. R. Capehart, Avoca.
- Frank Wood, Edenton.

OHIO:
- Albert Brewer, member Ohio Fish Commission, Tiffin.

PENNSYLVANIA:
- D. P. Corwin, secretary Pennsylvania Fish Commission, Pittsburg.
- Jacob Dowler, member Pennsylvania Fish Protective Association, Philadelphia.
- W. E. Meehan, member Pennsylvania Fish Protective Association, Philadelphia.
- Mrs. W. E. Meehan, Philadelphia.

RHODE ISLAND:
- Dr. H. C. Bumpus, member Rhode Island Fish Commission; professor of comparative anatomy, Brown University, Providence.
- Charles W. Willard, member Rhode Island Fish Commission, Westerly.

TENNESSEE:
- Dr. W. H. Jarman, Knoxville.
- J. O. Kirkpatrick, jr., Nashville.
- A. J. McIntosh, Nashville.

VERMONT:
- Dr. James B. Tanner, Burlington.
- John W. Titcomb, superintendent U. S. Fish Commission station; member of the Vermont Fish and Game League, St. Johnsbury.
- Henry Wells, Burlington.

WASHINGTON, D. C.:
- Dr. H. F. Moore, naturalist, steamer *Albatross*, U. S. Fish Commission.
- T. C. Pearce, car and messenger service, U. S. Fish Commission.
- W. de C. Ravenel, in charge Division of Fish Culture, U. S. Fish Commission.
- Dr. H. M. Smith, in charge Division of Scientific Inquiry, U. S. Fish Commission.
- Lieut. Franklin Swift, U. S. N., commanding U. S. Fish Commission steamer *Fish Hawk*.
- Dr. J. S. Thompson, U. S. Fish Commission steamer *Fish Hawk*.
- C. H. Townsend, in charge Division of Statistics and Methods of the Fisheries, U. S. Fish Commission.

WISCONSIN:
- George F. Peabody, vice-president American Fisheries Society, Appleton.
- Hon. Calvert Spensley, member Wisconsin Fish Commission, Mineral Point.

CHINA:
- Chow Tsz-chi, Chinese legation, Washington, D. C.

SPAIN:
- José Buigas, Spanish vice-consul.
- Capt. E. R. del Arbol, Spanish navy.
- Pedro Solis, Spanish consul.

INTERNATIONAL FISHERY ASSOCIATION.

On January 25, 1898, at the close of a session of the National Fishery Congress, convened at Tampa, Fla., persons interested in the formation of an international fishery association met. Prof. Herman C. Bumpus, of Brown University, Providence, R. I., a member of the Rhode Island Fish Commission, was made temporary chairman, and Dr. Hugh M. Smith, of the United States Commission of Fish and Fisheries, was made temporary secretary. The following letters were read:

[Society for Professional and Technical Instruction in the Marine Fisheries.]

25 QUAI SAINT-MICHEL,
Paris, November 19, 1897.

Dr. H. M. SMITH,
United States Fish Commission:

We will hold at Dieppe, in the latter part of August, 1898, an International Congress of Marine Fisheries under the presidency of M. Perrier, member of the Institute. We will organize in 1900 a third International Congress. If you organize at the Congress of Tampa an International Fish Society, this society would have charge of the organization of the Congress of Dieppe and of that of Paris in 1900.

I hope that you have requested the minister of marine to be represented at the Congress of Tampa. If not, it would be necessary to do so immediately, in order that we may avail ourselves of the opportunity.

Please accept, dear doctor, the assurance of my highest consideration.

E. CACHEUX,
President of the Society for Professional and Technical Instruction in the Marine Fisheries.

PARIS, *January 14, 1898.*

Mr. PRESIDENT: Not being able, to my regret, to be present with you at this time, I desire to announce to the members of the Congress at Tampa, that the Second International Congress of Fisheries and Agriculture will assemble at Dieppe on September 5, 1898. At the general meeting the following questions will be considered:

1. The economical transportation of fish by railroads.
2. Modifications of the rules relating to lights on fishing vessels, to avoid collisions.
3. Actual conditions of oyster-culture in France, and of the culture of mollusks.
4. Mutual agreements among sea fishermen to provide remedies in case of loss of apparatus, etc.
5. Effects of trawling near the coast.

At the meetings of the sections various questions of interest will be discussed, among which I will cite:

Diseases caused by the consumption of fish and shellfish taken from polluted waters.
Practical means of improving the lodgings of marine fishermen.
Charts of fishing banks.

I have addressed to you by the same mail a report of the proceedings of the first congress.

It will be desirable that the United States unite with us in organizing the International Society of Marine Fisheries or, rather, a permanent committee which will interest itself in such international congresses, and especially that which will be held in Paris in 1900.

Please accept the assurances of my highest esteem.

E. CACHEUX,
President of the Society for Professional and Technical Instruction in the Marine Fisheries.

A telegram was read from Hon. John Sherman, Secretary of State of the United States, expressing his interest in the formation of an international association and stating that he would take pleasure in bringing the matter appropriately to the attention of foreign Governments.

After informal discussion of the importance and functions of such an association, the following resolutions were adopted:

Resolved, That pursuant to published announcements, there be organized at this congress an *International Fishery Association* for the promotion of friendly relations, the exchange of information and experience in fishery and fish-culture matters, and cooperation in preserving and protecting the fishery resources among the nations of the earth.

Resolved, That there be chosen at this time by this meeting a president, two vice presidents, and a secretary and treasurer, and a committee, not to exceed forty persons, who, with the officers named, shall constitute an executive board. This board is authorized to appoint an advisory board, consisting of persons of all nations who are prominently identified with the fisheries, fish-culture, fish protection, and the study of water animals. The executive board is also empowered to select a suitable number of vice-presidents at large for the United States and foreign countries and any other officers who may appear desirable. This board is further authorized to formulate rules for the government of the association, to fill vacancies, and to call meetings, five members constituting a quorum.

The following officers were then elected:

President: Prof. Alexander Agassiz, Museum of Comparative Zoology, Cambridge, Mass.

Vice-Presidents at Large:

Prof. Edmond Perrier, Paris, France, member of the Institute and president of International Congress of Fisheries and Agriculture to meet at Dieppe, France, in September, 1898.

Hon. A. Nelson Cheney, chief fish-culturist of the State of New York, Glens Falls, N. Y.

Secretary-Treasurer: Dr. Hugh M. Smith, U. S. Commission of Fish and Fisheries, Washington, D. C.

The following members of the executive board were also elected:

Hon. George M. Bowers, United States Commissioner of Fish and Fisheries (ex officio), Washington, D. C.
Hon. A. A. Adee, Assistant Secretary of State, Washington, D. C.
Hon. L. T. Carleton, chairman Maine Fish and Game Commission, Augusta, Me.
Mr. Clarence B. Mitchell, Boston, Mass.
Prof. Herman C. Bumpus, member of Rhode Island Fish Commission, and professor of comparative anatomy in Brown University, Providence, R. I.
Hon. Eugene G. Blackford, New York, N. Y.
Mr. William E. Meehan, Pennsylvania Fish Protective Association, Philadelphia, Pa.
Prof. Theodore Gill, Smithsonian Institution, Washington, D. C.
Dr. W. R. Capehart, Avoca, N. C.
Hon. W. D. Bloxham, governor of Florida, Tallahassee, Fla.
Col. F. C. Zacharie, New Orleans, La.
Prof. Jacob Reighard, professor of zoology, University of Michigan, Ann Arbor, Mich.
Prof. S. A. Forbes, professor of zoology, University of Illinois, and director of the Illinois Laboratory of Natural History, Urbana, Ill.
Prof. David S. Jordan, president Leland Stanford Junior University, California.
Mr. Marshall J. Kinney, Astoria, Oreg.
Prof. C. C. Prince, Superintendent of Fisheries of Canada, Ottawa, Canada.
Mr. Adolphe Neilsen, Superintendent of Fisheries, St. Johns, Newfoundland.
Mr. R. B. Marston, The Fishing Gazette, London.
Mons. Raveret-Wattel, Paris, France.
Mr. S. Jaffé, Osnabrück, Germany.
Mr. C. J. Bottemanne, Berg-op-Zoom, Netherlands.
Dr. C. G. Joh. Petersen, Copenhagen, Denmark.
Dr. Rudolph Lundberg, Stockholm, Sweden.
Prof. A. Landmark, Inspector of Fresh-water Fisheries, Christiana, Norway.
Mr. Alexander Hintze, Helsingfors, Finland.
Dr. Nicolas Borodine, Russian Association of Fisheries and Fish-Culture, Uralsk, Russia.
Dr. Anton Dohrn, director of the Naples Laboratory, Naples, Italy.
Capt. Guilio Ricotti, Leghorn, Italy.
Capt. E. R. del Arbol, Spanish Navy.
Mr. Chow Tsz-chi, Chinese Legation, Washington, D. C.
Mr. K. Ito, Hakodate, Japan.

The letters of Mr. Cacheux and the telegram of Secretary Sherman were referred to the executive board, after which the meeting then adjourned, subject to the call of the board.

HUGH M. SMITH, *Secretary.*

METHODS OF PLANKTON INVESTIGATION IN THEIR RELATION TO PRACTICAL PROBLEMS.

By JACOB REIGHARD,
Professor of Zoölogy, University of Michigan.

In this country the fisherman as a rule continues to fish in any locality until fishing in that locality has become unprofitable. He then moves his operations to new waters until these in turn are exhausted. He is apt to look upon each new body of water as inexhaustible, and rarely has occasion to ask himself whether it is possible to determine in advance the amount of fish that he may annually take from the water without soon depleting it.

On the other hand, the fish-culturist is apt to plant his fry in waters that are quite unsuited to them or to plant them in numbers far in excess of what the water can support.

The fisherman proceeds as a farmer might who imagined that he could continually reap without either sowing or fertilizing; while the fish-culturist proceeds often as if convinced that seed might grow on barren soil or that two seeds might be made to grow in place of one.

In some regions the public is beginning, through the machinery of the State, to insist that its interest in the fisheries be guarded; that neither fishing nor planting of fish should be carried on in excess; and the time is fast approaching when the State will everywhere exert its authority to control the fisheries. It will then become necessary to determine, at least approximately, the productive capacity of any body of water.

It is the purpose of the present paper to discuss the method by which it has been proposed to determine the relative productive capacities of bodies of water. This method, for there is really but one, was first proposed by Hensen[1] in the sea, and is based upon two principles. It is known that the many species of plants and animals which inhabit a body of water are interdependent. In the final analysis all the fishes are dependent, directly or indirectly, on the minute floating plants and animals which, taken together, we call the plankton. The total mass of plankton is, in most bodies of water, so great that, in comparison with it, it is customary to neglect the fixed plants along the shore and the animals that they harbor. That the plankton lies at the base of all life in the water is, then, the first principle.

The second principle is that the plankton, considered as a whole, is uniformly distributed. There is no longer any doubt that some constituents of the plankton, e. g., the crustacea, may not be distributed uniformly.[2] Wherever measurements have been

[1] Hensen, Victor. Ueber die Bestimmung des Planktons. Kiel, 1887.
[2] Marsh. On the Limnetic Crustacea of Green Lake. Transactions Wisconsin Academy of Science, Arts, and Letters, vol. 11, 1897, pp. 179-224.

made of the total plankton it has, on the other hand, been found[1 2 3] that this is so distributed that nearly the same volume of it occurs under each square yard of the surface at equal depths.

From these two principles Hensen concluded that a determination of the amount of plankton under a unit of area of any part of the sea would afford a measure of the productive capacity of that part.

It remained to find some means of making such determination. After much labor Hensen finally adopted the method of drawing a net vertically from the bottom to the surface. Such a net strains out the plankton contained in a vertical column of water and catches the whole amount of plankton under an area of the surface equal to the net opening. From the plankton so obtained the total plankton of the water under consideration may be calculated and the results expressed in volumes or by weight or by enumerating the contained individuals. The productive capacity of a body of water, as expressed in its plankton production, may thus be compared to that of other bodies of water and so may be made of practical use.

The method which Hensen used in the sea was later extended by Apstein, his pupil, to fresh water. Apstein's results were published in various special papers and finally collected into a single very useful volume.[1] This method, with some slight modifications, has since been used in this country by Reighard,[2] Ward,[3] and others.

The great advantage which this method enjoys over others is that the water from which the net strains the plankton is a vertical column extending from bottom to surface, and is thus a representative sample of all the water from all depths in the lake examined. This column of water bears the same relation to the whole body of water that a sample removed from a sheet of metal by a punch bears to the whole sheet. There is no other method applicable to all conditions which has been shown to have this advantage.

There are, however, certain difficulties in the use of this method. These were known to Hensen and he attempted to obviate them. The net does not, as a matter of fact, filter the whole of a column of water through which it passes. A part of the water is pushed aside and a part filtered. By an elaborate set of experiments Hensen tried to determine what part of the water was pushed aside. This depends upon the form of the net and upon the material of which it is made. If the net filters half of the column of water, then in order to know the amount of plankton actually in the column it is necessary to multiply the amount of plankton taken by two. The number by which one must thus multiply is known as the coefficient of the net. The coefficient of the net was assumed by Hensen to remain practically constant. There are, however, two factors which may cause a change in the net coefficient—clogging of the net by foreign particles and shrinkage of the net cloth so as to diminish the size of the openings in it. This change in net coefficient is the first difficulty in the use of Hensen's method. If the pores of the cloth (No. 20 bolting-cloth) used for such nets become clogged the net will filter less water than before, i. e., its coefficient will become greater. If the net coefficient thus changes, the results obtained with a given net at different times, or by different observers with different nets, can not be accurately compared, and a large part of the advantage of the method is lost. It is

[1] Apstein, C. Das Süsswasserplankton. Kiel, 1896.

[2] Reighard, Jacob. A biological examination of Lake St. Clair. Bulletin of the Michigan Fish Commission, No. 4.

[3] Ward, H. B. A biological examination of Lake Michigan. Bulletin of Michigan Fish Commission, No. 6.

customary in order to prevent clogging to wash the net at the end of each haul with a stream from a hose. It was further suggested by Hensen,[1] who recognized the effect of clogging on the net coefficient, that the net be more thoroughly washed at the end of each day's work. Hensen[2] and Frenzel[3] have more recently suggested other methods of cleaning the net.

The change in the net due to shrinkage of the cloth and consequent narrowing of the pores does not seem to have been noted by Hensen. It was first pointed out by Reighard.[4] Both causes of change in the net coefficient have been since studied by Kofoid.[5] He finds that owing to clogging of the net "the coefficient of the net varies with the amount and constitution of the plankton from 1.5 to 5.7," and that "from 84 per cent to 96 per cent of the 30-meter catch is taken in the first 15 meters of the (horizontal) haul." Kofoid finds further that from the shrinkage of the net "the total area of the openings in a square centimeter . . . decreases over 50 per cent."

The first difficulty in using Hensen's method, that arising from change in net coefficient, owing to clogging and shrinkage, seems at first sight to be sufficiently serious. The second difficulty is that the openings in the cloth, although very minute, are still so large that some of the organisms of the plankton pass through them and are lost. After correcting the "catch" by multiplying by the net coefficient, the result still does not express the total amount of plankton present in the column of water through which the net was drawn. This source of error was known to Hensen,[6] but he does not appear to have determined the extent to which the smaller plankton organisms pass through the net. Kofoid[5] has now called attention to this subject and has determined for certain forms the percentage of loss from this source. He finds that "of Codonella as many as twenty-one individuals may escape to one retained" and that there is a great loss of other small organisms. Kofoid adds, referring to his predecessors, that, "the leakage of the plankton through the silk has been minimized or ignored and without tests of the extent to which it occurs." An active purpose on the part of plankton workers, such as is implied in the phrase "minimized or ignored," is nowhere evident in the literature. The truth is rather that Kofoid's predecessors have omitted to investigate this source of error quantitatively.

Though neither the variation in the coefficient of the plankton net nor its penetrability to the smaller plankton organisms were discovered by Kofoid, he has rendered important service in pointing out their extent.

It remains to consider to what degree the errors due to the above causes detract from the value of the results hitherto obtained by the Hensen method. The plankton catches thus far made by this method (as by others) have been utilized principally in two directions:

I. They have been measured in order to determine the volume of plankton present in the water. For this purpose the plankton is concentrated, either by allowing it to settle in a graduated cylinder or by the use of the centrifuge, and the volume is then read off. This method is not accurate; it is merely the best method hitherto devised for the purpose. The plankton, which is thus measured, consists of large and small organisms, and as it settles the smaller organisms are mostly packed between the

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[1] Hensen. Bestimmung des Planktons, p. 13.
[2] Hensen. Bemerkungen zur Plankton Methodik. Bio. Centralblatt, XVII, 1897, p. 510–512.
[3] Frenzel. Zur Plankton Methodik. Bio. Centralblatt, XVII, 1897, p. 364–371.
[4] Reighard. Loc. cit., p. 59.
[5] Kofoid. On some important sources of error in the Plankton Method. Science, Dec. 3, 1897.
[6] Hensen. Die Bestimmung, etc., p. 10, sec. 3, and p. 75.

larger, but being lighter, are in part deposited in a thin layer on the top of the mass of larger organisms. We may consider separately the errors which are introduced into the volumetric method from the three sources above mentioned.

(*a*) *Errors due to clogging of the net.*—This depends principally upon the area of the filtering surface of the net as compared to the volume of plankton present in the water. If the net surface is large and the volume of plankton in the water filtered small, there is but little clogging. The net employed by Kofoid was 25 cm. in diameter at the base and 40 cm. on one side. The plankton appears to have been unusually abundant (Kofoid gives no data) and the conditions otherwise unsuited to the use of any sort of net. The net employed by Reighard and Ward in the work above referred to had a diameter of 60 cm. and a slant height of 100 cm. Its filtering surface was thus about six times that of the net used by Kofoid, while the plankton in the water in which it was used was very little. In the work done by Reighard not more than 4.5 c.c. of plankton was taken in the net at one time and in the work of Ward not more than 11.9 c.c. In a majority of the hauls not more than a fraction of these volumes was taken. The net used by Hensen was much larger (Hensen, loc. cit., p. 6), while that used by Apstein was about the size of Kofoid's net, but it was probably used under more favorable conditions. Clogging, then, does not seem to me to be an important factor with nets of the size used by Hensen, Reighard, and Ward. It becomes important only in case a small net, such as Kofoid's, is used under unsuitable conditions. Some measure of its extent is desirable.

(*b*) *Error due to shrinkage.*—This error is largely if not wholly eliminated by previous thorough shrinking of the net. The cloth used by Reighard and Ward was several times dampened and ironed before it was made up into the net and was thus presumably thoroughly shrunken. The net was also many times wet and dried before it was used for quantitative work. As may be seen from the table on page 57 of Reighard's report, the cloth of the net used by him and later by Ward differed but little after a summer's use from new cloth which had been once wetted and then dried; the cloth in the two cases being measured under as nearly as possible the same conditions. Whether the nets of other workers were similarly shrunken before use does not appear. I have not encountered any such enormous shrinkage as that recorded by Kofoid, in which the average size of net openings was reduced from .000024 to .00001 sq. cm. Everything here depends on a uniform method of measuring the cloth.

(*c*) *Errors due to permeability of the cloth.* A large number of the smaller plankton organisms escape through the pores of the cloth. According to Kofoid "the silk net retains from $\frac{1}{2}$ to $\frac{1}{45}$ of the total solid contents of the water." "The amount escaping through the silk bears no constant relation to the amount retained." These statements are certainly very startling, but one must reserve final judgment concerning them until the conditions of the experiments upon which they rest are made known. This degree of leakage through the net may be due to the peculiar constitution of the plankton examined. The extent to which this source of error vitiates previous work can only be determined by tests of the nets used by previous workers in comparison with other methods and in the waters in which the nets were used. In volumetric determinations most of the smaller plankton organisms are packed between the larger organisms in such a way as not to affect the total volume of plankton in the measuring tube. Some of them, however, remain in suspension longer than the larger and heavier organisms, and when they settle lie at the top of the whole mass measured, and so increase its volume.

On the whole, one may say that where nets of sufficient size have been used under favorable conditions there is no good reason for assuming that the volumetric results obtained by Hensen's method are vitiated by the first two sources of error noted above. To what extent they are vitiated by the third source of error (leakage) remains to be determined. Since the organisms which escape are the smallest in the plankton, they may be volumetrically of little importance. Their importance depends upon their abundance, and this must be investigated by other methods. When the considerable variations in the volume of the plankton itself are taken into account it seems improbable that the error arising from leakage is sufficient to seriously vitiate volumetric determinations by the Hensen method or their use for practical purposes.

II. The catches made by the Hensen net have also been used for enumerating the number of organisms contained in them. Of the three sources of error above enumerated the first two affect this method to the same extent that they affect the volumetric method, so that by using suitable nets properly shrunken these two sources of error may be avoided here also. The third source of error, that arising from permeability of the net, is, however, fatal to the method of enumeration, in so far as it is applied to smaller organisms. In the tables of Apstein and Hensen, then, the enumerations of smaller organisms can not be accepted as final until it is shown that these organisms can not escape through the net in considerable numbers.

For determining the productive capacity of a body of water use has been made of the volumetric method only. Where the net used has sufficient filtering surface, and where it is not attempted to use the net in situations to which it is unsuited—i. e., among water-plants and in silt-laden waters—it seems to me that this method is not only practicable, but it is the only practicable method hitherto devised, since it is the only method by which the plankton may be obtained from a representative sample of the entire body of water. It should be noted in this connection that the variations in the plankton itself are far greater than the errors of the method.

We may now consider the substitutes that have been offered for the Hensen method. By this method the plankton is removed from a measured quantity of water which remains in position in the lake. We may analyze this procedure into two processes—the measuring of the water and the obtaining of the plankton from the water. For each of these processes, as carried out by the Hensen method, one or more substitutes have been proposed.

Owing to the inconstancy of the net coefficient due to clogging and shrinkage, it may be a matter of uncertainty as to how much water the net actually strains. To obviate this difficulty it has been proposed by Kofoid (loc. cit.) and by Frenzel[1] that the water to be examined should be pumped through a hose. Water from any desired depth may thus be brought aboard the boat and plankton then removed from it by the Hensen net or other means. It is obvious that by this method the quantity of water obtained may be known with exactness, so the difficulty connected with net coefficient vanishes. By the Hensen method the column of water from which the plankton is obtained extends vertically from the bottom to the surface. This column includes equal volumes of water from all depths and is representative of the whole lake. It does not seem to me possible to obtain a representative sample of the water of the lake in any other form than that of a vertical column extending from

[1] Frenzel, Joh. Zur Plankton Methodik, I, Die Planktonpumpe. Bio. Centralblatt, XVII, 1897, pp. 190–198.

bottom to surface. If it is possible to obtain by the pump such a column of water, then the pump may very well replace the net so far as this part of the process is concerned. I do not say that this is not possible, but we should not assume that the water drawn in by a pump through the submerged end of a hose, which is being slowly moved from top to bottom, or vice versa, is a vertical column of water. Before the pump can replace the Hensen net there must be sufficient evidence that this is so, and such evidence is not yet forthcoming.

Having obtained the water by use of the pump, it is necessary to separate the plankton from it. To accomplish this, the second process into which we have analyzed the Hensen procedure, various means have been proposed. Frenzel, and at first Kofoid,[1] made use of the Hensen net to strain the water pumped. In order to avoid the loss of plankton due to the permeability of the net to small organisms, Kofoid later tried various other methods of separating the plankton from the water. These were the sand filter, the filter paper, the centrifuge, and the Berkefeld filter. By each of these methods a greater number of plankton organisms is retained than by the Hensen net. (Nothing is said of volumes.) In some cases as much as 98 per cent of the total number of organisms present is retained. By none of these methods is it possible to obtain the plankton from a large volume of water in a short time, and each has besides other disadvantages which are enumerated by Kofoid. In the case of the Berkefeld filter, which was found to be the most efficient method, it was necessary to remove the catch from the surface of the filter with a "stiff brush." The surface of the filter, which is composed of infusorial earth, was thereby disintegrated and the plankton contaminated by the fragments. It is to be hoped that the disintegration is confined to the filter. The large form of the Berkefeld filter (army filter) filters about 2 liters of water per minute. This is a very slow rate of filtration if one has to deal, as is sometimes desirable in plankton work, with a column of water several hundred feet long and perhaps 10 inches in diameter.

The methods which it has been proposed to substitute for the Hensen method are thus seen to be deficient in two ways. For obtaining the water the pumping method is (so far as yet shown) defective in that the source of the water pumped is uncertain. It is not known that the pump can be made to deliver with accuracy the contents of a vertical column of water. For filtering the water the methods proposed, although they remove the plankton organisms more perfectly than the Hensen net, are yet inferior to it in that they are incapable of handling large volumes of water. Is it possible to so modify the Hensen method or to so combine it with other methods as to correct its errors and at the same time retain its good points? Its errors are the variation in net coefficient, due to clogging and shrinkage, and the permeability of the net for small plankton organisms. Its advantages are that it filters a representative vertical column of water, and that it filters rapidly very large volumes of water. Now, if it is possible to measure the volume of water that passes through the net at each haul the difficulties of clogging, shrinkage, and net coefficient at once vanish. I have not made any attempts in this direction, but I see no reason why a small current meter can not be placed within the opening of the plankton net, so as to register the rate of the current of water passing through the opening during each haul. If this rate were known the volume of water passing through the net could be calculated,

[1] Bulletin Illinois State Laboratory of Natural History, vol. V, article I.

and the plankton taken would be that found in this volume of water. No further calculations of any sort would then be necessary.

If it is possible to thus meet the difficulty arising from clogging and shrinkage there still remains the further difficulty due to the leakage of small organisms through the net. The net will have collected the larger organisms from a representative column of water. In order to obtain these large organisms it is desirable that the net should filter a very large volume of water, in some cases many cubic meters. In order to obtain the smaller organisms it is, however, not necessary to filter so large a volume of water; a few liters would probably suffice. Water for this purpose might be obtained by the pumping method or perhaps quite as satisfactorily by the well-known method of using flasks so arranged that they can be filled after being lowered to desired depths. It would be necessary to take small samples of water from several different depths and to remove the plankton from them by some one of the methods described by Kofoid as retaining the smaller organisms. The objection to this double method is that while it is entirely accurate for the large organisms taken by the net from a vertical column of water, it does not give us the smaller organisms from the whole of this vertical column of water, but rather from isolated samples of water from different levels. It seems to me, however, that if we know the large organisms in a vertical column of water, and if we know also the ratio of the larger to the smaller for certain parts of the column, we may readily calculate the volume or number of small organisms in the whole column. This volume may then be added to that obtained by the net and the total volume thus obtained.

In conclusion, it seems to me that the errors of the Hensen method, the extent of which Kofoid has pointed out, are probably greatly exaggerated by the condition under which he has used the method. This Kofoid himself suggests. The originator of the method probably never intended that it should be used among water-plants and in silt-laden waters. For such waters, which are shallow, the pumping and filtering methods described by Kofoid are undoubtedly best adapted. On the other hand, these methods are by no means so well adapted to deeper and larger bodies of water. For these it seems to me the Hensen method must still be retained, and if it can be modified as suggested above, it may be of value in such waters as those of central Illinois. Whether or not it can be modified in the way suggested, it can at least be supplemented by a method by which the smaller organisms may be more perfectly obtained.

Even in its present form the method is probably sufficiently accurate under most circumstances for the purpose of making rough determinations of the relative productive capacities of different bodies of water. It must be remembered that the method as used for this purpose is at best rough, but it must also be remembered that the variations in volume of plankton are considerable, so that the errors in method are probably within the variations in the material upon which it is used.

Zoological Laboratory of the University of Michigan,
Ann Arbor, Michigan, January 16, 1898.

THE IMPORTANCE OF EXTENDED SCIENTIFIC INVESTIGATION.

By H. C. BUMPUS, Ph. D.,
Professor of Comparative Anatomy, Brown University.

We meet here as members of a government that within less than three decades has not only revolutionized the methods of fish-culture, but has preserved to its several States, inland as well as seaboard, an industry yielding an annual income of over $45,000,000; a government which now maintains for the propagation of its fishes a fleet of steam and sailing vessels, more than a score of liberally equipped hatching and breeding stations, and which gratuitously issues to those unable to inspect its work a series of publications of great value to practical fishermen, of vast importance to the fish-culturist, and of sterling worth to the scientific world. The names of Baird, Verrill, Goode, and Ryder are familiar in every college and university, and their well-worn publications are conspicuous in biological laboratories from Italy to Scandinavia, and from Liverpool to Tokyo. Abstracts from reports of the United States Fish Commission form a considerable proportion of the last annual of the British laboratory at Plymouth, England, and other governments have frequently sent commissioners to inspect our hatcheries and acquaint themselves with American methods of work.

We should be careful, however, lest the consciousness of a successful past act as a sedative for the present. The lines of research wisely indicated by the founders, I might rather say founder, of American fish-culture should be assiduously followed, and the bypaths explored. The excellent reports of the one lately in charge of the Division of Fishery Methods and Statistics of the Commission—the secretary of this Congress—give an annual guarantee of the work actually accomplished and prove beyond peradventure that the Commission is not only self-supporting, but that the fisheries under its assistance are of rapidly increasing importance.

The introduction of the shad into the Pacific has yielded an average income of approximately $20,000, and the shad industry of the Atlantic, an industry yielding $2,000,000 annually, owes its continuance, if not also its existence, to the efforts of the United States Fish Commission. The planting of cod fry upon the coast of New England has replenished the waters of the east, and it is a fact that the fish were so plentiful in Narragansett Bay during the past autumn that nets could not be drawn, and the neighboring markets became overstocked.

The intelligent propagation of the cod rests upon the scientific work of Professor Ryder. Successful shad raising is largely due to the researches and devices of Commissioner McDonald. The life-history of the oyster was practically unknown until worked out by Professor Brooks. The migrations of the menhaden were unexplained before the researches of Dr. Peck. The work of Professor Libbey bears directly upon the question of distribution of the mackerel, and I venture to predict that successful sponge-culture will follow upon the continuation of the work begun at Woods Hole by Prof. H. V. Wilson. A continuance of these and similar lines of research is an absolute necessity for the growth and development of the more immediately practical work of propagation and distribution.

The collection and distribution of seeds is not the only function of the Department of Agriculture. This Department maintains a corps of scientific workers at home and abroad, and there is not a State, county, town, or hamlet that is not directly benefited by the results of its organized system of acquiring and diffusing knowledge. The efforts of the United States Fish Commission have been along similar lines and have yielded grand results, but the possibilities of the development of the fish industry have scarcely been indicated.

For some years the starfish have wrought havoc among the oysters of the colder water of our coast. The fishermen have laboriously "mopped" the "beds" with tangles of cotton waste, but have remained quite ignorant of the life habits of their enemy. A brief scientific study of the subject, however, has revealed many facts which point toward a possible, if not a probable, early correction of the evil. It has been found that the young, almost microscopic, gather in a narrow band along the shore, hidden in the eelgrass, where they may be killed off by the thousand with little labor and slight expense. Each oysterman, quite unwittingly, has been actually supporting, immediately around his oyster-bed, a nursery for the propagation of his enemy, the starfish.

In one direction in particular there is crying need of both extended and extensive scientific research. I refer to a matter that received some attention at the Chicago congress, namely, that research which shall result in the *development of the market* for food-fish. I think I do not overstate the fact when I say that there should be three times as much fish consumed as is consumed at the present time. The problem is not alone how shall we produce more fish, but how shall we improve the industry by providing a better and a more stable market for what is already produced. I feel that the fisherman and the fish-dealer are in a measure responsible for the fact that the average American can not endure fish oftener than one day in seven, and were it not for a wise provision of the church perhaps one day in seven would be far too frequent. While the dressing and shipping of meat and poultry has become almost an art, the methods of dressing and handling fish are crude in the extreme.

The abuse of fish as an article of food begins at the moment it is captured and extends to, and often beyond, the kitchen. I need not relate the rough handling on board the smack, the careless packing, and the slovenly condition of our markets; these are all prejudicial to the consumer as well as to the fish; but I wish to emphasize the fact that they are also sources of great loss to the dealer.

The blood that is ordinarily allowed to remain in the fish is the very medium that the bacteriologist uses for the culture of microbes, and its retention in the body of the fish provides the very medium in which the germs of decay delight. Should the fisherman bleed the fish immediately on its capture he would do much toward its reaching the consumer in a healthy condition.

The digestive organs of the fish are very active, and its processes of digestion continue after death; but while before death the contents of the alimentary tract are alone acted upon, after death the digestive ferments attack the surrounding tissues, and they attack these tissues with great energy. A few minutes is often sufficient for the deterioration of the flesh immediately inclosing the abdominal cavity. It would be a great saving to the dealer if the fish could be disemboweled and thoroughly washed as soon as captured.

Decay is practically an infectious disease. It is the direct result of the activity of certain microscopic organisms. If these organisms have difficulty in entering the tissue of the fish, or if their activity is inhibited through the application of cold or certain chemicals, the process of decay is retarded. Every time a fish is roughly handled, thrown upon the deck or pitched about as so much offal, walked upon or bruised in any way, the continuity of its flesh is broken and decay germs flood into the rupture. The slightest bruise of an apple or pear results in the formation of a center of decay quite visible to the eye. In the fish the center of decay is not so easily detected by the eye, but it is nevertheless present, and its presence is damaging to the dealer and disappointing to the consumer.

Animal tissue absorbs water very readily, but on the absorption of water it changes its structure, loses its flavor, and rapidly deteriorates. Fish should not be allowed to lie in their own slime on wet floors, or in poorly drained barrels and boxes.

The present method of shipping fish by the use of chopped ice is crude, expensive, and often ineffectual. Poultry, meat, or anything but a fish would find no market if shipped in a similar way. The fish arrive at their destination in a thoroughly uninviting condition, they are reeking with slime and filth, ghastly to the sight, offensive to the smell, and disgusting to the touch.

If the retailer, along the coast as well as inland, can be provided with fish that have been properly killed, skillfully cleaned, and carefully handled he will be in a position to present them to his customers in an attractive form, and the consumer will discover that all fish do not taste alike, which is synonymous with saying, all fish are not equally bad.

While urging that all lines of research already undertaken by the Government should be continued, I would suggest that a definite series of experiments be instituted which shall ascertain the best methods of preparing, packing, shipping, storing, and retailing fish, for I am convinced that improvements are possible along all these lines, and that with improvement the demand for food-fish will be very materially increased. Such an investigation, moreover, is eminently appropriate to the United States Fish Commission, since private enterprise can not be expected to experiment unselfishly for the public good.

This opens up another question: When more improved methods have been devised, how shall these, as well as the innumerable improved methods already familiar to the Commission, be brought to the attention of the fisherman?

There is no school, academy, or college, to my knowledge, in the entire United States which gives even one short course in the economics of fish-culture. There are, however, over 1,000,000 men, women, and children dependent upon the fisheries for their existence. The importance of providing instruction in practical fishery has already resulted in the establishment of schools in Norway, Sweden, Germany, and Japan. Dr. J. Lawrence-Hamilton has indicated the scope and outlined the courses for a Fisherfolk's Free Technical School in England, and the late Professor Goode urged the establishment of similar schools in this country. Though the first purpose of such a school should be to instruct, its laboratory would provide opportunities for research, its field equipment would stimulate investigation, and its existence would guarantee the collection and preservation of scientific data that would be of incalculable value to the fisherman as well as to the dealer.

It is a fact that at present there is not a single institution along our entire coast where one can observe the habits of our marine animals uninterruptedly throughout the year. There is no place where our biologists may go for a few weeks during the winter or early spring, when the ocean is teeming with animal life. The summer months are as the autumn to marine forms, and he who would study ocean life at its best must work in the early spring. The organization or individual that accomplishes the establishment of a permanent institution where instruction in practical fish-culture and fishery economics can be given; where apparatus is provided for the investigation of the lakes, rivers, and sea; where naturalists from our universities and commissioners from our States will be welcome at all times of the year, and where problems of scientific and economic interest can be studied and solved, will obtain what Baird, Goode, and Ryder saw in the distant future, and will combine and control the purely practical and the purely scientific. The need of American biology to-day is the same as the need of successful fish-culture—coordination, cooperation, and the establishment of a station, or the devotion of a station already established, like that at Woods Hole, to instruction and to extended uninterrupted scientific research.

PROVIDENCE, RHODE ISLAND.

THE UTILITY OF A BIOLOGICAL STATION ON THE FLORIDA COAST IN ITS RELATION TO THE COMMERCIAL FISHERIES.

By SETH E. MEEK, Ph. D.,
Assistant Curator of Zoölogy, Field Columbian Museum.

There seems to be considerable disposition of late years on the part of some individuals and institutions of learning to establish biological stations in different parts of the world. Some of these stations are permanent, others only temporary; none, I believe, on our own coast are open during the entire year. They are largely established to supplement biological study in our colleges and universities and to facilitate and promote original research. In none except the Woods Hole Government Station are there any special attempts to solve problems of economic importance.

The scientific work done in these is fragmentary in character. Each investigator continues his particular line of work, with no special reference to its bearing on other problems. The investigator's mind is not troubled as to whether or not the results of his studies will give to anyone the means of securing wealth or be of economic importance to the general public. He is solving, so far as his ability and facilities will permit, some purely scientific problem, without any special interest as to what practical use may be made of its solution.

In our own country, and in this so-called practical age, there is always an attempt to make some practical use of every discovery. The brains of our inventive genius are strained to their utmost to turn new facts into common use; to make scientific discoveries things of commercial utility. In Franklin's time no one ever dreamed that electricity would serve the commercial world as it is doing to-day. Hardly had the discovery of X-rays been made known when thousands were racking their brains to find in them as many methods for their practical use. So far has this idea of utility been developed in this country with regard to the physical sciences that every new fact must in some way serve mankind. This feature is not so prominent in the biological sciences, though much has been done in this direction, especially in medicine and in the propagation of many of our useful plants and animals.

The mapping of the life zones of North America, as begun some few years ago by our Agricultural Department, is already asserting its usefulness. These zones are based on a careful study of the geographical distribution of our land plants and animals, their life-histories and interrelations. This same kind of work must also be extended to our waters, from which we receive such a delicious and abundant supply of food. Observations to this end must be frequently made and constantly carried on during the entire year and under favorable circumstances. Our knowledge of the marine animals which we use for commercial purposes is far too limited. Much information concerning their geographical range, breeding places and habits, migrations and laws governing the same, is very meager and indefinite. On the other hand, there are thousands of other animals upon which these are more or less dependent, concerning the life-histories of which we know nothing.

The work done in our present marine biological stations is worthy of high commendation, and any effort to establish other stations should be encouraged. As I have remarked, these stations are established only to afford students an opportunity to study fresh marine forms and to promote and facilitate research purely scientific.

It seems to me that the time is now ripe to establish on our coast Government biological stations, whose objects should be not only to encourage, aid, and promote scientific research, but also to devise means to turn into practical use, as far as possible, all of our knowledge of marine life. These stations should give especial attention to the study of the geographical distribution of all animals, their migrations, and laws governing the same—in fact, everything which bears on their life-histories and their interrelations.

These stations should maintain each a dozen or more tables for the use of investigators from time to time from our various educational institutions. These tables should be used only by men who had already demonstrated their ability to do research work of a high character, and whose purposes at the station were clearly defined. In this respect I would suggest that the policy of the zoological station at Naples be largely followed. This station is the most perfect, and from a scientific standpoint the most useful, of any in the world. It has been in existence a little more than twenty-five years, and its privileges have been used by many investigators from all civilized countries. It is in possession of more information concerning the life of the Bay of Naples than is possessed of a like extent of sea by any other institution. It is strictly a scientific institution, and in this respect has been eminently successful. Its success is largely due to the facts that it is open during the entire year and that its privileges are used only by a high grade of scientific men. A station of like nature established somewhere on the Florida coast, and which would combine the additional feature of the solving of biological problems which have a direct bearing on the commercial products of the sea, is a greatly needed institution, and should, I believe, be largely maintained by our Government and controlled by our United States Fish Commission.

The fishery interests of Florida coasts alone are steadily becoming of immense importance. Her fishes, oysters, turtles, sponges, etc., are found in the markets of our great inland cities. Concerning the growth of these products we know too little. Concerning the plants and animals upon which they are dependent for food we know far less, and our knowledge of the enemies they encounter while in the sea is very deficient. Our information along these lines can best be increased through the agency of one or more biological stations, as I have mentioned. I have remarked that these stations should be controlled by the Fish Commission. The work for them to do lies strictly within its province. It is partially equipped, both as to men and apparatus, for the work.

The fact that this Congress is attended by representatives of many scientific institutions is a sufficient guaranty of their appreciation of the work of the Commission and their interest in the problems connected with the fishery industries. The solution of these problems must fall to the labors of our trained scientific men, and in the establishment of a Government marine biological station efforts should be made to invite to it the best talent in the country. In the Naples station tables are supported by Cambridge and Oxford universities. Fellowships are given in these institutions which permit students of excellent record to use these tables, in addition to which each student receives from the university a certain amount of money.

In our own colleges and universities are many undergraduate and graduate students engaged in research work, and who are much hampered because of the lack of material. Some of them, because of the expense in securing the proper material when on the coast, are obliged to abandon indefinitely lines of investigation which they have begun. Many of our leading universities give fellowships to meritorious students. These fellowships give the student special privileges of the university, and from nothing to about $1,500 per year. Often the student is allowed to spend his time in study in some other university, usually abroad, because of the special advantages it offers in his particular line of work. A Government biological station could be established and so managed that it would invite these students to its privileges, more especially that particular grade of students engaged in special lines of work having the most direct bearing on problems of economic importance. In this way the greatest possible results could be attained at a minimum of expense.

We have represented at this Congress the United States Fish Commission, some State commissions, commercial fishermen, sportsmen, and a number of scientific institutions, and I believe it could fulfill no better mission than to in some way encourage our National Congress to supplement its appropriation to the Fish Commission, and urge that it establish and maintain at least one biological station on our southern coast, somewhat after the manner which I have outlined. Its importance and usefulness would soon be appreciated, and I am sure it would be productive of valuable results.

Chicago, Illinois.

ESTABLISHMENT OF A BIOLOGICAL STATION ON THE GULF OF MEXICO.

By W. EDGAR TAYLOR, Ph. D.,
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The Gulf region has a coast line much longer than any other geographic division of the coast States. The Gulf coastal line is nearly 7,000 miles long, while the middle Atlantic States have but 5,400 miles of coast. Furthermore, the Gulf region is at the natural trading focus of a very large geographic section. The United States is divided into three great regions, namely, the Atlantic slope section, east of the Appalachian system; the Pacific slope section, west of the Rocky Mountain divide; and thirdly, the great hydrographic basin of the Mississippi. This immense basin contains two-thirds of the area of the United States. Likewise, from the standpoint of foreign trade there are three centers, namely, New York, San Francisco, and New Orleans. Hence the Gulf States are most favorably located for supplying a large part of the the country with marine products.

Again, nature has, for the most part, given the Gulf region a united river system, thus giving the great Mississippi basin a fauna and flora intimately and peculiarly connected with the life of the Gulf region. This great basin offers opportunities not found elsewhere for a study of life under different climatic conditions. Hence the establishment of a biologic station on the Gulf of Mexico is not simply of interest to the Gulf section, but to the Upper Mississippi basin is of more direct value than a station on either the Atlantic or Pacific coast.

Our natural-history resources are proportionally greater, considering the fact that less attention has been given them, than any other section of our country. The Gulf section is supplied with an abundance of marine and fresh-water products, including the oyster, fish, reptiles, sponges, crustaceans, and others. Among invertebrates the oyster ranks first in commercial importance. It is extremely abundant throughout the entire Gulf section, and constitutes the most prominent fishery product. In 1890 Louisiana ranked fourth in the list of States in the quantity of oysters gathered from public reefs, surpassing all the other States excepting Maryland, Virginia, and New Jersey. Louisiana, Florida, Alabama, Mississippi, and Texas each have undeveloped oyster interests. Among crustaceans the shrimp is taken on the coast of Louisiana, Texas, and Mississippi. Crabs of various species are abundant. Several species of crawfish exist in the waters of the Gulf region, becoming very abundant in Louisiana rice fields, where they are sometimes collected and marketed.

The economic value of the reptiles inhabiting the Gulf section is greater than in any other section. They occur in both fresh and salt water. The crocodile is found in Florida, while the alligator occurs in every State of the Gulf coast. Turtle farming is carried on in Mississippi, and is being developed in other States, most notably in Louisiana.

The fishes of the Gulf section are abundant, their great abundance possibly being the cause of the delay in their more scientific propagation. Thus it will be seen that the Gulf section, both from a geographic standpoint and the standpoint of its fauna and flora, is at the natural focus of at least two-thirds of the territory of the United States.

But these are not the only reasons why the Gulf section should favor the study of the biologic sciences. The great problems of the preservation of public health; the prevention of the spread of infectious diseases among both lower animals and man, are in themselves demanding most serious consideration. The scientific study of horticulture and agriculture, recognized in all countries as important, is still more necessary in the Gulf section, where all forms of life are more abundant and difficult to control. Other countries are trying to solve the mysteries of malaria, yellow fever, cholera, and other diseases, and why should not we at least do our part? No country on the face of the globe has greater cause for encouraging scientific investigation and progress. Thousands of other problems of equal importance remain to be solved by careful, painstaking investigation.

The great need of the biologic interests of the Gulf section is a well-directed Gulf laboratory liberally supported. Marine biological laboratories have distinct purposes of their own. Unlike many of the summer schools, they are not designed to give many brief courses, from which students can obtain merely a smattering of a large number of subjects. The biological school confines itself to the pursuit of one branch only, is designed to give thorough work in this line, and the work in these laboratories must not be confused with that of many of the summer institutes. A summer biological laboratory must almost of necessity be placed upon the seashore. The ocean is the great home of life. Some large groups of animals are absolutely confined to the ocean, and others are almost wholly so. Marine life, too, furnishes the biologist with most of the interesting and important problems whose solution is solving questions of wide interest.

So well understood is it that the ocean is the great source of life that it is beginning to be felt that no biologist is to-day thoroughly equipped until after he has had the opportunity of spending more or less time in work with living specimens at the seashore. The marine laboratory has about the same relation to biological work in the schools that the ordinary laboratory has to the text book. We no longer regard text-book knowledge as sufficient for a satisfactory equipment in scientific lines, and it is beginning to be felt with equal force that no biologist is properly trained until practical seashore work has familiarized him with the great ocean and its inhabitants. Students in our schools taking their courses away from the shore can, of course, gain a certain practical knowledge, but a knowledge that ought to be completed by the study of the living specimens in their native haunts. Many departments of zoology indeed can hardly be studied except at the seashore. Embryology and comparative physiology are hardly possible except where living, growing specimens are at hand, and certain types of life can not be satisfactorily studied except alive. The teacher in our public schools is learning that to teach zoology or any branch of biology requires not only text-book knowledge, together with laboratory instruction, but requires actual contact with life as it exists in the ocean. Summer seashore work is fast becoming a necessity for the science teacher who wishes to take high rank.

To the college professor also a marine laboratory offers its own special advantages. He who tries to keep himself in the front ranks among our teachers knows that he can only do this by carrying on research in some chosen line. Along biological lines it is the ocean that contains the great problems for solution, and there the college professor comes, therefore, to obtain his material and to carry on those researches which he knows are the means of keeping himself abreast with the advanced students of his day. The ocean, indeed, is the great source of supply for most departments of biological work. Hence it is that summer biological schools locate themselves at the seashore and aim at work of the very highest character.

A marine laboratory supplements the college or university, and through these the lower schools. It is here that the student meets representative investigators and fellow-workers. Here he finds out technical methods and carries on quietly investigations which could not be made elsewhere. In every country the marine laboratory has become a need to the student and a guide to scientific economic work.

The entire coast line of Europe has become dotted with biologic stations established by societies, private individuals, or governments, or by the combined efforts of these organizations. As early as 1891 France had at least eight biological stations; Great Britain, five; Austria, Holland, and Sweden, two each; Belgium, Germany, Italy, Japan, and New South Wales, one each. In the main each of these laboratories is liberally supported and supplied with buildings and other equipments. The biological laboratory at Naples has cost in plant alone over $100,000, and is carried on at an annual expense of at least $20,000. The laboratory and fittings of the English station at Plymouth were completed at a cost of over $60,000, raised by subscription. These facts alone are sufficient to attest the efficiency and popularity of these stations in Europe.

Of late years biologists have established marine stations at Woods Hole and Cold Spring Harbor on the Atlantic coast, while Leland Stanford Junior University has a station on the Pacific. In the interior stations have been established by the University of Illinois and Monmouth College, Illinois, and the University of Indiana. Other schools, as well as legislatures and private individuals, have made appropriations for natural-history explorations and discoveries. But so far the entire Gulf section, with its immense geographic and biologic interests, has not a single Gulf station. Shall we longer delay this matter? Are not our interests sufficient to induce this Congress to take steps toward encouraging the establishment of such a station?

A Gulf biological station should supplement the school work being done through the school year, more particularly our State schools and higher schools. Here all these schools may combine equipment and biologic faculties, and otherwise materially aid each other. One of the objects, though not the prime object, of a Gulf biological laboratory should be to give instruction to teachers of the biologic sciences. Throughout the Gulf section, teachers possessing more thorough and more modern training in the sciences are needed. In addition to more advanced work, courses should be given in elementary zoology and botany. These courses should be designed both for the teachers whose knowledge of elementary biology is somewhat slight and for students of higher institutions who may desire to supplement a college biological course with a practical study of marine forms. Each of these courses should be arranged so as to provide the fundamental training needed for a teacher or for independent work of investigation. Hence emphasis should always be placed upon practical work rather than upon class work. A biological laboratory might add much to its usefulness by creating a department of supply. Colleges and high schools are constantly demanding more material for class work, while the lower grades of the primary schools are using natural-history specimens for nature studies. The demand for such specimens has been growing, but such material is costly. The price of this material should be made low in order to stimulate more practical work in our schools. The great good already accomplished by the United States Fish Commission through the Smithsonian Institution is an excellent illustration of what may be done in this direction.

It is customary in connection with these stations to arrange for courses of semi-popular lectures. These lectures are authentic résumés of the most recent investigations, and when published do much toward educating the masses and directing public opinion in proper channels. They create a healthy public feeling in reference to the function of scientific work and the utility of original investigation.

All of the arguments so far advanced are important, but the highest and greatest benefit to be derived from a station must come from its original contributions to our knowledge of biology. The distinctive features of such a station must be its capability for carrying on independent investigation. Private rooms for research should be provided and every facility for research supplied. The station should be a place where investigations are made by people who come together for experiment and mutual assistance. Its work should be of such a character and should attain a reputation such that persons contemplating economic work of a biologic nature will unhesitatingly trust the results of its investigators.

The work of a Gulf biological station should be carried on in connection with similar work of the U. S. Fish Commission. This Commission has for some time had under contemplation the establishment of a laboratory on the Gulf coast, and this Congress, in our opinion, should in every way further this movement. The establishment of a biological station in connection with the laboratory and Fish Commission would offer an especially desirable place for public-school teachers interested in scientific topics; would draw college students desiring to supplement a college course with practical work; attract medical students who feel the necessity of a knowledge of biological subjects in connection with their work; would serve as a distributing point for schools wanting marine forms; furnish college and university men chances to meet and compare notes; would immensely increase the development of all our economic interests, and lastly, would crown all of these advantages by stimulating that highest of all labors—the capable, painstaking, original investigation.

RUSTON, LOUISIANA.

SOME NOTES ON AMERICAN SHIPWORMS.

By CHARLES P. SIGERFOOS, B. S., Ph. D.,
Assistant Professor of Animal Biology, University of Minnesota.

In a Congress like this, where men meet to discuss the means of protecting and increasing the supply of the toothsome products of our waters, a paper on shipworms may seem in strange company. While we wish to preserve and protect most of the products of our waters, these creatures we would gladly obliterate from the realm of living things. We have been studying and combating them for a century and more, but have found no adequate means of counteracting their depredations.

During the summer of 1893, while engaged in observations on the oyster at Beaufort, N. C., for the U. S. Fish Commission, the writer became interested in the various shipworms found so abundantly in the waters of that region, and having made some observations on their natural history he returned for periods during the two succeeding seasons to continue them. The results have been incorporated in a paper on the "Natural History, Organization, and late Development of the *Teredinidæ*," which is almost ready for publication.

Shipworms were favorite objects of study during the eighteenth century, on account of their great damage to the dikes of Holland in 1733 and subsequent years. The contemporaneous observers seem to have been unaware of the observations of Pliny and others in ancient times, and supposed the shipworms were natives of India, whence they had been brought by shipping in modern times. During these times they were considered true worms, and it was not till the time of Cuvier that their molluscan characters were recognized.

Even if shipworms were not recognized to be bivalve-mollusks from their adult organization, it would be easy to determine this fact from a study of the development. They start as eggs which none but a specialist could distinguish from the eggs of most bivalves. In the American forms that seem most abundant, at least in our southern waters, the eggs are cast freely into the water and soon fertilized by the male element. They soon begin to develop, and in our warm southern climate become little free-swimming creatures in three to four hours. As yet these little creatures have none of the distinctive features of the shipworms or even of bivalve-mollusks, but within a day the bivalve shell is acquired. For a few days one can rear the larvæ in aquaria, but after a time the conditions become unfavorable, and they disappear. For perhaps three weeks more, in a state of nature, they lead a free-swimming life, and are gradually transformed into little free-swimming bivalves, almost exactly like the little clam or oyster. But how and where, in nature, this transitional period is passed has not been observed.

The next stage which the writer found were the little bivalves about $\frac{1}{100}$ inch in diameter, crawling over the surface of the wood, in quest of their future homes. Once they have found appropriate places, they begin to change. One by one the bivalve characters become masked, and the little bivalves are transformed into the very long, worm-like shipworms which are found in wooden structures in salt water the world over.

But along with the transformation the bivalve shell is preserved, though it is much modified as compared with other bivalve shells, and covers only a small part of the head end of the body. With it the shipworm excavates the burrow in the wood in which it lives, and seems equally able to penetrate the hardest or softest kind of wood with equal facility. As the wood is grated away by the shell, the small particles are taken into the digestive canal, and the débris is extruded through the anus; but whether it serves for food in any way is a question in dispute. During its life in the wood at least the larger portion of its nutrition is taken in through the tube which at rest hangs in the water, and consists of small animal, and especially vegetable, organisms. In thinking of shipworms, then, it should be remembered that the wood in which they form their burrows is primarily for their own protection, and that without this protection their long, naked, delicate bodies are defenseless.

At Beaufort all kinds of unprotected wood become literally riddled in a very short time. Two kinds of worms are found there in great and about equal abundance—*Teredo norvegica* and *Xylotrya fimbriata*, whose mode of spawning has been already described. A very small proportion of specimens were of *Teredo navalis*, one of the common European forms, in which the eggs are retained in the gills of the mother during a considerable period of their development, perhaps almost till time for them to set into the wood. It is apparently this last species which the writer has found most abundant in Long Island Sound, though a considerable portion of *Xylotrya fimbriata* were also found.

The breeding season in North Carolina, so far as determined, lasts at least till the middle of August and perhaps throughout the summer. That the latter is true is indicated by two sets of facts. In the first place, individuals were found with ripe sexual products during the early part of August, and the young derived from eggs laid at this time must continue to set till September or later. In the second place, the young were setting in the wood abundantly till the middle of August, a fact which indicates that the same continues to some degree for some time longer. Of course, from an economic standpoint, the period during which the wood is attacked is one of the most vital points to discover.

The number of young produced is amazing—estimated in one case, from a single very large female, at 100,000,000—and while the greater part are lost before the setting stage is reached, yet the number that set is very great, and one of the most discouraging features in dealing with shipworms in a practical way. If the spat were of fairly appreciable size and set in but moderate numbers it might be feasible, by the careful removal of all old piles and other old timbers, to sufficiently reduce the number to a minimum. But when, under favorable conditions, over 100 to a square inch set where there is not room for more than one or two to reach maturity, it is easily seen what an excess is always present and how futile it is to try to combat the larvæ before they enter the wood. The practical way, of course, is to prevent their entrance into the wood by protecting the wood with copper paint and sheeting. With small piles and timbers it would seem to be worth while to try various means of keeping the bark on the wood, which, so far as I know, has not been done; for it is well known that as long as the bark is on timbers they are not attacked by shipworms.

Once the shipworm has set into the wood it grows with amazing rapidity in our southern waters. In twelve days it has grown to be an eighth of an inch long, in twenty days about half an inch, and in thirty-six days 4 inches, when it is thousands of times as large in volume as when it sets. It has become sexually mature, and is ready to produce a new generation. How long shipworms may live has never been observed, though it is probable for several years, and that during this time they keep growing if there be room in the wood for growth, though when crowded the individuals become dwarfed. The writer has found specimens of great size of *T. norvegica*, some 3 to 4 feet long, and it is easily seen how destructive may be a few of these individuals which may be almost an inch in diameter. The age of such specimens I have not been able to determine, but it is estimated to be less than two years.

In the colder waters of Long Island the writer has found specimens of both *T. navalis* (?) and *Xylotrya fimbriata*, the former the more abundant. They seem to set most abundantly after the 1st of July, though observations for one season can not be conclusive. The rate of growth is much slower, and it would seem to take twice as long to attain the same sizes as in the warmer southern waters.

The writer in his studies of shipworms has paid most attention to features purely scientific in their interest. Observations of any considerable economic value must cover a variety of localities under different conditions and extend through a period of years—observations which the writer has not had sufficient opportunity to make, and which for our American forms have unfortunately never been made.

MINNEAPOLIS, MINNESOTA.

AN ECONOMICAL CONSIDERATION OF FISH PARASITES.

By EDWIN LINTON, Ph. D.,
Professor of Biology, Washington and Jefferson College.

It is not the purpose of this paper to attempt more than a brief sketch of the subject. Before an exhaustive discussion of the economics of parasitism of fish could be profitably undertaken it would be necessary for us to know a great deal more than we do about the life-histories of the forms which infest fish. All that I shall attempt to do, therefore, will be to gather together in brief space such points as have come under my notice which seem to me to bear on the general thesis of parasites of fish economically considered.

The literature of parasitism as affecting fish, mainly systematic or morphological, is widely scattered through a great variety of publications and in many languages; and on account of the great amount of pioneer work which needs to be done—for only a comparatively small number of species of the fishes of North America have been examined for parasites with care—no compilation is yet possible for the parasites of fishes which could be of such permanent utility as the excellent ones which are being prepared for the Department of Agriculture by Dr. C. W. Stiles relating to the parasites of the domestic animals.

I think it must be acknowledged also, for the present at least, that by far the greater number of species of parasites infesting fishes are of interest to the zoologist alone and do not concern the practical fish-culturist, except as he may be interested in questions which have not yet emerged from the comparatively limited field of scientific investigation into the broader field of practical application. And yet even here it may not be wise to despise the day of small things. Under conditions incident to the work of fish-culture the natural interworking of bionomic relations may be so far disturbed as to give an otherwise insignificant parasite all the importance which attaches to the efficient cause of an epidemic. It is quite within the bounds of possibility for damaging cases of parasitism to arise among the fish of a given fish pond which owe their origin to the casual visit or brief sojourn of a fish-eating bird.

An unusual, though altogether natural, condition of this kind exists in Yellowstone Lake, which has been much written about. It is sufficient to say here that the lake when first discovered contained but a single species of fish—the Rocky Mountain trout—which, it is thought, made its way across the great continental divide by way of a bifurcating stream on Two-Ocean Pass. A considerable percentage of the trout of the lake were found to be infested with a parasitic flesh-worm. Upon a careful examination it was found that this worm, although more commonly occurring in cysts in the body cavity, very frequently left the cyst, and, migrating into the flesh of its host, there developed until it was, in extreme cases, a foot or more in length. This worm was plainly a serious drain on the vitality of its host and doubtless caused the death of large numbers of the trout. The very probable source of infection in this case was shown (No. 12) to be the pelican, which in 1890 frequented the lake in large numbers and had at least one breeding-place on some small islands in the southeastern arm of the lake.

The case is of interest here because the unusual conditions at Yellowstone Lake are, in great degree, parallel to those which exist in an artificial pond; that is to say, the natural enemies are diminished in number and the geographical range of individuals is limited. In the case of the fish of Yellowstone Lake the effects of parasitism were more marked and the instances more numerous than they were in Heart Lake, where usual conditions of food, enemies, and geographical range prevail. So, in any confined area, such as a fish pond or even lake, if conditions favorable to parasitism exist, the cases of parasitism will, in all probability, be more numerous and more serious than they will be in an ordinary stream. A knowledge of the life-history of the parasite in question will be of the greatest value. This will help us to understand the importance of what we usually call purely scientific work.

As fish-culture becomes more extensive, there will naturally develop a condition of things in a degree paralleled by what we see in the case of the domestic animals. As civilization advances, the carnivorous enemies of the domesticated animals are exterminated, or at least driven out, and are no longer a source of loss to the sum total of herbivorous animals. Further, a link in the chain of an important group of animal parasites is thereby broken, and occasional cases of infection, to a degree which might prove fatal to the herbivorous host while the carnivores were ranging the country, would be impossible under the conditions imposed by civilization.

So the cultivation of useful food-fish should lead naturally to the extermination of such enemies as fish-eating birds, mammals, and fish which are not of economic value. Thus one source of parasitism would be destroyed.

In those cases, however, where the food-fish is the final host, the intermediate host being an invertebrate which is a necessary source of food for the fish, no link in the chain of parasitic existence is broken, and the extermination of such parasites seems to be altogether impossible. Something can be done, possibly, by instructing fishermen to burn or bury fish which are not in good condition and the viscera of fish, and not to throw them back into the water. Especially should this be insisted on where the fishing is done in the smaller lakes. It should be remembered that the destruction of a single adult cestode worm destroys immediately many thousands and even millions of eggs and prevents many thousands more from developing for each month which the worm might continue to live.

For some general considerations on this subject, as well as upon some phases of the economics of parasitism, reference is here made to an article prepared for the World's Fisheries Congress held in Chicago in 1893, and published in the Bulletin of the United States Fish Commission for 1893, pages 101–112; especially Sections III and IV of that article. In order, as far as possible, to avoid repetition, I shall continue the discussion under headings corresponding to the several natural orders or groups which furnish the majority of cases of parasitism among fish.

It does not come within the proposed scope of this paper to discuss vegetable parasitism among fishes. Reference may be made, however, to an article in the U. S. Fish Commission Bulletin for 1893, by G. P. Clinton: Observations and Experiments on Saprolegnia infesting Fish, pp. 163–172, with a bibliography.

A list of authorities, for the most part found in publications of the U. S. Fish Commission and National Museum, is appended, and will be referred to by number. More extended reference to the literature of the subject will be found in these publications.

PROTOZOA.

Parasitism occasioned by the presence of one-celled organisms has not been much studied in this country. Gurley's paper (No. 5) is an admirable compilation, and, it is to be hoped, will be followed by systematic work on the psorosperms of fishes inhabiting American waters. From an economic point of view, it is probable that parasitism which results from infection with protozoan parasites will, of all kinds, be found to be most important. Epidemics among European fish have been repeatedly traced to this source. The fatality which attends infection with psorosperms appears to be due to a secondary cause, however, namely, to bacilli which develop within the psorosperms (*Myxobolus*) tumors and give rise to ulceration. The discharge of these ulcers then disseminates the disease. For an account of an epidemic among barbels in the Meuse and other rivers of France and Germany, see Gurley's paper (No. 5), p. 231.

Brief mention of the remedies there proposed, pp. 233–234, may appropriately be repeated here. Mégnin sees no other method than to collect all the dead or sick fishes and destroy them by fire. Ludwig thinks that the waters should be kept pure and that the pollutions of the rivers by communities or industrial establishments should be interdicted. Further he says:

> That most dangerous contamination of the water by the *Myxosporidia* from the ulcers can not of course be stopped entirely, but it is evident that it will be less if all fishermen are impressed with the importance of destroying all diseased and dead fish instead of throwing them back into the water. Such destruction must be so effected as to prevent the reentry of the germs into the water.

Railliet says that it is expedient to collect the diseased fish and to bury them at a certain depth and at a great distance from the water-course. He further states that this was done on the Meuse with success, so that at the end of some years the disease appeared to have left no trace.

TREMATODA.[1]

Representatives of this order are numerous among the parasites of fishes, but, so far as I have observed, are not likely to occur in sufficient numbers to occasion serious loss. Their presence will be a tax, nevertheless, on the vitality of their host, which may be, in many contingencies, the determining factor in causing that host to fall an easier prey to its pursuer than its uninfected comrade will do.

In my paper on Trematodes, No. 17 of the appended list, are described 31 distinct species and one variety taken from 25 specifically distinct hosts. In the majority of cases these worms were found in small numbers in the intestines of their hosts, and presumably occasioned little inconvenience. In a few cases, however, I found them encapsuled in various positions in the body cavity, and occasionally in such numbers that they must have affected seriously the vitality of their hosts. For example, a species (which was referred to Diesing's *Diplostomum cuticola*) was found in great abundance on the viscera of three species of sunfish, *Lepomis auritus*, *Chænobryttus gulosus*, and, probably, *Lepomis pallidus*. The viscera consisted mainly of hearts and livers, and were sent to me by Mr. N. A. Harvey, of Kansas City, Mo., January, 1894. The serous coats of these organs were thickly studded with cysts. These were very numerous, and varied in size from minute specks to capsules measuring over 1 mm. in diameter. The largest larva, upon removal from its cyst, measured, in alcohol, a little over 1 mm. in length and about 0.4 mm. in breadth. On account of the immense numbers of these parasites they might very easily prove to be an economic factor of

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[1] See List of Authorities: No. 6 and 13, pp. 553, 554, pl. 65, figs. 22–30; Nos. 17, 18, and 19.

considerable moment, and it is desirable that our knowledge of the life-history of the species should be extended. There is some reason for thinking that the final host is a fish-eating bird, although it may be some voracious fish, like the gar.

Dr. H. B. Ward has published some very interesting notes of his observations on the fish parasites of the Great Lakes (No. 18). From an examination of 20 species of lake fish, the total number of individuals examined being 102, 95 of which were infested with parasites, he obtained something over 4,000 Trematodes, 2,000 Acanthocephala, 200 Cestodes, and about 200 Nematodes. Trematodes were obtained from every species examined, and in enormous numbers from the dogfish (*Amia calva*). Cestodes were obtained from 14 of the 20 species, Acanthocephala from 13, and Nematodes from 7. Dr. Ward describes a new Distoma from *Amia calva* (No. 19,) encysted forms of which he finds in the crayfish (*Cambarus propinquus*), thus establishing its life-history. The adult form was found also in the channel catfish, *Ictalurus punctatus*, and the yellow perch, *Perca flavescens*.

I would conclude from the results of Dr. Ward's researches, as compared with what I have had the opportunity to observe, that Trematodes are relatively much more abundant in fresh-water fishes than in marine fishes.

CESTODA.[1]

My investigations have been mainly on marine fishes, in which I have found the members of this order very abundant, largely, perhaps, because of the predilection which the adult forms appear to have for the spiral valve of the Elasmobranchii. The individual shark or skate is not only an engine of destruction, but a source of infection from which innumerable ova of a variety of cestode parasites issue to become encysted in various animals which serve them for food. There can be little doubt that if the sharks and skates were to be exterminated, or sensibly diminished in number, the aggregate of intermediate parasitism among the teleosts, squids, crustacea, and other food of sharks and skates would be materially lessened. The destruction of the Elasmobranchii, while probably not practicable, would be a disturbance of the balance of nature wholly in favor of the food-fishes.

I find larval forms of two genera (*Rhynchobothrium* and *Tetrarhynchus*), in which the adult forms are peculiar to sharks and skates, very commonly encysted in many species of marine food-fish, such, for example, as the squeteague (*Cynoscion regale*). Of adult forms, while the genus *Dibothrium* is somewhat abundant in cods (*Gadidæ*) and flounders (*Pleuronectidæ*), and tapeworms not unusual in the eel and some fresh-water fish, the vast preponderance is to be found infesting the *Elasmobranchii*. The case of the *Dibothrium* of the Rocky Mountain trout has already been mentioned.

It is very desirable that our knowledge of this important group of parasites be extended, both in the direction of ascertaining what forms are to be found in the fish of our waters and in working out the life-histories of forms already known. It should be remarked that one species of human tapeworm (*Bothriocephalus latus*) is believed to be got from eating the flesh of the European tench.

I take this opportunity of calling attention to a paper by Dr. F. S. Monticelli (Boll. d. Soc. d. Nat. Napoli, Serie I, vol. VIII, Anno VIII, Fasc. I, 1894) *Si Mangiano le Ligule in Italia?* In this paper the author affirms that Leuckart is in error in stating (*Die Parasiten des Menschen*) that in Italy the ligula—a larval form of a cestode worm which develops in the abdominal cavity of certain fresh-water fish and there

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[1] See List of Authorities: Nos. 7, 8, and 10 to 16.

attains considerable dimensions—is "eaten as living macaroni." This statement of Leuckart's has been taken without question and repeated in various forms by different writers. Donnadieu (Contribution à l'histoire de la Ligule, Journal d'Anatomie et de la Physiologie 1877) repeats the assertion and adds that many people in Lyons have the same habit. Doubtless the truth is that ligulæ have been eaten along with the fish which harbored them, much as roe is eaten, by persons who did not know the real nature of the tidbit, which no doubt, in the blissful ignorance of the eater, pleased his palate quite as well as did the flesh which was a part of the fish.

ACANTHOCEPHALA.[1]

The members of this order, so far as my observation goes, are not found in large numbers in many species of fish, although they are likely to occur in great number in occasional individual hosts, particularly among the flounders (*Pleuronectidæ*). The most persistently occurring cases of parasitism which I have observed, however, have been in this order. I have examined the striped bass (*Roccus lineatus*) repeatedly in successive summers at Woods Hole, Massachusetts, and have rarely found an individual which was not infested with a thorn-head worm (*Echinorhynchus proteus*). Sometimes it occurs in considerable numbers, and almost always penetrates with its thorny proboscis the coats of the intestine of its host, thus causing more or less local irritation, followed by a waxy degeneration of the tissues.

There is probably no practical way of counteracting the bad influences of worms of this order, since their larval state is passed, in some cases certainly, and in most cases probably, in small crustacea, which constitute a constant and necessary source of food for the fish. The same remark which was made in another connection with regard to the disposal of the viscera of fish applies here. In no case should the viscera of fish be thrown back into the water. In this order the sexes are distinct, and the females become at last veritable sacs for the shelter and nourishment of enormous numbers of embryos. The importance, therefore, of arresting the development of as many embryos as possible is at once apparent.

NEMATODA.[2]

The round worms are very abundant, especially in immature stages, in marine fishes. In fresh-water fishes they are probably not so abundant.

I have lately gone over a large collection of nematode parasites of fishes, made in part by myself at Woods Hole, Massachusetts, and in part belonging to the United States National Museum, having been collected in various localities. In this collection there are nematodes from over 60 species of fish. I have noted some 80 distinct kinds, 14 of which have to be recorded as "*Ascaris* species," they being immature, although free in the intestines of their hosts. They plainly belong to the genus *Ascaris*, but do not have distinct characters which will enable one to refer them to species already established or to make it advisable to give them new specific names. At least 40 kinds, from as many specifically different hosts, I have been obliged to refer to a section headed "Immature nematodes, encapsuled, and for the most part belonging to the genus *Ascaris*." It would not be profitable to give names to these immature forms, since many of them are doubtless different stages in the development of the same

[1] See list of authorities: No. 7, pp. 490–498, pl. v, vi; No. 9; No. 13, pp. 555–556, pl. 65–67.
[2] See list of authorities: No. 13, pp. 557–561, pl. 67; No. 14, pp. 111–112.

species. Often in a lot of encapsuled forms, collected at the same time from the same host, individuals are obtained which differ very considerably one from another.

One viviparous species belonging to the genus *Ichthyonema* (which I have referred, with some hesitation, to the species *Ichthyonema globiceps* Rudolphi) on account of the enormous number of young which the adult specimens contain, might, under favorable conditions, become of serious import. I shall speak of it somewhat in detail. The several lots of worms which I refer to this species come from the following hosts:

1. Bluefish (*Pomatomus saltatrix*), ovaries, Woods Hole, August, 1884.
2. Spanish mackerel (*Scomberomorus maculatus*), ovary, New Jersey coast, S. E. Meek, collector, October, 1886.
3. Black grouper (*Lobotes surinamensis*), peritoneum, Woods Hole, August 3, 1887.
4. Black grouper (*Lobotes surinamensis*), viscera, Woods Hole, August 6, 1887.
5. Tarpum (*Tarpon atlanticus*), U. S. Nat. Mus. collection, locality and date of capture not given.

The specimens are all females, and, with the exception of lots 2 and 5, have the uterus, at least its lower portion, filled with embryos. They are all very long and of nearly uniform diameter throughout, and rather bluntly rounded or conical at the extremities. In lot 1 the embryos, which occur in myriads, appear to have escaped by rupture of the uterus into the body cavity. Lot 3 consists of two specimens obtained from the body cavity of their host. They measured living 510 and 580 mm. in length, respectively, and 1.48 mm. in diameter; color, brownish. The intestine appeared as a dark-brown line for more than two-thirds of the entire length and as a white line for the remainder of its length. The intestine ends blindly at its posterior extremity. My notes, made at the time of collecting, state that the external opening of the uterus is at a point about 1 mm. from the anterior end, where it was observed that the young were being discharged in vast numbers. Under slight pressure, however, two tubes were seen protruding for a short distance, from each of which young were escaping. This would appear to indicate that the uterus had been broken, and what was taken to be an external opening may have been a break in the body wall.

The embryos measured about 0.4 mm. in length, 8μ in diameter at the posterior end, and 13μ in greatest diameter. The anterior end was very slender, appearing as a mere line, even when highly magnified. These embryos are characterized by having a few, about four, dark-brown granular masses scattered along the middle region of the body. A slight notch was noticed at the posterior end of some. A favorite position of these embryos is with the posterior end bent rather sharply, often so much so as to point forward. The anterior end is also often bent so that the two ends point toward each other. Where they occur in the greatest abundance in the parent worm they impart to the latter a plump and even distended appearance. After the discharge of the embryos the worm is transparent, much contracted, quite irregular in outline, and in places flattened and shriveled. I do not know what the history of this worm is between the embryos as seen in these specimens and the adult. The embryos are eminently well fitted for making their way by means of their attenuated and filiform anterior ends through the tissues of their host, whatever that host may be. If they have a history anything like that of *Trichina spiralis*, then the animal which would make a meal off of a fish harboring one or more adult *Ichthyonemæ* has trouble ahead.

While encapsuled nematodes were found in a large number of the species of fish examined, and in considerable abundance in some, they were almost always confined to the body cavity, where they lay in flat coils for the most part on and among the viscera. They were very seldom seen in the flesh. The adults in the alimentary canal in most cases occurred in comparatively small numbers in the several hosts. The only fish in which I found numerous adult nematodes was the swordfish (*Xiphias gladius*). These worms were referred to the species *Ascaris incurva* Rudolphi. They were found in the stomach and were of different sizes, from immature, filiform specimens up to large, plump individuals 250 mm. in length. The largest of which I have any record was 267 mm. in length and 3 mm. in diameter.

I pass over cases of external parasites of fishes, leeches, lerneans (fish lice), etc., as not coming within the proposed scope of this paper.

WASHINGTON, PENNSYLVANIA.

Partial list of American authorities on fish parasites, especially such as have been published by the U. S. Fish Commission and the U. S. National Museum.

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2. Notice of the occurrence of protozoan parasites (Psorosperms) on cyprinoid fishes in Ohio. Edwin Linton. Bulletin U. S. Fish Commission for 1889, pp. 359–361, pl. CXX.
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HELMINTHA.

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15. Notes on larval cestode parasites of fishes. Edwin Linton. Proc. U. S. National Museum, vol. XIX (1897), pp. 787–824, pl. LXI–LXVIII.
16. Notes on cestode parasites of fishes. Edwin Linton. Proc. U. S. National Museum, vol. XX (1897), pp. 423-456; pl. XXVII–XXXIV.
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THE FISH FAUNA OF FLORIDA.

By BARTON WARREN EVERMANN, Ph. D.,
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There is perhaps no State in the Union whose fishes have attracted more general attention than have those of Florida. The interest in the fishes of this State is shared by the commercial fishermen, the angler, and the ichthyologist. The number of species that are sought because of their commercial value is far greater than in any other section of America. Those that are of interest to the angler are more numerous than any other State can boast, while the richness and peculiarities of the fish fauna of Florida have made this State a fascinating field to the ichthyologist and student of geographic distribution.

Before entering upon the detailed discussion of the fish fauna let us notice for a moment a few of the more important geographic and cl matological factors of the State, for these are the features which determine the character of the fish fauna of any region.

Florida is the most southern of all the States, the entire State lying south of the thirty-first parallel. Its most southern point is in latitude 24° 30′, about 1° 30′ farther south than any other point of our territory. In longitude it extends from the eightieth meridian to that of 87° 30′. It will be thus seen that the State extends through 6½ degrees of latitude (nearly 400 miles) and 7½ degrees of longitude (or about 400 miles). It has relatively and actually by far the greatest shore line of any State, the total being not fewer than 1,200 miles, or more than 1 mile of shore line for every 5 square miles of territory—in fact, about 230 more miles of sea front than it could have if it were a square island.

Though Florida has not the diversified geographic features possessed by many other States, such as Georgia, which give it mountain torrent, upland river, and lowland marsh, nevertheless its numerous lakes and rivers are not without variety. Some of the streams are more or less turbid, some clear and cold, others temperate, and others warm. All are rich in water vegetation, which invariably implies a rich fauna as well, and the vast Everglades present conditions hardly to be duplicated elsewhere in America.

The more than 1,200 miles of coast line present great diversity as to nature of shore and temperature of water. There are to be found on the Florida coast almost any kind of shore one may desire; vast areas of mud flats in some places, long reaches of clean sand and shallow water in others, rocky shores with shallow tide pools, a multitude of narrow, shallow channels and mangrove islands, and the great chain of Florida Keys, among which a wide diversity of conditions is found, such as great mud flats, large fields of algæ, forests of gorgonians, great sponge-grounds, coral reefs, etc., not duplicated anywhere on our coast.

From the relatively cool waters of Pensacola and Fernandina the temperature gradually rises southward until we reach the Keys, where it becomes noticeably higher on account of the Gulf Stream as it sweeps through the Florida Straits and up the eastern coast. Nowhere else on our coast is the influence of the Gulf Stream so great, and nowhere else does the fauna of tropical seas extend so far north. Indeed, among the Florida Keys we find the nearest approach to tropical conditions to be found anywhere in the United States.

It is remarkable that the rich fish fauna of Florida did not attract the attention of students earlier than it did. Prior to 1870, scarcely anything was known concerning the fishes of the State. So far as we have been able to learn from an examination of ichthyological literature the earliest references to Florida fishes are those of Mark Catesby in 1754, LeSueur in 1824, and Holbrook in 1855 and 1856. Catesby's Natural History of Carolina, Florida, and the Bahama Islands, a mammoth work of two volumes, royal folio, with 220 colored plates, contains a few references to Florida fishes, but this was before the beginning of binomial nomenclature (which dates from 1758), and no names were given. In 1824 Messrs. Maclure, Say, Ord, and Peale, of the Philadelphia Academy, all great men in the early history of science in America, made a trip to Florida and brought back with them dried specimens of one ray and one skate. These were described in the same year by LeSueur as *Raia sabina* and *Raia desmarestia*, but are now known as *Dasyatis sabina* (one of the most common rays on the Florida coasts) and *Raja eglanteria*, the brier skate, less common than the other species. These, so far as we have been able to learn, are the first fishes ever described from Florida localities.

In 1856 Dr. John Edward Holbrook published an "Account of several species of fishes observed in Florida, Georgia, etc." In this paper 6 species were credited to the St. Johns River, 5 species of sunfishes and 1 darter, all of which were described as new, but not one of which proved to be so. In 1855 Holbrook published the first edition of his Ichthyology of South Carolina, and in 1860 the second edition of the same work appeared. In this work 12 species are referred to definite Florida localities in the first edition and 22 in the second, one of the latter (*Esox ravenelli*=*Lucius americanus*) being described as new.

In the twenty years following the appearance of the first edition of Holbrook's Ichthyology little or nothing was added to our knowledge of the fishes of Florida. Not until 1878 was any serious or considerable study made of the fishes of this State. In that year Mr. Silas Stearns, of the Pensacola Fish and Ice Company, began sending specimens of Florida fishes to the U. S. National Museum. The first specimen was described by Goode & Bean as the type of a new species, the blanquillo (*Caulolatilus microps*), a near relative of the noted tilefish, whose sudden appearance in myriads in the Gulf Stream about the same time and whose as sudden disappearance in 1882 remain to this day among the marvels of the natural history of fishes.

In the winter of 1877–78 Mr. Stearns began a most active and intelligent study of the distribution and habits of the fishes of the Gulf coast of Florida. Particular attention was paid to the food-fishes and the fishes found on the Snapper Banks. Specimens of the various species were sent to the National Museum, which formed the basis of numerous important papers by Goode & Bean, Jordan, and Stearns.

I wish to call special attention to the work done by Mr. Stearns. It was of very great importance and deserves more than a passing notice. During the few leisure hours of an active business life Mr. Stearns found time to make a study of the natural history of the fishes of the Gulf coast which even to this day constitutes the bulk of our knowledge of many of the species of that region. He made invaluable collections, containing many species new to science, and his own direct contributions to the literature of Florida fishes, published in the Fishery Industries reports of the Tenth Census, may well serve as models for writers on natural-history subjects. The untimely death of Mr. Stearns in 1888 was a severe loss to science as well as to the State of Florida.

Since 1878 a number of persons have done more or less collecting in Florida; among them the following may be mentioned: Dr. J. W. Velie, in Clearwater Harbor and vicinity; Dr. J. A. Henshall, from Biscayne Bay around the coast to Tampa; Dr. Jordan, at Pensacola, Cedar Keys, and Key West; Dr. O. P. Hay, about Captiva Pass; the vessels of the Fish Commission, at the Tortugas, on the Snapper Banks, and elsewhere along the Gulf coast; Messrs. A. J. Woolman and L. J. Rettger, in the streams of the western part of the State; Mr. Einar Lönnberg, in the fresh waters about Orlando; Mr. Charles H. Bollman and the writer, at Pensacola and on the Snapper Banks; Mr. Barton A. Bean and the writer, in Indian River and Lake Worth; Dr. H. M. Smith, in Biscayne Bay; Dr. William C. Kendall, in the St. Johns River; and Dr. Kendall and the writer, about Biscayne Bay, Key West, Tampa, and Tarpon Springs. The characteristics of the fish fauna of the other portions of the State are almost wholly unknown; and our knowledge of those regions which have received some attention is far from satisfactory. New species and new and important facts about known ones are discovered each time any investigations are made in any part of the State. A vast amount of work remains to be done before we may consider our knowledge of the fishes of Florida even approximately complete.

THE FISHES OF FLORIDA.

The total number of species of fishes known from Floridian waters is about 600, or about one-fifth of the entire fish fauna of America north of Panama. This number is far larger than can be found in any other section of our country, and is due to the diversity and peculiarities of the climatic conditions already mentioned. The Florida fish fauna may be regarded as made up of at least five more or less distinct faunas: (*a*) the salt-water fauna of our South Atlantic States, (*b*) the subtropical fauna of the Florida Keys, (*c*) the Gulf of Mexico fauna, (*d*) the fresh-water fauna of the southern portion of the Lower Mississippi Valley, and (*e*) the fresh-water fauna of the Everglades.

These, of course, overlap more or less, and in a consideration of the entire fish fauna of America these regions would not be regarded as constituting distinct faunal areas; but for our present purpose they may properly be considered as fairly distinct. From Fernandina southward to Biscayne Bay are found most of the species characteristic of the coast south of Cape Hatteras. From Biscayne Bay to Key West and the Tortugas is found a fish fauna marvelous in its multitude of species and in their richness of coloration.

Among the fishes of this region which deserve special mention are the great numbers of groupers, snappers, grunts, and porgies, all important food-fishes; the many labroid species, such as the hogfish, pudding-wife, and the various parrot-fishes, all remarkable for their brilliant coloration; the many species of pipefishes, the tangs, angel-fish, and chætodonts, among them several of the most gorgeous of American fishes.

The fish fauna of the Florida Keys resembles that of Cuba very closely. Nearly all the food and game fishes at Key West are also found at Havana. The warm waters of the Keys serve as a more or less effective barrier to the passage of fishes living in colder water. As a result many species are found on the east coast of Florida which do not occur on the Gulf coast, and vice versa. There are so many species found on the west coast of Florida that are not known from the east side that the two coasts may be regarded as having separate faunas. This west-coast fauna extends from the "bay" to Pensacola and beyond, and is not essentially different from that found elsewhere on the Gulf coast.

In the fresh waters of the northern part of the State the fishes are essentially the same as occur in the streams and ponds of the other Gulf States, and include several species of minnows, sunfishes, catfishes, suckers, *Amia*, and a few darters. From the little that is known about the fresh-water fishes of the extreme southern part of the State, it is believed that the species are to a large extent distinct and peculiar to that region. There is great need, however, of further investigation in this region.

Of the 600 species of fishes credited to Florida waters about 51 are fresh-water species, 20 may be regarded as brackish-water species, and the remaining 529 constitute the salt-water fish fauna of the State.

FRESH-WATER SPECIES.

The number of fresh-water species known from the State is not large. They belong to the following families:

Petromyzonidæ (Lampreys)	1	*Pœciliidæ* (Killifishes)	13
Lepisosteidæ (Gars)	3	*Aphredoderidæ* (Pirate Perch)	1
Amiidæ (Bowfins)	1	*Atherinidæ* (Silversides)	1
Siluridæ (Catfish)	8	*Elassomidæ* (Pygmy Sunfishes)	1
Catostomidæ (Suckers)	1	*Centrarchidæ* (Sunfish and Bass)	10
Cyprinidæ (Minnows)	7	*Percidæ* (Darters)	2
Luciidæ (Pikes)	2		

Of these 51 species the only ones of commercial importance are the catfishes, pikes, sunfishes, and the large-mouthed black bass. This list is remarkable in that it contains so few of the *Catostomidæ*, *Cyprinidæ*, and *Percidæ*. Each of these is a very large family, the approximate number of species of each in American waters being as follows: *Catostomidæ*, 70; *Cyprinidæ*, 227; *Percidæ*, 88.

The most southern locality in Florida from which specimens of fresh-water species have been obtained is Miami, 8 species having been collected there in the Miami and Little rivers in 1896. Doubtless many additional species will be discovered when the waters of the State are more thoroughly explored. The regions which promise the richest and most important results are the Everglades, the lakes in the interior south of Lake George, and the streams crossing the northern boundary of the State.

BRACKISH-WATER SPECIES.

In this category may be included all those species which live habitually in brackish water, those more truly salt-water species which are also found more or less commonly in brackish and even fresh water, and also those more truly fresh-water species which are occasionally found in brackish water. In this division will fall, of course, all anadromous and catadromous species, such as the shad and the common eel. The family having the greatest number of species in this division is the *Pœciliidæ*, preeminently the family of brackish-water fishes. Florida contains 21 species of this family, of which at least 8 live habitually in brackish water and each of the other 13 may occasionally occur there. This family is worthy of note as containing the smallest known fish, *Heterandria formosa*, which is less than an inch in length.

Two species of shad are known from Florida. On the east coast the common shad (*Alosa sapidissima*) is a common and valued species. It occurs regularly and in considerable numbers in the St. Johns and St. Marys rivers and rarely in the Indian River It is not positively known to occur in any other waters of the State. At Pensacola a few young shad were obtained by Dr. Jordan in 1882 and provisionally identified as a species distinct from the common shad, but no name was given to them and no description published. In the spring of 1896 an unusually large run of shad occurred in the Black Warrior River at Tuscaloosa, Ala., and specimens were sent to the United States Fish Commission for identification. They proved to be different from the common shad and a new and undescribed species, to which the name *Alosa alabamæ* was given by Jordan and Evermann. When studying these specimens I also studied those from Pensacola (now in the United States National Museum) and found them identical with the Alabama shad.

Shad have been reported from various west Florida rivers, particularly the Suwanee, Apalachicola, and Escambia rivers. It is not positively known what species these may be, but it is more than likely that they are the Alabama shad. An actual examination of specimens from these rivers will be necessary to determine the matter, and the United States Fish Commission would be glad to receive specimens from anyone who has an opportunity to collect them.

SALT-WATER SPECIES.

The great majority of Florida fishes are, of course, salt-water species, there being not fewer than 529 species, distributed among many families and genera. On the east coast approximately 175 species are found, among the Florida Keys 290, and on the west coast about 300. Several important species are found throughout these three regions. Key West is the most important and interesting of all Florida localities as regards the number of species, about 250 species being known from there, of which about 100 are food-fishes of greater or less importance. The richness of Key West in food-fishes will be seen when we recall the total number of food-fishes in each of the other important fishery regions of the United States, as shown in the following list:

South Atlantic States	55	Pacific States	40
Middle Atlantic States	50	Great Lakes	16
New England States	48	Gulf States (Florida excepted)	42

The more important species handled at Key West are the grunts (6 species), the porgies (5 species), the groupers (8 species), the snappers (4 species), the hogfish, kingfish, Spanish mackerel, the carangoids (8 species), and the mullets (3 species). Besides these there are some 60 or 70 species which for one reason or another are less important but are nevertheless handled to some extent. A great many, perhaps a majority, of the food-fishes at Key West occur also about Cuba and may be seen in the Havana market.

The method of handling fish at Key West is unique, and calculated to conserve the fisheries of that region to the fullest extent. Practically all of the fishing is done with hook and line, and every fishing boat has a well into which the fish are placed. All salable fish are brought to market in the wells of the vessels and kept alive until sold. The prospective purchaser visits the fish wharf, selects from some one of the boats the fish he desires, and it is then killed and dressed by the fisherman. This excellent method insures perfectly fresh fish to the purchaser, and few or no fish are lost or wasted.

There is no other place in the United States where one can study live fishes so satisfactorily as at Key West. Fishing boats are lying at the fish wharf at all times and in their wells may be seen specimens of numerous species, many of them of brilliant coloration; and by going out with the fishermen upon the bars and coral reefs one may, by the aid of a water glass, spend many hours observing and studying a multitude of fishes and other interesting forms as they disport themselves in the clear waters beneath the boat.

FOOD-FISHES OF FLORIDA.

While the waters in the vicinity of Key West are wonderfully rich in species of fishes used as food, not all the food-fishes of Florida are found there. The shad does not occur there; neither does the black bass nor any of the fresh-water species; nor do we find there, except possibly as stragglers, the spotted sea trout, the red drum, spot, whiting, pompon, flasher, and perhaps still other species known from Indian River. Additional species are known from Pensacola which do not occur at Key West. The total number of different species of food-fish now known to occur in the waters of Florida is approximately 140, divided among 36 different families, as follows:

Acipenseridæ (Sturgeon)	1
Siluridæ (Catfishes)	4
Catostomidæ (Suckers)	2
Cyprinidæ (Minnows)	1
Anguillidæ (Eels)	1
Elopidæ (Tarpons)	2
Albulidæ (Lady-fishes)	1
Clupeidæ (Herrings)	8
Luciidæ (Pikes)	2
Esocidæ (Needle-fishes)	2
Hemiramphidæ (Balaos)	4
Mugilidæ (Mullets)	4
Sphyrænidæ (Barracudas)	2
Polynemidæ (Threadfins)	1
Holocentridæ (Squirrel-fishes)	1
Scombridæ (Mackerels)	4
Trichiuridæ (Cutlas-fishes)	1
Carangidæ	14
Pomatomidæ (Bluefish)	1
Centrarchidæ (Sunfishes and Black Bass)	10
Centropomidæ (Robalos)	1
Serranidæ (Sea Bass)	10
Lobotidæ (Triple-tails)	1
Lutianidæ (Snappers)	8
Hæmulidæ (Grunts)	12
Sparidæ (Porgies)	12
Gerridæ (Mojarras)	4
Kyphosidæ (Rudder-fishes)	1
Sciænidæ (Croakers)	11
Labridæ (Wrasse-fishes)	1
Scaridæ (Parrot-fishes)	2
Ephippidæ (Angel-fishes)	1
Chætodontidæ (Butterfly-fishes)	3
Teuthiididæ (Tangs)	3
Scorpænidæ (Rockfishes)	1
Pleuronectidæ	4

This large number represents about one-twentieth of the entire fish fauna of America north of the equator.

The value to the State of these commercial fishes will doubtless be set forth in other papers to be presented at this Congress, and need not be dwelt upon here. Suffice to say that the money value of the annual fish output of the State is, in round numbers, not less than $1,000,000.

THE GAME-FISHES OF FLORIDA.

The fame of the game-fishes of the State of Florida extends throughout America, and beyond. Wherever there are anglers and rod and gun clubs, the prowess of the "silver king" is known and talked about. The one great hope of every angler is that he may go to Florida and kill a tarpon before his fishing days are over. But while the tarpon or silver king is the king of the game-fishes of this State, it is by no means the only game-fish. Some of the largest black bass known have been caught in Florida waters. The sunfishes are the largest of their kind. The ladyfish and the bonefish are thought by many to equal their relative, the tarpon, in real game qualities. Trolling for kingfish, jack, crevallé, bluefish, Spanish mackerel, and spotted sea trout, at Indian River, Lake Worth, Key West, or Biscayne Bay, furnishes sport of the most exciting kind; while still fishing for sheepshead and mangrove snappers at Indian River Inlet; for chubs, porgies, porkfish, yellow-tails, snappers, and grunts at Key West; or for red snappers, red groupers, and others of their kin on the Snapper Banks, furnishes sufficient variety to please any angler, in whatever mood he may chance to be. I have fished in every State and Territory in the Union but three, and from Siberia and Bering Sea to the gulfs of California and Mexico, and, all things considered, regard Florida as unequaled in the richness and variety of its attractions for all sorts of sport with rod and reel.

THE NECESSITY OF A BIOLOGICAL STATION IN FLORIDA.

The only station for biological research on the coast of the United States which receives Government support is that at Woods Hole, Massachusetts. While it has never received the support which it should, and has never been fully equipped, it has nevertheless been one of the most important centers for biological study in this country. The location is in many regards admirable. In addition to a rich local fauna and flora, many forms of marine animal and plant life are brought there by the Gulf Stream, thereby greatly increasing the variety of life in that vicinity. But the station is kept open only for a few months during the summer, the winters being too severe for satisfactory work.

The ideal marine biological station must be located at some point not only where the local fauna and flora are rich both in species and individuals, but where the climatic conditions will permit investigations and observations to be carried on throughout the year. The region should also be one in which are found in abundance many of the species of animals and plants which are of special interest to biologists, those the study of whose development and life-history will add greatly to our knowledge of the relationships of the larger groups.

There is no other place on our coast where these conditions are so fully met as on the southern coast of Florida. The climatic conditions are all that could be desired. Investigations could be carried on throughout the year. The waters fairly teem with hundreds of species of fishes, mollusks, crustaceans, echinoderms, corals, sponges, marine algæ, and many other groups, while the abundance of individuals of many of the species is marvelous; and, what is of prime importance, many of the species are permanently resident and can be observed and collected at any time throughout the year, thus enabling the investigator to make a study of the complete life-history of the species.

Without even mentioning the numerous purely scientific problems of deep interest to the embryologist which could be studied under most favorable conditions at such a station, I wish to call attention to a few of the many investigations which are sure to prove of great economic importance and which can be conducted here to the best advantage. I may mention the following:

1. The spawning habits of the numerous food-fishes of the coast and the possibility of their artificial propagation.

2. The food of the various species of fishes.

3. The life-histories of the manatee, alligator, crocodile, and the several species of turtles, and the development of methods for increasing their commercial value.

4. Experimentation regarding the artificial cultivation of the commercial sponges.

There is not a marine species of Florida fish whose life-history is fully known. We are ignorant of the habits of even the most common and important species. Take even such an important fish as the pompano; we know absolutely nothing of the time, place, and manner of spawning, the habits or food of the young, and the possibility of propagating the species artificially; and we are quite as ignorant concerning the bluefish, red drum, spotted sea trout, sheepshead, red snapper, and all of the numerous other snappers, groupers, grunts, and porgies. It is not at all unreasonable to suppose that a study of these species would show that many of them can be cultivated artificially, and the time will doubtless come, and all too soon, when artificial propagation will have to be resorted to to save some of these fishes from practical extinction. It is the part of wisdom to develop the methods requisite for conserving the fisheries and have them perfected and ready for use before any serious diminution begins.

No study has ever been made of the food of any of these food-fishes or the many others which swarm in Floridian waters. Except in the most general way we know nothing of the interrelations existing among these various species, and the conditions favorable or unfavorable to the well-being of the useful species.

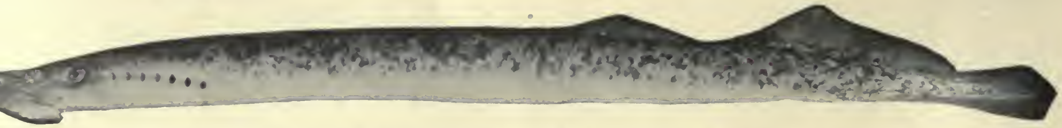
The life-history of the manatee has never been critically studied, and we have doubtless underestimated the importance of its preservation. The same is true of the alligator, crocodile, porpoise, and the several species of turtles found on the Florida coast, all of which are animals of commercial value and of unusual interest to the naturalist.

The discovery and perfecting of methods by which the various commercial sponges of Florida may be cultivated artificially furnish a field for investigation which will prove fascinating in the highest degree and will doubtless yield results of the greatest economic importance.

Each and every one of the lines of investigation indicated is important and worthy of serious attention. Some of them have already been too long neglected. These problems are legitimate fields of investigation.

The establishment of a station for biological research at some point on the coast of Florida is abundantly justified upon both scientific and economic grounds, and should receive the early and serious attention of the General Government and the Commonwealth of Florida.

WASHINGTON, D. C.



LAKE LAMPREY (*Petromyzon marinus unicolor* De Kay) FROM CAYUGA LAKE, IN WINTER. One-half natural size.

BROOK LAMPREYS (*Lampetra wilderi* Gage). Natural size.
(*a*) male, and *b*) female, taken at spawning season and photographed under water with a vertical camera.
(From Plate IV, in the Wilder Quarter Century Book, by S. H. Gage.)

PICKEREL (*Lucius reticulatus*) AND SUCKER (*Catostomus commersonii*) WITH LAMPREY SCARS.
In both cases the wounds penetrate the abdomen.
(Photographed fresh under water, with a vertical camera.)

LAKE LAMPREY CLINGING TO THE SUCKER UPON WHICH IT WAS CAUGHT.
Note the characteristic Lamprey scars by the pectoral and pelvic fins.

THE LAMPREYS OF CENTRAL NEW YORK.

By H. A. SURFACE, M. S.,

Fellow in Vertebrate Zoology, Cornell University.

The greatest enemy of the fish of Cayuga Lake, New York, is a fish-like animal commonly known as the lake lamprey or lamprey eel (*Petromyzon marinus unicolor*). The name lamprey eel, however, conveys an erroneous idea, as the lamprey is not an eel and resembles the eel only in general external appearance. The name lamper eel is also applied to the mutton-fish or ling (*Zoarces anguillaris*) of the Atlantic coast. It is possibly from the habits of young lampreys that the authors of our old First Readers justified themselves in the statement: "Eels live in mud." Although this animal is altogether too well known to the fishermen of this region, to most persons it is an unfamiliar object.

The generic name, *Petromyzon*, signifies a "rock sucker," because it is sometimes found clinging by its mouth to stones. The specific name *marinus* indicates the fact that its primary or normal home is the ocean; but the variety *unicolor*, of which the type is found in Cayuga, Seneca, and the other "finger lakes" of this region, is a land-locked form which has been able to adapt itself to the inland fresh-water conditions throughout the entire year. This variety, now known as the lake lamprey, has become smaller and more uniform in color (hence the varietal name, *unicolor*) than its probable ancestor, the sea or marine lamprey.

There are about 20 species of lampreys known to science, mostly inhabitants of temperate regions. Two species are found in the Cayuga Lake Basin, of which the lake lamprey is very injurious to our best fishes. The brook lamprey, *Lampetra wilderi* Gage, named in honor of Dr. B. G. Wilder, professor of vertebrate zoology in Cornell University, is much smaller than the former, is not known to be injurious to fishes, and does not occur in the lake. It receives its common name from its constant occurrence in streams. It is not known in the lake, and no reference has been found indicating that it has even been collected in any lake. In the adult state it has never been known (by us, at least) to take any kind of food, and the assumption will doubtless be confirmed that this vertebrate, like some insects, does all of its feeding in the larval stage, and remains in its mature stage or condition only long enough to reproduce its own kind. Its very long larval period (two or three years) and short adult period (a very few months) would appear to give weight to this assumption.

This species of lamprey has never been known here in the adult state except during the spring and summer months, and if it has been collected at any other time in other localities particulars of its occurrence are desired. If there is any reference to this species attacking fish, or taking other food in the adult state, the information will be very acceptable. Professor Gage has found transforming larvæ the last of October, and full adults on the spawning-beds as early as the 26th of April. Their transformation is doubtless completed before midwinter.

Some very interesting "Notes on the spawning habits of the brook lamprey (*Petromyzon wilderi*)" have been contributed by Bashford Dean and F. B. Sumner (N. Y. Ac. Sci., vol. XVI, December 9, 1897). The authors compare their dates with recorded dates for this region, and conclude that "the spawning season of our local (New York City) lamprey is thus found to be nearly a month earlier than at Cayuga Lake," but to draw accurate conclusions dates in the same year should be compared. In 1897 the brook lamprey was found on beds here on April 30. This makes a difference of 14 days instead of 30 days between New York City and this region. These two species of lampreys are apparently identical in places of spawning, habitat of larvæ, and observed external appearances (i. e., *specific* determinations in the ammocœtes stage are impossible), but the brook lamprey spawns from one to two weeks earlier than the lake lamprey.

Plate 10 shows one of the lake lampreys attached to a common white sucker (*Catostomus commersonii*), which is also pierced by lamprey marks near both its ventral and pelvic fins, the body-wall being entirely cut through by these blood-suckers, and the abdominal cavity penetrated. This illustration is from a photograph of fresh specimens, under water, taken with a vertical camera, by Prof. S. H. Gage, at Cornell University. Professor Gage and Dr. Wilder have done more work with the lampreys of this region than have any other persons, and it is from Professor Gage's article on "The lake and brook lampreys of New York," in the Wilder Quarter Century Book, 1893, that much information is taken for the present paper. The other illustrations are from photographs of specimens collected in Cayuga Lake or its inlet by persons at Cornell University, and were made for the purpose of showing some special features of the habits of this enemy of our fishes.

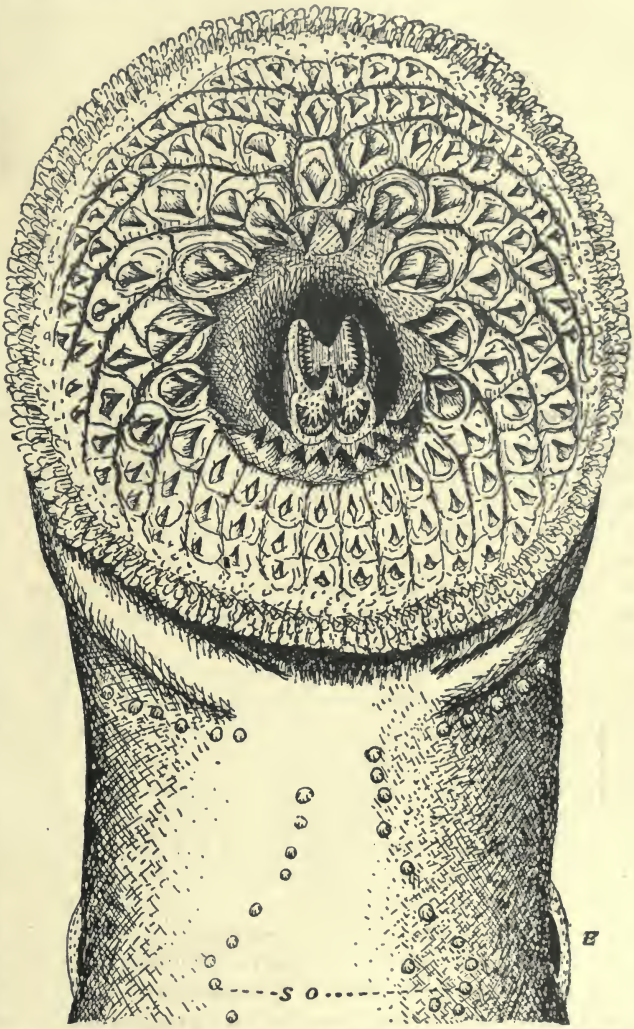
The lamprey is similar to the frog and most other amphibians in the fact that from the young stage to the adult it passes through a metamorphosis slightly comparable with the change of a tadpole into a mature frog. Its full life-history, as determined by Professor Gage, is, briefly, as follows:

The adult passes about three years in the lake, living exclusively by sucking the blood from living fishes, most of which are good food-fish. In the springtime, about the middle of April, apparently, they start out independently from the various points of the lake, each one forsaking its prey and swimming vigorously or stealing a ride by attaching to the bottom of some boat moving in the right direction. On they go until the current of the inlet gives them the clue, and they follow it. Frequently, also, ordinary fishes bound on the same errand throng the streams, and then the lampreys, with their inherent desire to be taken care of by the labor of others, fasten to the larger fishes and are carried along up the stream. It not infrequently occurs that from the natural inclination of the stream, or from some of man's obstructions, there are rapids or dams to be surmounted. Nothing daunted, the lamprey swims up just as far as possible by a tremendous effort, grasping a stone or other object so that he can not be carried downstream again, rests for a while, and then, by a powerful bending and straightening of the serpentine body, a leap is made in the right direction, and what is gained is saved by again fastening the mouth to a fixed object.

This goes on until the obstacle is surmounted, if it is not too great. Then, without delay, the lamprey pushes on upstream, sometimes 8 or 10 kilometers, until clear water and numerous ripples are found. Just above some ripple the lamprey begins to make ready a secure place for a new generation.

The male arrives first and begins the nest building by removing and placing stones with his suctorial mouth. In a few days he is joined by a female, and together they labor away until they have made a basin, or in some cases a ditch across the bed of the stream. Now they fasten themselves with their mouths to stones at the upper edge of this basin, and their bodies swing downstream and sway in the current.

Many hundreds of lampreys have been actually counted on beds in the inlet in a single season by observers at Cornell University, and in 1891 Professor Gage saw there fully 1,200. In these nests the eggs, after being fertilized, sink to the bottom and adhere firmly to the sand and stones, being covered by the lampreys stirring up the sand with their tails. After some days the eggs are hatched and the young lampreys, very much like small angle-worms, burrow into the sand. At first they live in the sand at the bottom of the nests, but soon make their way to the sand along the banks of the stream. Here they remain for perhaps two years or longer, with their eyes only rudimentary and their mouths valvular, feeding on very minute organisms that live in the mud and sand.



Mouth of lake lamprey (*Petromyzon marinus unicolor*). Reproduced from a drawing by Mrs. S. H. Gage. E, eye; S O, sense organs.

It is said that the adult lampreys die soon after spawning, but this is not fully determined. It is also believed that some may return to the lake. When the young are sufficiently developed they metamorphose into adults, find their way down the inlet into the lake, and begin the same kind of parasitic bloodsucking life that their parents led. Thus is the cycle of life completed for these creatures.

In structure and zoologic position the lampreys are the lowest vertebrates found in this region, being placed at the very foot of the list of fishes and by most recent authors they are even denied admission into the class of fishes. The class to which they belong is Marsipobranchii, or "pouch gill," because the gills form a series of pouches, seven on each side of the head. They receive their water through as many independent gill-openings.

The adult lamprey swims in the water like a fish, only with more of a wriggling or snake-like movement, but it does not have paired fins placed as in the true fishes. The only organs that it has that functionate as fins are membranous expansions on its back and on the dorsal and ventral sides of its tail.

As will be seen from the figure of the mouth (p. 211), it has no jaws, but its mouth is a large circular disk, thickly studded with large, strong, chitinous spines or teeth, which enable it to more securely grasp its victim. This disk is surrounded by a softer membrane, which readily fits tightly over any surface and makes it possible for the animal to adhere quite firmly to an object by suction when the piston-like tongue in the center is drawn back. Having fastened itself by this wonderful mouth, which is larger around than its head, it rasps away with the saw-like teeth on its tongue, using nearly 150 other teeth, until it has worn through the thick skin or scales of its victim. Then it has nothing to do but to remain attached to the fish and be carried around by it, sucking blood when it is hungry, and occasionally rasping away at its raw flesh, making the hole deeper and deeper until finally the abdominal wall is completely perforated and the body cavity penetrated. Often the intestines or other organs of the fish are attacked and cut to pieces, but more frequently the lamprey fastens itself at another place if its victim has any blood left, or if not it seeks another fish.

The intestines protruding and the blood escaping from the deserted wound, in a great many cases sooner or later cause the death of the fish, which are often seen swimming in the lake in the miserable condition just described. The injured fish does not always die, but in every case it is seriously weakened and reduced in flesh and blood, and in the power of fully reproducing its kind. Among some specimens recently collected for study here was a bullhead or horned-pout (*Ameiurus nebulosus*) that had been so severely attacked by a lamprey that its stomach protruded through the hole in the side. This fish was kept alive in a tank (for the purpose of observing its condition) for three weeks.

Last spring (1897), when using a collecting seine under the permission and direction of the New York Fisheries, Game, and Forest Commission, the writer found by actual experiment that it was easy to distinguish the bullheads that had been attacked by lampreys, even when they were purposely turned over so that the holes were not visible. The injured fish loses entirely its rich golden hue, and, assuming a sickly appearance, grows paler and weaker. It is not at all uncommon to find dead fish along the shores of Cayuga Lake, and upon examination the marks of the lamprey may be seen. Among such fish recently found are the bullhead or catfish (*Ameiurus nebulosus*), suckers (*Catostomus*), carp (*Cyprinus carpio*), lake herring (*Argyrosomus artedi*), and pickerel (*Lucius reticulatus*). Other species of food-fish are also injured. It is a serious enemy of the sturgeon (*Acipenser rubicundus*), one of which was caught in

A DOZEN CATFISH (*Ameiurus nebulosus*) FATALLY ATTACKED BY LAKE LAMPREY (*Petromyzon marinus unicolor*).
Collected and photographed by H. A. Surface.

EIGHT CATFISH (*Ameiurus nebulosus*) FATALLY ATTACKED BY LAKE LAMPREY (*Petromyzon marinus unicolor*).
Collected and photographed by H. A. Surface.

Cayuga Lake with six lampreys on it. A local fisherman claims to have captured a very large sturgeon which had 21 lampreys attached to it.

In addition to the above list other valuable fish which have been attacked are the whitefish, pike, muskellunge, bass, perch, lake trout, wall-eyed pike, redhorse or mullets (*Moxostoma macrolepidotum* and *M. aureolum*), the eel (*Anguilla chrysypa*), drum (*Aplodinotus grunniens*), white bass (*Roccus chrysops*), and others. In fact, of the 74 species of fish found in Cayuga Lake basin, none is known to be free from its attacks except those too small for its attachment and support. Several injured specimens of the bowfin, mudfish or dogfish (*Amia calva*) have been seen; even the heavy-scaled ganoid, the gar pike or billfish (*Lepisosteus osscus*), is sometimes attacked. Fine specimens of lake trout (*Cristivomer namaycush*) with as many as five wounds on one fish have been found. With smaller fishes one attack sometimes proves fatal; often, however, the fish may survive the first attack and fall a victim to the second or even third. Only a fish of considerable size and vitality can survive five or more wounds without intervals for recuperation.

The records kept in field work here show that lampreys are much more injurious, or a much greater percentage of fishes are injured in the early spring (February and March) than at any other time. This season of feasting may be to strengthen them for the long period of fasting and spawning, for it is shown that they not only refuse to feed during the spawning season, but owing to the atrophy of the alimentary canal they are entirely incapacitated for taking food.

Professor Gage has estimated that the lamprey annually does as much in reducing the available food-fish in this lake as all the work of the fishermen combined. He has also shown that of the bullheads captured in the lake 12 out of every 15 have been attacked by the lamprey. From careful observations made within the past year, the writer is prepared to confirm and emphasize both of the above statements.

The attacks on the bullhead or catfish alone are of great importance. It is safe to say that hundreds of barrels (probably about 500,000 pounds) of these are placed annually upon the markets in the State of New York. In most cases they are dressed. No wonder! Who wants to buy or eat fish with great festering sores or ulcers visible? And yet the bullheads are excellent food-fish. That their value is recognized by experts is attested by the fact that last year the State Fish Commission of New York furnished the State Fish Commission of Ohio with 1,200 of them for stocking certain streams in the latter State.

From every economical standpoint it would appear to be advantageous to rid the world en rely of the lampreys. It would certainly be greatly to the advantage of the fisheries of the State of New York if all were destroyed. Naturally, however, the student of biology must mourn the loss of a form so interesting and so instructive. The questions naturally arise: "How can the fish be protected from the lampreys; and is it possible to remove the lampreys from our lakes? Thanks to the service science has rendered by the twenty-five years' study of this subject by Dr. Wilder and Professor Gage, the modus operandi becomes comparatively simple, as shown by the following quotations from the latter's paper.

It will be seen that it [the lamprey] has one very vulnerable point, viz, leaving the lake and running up the tributaries to spawn. This seems to be the only point at which the lamprey can be attacked, and the hope of exterminating it is rendered still stronger from the fact that in Cayuga and Seneca lakes, so far as explored (during several seasons), the lampreys run up the inlet at the head of the lake only, and do not spawn in the tributaries entering the lake at intervals on each side.

Lampreys must be destroyed before spawning if they are to be exterminated. Nothing would be easier than to do this. A dam with a fishway—the fishway leading into an isolated inclosure—where the lampreys could be easily removed and disposed of, or a weir of some kind, could be constructed at slight expense. If this could be continued for three or four years in all the lakes and in the Oswego River, the race could be extinguished and the lakes wholly freed from their devastations.

In the diagram A represents perpendicular posts set in the stream and fastened, for the purpose of catching floating material that might otherwise tear or injure the weir below. B represents net wings for the capture of creatures running down the stream. C represents the main or chief net placed entirely across the stream to prevent passage either way. At D is the pocket or pen in which the fish coming up the stream will ultimately be found, being guided by the various wings of netting or wire E and F.

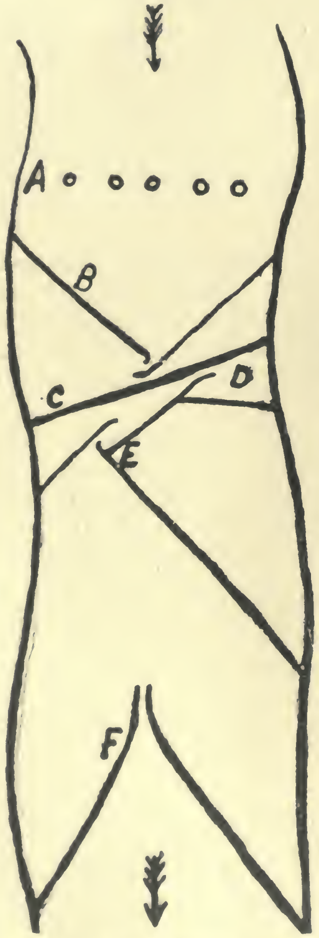


Diagram of weir for catching lampreys as they run up the stream to spawn. (Arrow indicates direction of current.)

It can be seen that if a weir for this purpose were established in the inlet of Cayuga Lake, not only would it do a great deal of good in removing the lampreys, but what is much more, it would give some vastly important absolute facts to the State authorities upon which they may be able to definitely base plans and calculations for more extensive operations at other lakes for another year. Also, one can scarcely estimate what a valuable amount of scientific information would be gained concerning our anadromous fishes as they run up the stream to spawn and return to the lake again. Important investigations could here very easily be made, and many valuable facts could be gained by such investigations properly conducted. Until trained investigators give our legislators many facts not now known, laws that will prove effectual in the protection and maintenance of fish or game can not be enacted.

For example, the laws for the protection of fish are in most cases based upon their spawning habits, and this is of course right; but no one can give or find correct answers to the following questions for even one-fourth of the number of kinds of fish found here:

Just when do they commence to spawn, and when is the spawning completed? How long before spawning do they run up the streams, and how long after do they return to the lake or sea? Just what species find it necessary to run up the streams for spawning, and what remain in the lake? What is their food, and what their enemies and diseases at this most important time in the life of the fish? What is their modification in structure, or condition of all organs, and their food before, after, and during spawning? In what numbers do they run up the streams, and what proportions are males or females? What kind of nest do they build, and do both sexes take part in its construction? Which sex cares for the eggs, and which for the young, and how? And, how long do the young need or receive parental protection?

All of these questions and many others that could be asked are of great importance, but can never be answered except through some such careful investigations as can be made in connection with the proposed weir, the diagram of which is given. The plans have been very carefully made, and meet the hearty approval of the State fish, game, and forest commissioners. It has been placed in the inlet above the limit of navigation and below the lowest place where the lampreys spawn. Two watchmen are employed to alternate in watching this weir constantly, day and night, during the "running" season, and, empowered as deputy sheriffs, the watchmen will be able to arrest any trespassers who might otherwise seriously interfere with the success of the experiment.

A specialist from Cornell University visits the weir every morning and evening at regular intervals, and with a shallow dip net removes the lampreys and helps over the good fish and lets them go on their way. A strict count and record is made of the kinds seen and of the number of each, their condition, development, habits, and such other points as are of economic or scientific interest and help to give correct answers to the questions above asked. By conscientiously performing this work it is also possible to determine what percentage of each species migrates in the daytime and what at night.

President B. H. Davis, of the Fisheries, Game, and Forest Commission, conferred with Senator Stewart on this subject, and the latter, at the request of the former and several other interested persons, introduced a bill, as an item in the general supply bill, for $500 for this work. Last year our legislators passed a bill appropriating $1,500 for the removal of the billfish or gar pike from Black and Chautauqua lakes; and here in Cayuga Lake, the largest of the interior lakes of the State, the lamprey is fully one hundred times as injurious to the fishing industry as is the billfish, and the amount asked for and granted is only one-third of last year's specific appropriation. The appropriation was made without dissent, and the New York State fish-culturist, Hon. A. N. Cheney, now has general charge of the affair. The special investigations and experiments are to be made by the writer and the results published by the Fisheries, Game, and Forest Commission of the State of New York.

Many eminent scientists and other persons have written, expressing interest in this subject and the possible results of this experiment.

ITHACA, NEW YORK.

ADDENDUM.

APRIL 25, 1898.

At this date the weir for removing lampreys from the inlet of Cayuga Lake is constructed and in successful operation. Although it is too early in the year for any results with the lake lamprey (*Petromyzon marinus unicolor*), some interesting facts have already been obtained concerning the brook lamprey (*Lampetra wilderi*). On April 9, the first day the weir was in working order, one adult male of this species was found in it, and on the 11th two others. On the 16th it contained several adult males and females; on the 20th one male and two females, and on the 22d two more females. These were striving to swim up the stream, presumably to regain the places from which they had doubtless been washed during the past year as larvæ in the sand, since their spawning-beds are all above this. In a tank at Cornell University several specimens taken from the sand six weeks ago have not only transformed into adults, but the reproductive organs of both sexes have matured, and one female was spawning when she died. This was without having taken food, and we are still further led to believe that adults of the brook lamprey are not parasitic, and, indeed, take no food at all.

H. A. SURFACE.

THE PROTECTION OF THE LOBSTER FISHERY.

By FRANCIS H. HERRICK, Ph. D.,
Professor of Biology, Adelbert College.

In the lobster fisheries we have an example of an industry which has increased rapidly in value in a very few years. In 1869 the Canadian fishery was valued at $15,275; in 1891, at $2,250,000.[1] In twenty-two years its value increased nearly 150 fold. The value of the products of this industry in the United States was nearly half a million dollars in 1880 ($488,432), and in 1892 over a million dollars ($1,062,392).[2] In 1896 there were 14,285,157 cans of lobster packed in Canada, having a value of $2,400,000. The average price per pound in 1883 was 9½ cents; in 1893 it had risen to 14.10 cents, and at the present time it is 18.72 cents.[3]

The decline of the lobster fishery is a well-worn theme. The facts pointing to its gradual but certain decay are too evident to be mistaken, such as the interminable legislation on the subject of protection, the increase in the number of traps, the decrease in the size of the lobsters themselves, and their increase in market value. Twenty-five years ago the lobster was common; now it is generally a luxury.

The cause of the depletion of the fishery is plain. The supply has been unequal to the demand. More lobsters have been annually destroyed than have been annually raised. No number of animals, however large, can stand such a drain. For twenty-five years the law in Canada has been called to the aid of the fishery. It has taken a vacillating course in both the Provinces and the United States, revoking one year what was enacted the year before, adopting this and that suggestion, and jumping from one expedient to another. Regard to personal interests, imperfect knowledge of the habits and needs of the animal itself, and perverted logic have characterized much of the legislation which governments have enacted for the preservation of animal life. There are, indeed, praiseworthy exceptions, and legislation, though it has often failed, may have been animated by the right spirit.

The problem of perpetuating an animal like the lobster, or rather of maintaining the supply, for it is not in the power of man to exterminate this species, is certainly a difficult one. In order to discuss this or any similar question profitably and intelligently, it is necessary to set aside pride and prejudice of every kind, whether personal, sectional, or national, and consider in a judicial spirit the conditions in which this

[1] Report on the lobster industry of Canada, 1892. Supplement to 25th Annual Report of the Department of Marine and Fisheries, 1893.

[2] The American Lobster. Bulletin of the U. S. Fish Commission, 1895, p. 12.

[3] Discoloration in canned lobsters, by Andrew Macphail. Supplement to 29th Annual Report of the Department of Marine and Fisheries, 1897.

problem is involved. We must know the state of the fishery and the principal facts pertaining to the life and habits of this animal.[1]

Until within a few years the life-history of the lobster was very imperfectly known, and this ignorance has nowhere been more clearly reflected than in the attempts to cure existing evils by legislation. Knowing the general facts of the case, we must interpret them in accordance with the principles of science and common sense. The principal facts are these[2]:

(1) The fishery is declining, and this decline is due to the persistence with which it has been conducted during the last 25 years. There is no evidence that the animal is being driven to the wall by any new or unusual disturbance of the forces of nature.

(2) The lobster is migratory only to the extent of moving to and from the shore, and is, therefore, practically a sedentary animal. Its movements are governed chiefly by the abundance of food and the temperature of the water.

(3) The female may be impregnated or provided with a supply of sperm for future use by the male at any time, and the sperm, which is deposited in an external pouch or sperm receptacle, has remarkable vitality. Copulation occurs commonly in spring, and the eggs are fertilized outside the body.

(4) Female lobsters become sexually mature when from 8 to 12 inches long. The majority of all lobsters 10½ inches long are mature. It is rare to find a female less than 8 inches long which has spawned, or one over 12 inches in length which has never borne eggs.

(5) The spawning interval is a biennial one, two years elapsing between each period of egg-laying.

(6) The spawning period for the majority of lobsters is July and August. A few lay eggs at other seasons of the year—in the fall, winter, and probably in the spring.

(7) The period of spawning lasts about six weeks, and fluctuates slightly from year to year. The individual variation in the time of extrusion of ova is explained by the long period during which the eggs attain the limits of growth. Anything which affects the vital condition of the female during this period of two years may affect the time of spawning.

(8) The spawning period in the middle and eastern districts of Maine is two weeks later than in Vineyard Sound, Massachusetts. In 1893 71 per cent of eggs examined from the coast of Maine were extruded in the first half of August.

(9) The number of eggs laid varies with the size of the animal. The law of production may be arithmetically expressed as follows: *The number of eggs produced at each reproductive period varies in a geometrical series, while the length of lobsters producing these eggs varies in an arithmetical series.* According to this law an 8-inch lobster produces 5,000 eggs, a lobster 10 inches long 10,000, a 12-inch lobster 20,000. This high rate of production is not maintained beyond the length of 14 to 16 inches. The largest number of eggs recorded for a female is 97,440. A lobster 10½ inches long produces, on the average, nearly 13,000 eggs.

(10) The period of incubation of summer eggs at Woods Hole is about ten months, July 15–August 15 to May 15–June 15. The hatching of a single brood lasts about a week, owing to the slightly unequal rate of development of individual eggs.

[1] In discussing this subject I have not attempted to discriminate between conditions which may exist in the United States and the Maritime Provinces. The questions to be considered have primarily a general significance.

[2] For further details see The American Lobster, Bull. U. S. F. C. 1895, pp. 1–252.

(11) The hatching period varies also with the time of egg-laying, lobsters having rarely been known to hatch in November and February.

(12) Taking all things into consideration the sexes appear about equally divided, though the relative numbers caught in certain places at certain times of the year may be remarkably variable.

(13) Molting commonly occurs from June to September, but there is no month of the year in which soft lobsters may not be caught.

(14) The male probably molts oftener than the female.

(15) In the adult female the molting like the spawning period is a biennial one, but the two periods are one year apart. As a rule, the female lays her eggs in July, carries them until the following summer, when they hatch; then she molts. It is possible that a second molt may occur in the fall, winter, or spring, but it is not probable, and molting just before the production of new eggs is a rare occurrence.

(16) The egg-bearing female, with eggs removed, weighs less than the female of the same length without eggs.

(17) The new shell becomes thoroughly hard in the course of from six to eight weeks, the length of time requisite for this varying with the food and other conditions of the animal.

(18) The young, after hatching, cut loose from their mother, rise to the surface of the ocean, and lead a free life as pelagic larvæ. The first larva is about one-third of an inch long (7.84 mm.). The swimming period lasts from six to eight weeks, or until the lobster has molted five or at most six times, and is three-fifths of an inch long, when it sinks to the bottom. It now travels toward the shore, and, if fortunate, establishes itself in the rock piles of inlets of harbors, where it remains until driven out by ice in the fall or early winter. The smallest, now from 1 to 3 inches long, go down among the loose stones which are often exposed at low tides. At a later period, when 3 to 4 inches long, they come out of their retreats and explore the bottom, occasionally hiding or burrowing under stones. Young lobsters have also been found in eelgrass and on sandy bottoms in shallow water.

(19) The food of the larva consists of minute pelagic organisms. The food of the older and adult stages is largely of animal origin with but slight addition of vegetable material, consisting chiefly of fish and invertebrates of various kinds. The large and strong also prey upon the small and weak.

(20) The increase in length at each molt is about 15.3 per cent. During the first year the lobster molts from 14 to 17 times. At 10½ inches the lobster has molted 25 to 26 times and is about five years old.

After reviewing the most important facts concerning the life of this animal we are ready to discuss the methods which have been tried to prevent its destruction, such as: (1) The protection of immature lobsters by establishing a legal-size limit, or by regulating the construction of traps, or by making close seasons—periods of the year when fishing is illegal; (2) protecting the "berried lobster" or females with external eggs; (3) regulating the canning industry; and (4) attempting to increase the supply of lobsters by artificial propagation. It must be admitted that up to the present time all these measures have proved very disappointing.

The desire to protect the immature lobster and allow it to breed at least once in its life is certainly commendable. It is largely because of the failure of efforts to attain this result that the fishery is now in decline. One reason for this is that there are no obvious means of determining whether a live lobster has in every case produced eggs or not, and another is that the lobster often matures at a much later period than has been generally supposed. The legal-size limit in Canadian waters fluctuated from 9 to 9½ inches between 1874 and 1892. In 1895 the legislature amended the law, making it illegal to take lobsters less than 10½ inches long. In 1895 the legal limit in Maine, Massachusetts, New Hampshire, and New York was 10½ inches; in Rhode Island 10, and in Connecticut 6 inches. The legislature of Massachusetts was ready to reduce the 10½ limit the next year, but its act was vetoed by Governor Wolcott.

Some lobsters are known to produce eggs when 8 inches long; therefore, it is said, a 10½-inch limit is too great. This can not be allowed. While a few female lobsters produce eggs when 8 inches long, the majority at this size do not. The same is probably true of lobsters 9 and 9½ inches long. Some lobsters do not spawn until after reaching the length of 12 inches, and the limit of 10½ inches is none too great. Thus we see how such attempts to protect the lobster have failed through the legalized killing of immature individuals.

The legislation on the subject of close seasons forms a curious piece of reading. Ignorance of the fact that the lobster carries her eggs for the period of ten months has been an element of confusion here. In Canada, almost every combination of the calendar has been tried. Close seasons for canning establishments, for fishermen, and for different sections of the coast have been tried in vain, but no combination has brought good or lasting results.

The object of a close season is to let the animal breed in peace, but there is a peculiar difficulty in the case of the lobster which makes it impossible to confer any protection upon it worth mentioning by a short close season. The difficulty lies in the fact that the animal does not drop its eggs in the sea or deposit them on some foreign substance, as the older naturalists believed, but carries them on its body. Consequently, in order to protect the eggs you have to protect the egg lobster. This has been attempted in the United States and in Canada by making it illegal to sell the "berried lobster." But the object is defeated by the ease with which this law can be evaded. It is only necessary to scrape the eggs from the body. Again, to obviate this, attempts have been made to allow the capture of "berried lobsters" and to buy up the eggs from the canneries and hatch them by artificial means. On this point I shall speak later.

The period of egg-laying on the coast of the United States extends, as we have seen, over the months of July and August. If fishing in these months is closed the spawners are protected.[1] This can be done, and would result in some good, but at either end the spawning females would be subjected to fire. First, there being no way to detect females which are ready to spawn, these would be killed in great numbers up to the beginning of the period; then, after the close in September, if egg lobsters were captured and the eggs removed and destroyed, the good which has been done would be partially neutralized.

Protection to the immature lobster by regulating the construction of traps, making the distance between the lower slats sufficiently great to let out all the lobsters except those of the legal size—10½ inches—is a measure which, if generally carried out, could not fail to be beneficial.

The canning industry is undoubtedly responsible for a large share in the depletion of this fishery. It is operated in the spring, and for years has destroyed large

[1] This period is well covered by the close period in Massachusetts, which extends from June 20 to September 20.

numbers of immature lobsters and of mature females nearly ready to spawn. The canneries have been allowed to use smaller lobsters than those which are sent to market, and we are told that if further restricted they could not exist. Whether this is true or not I do not know, but it is surely folly to protect an animal in one direction and allow it to be destroyed in another.

We have now to speak of the artificial propagation of the lobster as a means of maintaining or increasing the supply. In 1893 I tried to point out some of the fundamental errors which rendered the methods of artificial propagation abortive. The objections which were then made have never been answered or removed.[1] The difficulty is that a false logic has dominated the whole subject, not only of the propagation of the lobster, but of many of the true fishes, both in this country and in Europe. This is shown by the fact that the number of eggs hatched has been taken as a direct test of the efficiency of the method. The question of prime importance, which overtops all others, *what is the ratio between the number of eggs hatched and the number of young reared*, has been strangely left in the background or lost sight of. The following sentence, which I quote from a report on the lobster industry in Canada, illustrates the tendency to which I refer:

> The fecundity of the lobster is wonderful. Every female reaching the age of maturity emits from 12,000 to 20,000 eggs every season.[2]

What is here implied is that because the lobster produces a large number of eggs there must be a large number of lobsters raised from those eggs. This is a fundamental mistake. In the animal kingdom the production of a large number of eggs points, not to a great number of survivals and consequent abundance of the species, but to the great destruction of young, which makes a large number of eggs a necessity in order to maintain the species even at an equilibrium. A blue crab (*Callinectes hastatus*) of medium or large size produces 4,500,000 eggs, or 157 times the number of eggs laid by a lobster 13 inches long. Does this imply that the ratio of survival in the crab is 157 times greater than that of the lobster or that the crab is 157 times more abundant than the lobster at any point on the coast? Not at all. It rather implies that the crab lays a smaller egg, has a longer larval period, and is subject to far greater destruction by the elements of nature. In order to preserve its equilibrium, this expedient of producing a vastly greater number of eggs than can possibly survive has been tried in nature and has met with success. In the tapeworm we have an animal with individualized segments, capable of producing millions or even hundreds of millions of eggs, and yet it is comparatively rare, since the chances for survival of each of those millions of eggs is very slight, for in order to live the embryo or larva must find its way by chance to the body of two particular and distinct vertebrates.

In the course of the struggle for existence among animals and their evolution this chance of survival has been increased in other ways than by the multiplication of ova, as by asexual reproduction seen in budding, or by acquisition of special habits or instincts. In the vegetable world we are even more familiar with the great destruction of seed; thus in the common elm, how many of the hundreds of thousands of seeds which annually fall to the ground from a single tree are ever raised to maturity?

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[1] The habits and development of the lobster, and their bearing upon its artificial propagation. Bull. U. S. Fish Com. 1893, pp. 75–86.

[2] This statement is erroneous in that eggs are laid only every other year.

Is it possible to determine the number of survivals in an animal like the lobster? We can not fix the number positively, but we can fix a maximum limit beyond which we may be sure, reasoning from known facts, the number of survivals can not pass. By *survivals* I mean the number of eggs which develop and grow up to maturity, for death, at whatever point occurring at this period, means evil to the species in exactly the same degree. In order to maintain the species at an equilibrium it is only necessary that each female produce two adults in the course of her life, whether it be long or short. Then there will be neither increase nor diminution, but the species will hold its own. If more than two adults are raised from the eggs of each female in a given period, then the species must increase; if less, it must diminish. Under present conditions it is generally agreed that the lobster is declining, which means that each adult female produces less than two sexually mature individuals to take the place of their parents.

Spawning lobsters may produce as few as 3,000 eggs and as many as 90,000 or 100,000, the number of eggs laid increasing very rapidly in proportion to the increase in size, according to the law given above. While a 10-inch lobster produces on the average 10,000 eggs, a 12-inch lobster bears twice as many, and a 14-inch lobster nearly four times as many, or 40,000. Although sexually mature lobsters can produce eggs only once in two years, many live to hatch several broods and give rise to hundreds of thousands of young. Remembering that females become mature when from 8 to 12 inches long, to be on the safe side we may assume that on the average they mature at the length of 10 inches. A 10-inch lobster produces on the average about 10,000 eggs. Considering all the facts, it is erring on the safe side to assume that the average number of eggs produced by all lobsters which have spawned is 10,000. It is probably much greater than this. It can not certainly be less. Since it is necessary that only two of this number should survive to maintain the species at an equilibrium, we can get some idea of the amount of destruction which is wrought under existing circumstances. A survival of 2 in 10,000 or 1 in 5,000 is probably even greater than actually occurs. The remainder of this large number must be destroyed in one of two ways, by nature and by man, who assists nature in this work after the young are able to be caught in his traps. It can make no difference in the result what the agent of this destruction is, whether it is the ocean current, the storm lashing the rock-bound coast, the codfish, or man, except in so far as the evil wrought by man may be under control. If we award to man one-half of the blame, this would imply that instead of a saving of 2 in 10,000, under nature there might be a survival of 4. But such a survival would lead to a greater increase in the species than could probably ever occur.

What, then, is the ratio of the number of eggs laid to the number of young reared? Allowing that man does one-half of the work of destruction—which he certainly does not—and allowing an average total production of 10,000 eggs to each female that has spawned at all—undoubtedly too small a number—the species would be maintained under nature by a survival of 2 in every 10,000, or 1 in 5,000, if man did not interfere. A survival of 4 in every 10,000, or 2 in 5,000, would keep up the present stock with the added drain which man puts upon it. Considering that the fishery is declining, it can be maintained with a considerable degree of confidence that a survival of 1 in 5,000 is a very liberal allowance.

These considerations have a direct bearing upon the efficiency of the present methods of artificial propagation, which consist of stripping off the eggs from the berried female, hatching them, and liberating the young larvæ into the sea. Nature does not confer any special favors upon the young lobster thus brought into the world. It is not a case of making two blades of grass grow where but one would have grown before. A delicate, helpless organism, one-fifth of an inch long, it must contend alone with the forces of the world into which it is cast, the ocean, on the surface of which it is destroyed by millions through the indiscriminate forces of nature—the tempest, the tide, the ocean current, and wave-beaten shore—and we must add to this the destruction wrought by surface-feeding animals.

With the liberal allowance of the survival of 2 individuals out of every 10,000 hatched, we would have to hatch 1,000,000 eggs to produce 200 adults, 100,000,000 to get 20,000, and 1,000,000,000 to obtain 200,000 adult animals. To raise 1,000,000 lobsters would involve the hatching of 5,000,000,000 eggs. Since hundreds of thousands of adult lobsters are captured every month during the best of the season, it is evident that the annual supply can not be appreciably affected by this method unless conducted upon an altogether impracticable scale.

The greatest number of lobsters artificially hatched and liberated in a single year in Newfoundland, Canada, and the United States, according to the official reports for 1894, was 702,288,000.[1] This number of young at the rate of survival of 1 in 5,000 would yield 140,457 adults, while in a single year (1892) 68,000,000 lobsters have been captured in Canada alone. In order to put an equivalent number of lobsters back to make good this loss, not half or three quarters of a billion should have been hatched, but 340,000,000,000, or something less than 500 times as many as were actually liberated. In this case man has attempted by working on a small scale to stem the tide of destruction which nature working on such a vastly greater scale has been unable to do.

The conclusion which we reach is that too much has been expected from the present method of the artificial propagation of the lobster, and that it is totally inadequate to accomplish the task of restocking the depleted waters.

It may properly be asked of one who makes criticisms to suggest remedies, although he is not wholly responsible for the performance of this task. The following suggestions without further discussion seem to me to have a logical basis:

(1) That the coasts of those States in which the lobster fishery is of sufficient importance be divided, after careful consideration, into a number of well-marked areas, and that fishing for this animal be closed in each alternate section for a period of five years; at the end of this time the open areas to be closed, and so on alternately.

(2) That the legal limit be fixed at 10½ inches for all purposes and under all conditions.

(3) That all traps be registered and marked, and that their construction be regulated by law so that the space between the two lower slats be sufficient to allow free passage to all lobsters under 10½ inches in length.

[1] The number of young lobsters hatched and liberated on the Atlantic coast since 1893 is given by the official reports as follows:

Fiscal year.	United States.	Canada.	Newfoundland.
1893	8,818,000	153,600,000	517,353,000
1894	78,398,000	160,000,000	463,890,000
1895	72,253,000	168,200,000	174,840,000
1896	97,079,000	100,000,000	....
1897	115,606,000	....	....

(4) That the capture of berried lobsters be prohibited at all times. Though a law of this kind is sure to be more or less evaded, it is not expedient to encourage the destruction of eggs under any circumstances.

A series of experiments should be tried in raising the young in spacious inclosures, where crowding in vertical and horizontal limits could be avoided, and where a natural supply of food could be provided, the object being to determine whether it is practicable to raise the young up to the fifth and sixth stages, when they go to the bottom and are able to protect themselves. If then set free, the chances of survival would be many hundred times greater than in the first stages. If we could save 100 instead of 2 out of every 10,000 hatched, every 1,000,000 would give us 10,000 adults, and every 1,000,000,000 would yield 10,000,000 lobsters capable of reproduction. In such attempts to rear the lobster there are serious obstacles to be overcome in isolating the young, and giving them an abundant supply of pure water which shall at the same time yield the proper food, but we can not enter into the discussion of these subjects in this paper.

The close period referred to above should begin about June 20, and extend five years and two months from that time to August 20. To illustrate it, we will say that it begins June 20, 1900, and extends to August 20, 1905. During this period 6 sets of lobsters would spawn; 2 of these sets would spawn three times, 2 sets would spawn twice, and 2 once. Thus the set spawning in 1900 would lay eggs again in 1902, and again in 1904, and so on. Furthermore, the survivors of the broods of 1900 and 1901 would be mature, or nearly so, at the end of this period in 1905.

CLEVELAND, OHIO.

SHEEPSWOOL SPONGE.

From Matecumbe Key, 1895. Diameter of wreath, 30 inches; width of sponge proper, 7 inches; weight (dry), 1 pound 7 ounces.

THE FLORIDA COMMERCIAL SPONGES.

By HUGH M. SMITH, M. D.,
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The sponge fishery of the United States presents the interesting antithesis of an industry restricted to a single State and a product perhaps more generally employed and having a wider range of usefulness than any other article yielded by the American fisheries. There is scarcely a civilized habitation in the country in which the sponge is not in almost daily use. Besides its very general employment for toilet purposes, it is utilized in many other ways—in the arts, trades, and professions, and in domestic life—the mention of which would prove tedious.

In this paper it is not expected that much new or original information concerning sponges will be presented. All that is contemplated is to direct attention to certain aspects of the sponge industry, with a view to place it on a sounder basis. The special topics considered are the distribution, form, and peculiarities of the different species; their present and past abundance; the extent and causes of the decrease in the supply, as evidenced by a diminished annual catch; the protection of sponge-grounds; the cultivation of sponges on grounds now barren; and the increase of the productiveness of the industry by the introduction of some of the best grades of European sponges. In order to make the discussion of these subjects clearer to the sponge interests, it is desirable to briefly notice the zoological status of sponges and their methods of reproduction and growth. Reference is also made to the sponge legislation of Florida. Illustrations of the leading grades of marketable sponges are presented; these are based on specimens collected in Florida by the writer.

THE NATURE AND STRUCTURE OF SPONGES.

Although for many years the status of sponges—whether animal or vegetable—was in dispute, the time has long since passed when the right of the sponges to be placed in the animal kingdom was established. Even the propriety of assigning the sponges to a position higher than the lowest animals—the protozoa—is now conceded, and they are put either in a subkingdom of their own (Porifera) or in a subkingdom (Cœlenterata) with the corals, gorgonians, sea-feathers, jelly-fishes, etc.

The sponge in a natural state is a very different-looking object from what we see in commerce. The entire surface is covered with a thin, slimy skin, usually of a dark color, perforated to correspond with the apertures of the canals. The sponge of commerce is in reality only the home or the skeleton of a sponge. The composition of this skeleton varies in the different kinds of sponges, but in the commercial grades it consists of interwoven horny fibers, among and supporting which are spiculæ of siliceous matter in greater or less numbers and having a variety of forms. The fibers consist of a network of fibrils whose softness and elasticity determine the commercial quality of a given sponge. The horny framework is perforated externally by very many minute pores and by a less number of larger openings. These are parts of an interesting double-canal system, an external and an internal, or a centripetal and a centrifugal.

At the smaller openings on the sponge surface, channels begin which lead into dilated spaces (sacs or ampullæ); in these, in turn, channels arise which eventually terminate in the large openings (craters or oscula). Through these channels or canals definite currents are constantly maintained which are essential to the existence of the sponge. The currents enter through the small apertures and emerge through the large ones.

The active part of the sponge—that is, the part concerned in nutrition and growth—is a soft, fleshy mass partly filling the meshes and lining the canals. It consists largely of cells having different functions—some concerned in the formation of the framework, some in digestion, some in reproduction. Lining the dilated spaces into which the afferent canals lead are cells surmounted by whip-like processes (cilia); the motion of these processes produces and maintains the water currents, which carry the minute food products to the digestive cells in the same cavities.

Sponges multiply by the union of sexual products, certain cells of the fleshy pulp assuming the character of ova and others that of spermatozoa. Fertilization takes place within the sponge. The fertilized eggs, which should now be called larvæ, pass out with the currents of water; and, being provided with cilia, swim actively for a while, like larval oysters. In a comparatively short time, probably in 24 to 48 hours, they settle and become attached to some suitable surface, where they in time develop into mature sponges.

THE FLORIDA COMMERCIAL SPONGES.

The merchantable sponges of the waters of Florida fall under five heads—the sheepswool or "wool" sponge, the velvet sponge, the grass sponges (two species), the yellow sponge, and the glove sponge. Numerous varieties have been described by naturalists and many grades are recognized by dealers, but all are included in the foregoing designations.

The principal center of the industry is Key West, where more than seven-eighths of the business is carried on. Other places at which sponges are landed are Apalachicola, St. Marks, and Tarpon Springs. About 100 registered vessels and 200 unregistered vessels and boats are employed in the fishery, which, with their outfit, are worth about $260,000, and are manned by upward of 1,400 fishermen.

Sponges are by far the most important of the fishery products of Florida, representing about one-third of the annual value of the fishing industry.

In the calendar year 1895 the Florida sponge fishery yielded 306,070 pounds of sponges, of which the first value was $386,871. In 1896 the catch, as represented by the purchases of the wholesale buyers, who handled practically the entire output, was 234,111 pounds, having a value of $273,012. In 1897 the product was 331,546 pounds, valued at $284,640.

The quantity and value of the yield of the different grades in each of the three years named are shown in the following table. This information is compiled from the records of the sponge-buyers. The figures represent the actual purchases of the local dealers, with the exception of the business of one buyer, the details of which have been estimated.

Kinds.	1895.		1896.		1897.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Sheepswool	231, 272	$363, 107	149, 724	$248, 196	157, 476	$240, 599
Yellow	29, 509	11, 798	23, 655	9, 318	32, 362	13, 082
Grass	21, 387	5, 464	44, 617	11, 508	128, 622	29, 188
Glove	14, 857	2, 882	15, 365	2, 263	9, 292	1, 301
Others*	9, 095	3, 620	2, 950	1, 727	3, 794	1, 870
Total	306, 120	386, 871	234, 111	273, 012	331, 546	284, 640

*Includes, besides velvet sponges, "wire" sponges, "hardhead" sponges, and other miscellaneous grades having little value.

THE SHEEPSWOOL SPONGE.

The sheepswool is the best sponge found on the shores of the western Atlantic, and for most purposes has no superior anywhere. While the texture is coarser than that of the best Mediterranean sponges, this sponge is more durable—a quality of leading importance for most purposes. Belonging to the same species as the native sheepswool are the well-known eastern horse sponge, Venetian bath sponge, and Gherbis sponge.

The sheepswool sponge is taken on all the important sponging-grounds on the Florida coast. Its distribution may be said to be from Apalachicola on the west coast to Cape Florida on the east coast, although between Charlotte Harbor and Key West but few known grounds exist. The most productive are in the vicinity of Anclote Keys and Rock Island, and from these regions the best quality of sheepswool sponges comes. Between Key West and Cape Florida valuable grounds also exist, those in the vicinity of Matecumbe Key, Knight Key, Bahia Honda, and Biscayne Bay being especially important. This species usually grows on the bare coralline rock which underlies a large part of Florida and is exposed over large areas of the contiguous bottom. On sandy or muddy bottom it is rarely found. It is at present taken in water from 10 to 50 feet deep, but the largest quantities are obtained in depths of 20 to 35 feet. In the early days of the fishery, before the depletion of the grounds had begun, the principal part of the catch was from a depth of less than 12 feet.

With the methods in use in Florida sponges can not be profitably gathered in water more than 50 feet deep, and a question of considerable interest and importance is whether sponges grow in noteworthy quantities at a greater depth. Most spongers think that there are important grounds now beyond their reach, but others think that 50 or 60 feet is the maximum depth at which sponges grow. It is claimed by a few persons that beyond this depth the bottom is not adapted to the growth of sponges, the coralline rock being absent and sand predominating. Definite information on this point is, however, lacking, and a careful survey would be required to settle the matter. The probabilities are that in certain localities there are productive grounds beyond the present limits of operation, as there is nothing in the nature of sponges to prevent their inhabiting deeper water, and it seems improbable that the rocky bottoms should cease to exist beyond 50 feet.

Should future inquiry show the presence of sponge-grounds in water from 50 to 80 feet deep, the discovery of a method of utilizing them would be the first consideration and would prove a great boon to the sponge fishery. Not the least important outcome of such a discovery would be the opportunity afforded the shallower grounds to recuperate by the diversion of the spongers' operations. Attention may be drawn to the advisability of experimenting with an apparatus constructed on the principle of the so-called "deep-water oyster-tongs," by means of which oyster-beds beyond the reach of ordinary tongs become readily accessible.

The tongs in question, of which there are several types, consist essentially of two curved iron bars, riveted together near the middle to permit free motion. These are attached on one extremity to the teeth and cradles, and on the other to the ropes by means of which the apparatus is lowered and raised. Beneath the crossing-point of the two arms a weight is suspended. To the upper bar of one side an iron link or loop is attached by means of a staple, and on the lower bar, just below the link, is a small iron peg or stud over which the link fits when the teeth are separated to their widest extent. When oystering begins, the arms are locked by means of the loop and peg and the tongs lowered to the bottom. By suddenly dropping the tongs from the height of a few feet from the bottom the loop slips off the pin, by virtue of the weight referred to, and the teeth will then approach each other when the ropes are hauled taut. The weight and the loop and peg may, however, if desired, be dispensed with by attaching a line to the crossing-point of the two arms and placing weights at the upper ends of the latter, the tongs being lowered by means of the middle line and kept open by the weights mentioned.

The extreme simplicity of this apparatus is a great recommendation for its use in the oyster fishery, and suggests its employment in the sponge fishery. It is open to the objection of being somewhat heavier than the ordinary oyster-tongs, and in deep water a small windlass must be attached to the mast or elsewhere on the boat, by which it can be raised and lowered. The cost, complete, is about $15. If the principle embodied in this apparatus is found to be adapted to the sponge fishery a modification in the line of lightness and cheapness could doubtless be made. The number of teeth and the carrying capacity of the tongs required in the oyster fishery might be reduced and the apparatus made to consist practically of two opposing hooks, such as are now used in the sponge fishery.

The sheepswool is probably the most abundant of the Florida sponges, although it is not relatively so abundant as the catch of it and other species would indicate, owing to the fact that its greater value makes it more eagerly sought.

The decrease in the abundance of this species has been marked in many places. In the vicinity of Anclote Keys the grounds in 10 to 12 feet of water were exhausted before the civil war; but during the war the sponge-beds had a chance to recuperate, and later afforded some good fishing. They were very soon depleted, however, and have not since borne sponges in any noteworthy quantities. This is the general history of the "bay grounds." Deeper and deeper bottom has had to be resorted to in order to make the fishery profitable, until now some fishing is done in water as deep as 50 feet. Occasionally good fares are taken on the inshore and key grounds. The latter, in depths of 10 to 20 feet, seem to recuperate more rapidly than the bay grounds, and produce excellent crops some seasons; but they have in general shown the same depletion as other grounds, and the spongers have to work over a larger area and more assiduously than was necessary a few years ago. Even the deepest grounds now frequented are showing the effects of overfishing, and would doubtless soon prove nonproductive of marketable sponges if the weather and water were always favorable to the spongers, the preservation of the beds largely depending on the prevalence of storms or turbid water during some seasons or parts of seasons.

The sheepswool is believed by many observers to grow the most rapidly of any of the sponges, but information on this point is not as complete or accurate as might be desired. Some experiments performed and observations made by gentlemen of Key West lead them to believe that this species may, under favorable conditions, grow from the beginning to one-tenth of a pound weight in six months. The opinion that this sponge will grow from the spat to good commercial size in one year is practically unanimous and seems to be verified by the sponging operations. The spongers all testify that grounds which were thoroughly fished out one year are found to yield large numbers of commercial sponges twelve months thereafter.

The catch of the sheepswool in 1895 was fifteen times and in 1897 six times as valuable as that of all other species combined, and is thus sufficiently important to give prominence to the sponge industry, even if no other kinds were taken. The average prices per pound brought by sheepswool sponges were $1.57 in 1895, $1.66 in 1896, and $1.53 in 1897.

Of late, owing to a diminished supply, the relative catch of sheepswool sponges has been decreasing, cheaper varieties entering more largely into the receipts. In 1895 the percentage of sheepswool sponges in the total catch was 76; in 1896 it fell to 64, and in 1897 was only 47.

THE VELVET SPONGE.

This is an uncommon form, with a very limited distribution. Along the west coast of Florida it is rarely found, the yield coming almost entirely from certain grounds among the keys. It resembles the sheepswool in general structure, but has a smoother surface and finer fibers. The characteristic feature is the presence of soft protruding cushions, whence the name. It is also known as the boat sponge. Its shape is very irregular. Its average size is 7 or 8 inches in diameter, but the diameter of some is a foot or a little over. Its principal source of supply is the region adjacent to the Matecumbe Keys, where it is taken on coral bottom in water from 15 to 20 feet deep. The grounds have undergone serious depletion, and smaller cargoes are landed each year. Velvet sponges are taken in smaller quantities than any other Florida sponges. In 1897 many dealers did not handle any, and the receipts in recent years have never exceeded a few thousand pounds per annum. The usual price paid by dealers is 50 cents a pound.

THE GRASS SPONGES.

There are at least two species comprehended under the trade name of grass sponge, and the individual variations are numerous. One species (called *Spongia graminea* by Hyatt) has a coarse, open structure, with deep furrows on the sides, in which the afferent channels always begin. The general shape is that of a truncated cone, with the larger openings always on top. The other grass sponge (*Euspongia equina cerebriformis*) resembles one form of the yellow sponge, but differs in having its surface marked by parallel longitudinal ridges surmounted by two or three lines of tufts. In the depressions between the ridges the large efferent canals open, their orifices being in rows. Many forms of this species exist. The cup shape predominates.

Grass sponges are of relatively inferior quality, although largely consumed for special purposes. They are found in all parts of the sponge region, and are probably the most abundant of the Florida sponges, the annual yield not being proportional to the abundance. Large cargoes are obtained on the Rock Island, Anclote, and Key grounds. The Anclote region of late has produced the largest part of the catch, and the sponges there are of relatively good quality.

The recent increase in the production of grass sponges, especially from grounds in the Gulf of Mexico, has been noteworthy, as shown by the preceding table. In 1895 grass sponges constituted less than 7 per cent of the total yield; in 1896 the output rose to 19 per cent, and in 1897 was nearly 39 per cent. This utilization of larger quantities of a relatively cheap sponge is a strong indication of the decrease in the supply of the best quality of sponges.

THE YELLOW SPONGE.

This ranks next to the sheepswool in quality. It corresponds with the Zimocca sponge of the Mediterranean. The dealers classify the "hard-head" sponge in this grade—a form having a darker color, harder texture, and less value than the yellow proper. The distribution of the yellow sponge is coextensive with that of the sheepswool, both growing together among the keys and on the west coast of Florida. The yellow sponge is most commonly found on rocky bottom, at depths of a few feet to over 30 feet. Those taken for market are from 4 to 10 inches in diameter, 6 to 8 inches being the average.

The yellow sponge is very abundant, but less so than formerly, especially among the keys, whence most of the supply comes, and where the grounds, being more accessible, are more assiduously fished. The key sponges are of much finer quality than those from the "bay grounds," being softer in texture and more durable. The grounds about Matecumbe Key yield an especially good grade of yellow sponge, characterized by a rich yellow color, regular shape, and superior quality. Biscayne Bay and other grounds on the east coast also produce a fine class of yellow sponges.

This species ranks next to sheepswool in the commercial scale, although it commands a less price per pound than the velvet sponge. In the aggregate the value of the catch of yellow sponges was formerly more than that of all the remaining grades except the sheepswool, but of late the grass sponge has surpassed the yellow in this respect. The average price received by sponge fishermen is about 40 cents a pound.

THE GLOVE SPONGE.

This is the least valuable of our commercial sponges. Its fibers have a tendency to become brittle with age, it lacks elasticity, and it has very little market value. The skeleton is dense and the surface is much smoother than in the other sponges. It does not attain a large size, not often exceeding 8 inches in diameter and averaging less than 5 or 6 inches.

It is a singular and suggestive fact that this, the very poorest of our sponges, is of the same species as the very finest and best of the Mediterranean sponges, namely, the Levant toilet sponges and the Turkish cup sponges; even some of these, however, are of inferior quality. The fact is thus strikingly emphasized that the quality of sponges is to a considerable extent independent of their specific characters and depends on physical conditions.

The glove sponge has a more limited distribution than any other Florida species. It is found from Biscayne Bay to Key West, but appears to be either very rare or entirely absent on the grounds along the west coast. It grows on rocky bottom in comparatively shallow water, in company with other commercial sponges. Most of the catch is from a depth of less than 10 feet, although the species inhabits somewhat deeper water. It is taken in smaller quantities than any other standard species except the velvet sponge. This, however, is not an accurate criterion of its abundance, as it is less sought for, owing to its poor quality and small market value. It brings the spongers only about 10 to 15 cents a pound, a price so low as to discourage its gathering.

SPONGE LEGISLATION IN FLORIDA.

The sponge laws of Florida now in force relate to the gathering of small sponges, the use of dredges, the taking of sponges by diving, and the artificial propagation of sponges, the legislation covering the last-named item having been enacted in 1897. The full texts of the laws are as follows:

Whoever dredges or uses a dredge for the catching or gathering of sponge in or upon the waters of the Gulf of Mexico within three marine leagues of the shore, or upon any of the grounds known as sponging-ground along the coast line of Florida from Pensacola to Cape Florida, or whoever gathers sponge less than 4 inches in diameter, shall be punished for each offense by fine not exceeding $500, and by confiscation of the boat, tackle, and machinery, and in default of the payment of the said fine the offender shall be imprisoned not exceeding one year. (Revised Statutes of Florida, section 2772, chapter 3615, act of 1883.)

Whoever gathers or catches sponge in or upon any of the grounds known as sponging-grounds, along the coast of Florida, from Pensacola to Cape Florida, by diving either with or without a diving suit or armor, shall be punished by fine not exceeding $2,000, and by confiscation of all diving suits or armor, boats, and vessels used in such unlawful gathering of sponge, and in default of the payment of said fine the offender shall be imprisoned not exceeding one year.

The fact of having one or more diving suits or armors on board of any vessel or boat in and upon any of the grounds known as sponging-grounds along the coast of Florida, shall be prima facie evidence of the violation of the preceding section.

Whenever an officer arrests any person charged with an offense which, by the provisions of this article, may be punished by the confiscation of the vessel, boats, crafts, nets, seines, tackle, or other appliances used in such unlawful act, it shall be his duty to seize the same and take them into his custody to await the sentence of the court upon the trial of the offender.

If the offender be convicted, the court in awarding sentence shall make an order confiscating the said vessels and implements, and authorizing the executive officer of the court to sell them, after due notice, at public auction to the highest bidder. If the accused be acquitted, the said vessels and implements shall be returned to him. (Revised Statutes of Florida, sections 2773, 2774, 2775, 2776; chapter 3913, act of 1889.)

An act to protect and encourage the artificial growth of sponges within the waters of the State of Florida, and conceding certain riparian rights to those engaged therein, and to prescribe a license in certain cases.

Be it enacted by the legislature and State of Florida: It shall be lawful for any person or persons owning lands bordering upon the waters of the State to propagate and grow sponges in the waters in front of such lands, to depth not exceeding 1 fathom at low tide, and they shall have the exclusive right to sponge or propagate and grow sponges within such limits: *Provided,* That in no case shall this right extend beyond 300 yards from the shore line.

SEC. 2. Any person or persons owning lands bordering upon the waters of any bay, lagoon, sound, or strait, shall, within their headline, have the exclusive right to sponge, propagate, or grow sponges within such waters to a depth not exceeding 1 fathom at low tide: *Provided*, That this exclusive right to grow and propagate sponges shall not extend beyond the distance of 300 yards from the shore line. And when different persons own lands upon the opposite sides of such waters, and the depth thereof does not exceed 1 fathom, then the lines shall extend from lines drawn across their respective headlines to another line equidistant from the lines drawn across such headlines.

SEC. 3. It shall be lawful for any person or persons owning lands as described in the preceding sections, or surrounding any basin, bay, or lagoon not exceeding 1 fathom in depth at low tide, to inclose or stake off the waters in front of such land, not exceeding the distance of 300 yards from the shore line, for the purpose of protecting and marking the waters to which they are entitled, and they shall have the sole and exclusive right to sponge, propagate, and grow sponges within such limits out to a depth in front of such lines drawn through the headlines of their respective lines, and they shall have the right to post such inclosures and warn off trespassers: *Provided*, That no one shall obstruct the waterways necessary for the purposes of navigation, and that no right or privilege shall extend across or beyond any waters used for navigable purposes: *Provided further*, That the rights and privileges mentioned in this act shall only extend to those persons who are actually engaged in the business of raising and propagating sponges.

SEC. 4. That nothing in this act shall be construed as interfering with the rights of any person or persons to fish for fish or oysters in or upon said lands.

SEC. 5. Any person or persons who shall willfully and maliciously destroy, deface, or break down any sign, fence, gate, inclosure, or staked place for the purpose of defining and protection of waters used for sponge-culture shall, upon conviction, be punished by imprisonment in the county jail for a period not to exceed six months, or by fine not to exceed $500.

SEC. 6. It shall be lawful for any person or persons engaged in the business of artificial growth of sponge to gather sponges of any size to be used solely and exclusively for the purpose of transplanting.

SEC. 7. That any person not a citizen of the United States who shall engage in the business of sponge fishing, either for himself or any other person, shall, before entering into said business, pay an annual State license of $25. Any person violating the provisions of this section shall, upon conviction, be fined in a sum not to exceed $50, or be imprisoned in the county jail for a period not to exceed sixty days. (Act of May 12, 1897, chapter 4564.)

EVIDENCES AND CAUSES OF A DECREASE IN THE SPONGE SUPPLY.

Although the sponge fishery of Florida is only forty-five years old, the sponge-grounds are on the whole much less productive than formerly, as is acknowledged by practically everyone who is in a position to express an intelligent opinion. Of course there are still very important grounds among the keys and on the west coast of the State, and sponges still exist and are taken in very large quantities; but the efforts now made would result in a vastly increased catch if the sponges were found in anything like their original abundance. There are many points of similarity between the history of the Florida sponge-grounds and that of the oyster-grounds of some States in which dependence has been chiefly placed in the natural beds for supplying the demand. In confirmation of the diminution of the sponge supply, the following facts may be cited:

1. There has been a complete abandonment of some grounds formerly productive, especially the inshore grounds, which were the only ones resorted to in the early days of the fishery. The depletion naturally began in the shoaler waters, where sponges could be more easily gathered, and has gradually extended so as to embrace, to some degree, all available grounds.

2. The fishery has had to be prosecuted in deeper and deeper water in order to maintain the catch, until the maximum depth in which sponging is possible with present methods has been reached. Beyond 50 or 52 feet it is practically impossible to pull sponges with appliances now in use, although in the Mediterranean sponging is done in water as deep as 70 feet by using improved poles.

3. In general there has been a smaller catch per man and per vessel. Very many trips result in a loss to the owners or outfitters of the vessels, and it is now the exception for a vessel to bring in the average catch of earlier years.

4. The catch is very noticeably made up of small sponges, those under the legal size constituting a too prominent proportion.

The causes for the decrease are readily determined and are almost unanimously recognized by spongers and buyers. They are directly traceable to indiscriminate fishing, although stress is laid on natural agencies by some of those interested.

TAKING OF SMALL SPONGES.

This is undoubtedly the principal cause of the decrease in the supply of Florida sponges. While the State law, which has now been in force fifteen years, expressly forbids the sale of sponges less than 4 inches in diameter across the top, the law has never been seriously regarded by fishermen, dealers, or sheriffs, and the occasional spasmodic efforts made to enforce it have only added to the disrepute in which the statute is held. It is extremely doubtful if the law has resulted in the saving of a single undersized sponge or the slightest protection of the grounds. The attempt to remind the spongers of the existence of the law has usually been on the arrival of the fleet, when the damage has been done, and by the time vessels have returned to the grounds the law has been conveniently forgotten by law officers and law breakers alike.

Some figures are available which illustrate the great damage done to the industry by the gathering of small sponges, and show how short-sighted the fishermen are in this respect, and emphasize the necessity for a change in the present status.

The very small sheepswool sponges which the fisherman bring in, many of them only half the legal size, have little market value. When a sponge-buyer purchases a cargo these small sponges receive scant consideration and are often entirely discarded in determining the value of the lot. When undersized sponges are sold independently it has not infrequently happened that 20 bunches or strings, each holding 25 sponges, have brought the fishermen only $1 or $2. The same sponges if left on the grounds six months longer would have been worth $150 to $175. A case is cited in which 1,250 sheepswool sponges were sold in Key West for $5. Conservative estimates indicated that if left down six months longer these would have brought at least $390.

It is a very small sponge which the average sponge fishermen will now discard, and yet, on the authority of reputable dealers, it may be stated every season there are many thousands of sponges gathered which never reach the markets, but are thrown away. It may be safely asserted that each year the small sponges taken from the Florida grounds would add $100,000, or 30 per cent, to the value of the product if they could be left growing for six months.

EXCESSIVE FISHING.

Coincident with the gathering of small sponges has been the excessive sponging on grounds, season after season, without any regard whatever for the preservation of enough stock to secure the repopulation of the beds. A sponge fisherman will rarely willingly or knowingly leave any sponges of value on a ground; and the entire history of the sponge industry shows a flagrant disregard for the preservation of the supply.

It can scarcely be wondered at, therefore, that there is more difficulty each year in obtaining good cargoes, and that the output is decreasing. An average cargo now is only a half or a third what it was ten or fifteen years ago.

POISONOUS WATER.

A factor in the decrease in the sponge supply to which many of the spongers attach much importance is the so-called "black" or "poisonous" water. Its nature is not definitely established. Some think it is water from the Everglades, discharged into the Gulf in unusual quantities; others that it is due to submarine volcanic disturbances, resulting in the liberation of noxious gases. Whatever the cause, it is certainly destructive to all forms of life, and it is known to have depleted some very productive grounds. Fortunately this kind of injury is of infrequent occurrence, seldom coming in serious form oftener than once in a decade. Of the very disastrous poisonous water plague in 1878, the following account has been given:

The earliest indication of it was the floating up of vast quantities of dead sponges, chiefly loggerheads. The dead sponges were first noticed less than 40 miles north of Key West, but it was soon discovered that all the hitherto profitable sponging-grounds lying off the coast, as far north nearly as Cedar Keys, and particularly off the Anclotes, had been ruined. These grounds had only begun to show signs of recuperation as late as 1882; their abandonment from the reefs to Cedar Keys, during the three or four years which followed the occurrence, entailed a loss estimated at $100,000. Had it not been for the fortunate discovery, just at that time, of sponge tracts off Rock Island, northward of the Suwanee River, almost a famine in this article would have ensued.[1]

Too much stress, however, is now laid on this condition as a factor in the diminished supply during recent years.

REMEDIAL MEASURES.

With anything like fair treatment there is no reason why the Florida sponge-grounds should not only support the present drains, but permit much more extensive fishing than is now possible. The area of the grounds is so large, estimated to be over 3,000 square miles, and the growth of the sponges is so rapid that with proper precautions there is hardly a limit to the productive capacity of the beds.

Foremost among the remedial measures that are demanded I place the enforcement of the law relative to the gathering of small sponges. It is probable that the statute should be slightly modified, so as to make it more readily executed; it would doubtless be improved by having it prevent the landing or sale of undersized sponges. It is said that there is some question as to the State's jurisdiction over grounds lying beyond a marine league; if so, it is an additional reason for amending the law as indicated.

It is claimed by some that such a law is difficult to enforce, especially after years of flagrant violation. To this I take exception, and believe that the law will almost enforce itself if the State will show any disposition to encourage its observance. The sentiment in favor of the law and its impartial enforcement is remarkably strong. Dealers and vessel-owners, and others having pecuniary interests at stake, are unani-

[1] The Fishery Industries of the United States, sec. V, p. 831.

mous in the belief that the law is wise and beneficial in principle and that it should be enforced; and very many of the sponge fishermen entertain the same opinion. With this feeling prevailing among the sponge interests, the question very naturally arises, Why do not the buyers and outfitters observe the law even if the State regards it as a dead letter? The answer is that as long as such small sponges have any market value the fishermen will take them to fill out their cargoes, especially when large sponges are scarce. When sponges are once landed there is no reason for buyers to refuse to take them, especially as they pay very little for them.

The statement is confidently made that if the State officers in each sponging center should announce that the law would be enforced against all vessels and boats which sailed after the date of the notice, within six months a new order of things would be firmly established, to the benefit of all concerned.

The opinions of the fishermen themselves as to remedial measures should not be given too much weight. Very many of them are aliens (Bahama negroes), and few of them have any pecuniary interests at stake. The men owning vessels and having capital invested in the sponge trade are those whose views are entitled to consideration.

The present legal minimum size of sponge is almost unanimously regarded as too low by those pecuniarily interested. A sponge 4 inches in diameter across the top is very small and has little market value. There is a general sentiment favorable to an increase of the legal size to 5 inches, and some persons favor even a larger standard.

In order to permit the recuperation of the exhausted grounds and prevent the absolute depletion of beds, the prohibition of sponging on certain grounds for definite periods has been suggested, and meets with general approbation. A sponge merchant of Key West, who has devoted much attention to the subject, writes as follows regarding this matter:

> Let nature do its work by allowing it sufficient time. This can be done by dividing the area of the sponge-grounds at sea into squares each of 100 miles, more or less, and then allowing the fishermen to gather sponges only in certain squares each season of the year. According to all reports, on some grounds sponges grow much faster than on others. They have been noticed to grow to full size inside of four months in certain localities along this coast, while at other localities it takes young sponges at least six months to grow to full size. This fact can be put to advantage by restricting sponge gathering during several months on certain grounds, during which time the sponge fisherman can gather sponges on the other parts of this coast. However, as it is necessary to the sponge fishermen to have not only good weather, but also clear water, so as to enable them to see the bottom and to locate the sponges, it may happen that when they are out on their expeditions they may meet with muddy water on the unrestricted sponge-grounds of the season, while on the restricted grounds during that season the water may be clear and just in condition to allow them to locate and to gather the sponges. As the benefit that sponge fishermen could derive from the above restriction of certain grounds during certain seasons of the year would soon be important and lasting, it seems to me that no proper objections could be offered to the method.

In a report[1] on "The Fish and Fisheries of the Coastal Waters of Florida," the United States Fish Commissioner suggests that sponging on the grounds of Biscayne Bay and the Florida Keys be permitted only during a specified part of any period of twelve months, and that fishing on either the Anclote or Rock Island grounds be allowed only once in any period of twenty-four months, so arranged that the Anclote

[1] Senate Document No. 100, Fifty-fourth Congress, second session; also Report U. S. Fish Commission for 1896, pp. 263-342.

region may be open to unrestricted fishing one year and the Rock Island grounds the next.

Whatever action is finally taken by the State in this matter, there should be a careful preliminary investigation by a competent board, which should inquire into the special conditions in the different parts of the sponge region and determine the boundaries of the areas to be successively brought under restrictive provisions.

A final remedy for arresting the decrease in the sponge supply is the cultivation of sponges, the necessity for which depends to a large degree on the carrying out of the foregoing measures.

CULTIVATION OF SPONGES FROM CUTTINGS.

The growing of sponges from clippings may be said to have almost passed beyond the experimental stage, since the possibility of the procedure has been amply demonstrated. At the same time, the business of producing marketable sponges from clippings has not been engaged in, although there seem to be no insurmountable difficulties in this country at least; and the present indications are that before five years have elapsed private sponge-farms will have become established on parts of the Florida coast.

There are various reasons why the artificial growing of sponges should receive attention. In the first place, sponge-culture should partly arrest the further depletion of the natural grounds by diverting the energies of some of the spongers in the direction of the possibilities of the now barren grounds. If the cultivation of sponges becomes established along the many hundreds of miles of suitable coast, it will certainly prove a profitable employment to a large number of people, either independently or in connection with other branches of industry. Furthermore, the increase in the output which must follow the successful inauguration of sponge-culture will reduce the dependence of the United States on foreign sponges. Finally, the State may with great propriety obtain a revenue from this source.

The lines along which the planting of sponges must be conducted have been indicated in the different experiments already made, to the printed accounts of which those especially interested are referred.[1] No detailed statement of the methods employed by various experimenters is necessary for the purpose in view in the present paper.

It may be stated, however, that thirty-five years ago the question of artificial propagation of sponges received attention in Europe and was under consideration for ten years; that nearly twenty years ago limited experiments were conducted at Key West; that in 1889, 1890, and 1891 some very interesting trials were made in Biscayne Bay; and that at present the matter is receiving serious attention in the vicinity of Key West, where planting has begun on a commercial basis.

While the work of Mediterranean experimenters was of a more systematic and

[1] Reference is especially made to the following articles: (1) Experiments in sponge-culture at Key West about 1880: The Fishery Industries of the United States, sec. V, vol. 2, p. 832. Reprinted in Senate Document No. 100, second session, Fifty-fourth Congress, being a report of the United States Fish Commission on the coast fisheries of Florida. (2) Sponge-cultural experiments in the Adriatic Sea, 1863–1872: Die Aufzucht des Badenschwammes aus Theilstücken, by Dr. Emil von Marenzeller, Vienna, 1878. An abridged translation appears in the Fishery Industries of the United States, sec. V, vol. 2, pp. 833–836; the latter is also reprinted in the Senate document named. (3) Account of Sponge-cultural experiments in Biscayne Bay, 1889–1891, by Ralph M. Munroe. Contained in Rep. U. S. Fish Com. 1895, pp. 187, 188.

prolonged nature than that of our own countrymen, it can not be said that their results were as striking or encouraging. Their studies, which were supported by the Austrian Government and merchants of Trieste, were finally abandoned, owing to the hostile attitude and depredations of the fishing population.

The following are some of the special facts that have been established by the experiments in this country and abroad:

(1) Sponges may be cut into small pieces, which will live and grow if properly attached in suitable water. They may be cut in water or on a moistened board with a knife or fine saw. Care must be exercised not to express the soft matter. The preferred size of the cuttings is about an inch broad and a little more in height. The outer skin is to be retained as far as practicable. In cutting, the lines of the circulating canals should probably be considered, although pieces cut without any reference to the direction of the canals have lived and grown.

(2) Exposure of the sponge to the air in making and fixing the cuttings is not injurious, unless prolonged or in very warm weather. This is contrary to a prevalent impression, but seems to be amply proved. Mr. Munroe, in his experiments in Biscayne Bay, found that clippings from sponges that had been exposed several hours lived and grew; and in the Adriatic Sea sponge cuttings kept out of water, in a shady place, for eight hours in February, the air temperature being 48° F., took root when planted. It is probable, however, that in the case of larger sponges, when removed from their element, the weight of the contained water may have a crushing effect on the soft parts concerned in nutrition and thus retard growth in the clippings subsequently made therefrom. In a high temperature the sponges have a tendency to rot, hence the winter is regarded as the best time for planting.

(3) Clippings may be made from distorted sponges having little market value, and will assume a symmetrical shape during growth. A healthy cutting will become firmly attached to a surface comparatively soon if it does not move. Even as short a time as 24 hours has been sufficient, in the European experiments, to secure attachment during the prevalence of warm weather.

(4) The possible methods of attachment are various. This is a very important step, and probably the ideal practice is still to be determined. The things to be accomplished are: (*a*) to make the clipping fast pending the time when it will naturally take root; (*b*) to employ for this purpose some material that is not injurious to the sponge and will not distort its growth; (*c*) to place the attached clippings on the bottom in such a way that they will maintain the upright position and not be smothered by mud, sand, or sediment. The sponge clippings have been attached to boards, frames, poles, and different kinds of wire. The wooden parts are liable to attacks of worms, and some kinds of wire are injurious because of the chemical decomposition that ensues in salt water. The use of bamboo pegs seems to have given much satisfaction.

In Europe, the cuttings appear to have been placed at depths of 16 or 23 feet, light being considered an objection, but in Florida the experiments have been conducted in water from 8 feet to less than 1 foot deep at low tide, and good results have been had at the shallowest depths.

(5) The rate of growth in Florida waters is comparatively rapid. It is a common experience of spongers to find marketable sponges on grounds that had been thoroughly depleted of all salable sponges in the previous year, and the results of

experiments bear out this point. In as short a time as one year, under favorable conditions, the cuttings will attain a marketable size, and certainly within sixteen or eighteen months the harvesting of relatively large sponges may be depended on. These results are in marked contrast to those in the Adriatic, where the rate of growth was so exceedingly slow as to seriously militate against the feasibility of sponge propagation in those waters. The person in charge of the experiments states that "the clippings grow two or three times their original size during the first year," and that, "although some pieces will grow to a considerable size in five years, it will require seven years to raise completely matured sponges which are fit to become an article of merchandise." A writer who reviewed the experiments very pertinently remarked:

> The profitableness of sponge-culture would be far more evident if there was not such a long interval between planting and harvesting; in other words, if the sponges would grow more rapidly. This was certainly looked for when the enterprise was started; but it is dispiriting to have to wait for your crop for seven long years.

The attitude of the State toward the project to increase the supply of sponges by artificial means must necessarily exert considerable influence on its success. Adequate encouragement and authority should be given by the Commonwealth to those desiring to engage in this enterprise, to be supplemented by ample protection from poachers after grounds have been planted.

Artificial sponge-grounds are susceptible of the same methods of regulation that have proved of value in the case of the oyster. The State might levy a tax, which would defray the expenses incurred in protecting the growers, but if such action is calculated to discourage the business it should not be broached until the industry has been placed on a substantial footing.

The area of barren bottom which one person may be allowed to appropriate should be limited, so that no monoply will be created and the undertaking of the enterprise by numerous small planters be encouraged. The project is popular with many of the persons already interested in the sponge industry. Some, however, have expressed the fear that the best planting-grounds will fall into the hands of a few persons, who may in time secure control of the industry. The fear also exists among some of the sponge fishermen that extensive planting may deprive them of a livelihood, but there is little or no basis for such apprehension. Sponge-planting will give employment to many additional persons, and probably will indirectly prove of benefit to those who sponge on the natural grounds, by diverting some attention therefrom and permitting a larger growth thereon.

PROPOSED INTRODUCTION OF MEDITERRANEAN SPONGES.

While for general purposes there is no better sponge than the Florida sheepswool, some of the foreign sponges, used in surgical practice and in other special branches, are more delicate, and yield a much higher price per pound than any native species. Some of the small Levant toilet sponges bring as much as $50 a pound, and the consumption of these high-priced sponges in the United States is quite large.

The possibility of transplanting in our own waters some of the best of the foreign sponges, in order that our own fishermen may reap the benefits of the high prices, opens up a very interesting subject. It has been thought that a very small colony, properly nurtured, would, under favorable conditions, form a nucleus from which a large area might eventually be stocked. This subject has been discussed to some extent by those interested in the sponge industry, and the United States Fish Commission has been urged to make the experiment. The transplanting of Mediterranean sponges to the Bahamas has also been under consideration in Great Britain.[1]

The transportation of Mediterranean sponges to this country would involve difficulties which readily suggest themselves. There seems little doubt, however, that the project would be practicable by the use on the transporting vessel of tanks in which water could be kept aërated and of a suitable temperature.

If the acclimatization of Mediterranean sponges in Florida waters were accomplished the ultimate results of the experiment would still be problematical. It is a question whether, under the changed and less favorable environment, the introduced sponges would retain their superiority, or at least exhibit it in their offspring. Mr. Bidder states that the calcareous sponges exhibit a remarkable susceptibility to changes in environment, and thinks it not impossible that the progeny of the imported sponges would be similar in quality to the native sponges. The experiment is, however, worthy of the attempt.

There is a remarkable similarity between the marketable sponges of Europe and those of America. Hyatt thinks it evident that the Mediterranean sponges originated in the Caribbean Sea. The three leading American species (sheepswool, yellow, and glove) correspond respectively with the leading sponges of Europe (horse, Zimocca, and bath).

As to the cause of the superiority of the best Mediterranean sponges over our native sponges, there is some diversity of opinion, and different factors probably have their influence. An eminent American authority in considering this question expresses the opinion that the superiority may be due in part to the greater depth at which the Mediterranean sponges are taken, the deeper water being of better quality than the shallower, because freer from sediment, which is detrimental to the growth of the finest grades of sponge. Milky water (i. e., water made opaque by sediment) is incompatible with the best quality of sponge. While the coral reefs of the Florida coast, as in the Mediterranean, furnish excellent material for the attachment of sponges, the reefs in our own country are more exposed than in the Mediterranean, and large quantities of limy sediment are washed from them by the waves, a condition which does not exist to a conspicuous degree in the Mediterranean, where the coarsest species of sponges are found at those depths and in those situations exposed to the injurious influence of suspended matter. In the case of different grades of the same sponge the coarsest are in the shallower water. Coarseness consists in the greater stiffness and harshness of the skeleton, and is usually associated with a looser or more open structure—that is, a greater number of canals. It is this latter feature that is perhaps the most constant difference between the best Mediterranean sponges and the best Florida sponges.

The finest Mediterranean sponges grow in water having a surface temperature in winter of 50° to 57°, the mean air temperature at that season being from 63° to 70°. The sponges which occur in deeper water off the coast probably are not exposed to a colder temperature than 60° or perhaps 50° in January.[1] This differs considerably from the conditions on the southern coast of Florida, as shown by the following table,

[1] Note on projects for the improvement of sponge fisheries, by George Bidder. Journal Marine Biological Association of the United Kingdom, IV, No. 2, Feb., 1896.

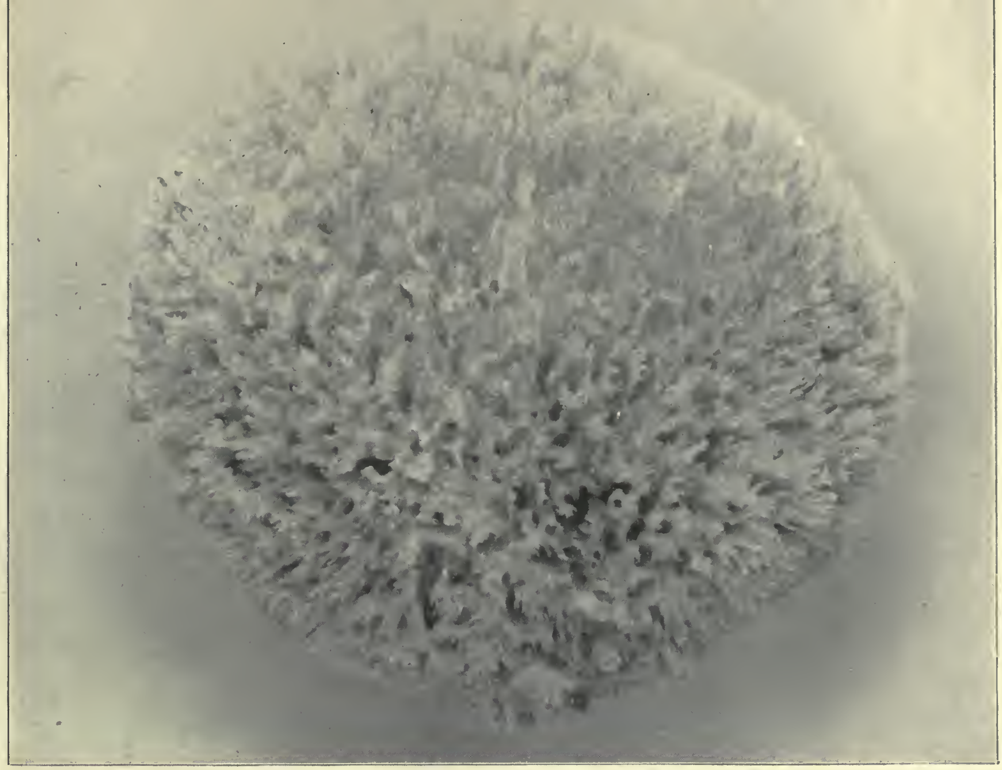
which gives the temperature of the air and surface water as observed at three light-houses in the sponging region. It is stated by Bidder (loc. cit.) that "the Levant variety lives where the atlas shows a mean annual [air?] temperature of about 7° F. below that of Florida, and the Adriatic variety at a mean temperature of about 7° F. lower still."

Statement of the mean air and surface water temperatures at points on the coast of Florida in the vicinity of the sponge-grounds.

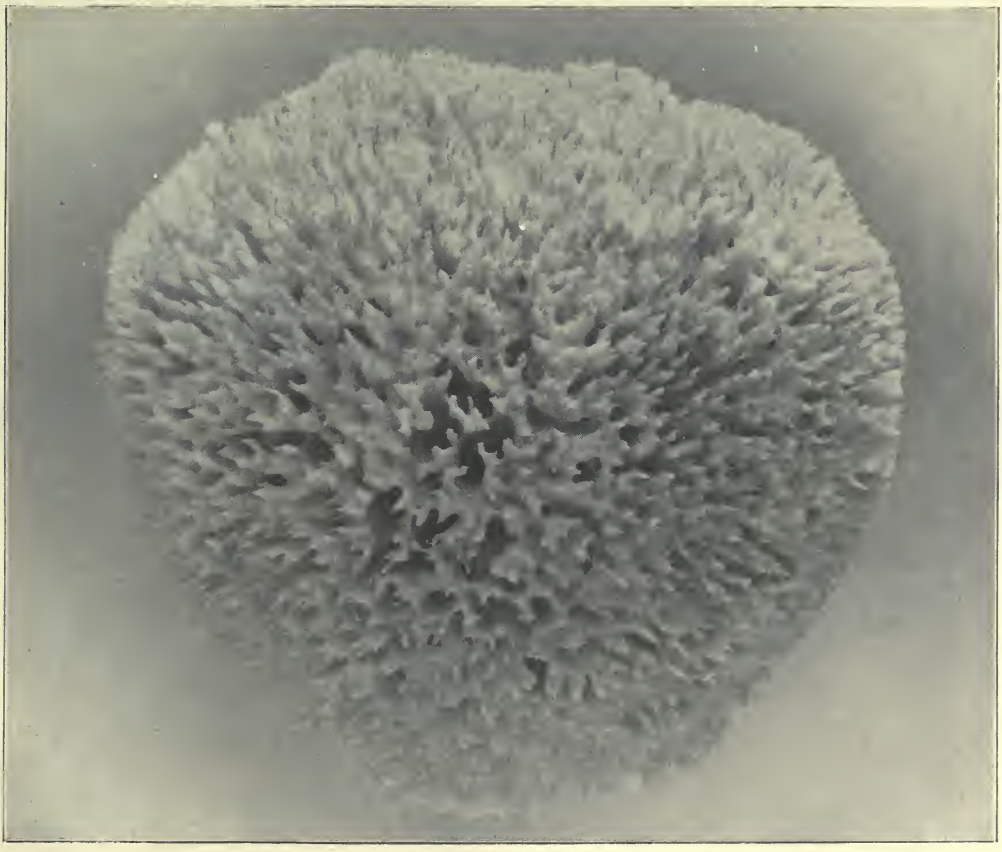
[Depths of water where observations are made: Fowey Rocks, 5 feet; Carysfort Reef, 3½ feet; Dry Tortugas, 4 feet.]

1895.	Fowey Rocks.		Carysfort Reef.		Dry Tortugas.		1896.	Fowey Rocks.		Carysfort Reef.		Dry Tortugas.	
	Air.	Water.	Air.	Water.	Air.	Water.		Air.	Water.	Air.	Water.	Air.	Water.
	° F.	° F.	° F.	° F.	° F.	° F.		° F.	° F.	° F.	° F.	° F.	° F.
January	70.41	72.98	70.95	71.98	71.47	73.03	January	74.60	69.18	69.20	72.20	68.93	70.17
February	68.87	68.71	64.17	70.45	66.48	67.93	February	72.38	70.47	69.38	72.31	68.87	70.15
March	73.23	73.45	72.32	72.16	73.87	73.41	March	76.85	72.13	72.37	72.05	71.22	70.43
April	75.50	74.78	75.35	73.53	76.20	74.98	April	76.40	75.10	77.37	76.45	76.41	75.61
May	78.40	78.18	79.85	78.45	81.27	80.07	May	83.77	79.60	80.50	78.31	81.02	79.41
June	80.35	79.38	83.22	81.73	83.25	81.01	June	85.85	82.66	83.47	81.90	82.82	82.01
July	82.83	82.70	86.60	85.40	84.32	84.01	July	86.48	85.23	84.80	83.90	83.25	82.60
August	83.93	83.75	84.42	84.30	85.05	84.97	August	88.58	86.58	85.88	87.74	85.92	85.73
September	84.47	84.70	84.13	84.31	84.33	84.60	September	87.53	86.16	85.03	83.73	84.13	84.88
October	79.47	78.88	82.75	81.38	81.27	80.97	October	83.15	82.18	82.62	81.15	81.98	81.08
November	75.82	75.88	77.50	77.48	77.87	78.13	November	83.45	82.00	80.90	79.51	77.75	79.28
December	74.58	71.64	69.75	73.54	70.75	73.45	December	77.11	72.62	72.63	75.68	71.95	74.60
Annual mean	77.31	77.08	77.58	77.89	78.01	78.04	Annual mean	81.32	78.66	78.68	78.49	77.86	77.99

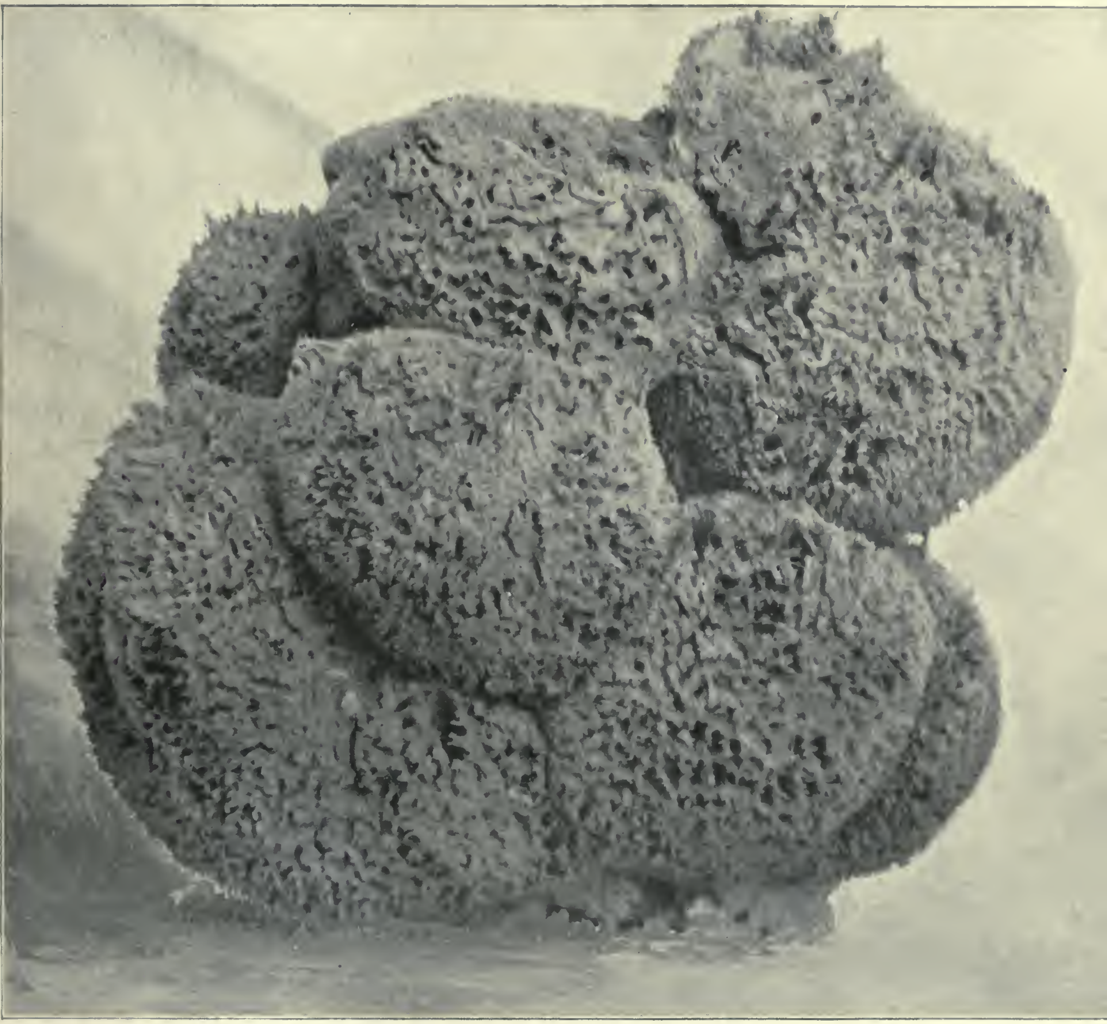
WASHINGTON, D. C.



SHEEPSWOOL SPONGE. From Matecumbe Key. Diameter, 8½ inches; weight (dry), 2⅛ ounces.

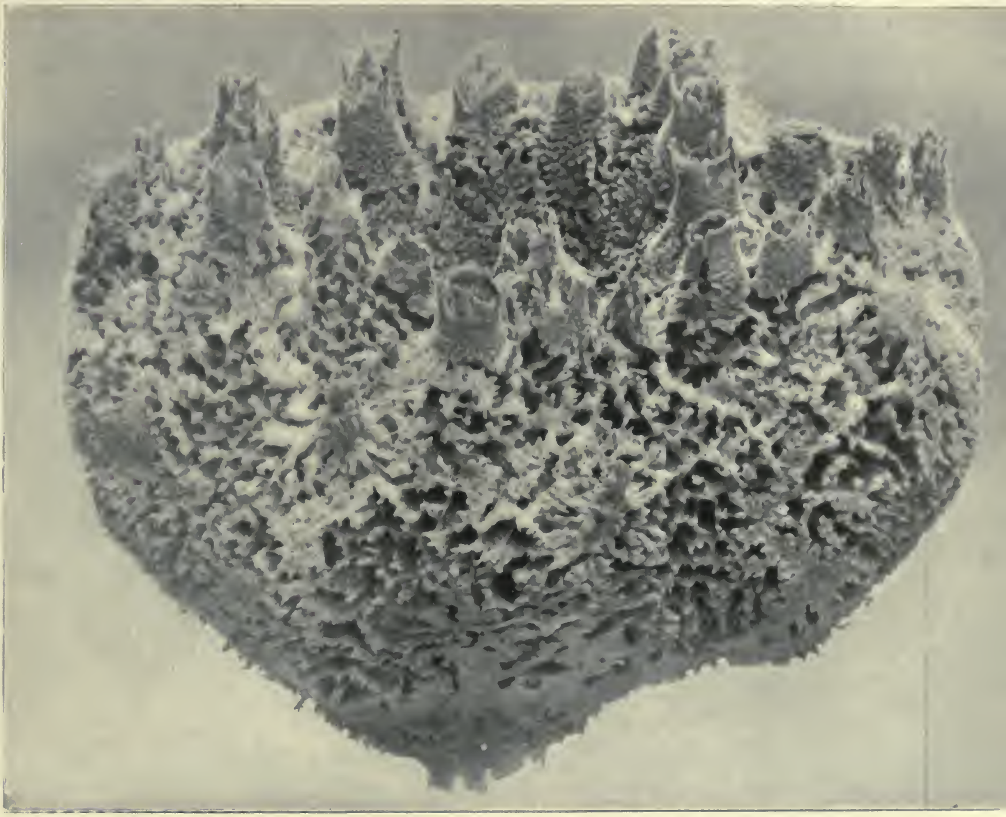


SHEEPSWOOL SPONGE. From Florida Keys. Diameter, 7 inches; weight (dry), 1⅛ ounces.

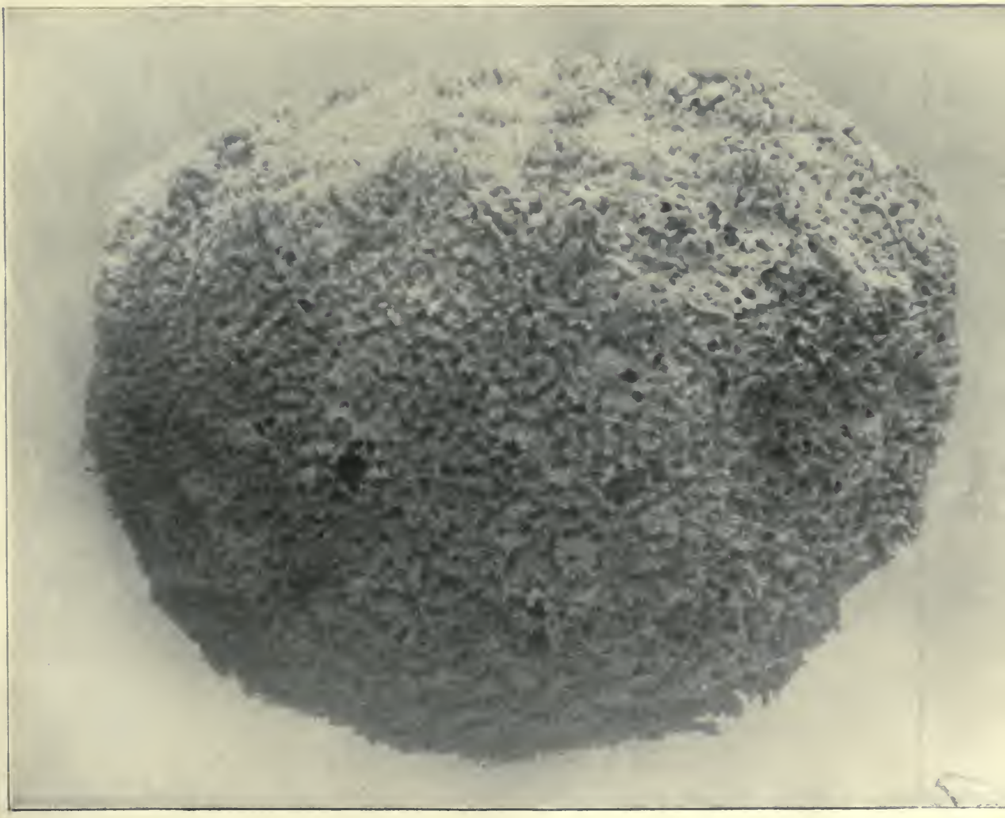


CLUSTER OF CONNECTED SHEEPSWOOL SPONGES.

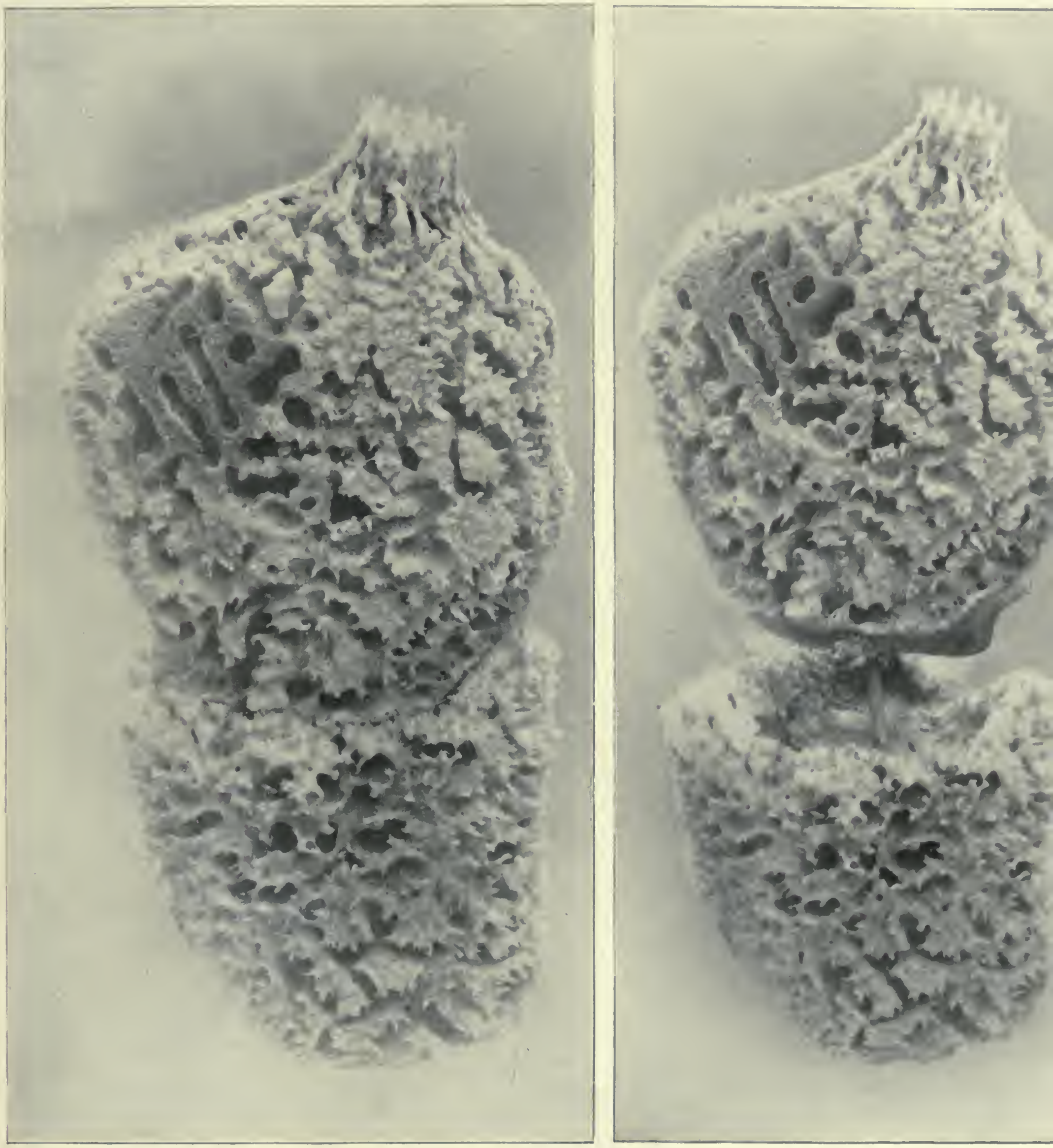
Taken near Cedar Keys, Florida, 1896, in 34 feet of water. Circumference, 6 feet 2 inches.



SHEEPSWOOL SPONGE. From Florida Keys. The craters or oscula very prominent. Diameter, 12 inches; weight (dry), 5½ ounces.

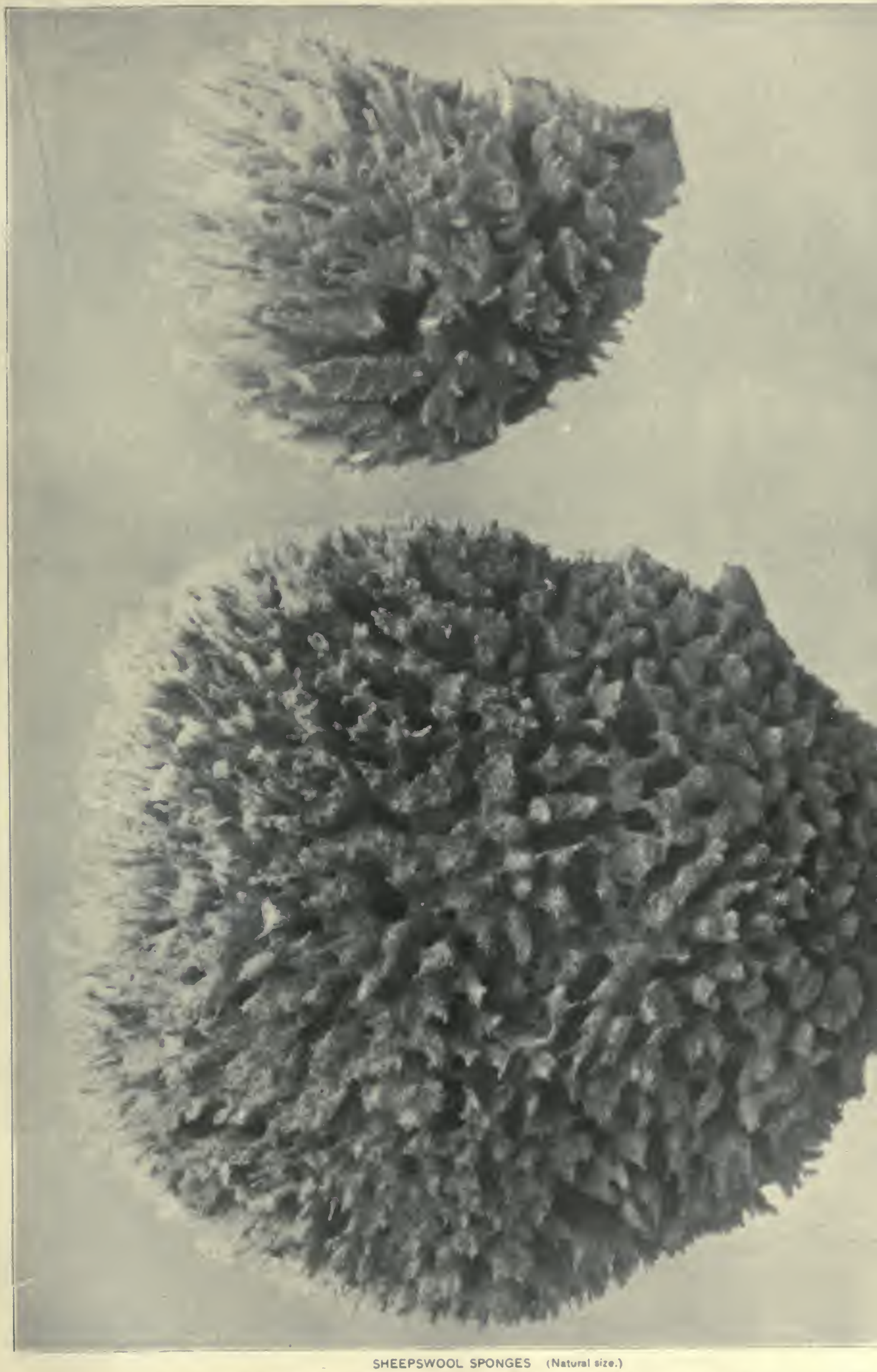


"WIRE" OR "BASTARD SHEEPSWOOL" SPONGE. Diameter, 9½ inches; weight, 4½ ounces.



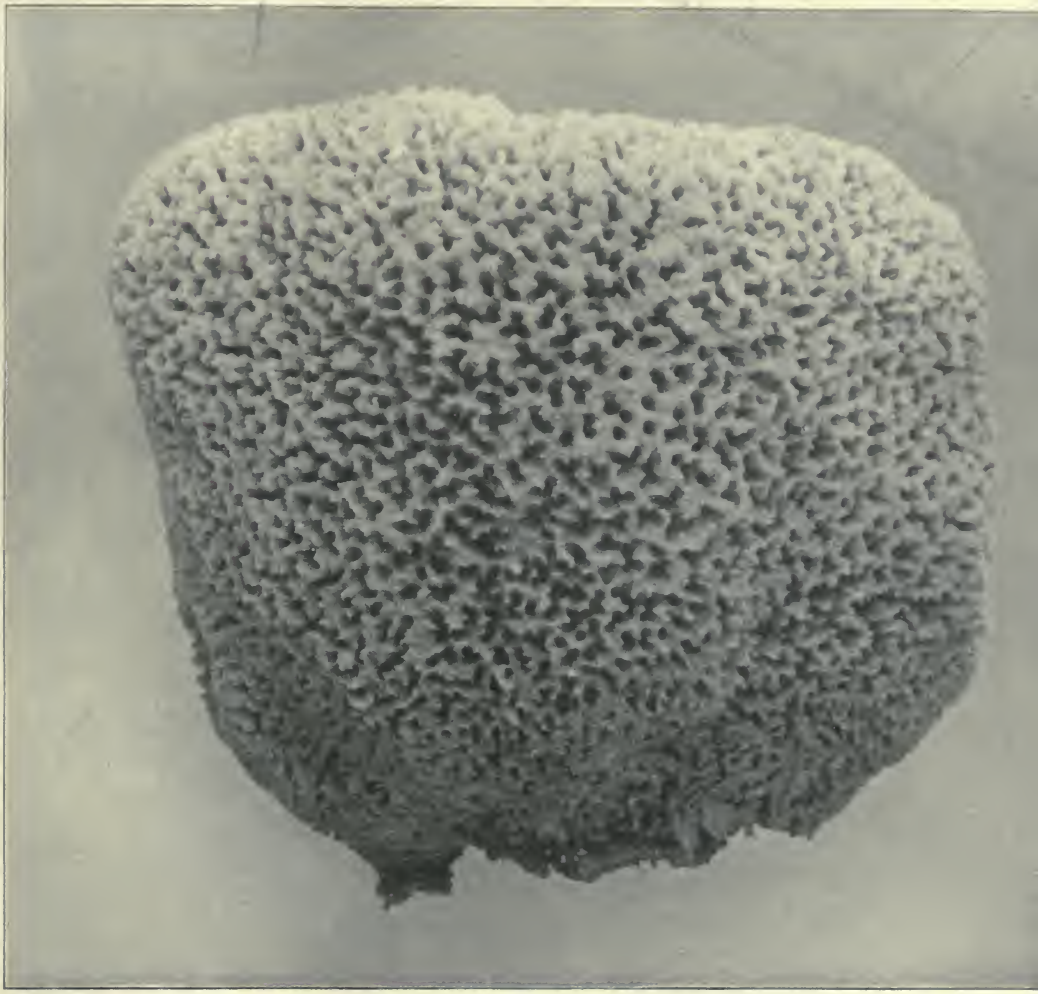
SHEEPSWOOL SPONGES.

One growing on top of the other and both perforated by the stem of a sea feather. About two-thirds natural size.



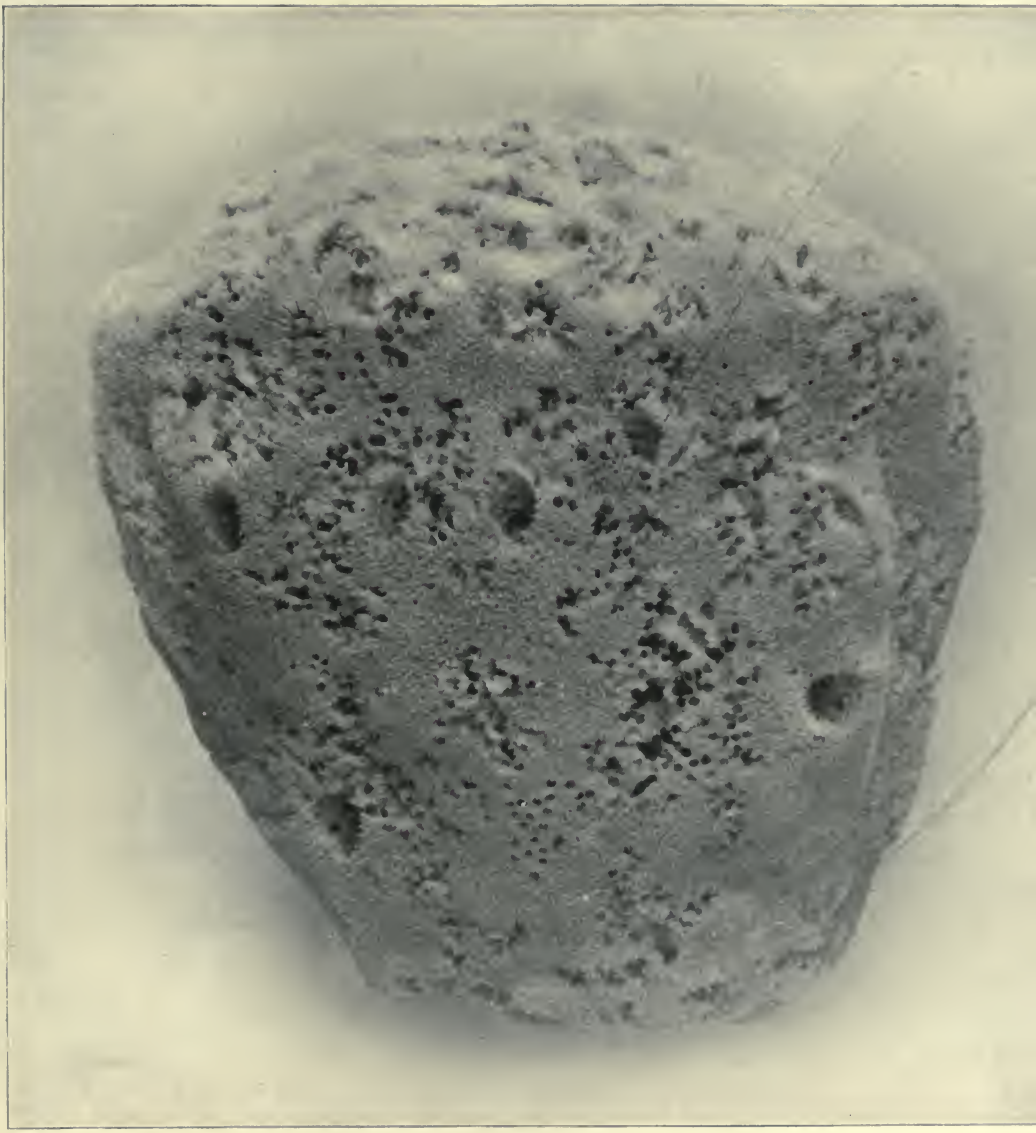
SHEEPSWOOL SPONGES (Natural size.)

Artificially grown from clippings. Larger sponge planted in May or June, 1897, and taken up in January, 1898. Smaller sponge planted in August 1897 January, 1898. Grown in 4 feet of water in sound near Key West.



VELVET SPONGE.

From Florida Keys. Diameter, 11 inches; weight (dry), 5½ ounces.



YELLOW SPONGE.

From Matecumbe Key. Height, 10 inches; greatest width, 9[illegible] inches; weight (dry), 4[illegible] ounces.

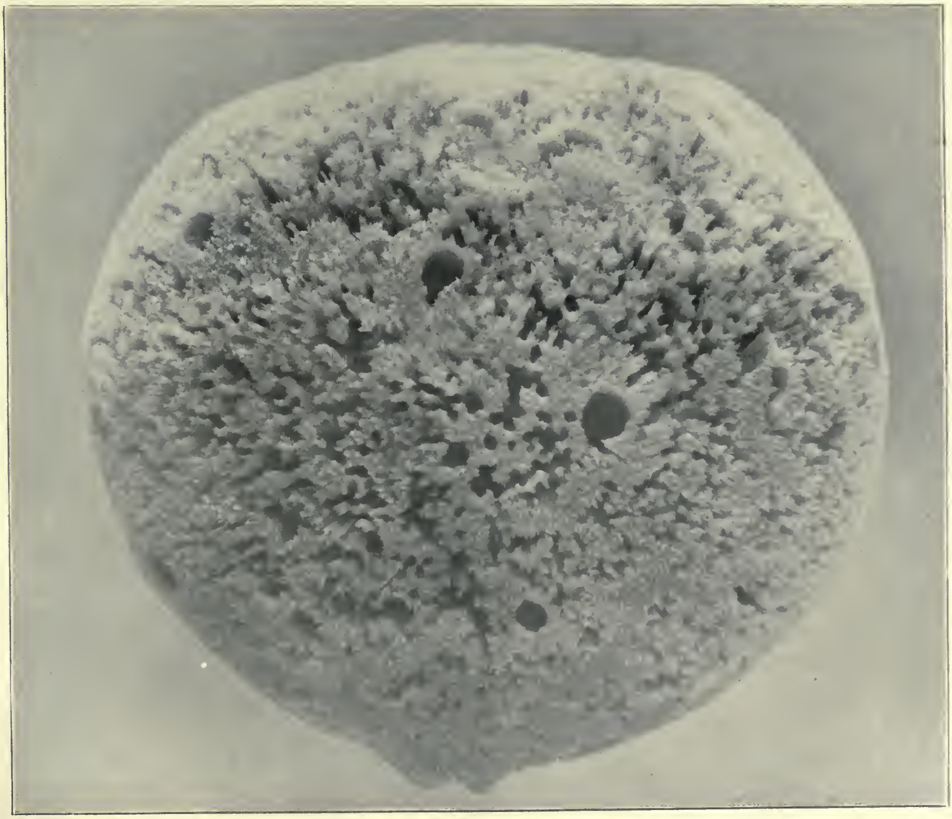
YELLOW SPONGE.

From Matecumbe Key. Width, 13½ inches; height, 10 inches; weight (dry), 7¾ ounces.

YELLOW SPONGE.

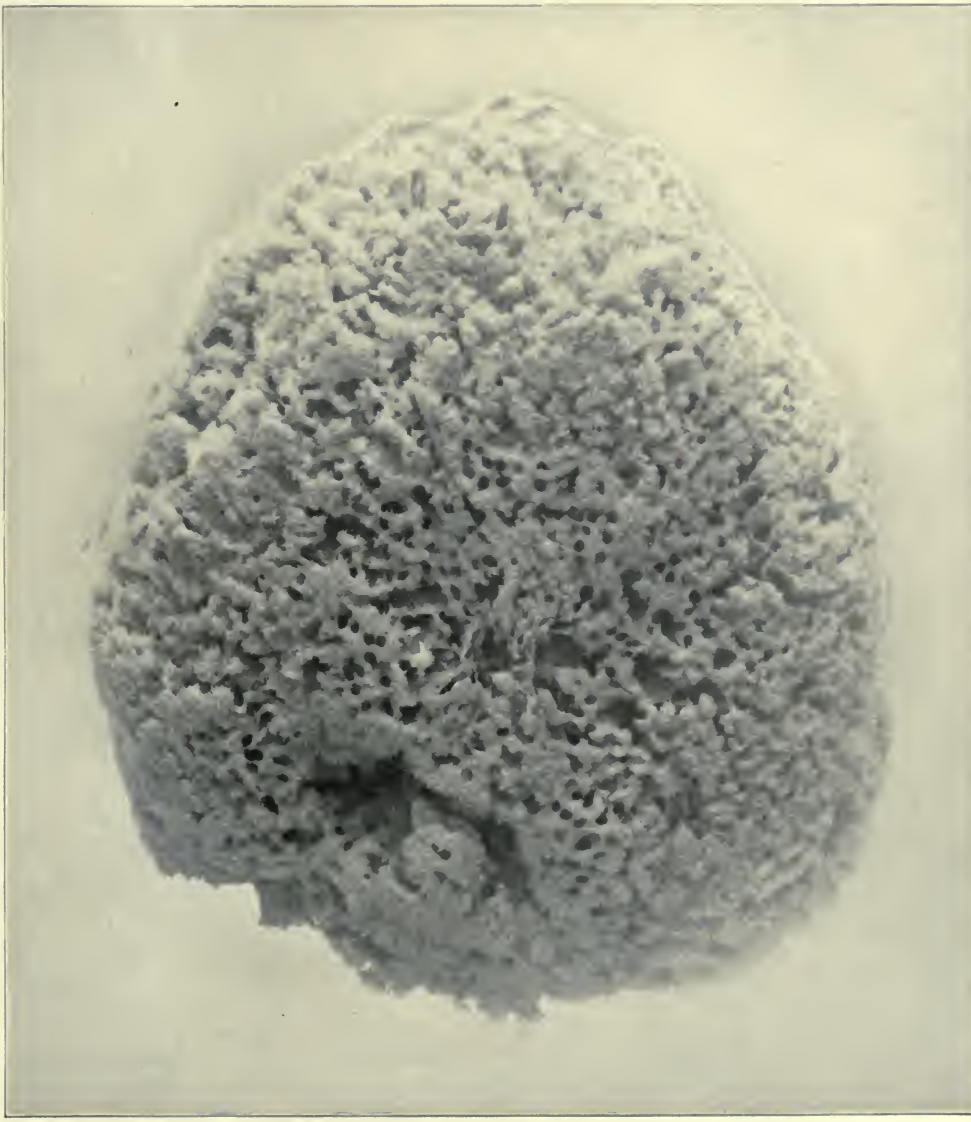
From Florida Keys. Length, 27 inches; weight (dry), 16 ounces.

YELLOW SPONGE. (Locally called "Hardhead.") From Florida Keys. Diameter, 5½ inches.



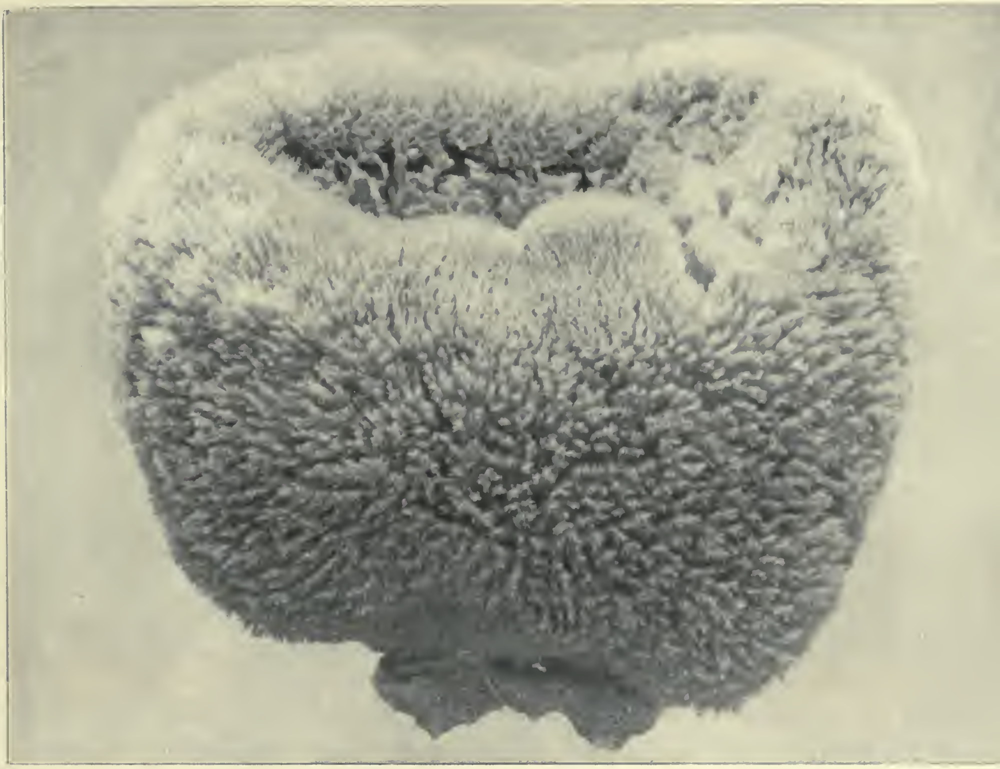
YELLOW SPONGE. From Biscayne Bay. Diameter, 8 inches; weight, 3 ounces.

This form is known as a "roller," or "rolling John," having been detached from the bottom and moved about by the currents.

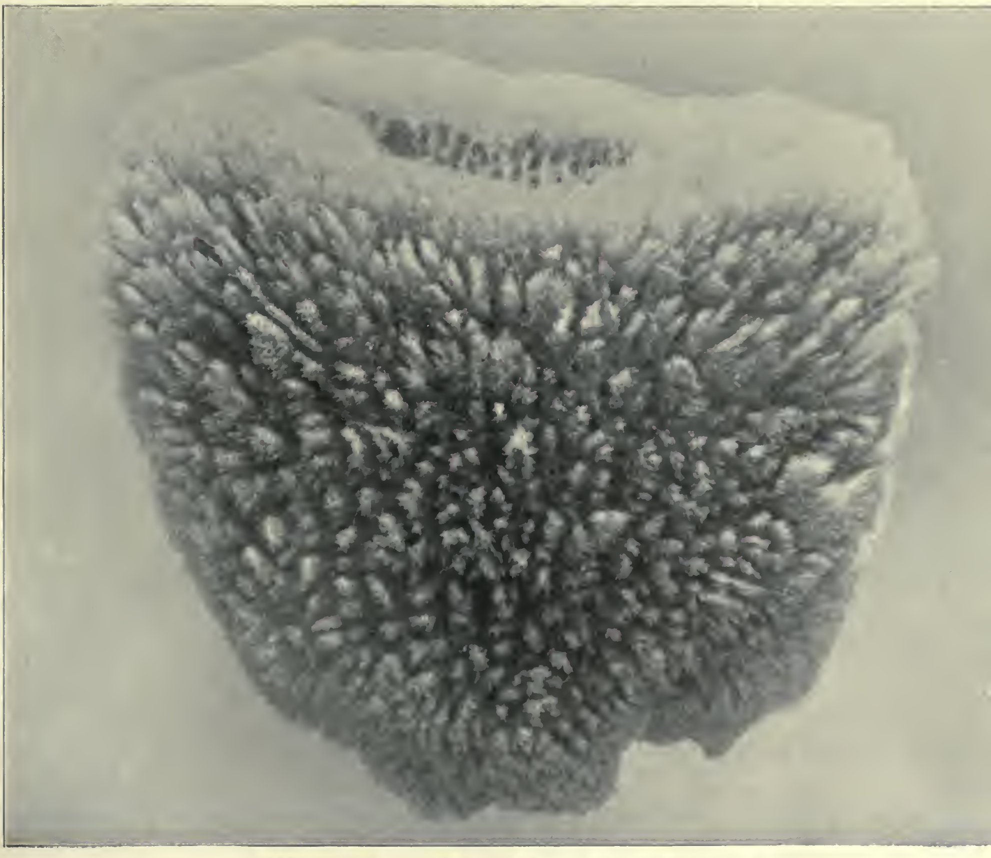


YELLOW SPONGE.

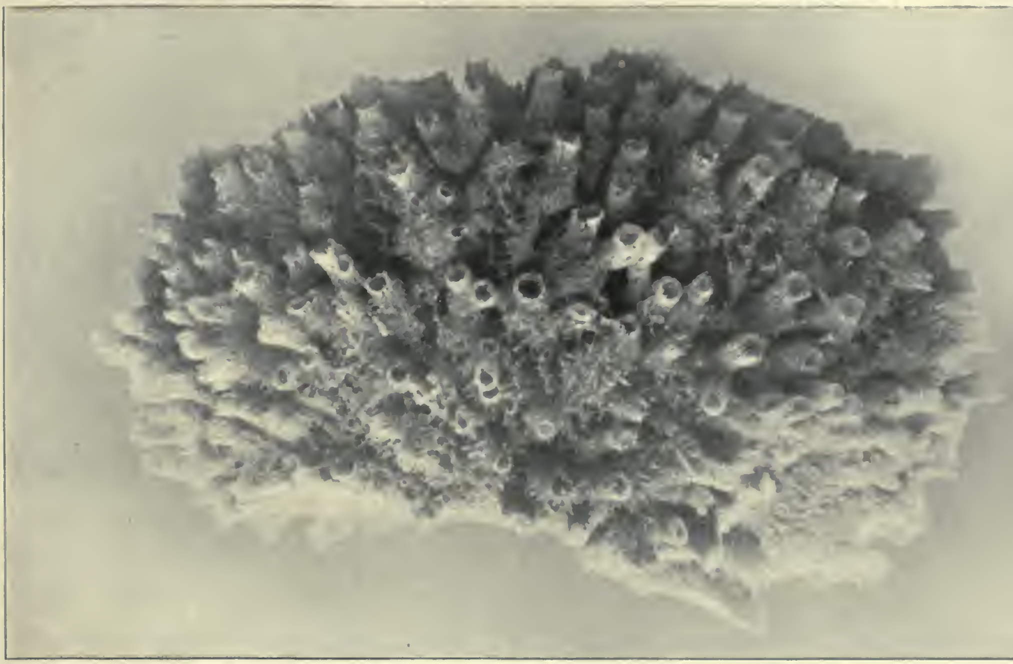
From Anclote Keys. Height, 11 inches; weight (dry), 4½ ounces.



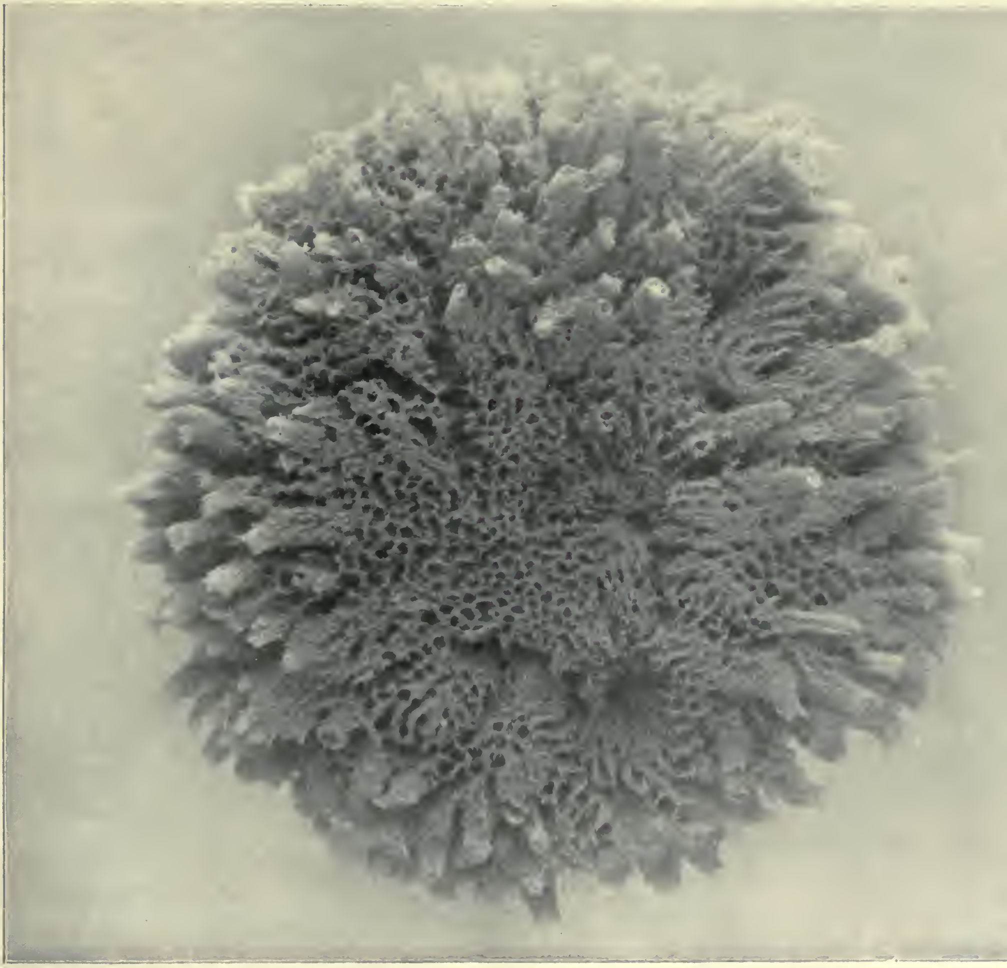
GRASS SPONGE. From Matecumbe Key. Diameter, 9¾ inches



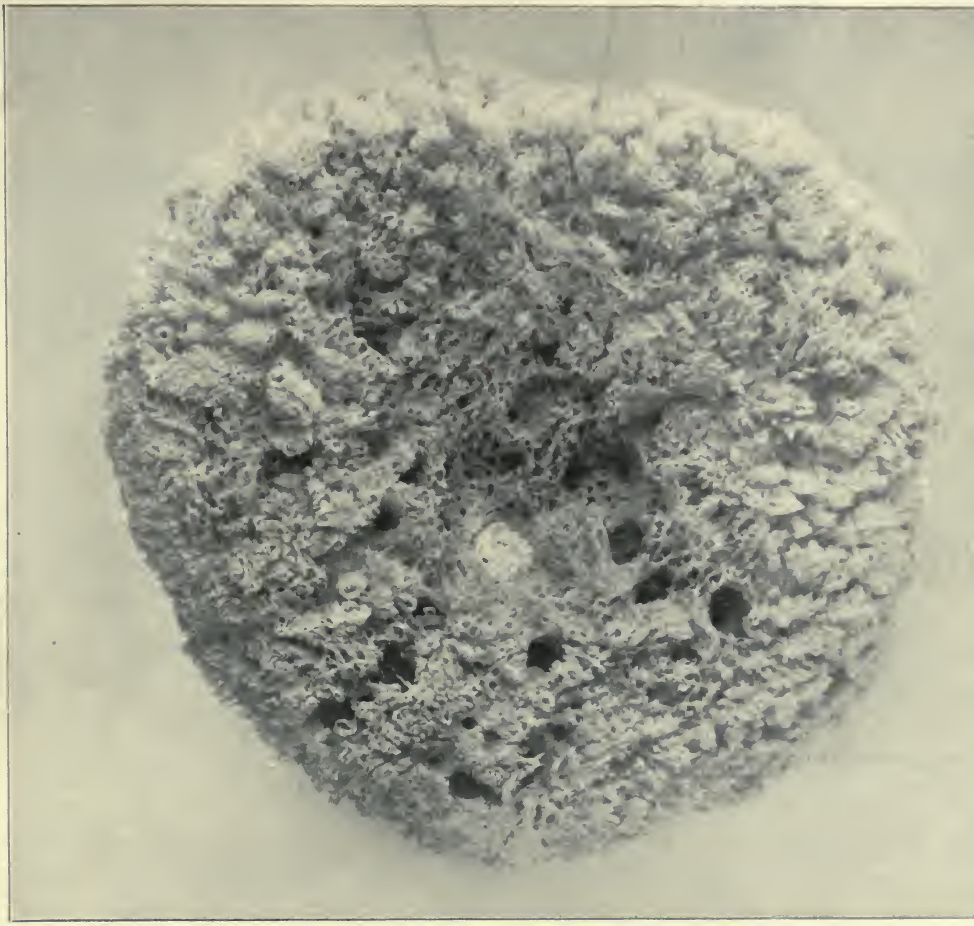
GRASS SPONGE. From Matecumbe Key. Diameter across top, 7½ inches.



GRASS SPONGE. From Florida Keys. Side view. Diameter, 8½ inches.



GRASS SPONGE. Same as above. Top view.

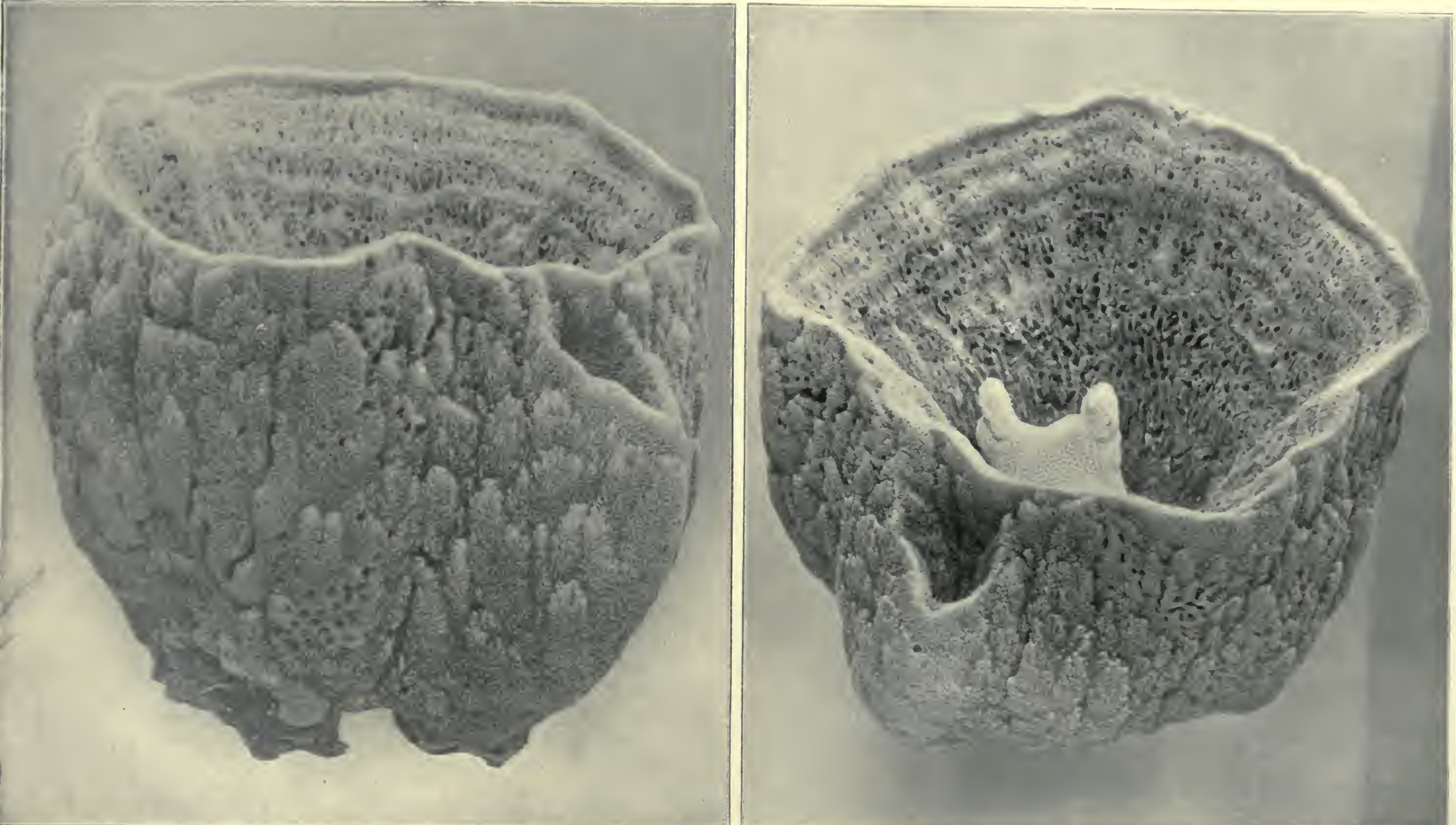


GRASS SPONGE. (Locally known as "Niggernead.") From Matecumbe Key. Top view. Width, 14 inches.

GRASS SPONGE. Same as above, viewed from side.

GRASS SPONGE.

From Anclote Keys. Height, 13½ inches; diameter, 12 inches

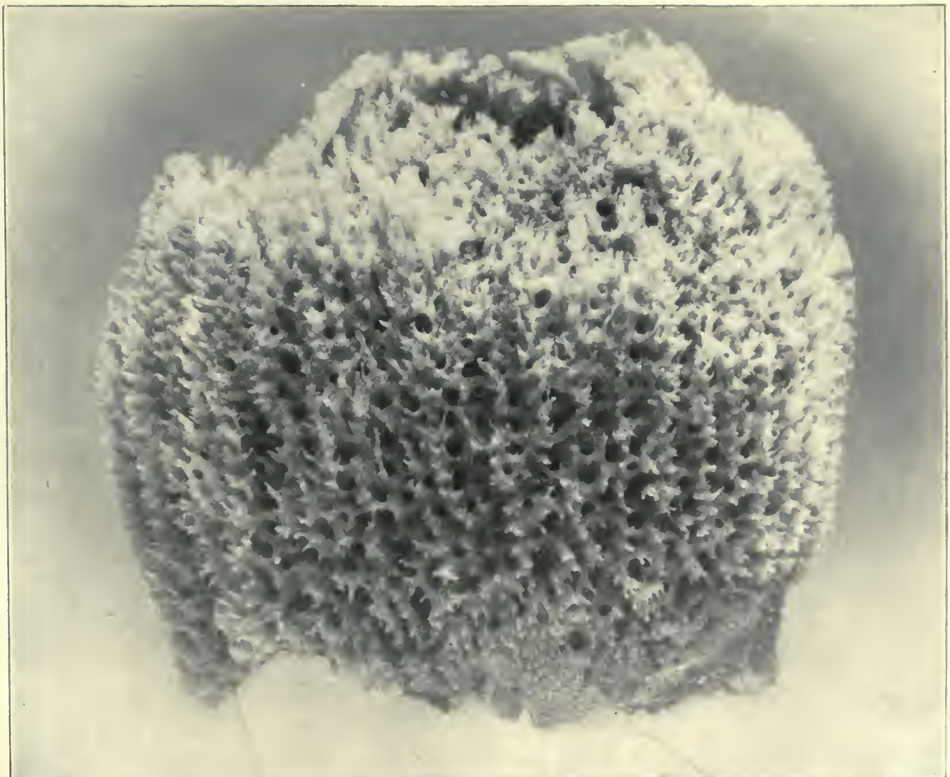


GRASS SPONGE. (Containing a large piece of coral in depression.) From Anclote Keys. Two views. Height, 15 inches; diameter across top. 18 inches.

GRASS SPONGE. From Anclote Keys. Diameter, 9 inches.

GRASS SPONGE. From Anclote Keys. Greatest height, 8½ inches; diameter, 7½ inches.

GLOVE SPONGE. From Florida Keys. Diameter, 7 inches



GLOVE SPONGE. From Florida Keys. Greatest diameter, 6¾ inches.

GLOVE SPONGE.

From Florida Keys. Diameter, 8 inches.

ON THE FEASIBILITY OF RAISING SPONGES FROM THE EGG.

By H. V. WILSON, Ph. D.,
Professor of Biology, University of North Carolina.

For the purposes of scientific investigation the problem suggested in the title of this paper presents no difficulties to the zoologist. Whether on the other hand it is practicable or even desirable to rear sponges from the egg for the purposes of the sponge-grower, is a question which can only be decided by experiments carried on continuously for some years. From the standpoint of the scientific breeder such experiments seem eminently desirable, and the probability that they would result in economic discoveries of importance is very great. It is my purpose to point out toward the end of this paper some of the advantages attainable, as I believe, by this method of breeding. I shall preface my remarks on the rearing of sponges with a brief account of the manner in which the egg development goes on.

Some sponges are known to be hermaphrodite, others have been described as of separate sexes. The probability is that sponges are in general hermaphrodite, but that the individual at one period produces chiefly male elements, and later chiefly female elements. Fertilization takes place in the body of the mother and the egg here undergoes its early development. The embryo eventually bursts the maternal tissue, and, passing into one of the canals, is caught by the current sweeping through the canal system and is discharged into the surrounding water through one of the large apertures (oscula) on the surface of the sponge.

In the great majority of sponges (horny and silicious forms) the embryo, or larva as it now should properly be called, since it leads a free life, is an oval, solid body, covered with slender hair-like processes of protoplasm, the so-called cilia. The cilia strike rhythmically to and fro, like so many minute and flexible paddles, and the sponge larva is by their means whorled through the water. Sponge larvæ, of course, vary in size, but frequently have a length in the neighborhood of 1 mm. ($\frac{1}{25}$ inch). The surface layer contains more or less pigment. Thus, in the commercial sponge, *Euspongia*, the larva is whitish, with a brown spot at one end. In *Tedania brucei*, a large red sponge, growing especially on the mangroves in parts of the Bahamas, the larva is a beautiful red.

The free-swimming life of the sponge larva is short, lasting, when bred in the laboratory, only a day or two. During this period the larva is moved along not only by its own relatively feeble motion, but, being subject to the action of currents, it may be carried a considerable distance from the spot where it was born. It eventually settles down on some firm basis and transforms. The cilia are lost, and the oval body flattens out into a disk so thin that it has the appearance of a minute incrustation. The circular outline of the disk is soon lost, the little sponge spreading in an irregular fashion over the surface to which it is now firmly attached. In two or three days the metamorphosis is complete, and we have a sponge, very small, to be sure, and without reproductive elements, but like the adult in fundamental structure. Its surface is perforated by minute apertures, the pores, through which water enters the body, and by a few larger apertures, the oscula, through which the water leaves the body. Ramifying through the interior is a system of spaces or canals which connect the pores with the oscula. Portions of this canal system form small spheroidal chambers, the walls of which are studded with cilia. It is owing to the motion of these internal unseen cilia that a current of water is constantly circulating through the sponge body, carrying to its tissues the oxygen and food (minute particles of animal and vegetable organisms) necessary for their life.

How long it takes for a sponge developed in this way to reach adult size and begin breeding is unknown. I have kept young sponges that have transformed and attached to the walls of my laboratory aquaria for days and weeks. After the first few days the increase in size has generally been imperceptible. But the unfavorable conditions incidental to such an unnatural habitat were doubtless responsible for this lack of success.

PRACTICAL SUGGESTIONS ON REARING SPONGES.

More species of sponges breed during the warm season than at other times. Yet in the Mediterranean (Naples) some sponges are found breeding at all times of the year. In the Bahama Islands and on our own coast, I have found the breeding time of many sponges to fall within the period from midsummer on through early autumn. For the inauguration of experiments I should recommend the months of July, August, and September.

It is easy to determine when one of the horny or silicious sponges is breeding. On cutting out a piece of the sponge, the developing eggs scattered through the tissues can be seen without the help of a lens. They are minute, rounded bodies, often very numerous, and sufficiently conspicuous to catch an observant eye.

The means employed for getting young sponges must always be different from those made use of in the case of animals like fish, oysters, etc., in which artificial fertilization is practicable. Since the sponge egg is fertilized and undergoes its early development in the body of the mother, artificial fertilization is here of course out of the question.

The young in numbers ample for study can, however, be obtained in the following easy manner. The sponge being raised to near the surface of the water is then dipped up in a glass aquarium or bucket, in such a way as not to expose the animal to the air. In a few minutes time the ciliated larvæ will begin to be discharged. In the study of some Bahama sponges I found it convenient to take to the sponge-grounds, in a boat, a couple of good-sized tubs. In one of these some sponges would be placed for about half an hour. At the end of that time they were transferred to the second tub. The water of the first tub was meanwhile examined for the sponge larvæ. In this I was aided by negro boys, who soon became expert. We bailed out the water in 2-gallon glass vessels in which the little larvæ could readily be seen. The latter were then picked out with glass tubes and placed in a special dish. By the time the examination of the first tub was completed, the second would be found to contain numbers of larvæ. These were collected in the same way, the sponges being thrown overboard.

It would seem in the case of sponges, as in so many marine animals, that the stimuli arising from confinement in a limited volume of water lead to the rather sudden discharge of those embryos (or in certain forms, eggs) that have reached the proper stage for birth.

I have no doubt that if the sponge were handled carefully, it would be possible to get from the same individual, day after day during the breeding season, numbers of larvæ, precisely as several batches of eggs are got from one codfish, for example.

The swimming larvæ thus obtained may be made to attach, during the next day or two, to the walls of the dishes in which they are kept, or to pieces of wood or small stones. After attachment the young, or, as we might say, the sponge "spat," are easy to handle. In this connection, however, it will be well to bear in mind that the circulating pipe water of aquaria, even large and elaborate ones such as those at Naples and Woods Hole, has been found to be unsatisfactory for the rearing of young sponges, as indeed it is for the young stages of many marine organisms. The sponges become covered with sediment, and bacteria develop. Changing the water in the dishes twice a day is, on the whole, a better method. But this is far from an ideal environment. It will probably be much better, after the attachment of the spat to pieces of wood, shells, etc., at once to transfer the latter to some natural site known to be adapted to the growth of sponges.

I hardly think that the method of getting young sponges which I have just described can ever be adapted to the needs of the sponge-grower. And yet, for the purposes of experiment, where a few hundreds or a thousand young sponges would suffice, the method is adequate. I believe, however, that live-boxes may be devised in which the sponge may be kept imprisoned in its natural home, though at some convenient depth, and in which the discharge of larvæ may go on normally day after day. Such a box must have fine metal gauze windows on the sides and above, through which the water may pass freely, and yet with meshes sufficiently fine at any rate to hinder the passage of the larvæ through them. Projecting shelves, which must be easily removable, might be arranged one above the other. The sides and bottom of the box should, moreover, be covered with removable pieces—tiles, for instance. The larvæ settling down on the removable shelves or other pieces would attach to them, and might from time to time be taken out with as much ease as the honey stored up in the modern manufactured comb is removed from the hive.

The precise form of live-box to be used will naturally only be determined after proper experiments. To prevent as far as possible the settling of the larvæ on the body of the mother, a phenomenon very apt to occur, it will perhaps be found well to place the adult on a perforated tray near the top of the box, and a series of such trays, one above the other, may be found a good device. In planning experimental boxes of this sort, the character of the motion of the sponge larva should be borne in mind. The larva not only swims, frequently making long, shallow dives, but also creeps about over the sides and bottom of the vessel in which it is kept.

The live-box has proved itself of great use to the naturalist desirous of obtaining the young stages of animals, which are difficult to keep or breed in the laboratory. In this connection I well remember the experiences of a companion (Prof. C. L. Edwards), engaged in the study of the development of the large holothurian or sea-cucumber

(Mülleria), so common in parts of the Bahama Islands. It was with the greatest difficulty that a few embryos of this form could be got in the laboratory. When, however, the animals were confined in a large box anchored in about a fathom of water, quantities of developing eggs could be had by drawing up with a tube some of the sediment in the bottom of the box.

The "spat" once obtained in abundance, success will next depend largely on the selection of the locality in which the young sponges are to be set out. A careful study of the Florida grounds should be undertaken, with the view of investigating, among other points, this very matter of the kinds of locality best adapted to the growth of the various grades of sponges. Quiet water, a firm bottom, and an absence of muddy sediment seem essential desiderata. The question of enemies is probably of minor importance, and yet the well-known student of sponges, Vosmaer, mentions that he has several times seen the European hermit-crab (*Pagurus*) greedily eat a common silicious sponge (*Suberites*), certainly quite as unappetizing a morsel as the coarsest commercial sponge.

When it has once been accurately determined what are the physicial and biological characteristics of the Florida grounds, which produce the finest sponges—and it may be mentioned here that sponges are among the most variable of animals and seem to be peculiarly affected by their surroundings—a detailed comparison should be made between these grounds and those parts of the Mediterranean producing the finest grades. The purpose of such a comparison would be to discover whether we really lack any of the natural advantages necessary for the production of the finest sponges and, if so, whether these can be artificially reproduced—whether, for instance, it would be possible or desirable to imitate on this side a particular kind of bottom found in the Mediterranean.

Following on the investigation of the sponge-grounds, I believe it to be eminently desirable to start a series of experiments, the purpose of which shall be to discover how far, along what lines, and by what means sponges may be artificially altered by breeding. The great variability of sponges in nature leads one to believe that they would quickly respond as individuals to a change in the environment, and thus, simply by growing the animals in a superior locality, an improved variety, constant, as long as the sponges continue to grow in that locality, might be produced. It is quite likely that such improvements could be carried out on sponges propagated by cuttings as well as on those grown from eggs. In improving races, however, it has always been found that the two important means are sexual breeding from selected specimens and grafting, the latter method being commonly regarded as only applicable to plants.

In sponges, as in other organisms, increase of knowledge will in all probability confirm the belief, already fairly well grounded, that individuals developed from the fertilized eggs vary more, i. e., exhibit more differences one from the other, than individuals grown from buds or cuttings. Herein, to my mind, lies the advisability of growing sponges from eggs as well as from cuttings. The latter method, being quick, sure, and simple, can at once be made of great practical use. Breeding from the egg is more complex, and must be carefully tried by competent experimenters. In the end, however, I believe that it will lead to great improvements in the quality of our sponges.

I would suggest that, after selection of a proper locality, a small plantation of sponges developed from eggs be started and carefully watched. As the sponges grow, it would be a simple matter to pick out those individuals in which the fiber varied in the desired direction. A small piece cut out would not seriously injure the sponge and would show the quality of fiber as well as the entire body. Selected individuals might be removed from the general ground and during the breeding season placed together in large live-boxes. The "spat" collected from such individuals would doubtless develop into superior sponges. I do not know any marine animals which would seem to be so adapted to continuous rearing, with constant improvement of breed, as sponges. Their plant-like habit of growth makes it easy to handle and experiment upon them. Their variability, especially in the matter of the skeleton, would seem to insure success to selective breeding; and the very simplicity of what is desired, namely, improvement in the quality of the skeletal fiber, would at once lend a directness to the efforts of the cultivator, which should lead to comparatively early results.

In closing, I may direct your attention to a method of race improvement, so far practiced only in the cultivation of plants, but to which the vegetative character of sponges will readily lend itself. I refer to the method of grafting. The ease with which two or more individuals of the same species of sponge, irrespective of age, may be made to fuse, and become henceforth a single individual, is well known. Dr. Grant records observations on this head as far back as 1826. Among later experimenters I will only mention Vosmaer. This fusion of individuals goes on commonly in nature. An interesting account of a number of cases may be read in Johnston's British Sponges and Corallines, published 1842, page 11.

The natural tendency of sponges to grow together, coupled with the ease with which they may be propagated by cuttings, would make artificial grafting in these animals a simple matter. With a small plantation of very superior sponges at hand, the result of careful breeding from selected individuals, and other plantations consisting of sponges grown from cuttings, grafting ought to be not only a scientific but an economic success. At slight expense, large numbers of common sponges might be improved simply by pinning to the common cutting a piece of the improved variety.

CHAPEL HILL, NORTH CAROLINA.

THE HUDSON RIVER AS A SALMON STREAM.

By A. NELSON CHENEY,

State Fish-Culturist, New York Fisheries, Game, and Forest Commission.

During the past twenty-five years to my personal knowledge, and probably for a longer period, there have appeared in various publications, from time to time, articles describing the Hudson River as an original salmon stream. Some have merely made the broad statement that the river once contained *Salmo salar*, and others in more explicit language have described the great quantities of salmon that once inhabited the stream, and deplored the fact that they had become extinct in the river. Almost without exception the sole foundation for the statement that the Hudson was once a natural salmon river rests upon an extract from the log of Henry Hudson, of the *Halfmoon*, who records that in 1609 he saw a "great store of salmons in the river" which now bears his name.

Within the past fifteen years a gentleman wrote to a newspaper published in a city on the bank of the Hudson declaring that his grandfather formerly caught large numbers of salmon in the Hudson, and for this reason it was a proper water to be restocked with the king of fresh-water fishes.

That old, old story, which originated in England or Scotland one or two hundred years ago, that apprentices and servants provided, when indentured to their masters, that they should not be required to eat salmon oftener than twice a week, has been transplanted to the banks of the Connecticut and has even been applied to the Hudson and its alleged salmon.

Nevertheless I maintain, and will show in this paper—as I believe, conclusively—that the Hudson was not originally a salmon stream, and that no salmon were ever found in it except possibly an estray from the Connecticut, until planted by the United States Fish Commission and the Fisheries Commission of the State of New York.

As to Hudson's declaration, or to be exact the declaration of Robert Juet, the master's mate of the *Halfmoon*, for he it was who wrote the journal—under date of September 3, 1609, he writes: "So wee weighed and went in and rode in five fathoms, oze ground, and saw many Salmons, and Mullets and Rays very great. The hight is 40 degrees 30 minutes."

Under date of the 15th: "Wee ran up into the river, twentie leagues, passing by high mountains. Wee had a very good depth as thirteene fathoms, and great store of salmons in the river." A boat was sent out and with a net "ten great mullets of a foot and a half long apiece, and a ray as great as four men could hale into the ship" were taken.

Not a single salmon was captured at any time while the ship was in the river. The *Halfmoon* entered the mouth of the river September 3 and anchored inside Sandy Hook, and the next day, the 4th, the fishing was done. The ship ascended to the present site of the city of Hudson, and a boat's crew was sent up the stream to about where Waterford now stands, or a little north of the present city of Albany. The ship and its master returned and set sail for Europe on the 23d of September, so that all told Hudson was in the river twenty days in the month of September. Had there been salmon in the river he must have seen them between Sandy Hook and Waterford, and they would not have been in that portion of the river at that time, as their spawning habits would have taken them 50 miles farther up the river than Waterford, to Bakers Falls, to which point shad ran until stopped by the building of the Troy dam in 1825.

In some of the Canadian rivers there is a late run of salmon, the fish running as late as October, but this was not true of the Connecticut or of other New England salmon streams, nor has it proven true of the Hudson since it was stocked by artificial means. Hudson being an Englishman, and possibly more or less familiar with salmon in the rivers of his own country, and Juet being born at Limehouse, on the river Thames, where salmon were then common, it is perhaps fair to assume that seeing schools of large fish of some sort, one or the other associated them with the fish of his home waters and called them salmon in the log.

In a description of New Netherland, printed in Amsterdam, Holland, in 1671, occurs this sentence: "The streams and lakes, rich with fishes, furnish sturgeon, salmon, carp, bass, pike, roach, bleak, all sorts of eel, sunfish which resemble the bullhead in taste, and codfish which are caught near waterfalls." It will be observed that European common names are applied to the fishes, and doubtless the writer was familiar with the fishes of the old country and applied their names to the fishes in the new country that to him resembled those of the old. To this day codfish are not caught near waterfalls, and it is more than doubtful if salmon existed in the lakes and streams any more than bleak and roach.

New Netherland is bounded "on the south by Virginia, northeast by New England, north washed by the river Canada, and on the coast by the ocean." Besides codfish at the waterfalls and salmon in the streams and lakes, the writer found that "New Netherland hath, moreover, a wonderful little bird scarcely an inch long, quite brilliant in plumage, and sucking flowers like the bee; it is so delicate that a dash of water instantly kills it. When dried it is preserved as a curiosity." The humming bird is a little larger now and more hardy, but the description is perhaps as accurate as the statement that codfish are taken at waterfalls and salmon in lakes within the boundaries as given of New Netherland.

In 1680 Jasper Danker and Peter Sluyter, members of the society of Labadists in Holland, visited this country, and they record of the Mohawk, a tributary of the Hudson: "There are no fish in it, except trout, sunfish and other kinds peculiar to rivers, because the Cahoos stop the ascent of others." They dined in state "with Madam Rensselaer, at Albany, and had to eat exceedingly good pike, perch and other fish," but no salmon.

New York had salmon streams on the north, flowing into the St. Lawrence, Lake Champlain, and Lake Ontario, for I have found laws for their protection enacted in 1801 and later, and mentioning the Oswego, Grass, Racket, St. Regis rivers, and Fish and Wood creeks, as well as other streams. A law enacted in 1801 provided that no dams should be erected on streams flowing into Lakes Ontario, Erie, or Champlain to prevent salmon from following their usual course up said streams, and when dams were erected they should be provided with what are now called fishways, to enable the fish to pass over the obstruction. There is every indication that the lawmakers of the last of the last century and the first of this understood fully the value of the fish in the waters of the State as food and threw every possible safeguard around them, but there is no record of a law protecting salmon in the Hudson until 1771, when it was enacted:

> Whereas it is thought that [if] the fish called salmon, which are very plenty in some of the rivers and lakes in this and the neighboring colonies, were brought into Hudson's River, they would, by spawning there, soon become numerous, to the great advantage of the public.
>
> And whereas a number of persons in the county of Albany propose to make the experiment and defray the expense attending the same: In order that the good design may be more effectually carried into execution, it is conceived necessary that a law should be passed for prohibiting the taking and destroying the fish for a term of years.

This act was signed by John, Earl of Dunmore, and in less than a month after, viz, April 2, 1771, the common council of Albany passed the following resolution: "Resolved by this board, that a letter be sent to William Penturp for to come down and agree with the corporation, if he can undertake to bring live salmons into Hudson's River." There is no record, however, that anything was actually done under this resolution to stock the Hudson with salmon.

Samuel Latham Mitchill, professor of natural history in Columbia College, New York, wrote in the Transactions of the Literary and Philosophical Society of New York, in 1815: "There is no steady migration of salmon to this river. Though pains have been taken to cherish the breed, salmon has never frequented the Hudson in any other manner than as a stray."

In 1857 Robert L. Pell, of Pelham, Ulster County, petitioned the legislature to construct fishways in the Hudson, and offered to stock the river with salmon without expense to the State. There is no evidence that the State accepted the proposal of Mr. Pell, and certainly the fishways were not built.

I believe it unnecessary to quote further from old records and laws to prove that the Hudson River was not originally a natural salmon stream. The evidence is chiefly of a negative character, but I am of the opinion that it is conclusive.

What has been done to make the Hudson a salmon stream has been done within the past twenty-five years, and I will rehearse the operations of the national and State fish commissions to this end as briefly as possible. Beginning with 1873, and continuing for three years after, the Fish Commission of New York planted in the tributaries of the Hudson a quantity of fry of the Pacific salmon, hatched from eggs furnished by the United States Fish Commission. Several hundred thousand fry were planted, but so far as known, after going to sea as smolts, not a single fish returned to the river, and this is true also of other plantings of this species of salmon in other Atlantic coast rivers.

In 1891 the late Col. Marshall McDonald, then United States Commissioner of Fisheries, requested me to make an examination of some tributaries of the Upper Hudson with a view to making a plant of yearling quinnat salmon. He was thoroughly convinced that the attempt to stock the Atlantic rivers with the fry of this fish was an abject failure, but at the Wytheville station of the Commission in

Virginia rainbow trout from California had been established in the hatchery stream by planting fingerling fish after plantings of fry of this species of fish had failed, and he desired to try a like experiment with the salmon also from the Pacific coast. I selected several streams in Vermont, tributary to the Battenkill River, which in turn flows into the Hudson. The streams were free from everything injurious to young salmon and there were no natural or artificial obstructions in them. Later, I went to Vermont with one of the United States Fish Commission cars and planted several thousand yearling (California) salmon in the streams selected for the purpose. Not one of them has ever been heard of since they went down to the sea.

The experiment of stocking the Hudson with Atlantic salmon (*Salmo salar*) was begun in 1882, at which time 225,000 fry were planted in small streams tributary to the head of the river about 260 miles above Sandy Hook. Nothing was heard from this plant until 1886, or four years after, when adult fish returned to the river weighing from 9 to 16 pounds, and ascended to Troy, where they were stopped by the State dam. Every year since, with one exception, plants of salmon fry or yearlings have been made in the river, and every year adult fish have been captured in the lower river by the nets of fishermen.

One thing has been proven to my satisfaction beyond peradventure by these experiments. The young of the *Salmo salar* when planted in the Hudson do not go to the sea until they are two years old, and they return from the sea when they are four years old. If I should make this statement before a European audience I would be accused of rank heresy, and possibly right here in Tampa delegates to the National Fisheries Congress will desire to know what proof I have of this assertion. I planted salmon fry in a trout stream tributary to the Hudson which had never contained salmon, and it was two years before they arrived at the smolt stage and took their departure for the sea in silvery livery. Selecting another stream I made a like plant, and it was two years before the parr put on the smolt dress and turning their tails to the sea drifted down with the current. During the past fourteen years I have planted *salar* fry in various streams, and always, when in a new stream where they could be watched that no mistake would be made, they have remained for two years before going to sea.

Since the first plant of *salar* fry a total of 3,486,000 have been planted in the Hudson River, this number including 12,000 yearlings. All the eggs were furnished by the United States Fish Commission and came from the Penobscot River in Maine. For a number of years after the initial plant the United States paid all the expenses of hatching and distributing the young fish, but later the Government furnished the eggs and the Fisheries, Game, and Forest Commission of New York hatched and planted the fish at the expense of the State.

It is of record that in one year over 300 adult salmon, from 10 to 38 pounds each, were taken in nets in the Lower Hudson, every fish taken contrary to law. It is true that some salmon taken in nets are released by the fisherman, but the high price offered for Hudson River salmon in the New York markets sorely tempts a fisherman to kill such salmon as may be taken in his net, instead of releasing them uninjured, as the law directs. Fishways have been erected in the Hudson by the State at Troy, Mechanicsville, and Thomsons Mills, but other fishways must be built before the river is open to the fish from the sea to the pure water of the upper river where the salmon would naturally go to find spawning-grounds. The Cohoes Falls on the Mohawk is to-day as much of a bar to the upward migration of salmon as when Jasper Danker made the entry in his journal in 1680, which I have quoted. Baker Falls, on the main river, has been supposed to be one of the causes why salmon never frequented the river at the time they ran into the Connecticut. These falls stopped the shad and and it has been said that they would stop salmon. Possibly they would, but I visited the falls with the late Commissioner McDonald and we were both of the opinion that it was possible for salmon to surmount them on the proper stage of water.

Why the Hudson was not originally a salmon stream when the Connecticut, a neighboring river, was, I shall not attempt to explain. It may have been that Cohoes and other falls on the main river and its tributaries operated as a bar to keep them from their proper spawning-grounds, but one thing has been fully demonstrated: The Hudson River of to-day, with its sewage from towns and poisons from mills and factories, does not deter salmon from entering from the sea once the fry are planted in its headwaters, and with fishways in all the obstructions, natural and artificial, it could be made a self-sustaining salmon river if the netters would obey the law, while the State fisheries commission aided nature in keeping up the supply of young fish by artificially hatching the eggs. Colonel McDonald told me on more than one occasion that if the Hudson were open to salmon, and proper efforts were made to keep up the supply of young fish, and netting regulations were enforced, the river would from its salmon add $100,000 a year of profit to the State financially, while largely augmenting the food supply.

GLENS FALLS, NEW YORK.

A PLEA FOR THE DEVELOPMENT AND PROTECTION OF FLORIDA FISH AND FISHERIES.

By JAMES A. HENSHALL, M. D.,
Superintendent of United States Fish Commission Station, Bozeman, Monatna.

The principal fishing industries of Florida are prosecuted on the Gulf coast, at Pensacola, Tampa, Punta Gorda, and Key West. The shad fishery of the St. Johns River is also very important, and considerable business in this direction is done at various places on the east coast. At Pensacola the principal fish product is the red snapper, a fish of good size and with firm flesh of fine quality, which bears transportation well. It is taken with hook and line on the snapper banks in from 10 to 50 fathoms and from 10 to 50 miles offshore. At Cedar Key, Tampa, and Punta Gorda the bay and brackish-water fishes are taken by haul seines on the shores of the bays and inlets; the varieties mostly handled are mullet, redfish, or "bass," as it is known commercially, sea trout, pompano (the best of all fishes for the table), Spanish mackerel, jackfish, etc. The mullet is, perhaps, the most important, as it is shipped fresh, on ice, while large quantities are cured by salt.

At Key West many of the fishes are entirely different from those of the other waters of the State, and belong rather to the West Indian fauna. They comprise the coral fishes, salt-water fishes par excellence. All are taken with hook and line, as the various seines and nets can not be utilized owing to the ragged coral formation of the shores and reefs. The principal fish are kingfish, mackerel, groupers, snappers, grunts, jewfish, etc., which exist in great variety. The catch is almost entirely consumed at Key West. Formerly a fleet of smacks carried live fish in wells to Havana until a prohibitory import duty was imposed by the captain-general upon fishermen from the United States, which compelled the abandonment of the industry and the sale of the smacks to Spanish fishermen, who, besides taking fish contrary to law in Florida waters, carry on a nefarious trade in smuggling vile rum and poor cigars.

The Gulf coast line of Florida, Alabama, Mississippi, Louisiana, and Texas is more than 6,000 miles in length, being about 1,000 miles longer than that of the Middle Atlantic States. Of this extent Florida has nearly 3,000 miles, or about one-half. A statistical review of the U. S. Fish Commission, published some ten years ago, says:

> The Gulf States occupy a favorable location for supplying a large part of the country with marine products. A dozen or more States in the Lower Mississippi Valley have their nearest coastal connections through these States, and it will probably be in response to this section's demand for marine food products that the Gulf fisheries will reach their highest development.

The fulfillment of this prediction has been realized, for at present a large demand exists for the food-fishes of Florida in all the South Atlantic States, while the choicer varieties, as red snapper, pompano, Spanish mackerel, etc., are shipped to all the principal northern cities. The same report says:

> This region is favored with many highly esteemed food-fishes, which occur here in greater abundance than elsewhere on the coasts of the United States. The undeveloped resources of the Gulf States invite outside attention and afford a promising outlook for future increase. The possibilities of the region in the matter of oyster production and cultivation are believed to be great.

Few sections of the United States are better supplied with desirable and important marine-fishery products, including fish, reptiles, and invertebrates, than the Gulf States. Among the invertebrates the oyster ranks first in commercial importance. It is extremely abundant throughout the entire section and constitutes the most prominent fishery product. No other mollusks have as yet attained economic prominence, though in Florida the round clam or quahog is taken in small quantities, and the meat of the conch is used for bait and eaten locally. A number of species and varieties of sponge occur off the Florida coast, and are objects of an important fishery, the only one of the kind prosecuted from the United States. Among crustaceans the shrimp is the most prominent. Crabs are abundant in this region; in addition to the common blue crab of the Atlantic coast, there occur the shore crab, the lady or sand crab, and others of less importance. The stone crab, which reaches a large size and is very palatable, is probably most abundant on the coast of Florida.

The economic value of the reptiles inhabiting the Gulf States is greater than in any other section. Foremost among them is the alligator. There are at least five species of terrapins in this section which are valuable as food. Four of these occur in fresh water. The salt-water or diamond-back terrapin is also found in the salt marshes from Florida to Texas, and is a valuable article of fishery. This region is included within the range of three soft-shell tortoises. Two species of snapping turtle also inhabit the fresh waters of these States. Three important marine turtles frequent the Gulf of Mexico and are sought by the fishermen; these are the green turtle, the loggerhead, and the hawkbill or tortoise-shell turtle.

From the foregoing brief account of the fishery resources and kindred industries of Florida, it is evident that the present active demand for fish, oysters, etc., will be largely augmented in the future, especially in view of the fact that there is a material decrease in the supply of these products in northern waters; indeed, there are already many northern fishing smacks in Florida waters every winter, and lately there have been oyster-grounds located and taken up by northern parties with a view to an increased cultivation of oysters. The granting of these privileges should be paid for by the parties interested and made a permanent source of revenue to the State, the same as is done in the States of Virginia, Maryland, New Jersey, New York, etc. This is very important and should be attended to before the best grounds are disposed of gratuitously. A State fish commission could be supported by the revenue derived from the rental of oyster-grounds alone, and there should be an intelligent supervision of this branch of the fisheries, in order that those interested may keep pace with the improvements and discoveries that are yearly being made in the cultivation of oysters and be better enabled to foster this important industry.

The same necessity exists for an able and competent supervision of the sponge interests, in which Florida alone is concerned, for in the waters of that State are the only sponge-beds in the United States. It is of vital importance, then, that those beds should be properly protected, the taking of the sponges subjected to wise and judicious surveillance, and their cultivation prosecuted with vigor and intelligence in order that the supply may be maintained and increased, and the revenue to the State consequently enhanced.

The shad fishery of the St. Johns River constitutes one of the most important branches of Florida fishing industries, as the first shad of the season are shipped thence to northern markets at a time when they command the highest price. As the supply has lately been seriously decreasing, it is of paramount importance that the yield should be increased by artificial means. The artificial propagation of shad has been attended by more pronounced success, perhaps, than that of any other fish, a most convincing example being that inaugurated by the United States Fish Commission in California, where, by the planting of less than a million shad fry in the Sacramento River a few years ago, shad have become so numerous that they are now sold for a less price than in eastern markets. When it is considered that prior to this experiment there were no shad whatever on the Pacific coast, the argument in favor of the artificial culture of the shad is incontrovertible.

The State of Florida should have at least one hatchery on the St. Johns River, and as the shad-hatching season lasts but a couple of months, the expense is trifling, while the results are all important, far-reaching, and most bountiful.

There has been also a considerable decrease in some of the coast fishes, while a complaint of the scarcity of the best food-fishes in the inland waters of the State is universal. Now is the time to do something toward a restoration of the fish supply to these waters, or at least to prevent a further depletion by the proper and fostering care of a competent fish commission—one that is able to cope with the situation and to apply the proper remedy, whether it be by artificial cultivation or by increased protection, and by so doing to increase the food supply of the people.

In the Northern States the fishes of many of the interior streams have either been totally destroyed or very materially decreased by the pollution of the streams through the refuse and offal from manufacturing establishments. It would be the part of wisdom for the Florida authorities to be forehanded in this matter, on the principle that "an ounce of prevention is worth a pound of cure," and to enact such laws as will prevent a like decrease of the fish supply from similar causes.

The United States Fish Commission has done considerable work in Florida, and will do a great deal more; and it is also contemplated to establish a station for the cultivation of fish, oysters, sponges, etc., at no distant day. In view of such an event, therefore, it is all the more important that good protective laws and their effective enforcement by a competent State fish commission should be provided for, otherwise the work of the National Commission would be to a great extent rendered useless.

It will be readily seen, from what has been said, that it is of the utmost importance that the fishery industries of the State should be looked after by an efficient and competent commission. It has been thoroughly demonstrated in the many States, and particularly in Florida, that the plan of a complimentary fish commission, composed of several persons who receive no compensation, has not worked advantageously, although liberal appropriations were annually made in the older States. Too often such commissions degenerate into mere political machines for the securing of votes, while the legitimate work of the commission is neglected or frustrated. It can not be expected that men will give much time or attention to duties for which they receive no compensation, so it follows, as a matter of course, that if they can not command dollars they will command votes, if possible.

The fish commission of Florida is virtually obsolete at present, for, notwithstanding the appointment of three commissioners several years ago, as provided by law, I have learned on good authority that nothing has been done by them and that to all intents and purposes the commission has ceased to exist.

What is needed is the enactment of a law that provides for the appointment of a single commissioner of fish and fisheries at a fair salary, one who has a scientific and practical knowledge of fish and fisheries and is fully competent to deal with the subject in all of its bearings. Such a person would be able to materially augment the revenue of the State by an increased development and a more abundant yield of the various fisheries. If thought best, he might also have supervision of the game birds and mammals and see that the laws for their protection were enforced.

BOZEMAN, MONTANA.

INTERNATIONAL PROTECTION FOR THE DENIZENS OF THE SEA AND WATERWAYS.

By BUSHROD W. JAMES, A. M., M. D.

It is clear to the thoughtful mind that there is a yearly increasing necessity for economy in several directions, none of which is more decidedly marked than that concerning the denizens of the sea. That a deplorable mistake has been made by men and corporations in hunting the whale, walrus, and seal, until the first two are almost exterminated, while the like danger regarding the other is now agitating a great part of two continents, is sufficient apology for the reiteration of the theme selected for this paper.

Impelled with a keen desire for wealth, men will not pause to think that there is a serious menace to human existence in the wholesale destruction of any animal upon which it has relied for sustenance and clothing, not to mention warmth and shelter. Nor can they realize, when vessels return from whaling voyages with cargoes insufficient to meet expenses, that the decreasing animal population of coast and island on their routes is due to the same cause. The animals have been hunted too greedily and have either been destroyed or driven from their haunts, leaving men destitute who have always depended upon their annual return for nearly every life necessity. No one can accurately estimate the sufferings that have resulted in times past in diminishing numbers of Indians and Esquimaux along these seaboards; and common justice questions, is it right to take for one man's gain the food supply of inhabitants of American soil, bringing helpless fellow creatures to starvation and death.

Careful study will show that however valuable oil, whalebone, or ivory may be to commerce, a judicious economy in their production must be more advantageous to a steadily lucrative business than could be a few years of surprising overproduction and an aftermath of no returns for expensive expeditions. Such reports have come from the whaling fleet sent out from San Francisco in the last two years at least. It was due to want of success that the whalers are now ice-bound and in danger of death in the great frozen Arctic Ocean. Possibly if whaling and walrus hunting (or, as it is called, ivory hunting) are legally forbidden by the United States Government and Russia and Canada for a time, the great mammals will return to their old foraging and breeding grounds. If not, the dealers in such articles and the men heretofore engaged in the capture of the animals may look upon their occupations as practically discontinued for all time.

In support of this we need only point to the western plains, over which once roamed buffalos and antelopes by the million. So plentiful were the herds that the sportsmen of the world came to aid us in their extermination. Even if the plan for the protection and reproduction of the buffalo succeeds, which is doubtful, neither this generation nor the next will live to see its consummation. So with the sea mammals of which we have spoken. If to-day legislation stepped forth with its utmost power to protect, there will yet be years of unprofitable voyaging in the northern seas before they once more become plentiful. The belated arrangements relative to fur-seals in Bering Sea must be carefully carried out to insure any great commercial advantage from them in the future. The seal, whale, and walrus produce but one at a birth, the exception never being met in the seal, and if the others ever bear more there are but two, and these events happen but once in a year. Therefore, provided that a million seals are spared, and each cow is productive, the increase could be at the very utmost but one to every ten animals, and this, allowing a great percentage of the million to be females, the number of which never predominates to so great an extent.

It is plain, therefore, that the larger animals upon which whole populations have depended for food and other life necessities, i. e., the three most valuable denizens of the sea, must at once receive adequate protection or they will be destroyed beyond remedy in a very short time. Cooperative international agreements are necessary whereby the creatures will be safe from molestation, not only on their breeding-grounds but wherever they gather. We maintain that they belong to the countries upon whose territory they congregate for the purpose of carrying out nature's great design, and that there each government should execute the utmost prerogatives to secure safety for its property without any outside assistance, but only by peaceful international legislation can deterioration and future extinction be avoided. By no means do we mean to insure these animals alone from injudicious hunting, nor indeed do we desire to express belief that they are the most important denizens of the water. For only commensurate to their value to certain inhabitants can their true usefulness be adjudicated, as likewise that of the salmon, cod, halibut, shad, herring or any other fish equally important for commerce and for food. Except that the inhabitants of the northeastern part of the United States, as also those of Nova Scotia, Newfoundland, etc., are within reasonable distance of inland towns, their dependence upon the numbers and condition of the returns of their fishing fleets is almost as great as that of the Esquimaux upon the seal, whale, and walrus hunting.

If then those fisheries have become of national and international importance the people of the eastern districts should have their fishing interests equally well guarded from injury. Left to their own devices, the true fisherman—one born to the trade and relying upon its success—will be careful not to injure his future prospects by endeavoring to catch all the fish at one great sweep. Nor will he waste the other fish that enter his net among the more valuable kinds. Instead, he will cast the flapping, gasping, wide-eyed strangers back into the water, there to perform their part in the world of nature. Therefore, it is not among the life hunters and fishermen that we must look for the destroyers of the fish or mammals, but to men or companies who take spasmodic interest in them for a time, simply as a money-making scheme. The protection and propagation of the more desirable food-fishes seem to have become established sufficiently to remedy many of the evils heretofore existing, but trouble still exists and will continue so long as indiscriminate catching is permitted.

The reasons for this are obvious. Some years ago there was a company (or companies) formed called the "Menhaden Fisheries," ostensibly for taking menhaden, a comparatively useless fish, whose reputation was to be redeemed by making oil and compost of the enormous catches of this fish off the Atlantic coast particularly. Admitting that the important fish, such as shad, leave the waters of the Atlantic rivers and are consequently safe during their absence, how can it be credited that the great nets full of menhaden are not very largely mixed with young food-fishes? Or, even if that is not so, must we not concede that menhaden, though unfit for human food, are in some shape the chief food for edible fishes—if not as full-grown animals, possibly in the form of spawn and quite young fish. It must be thus that they are useful, and consequently their wholesale and relatively useless destruction is a great wrong, which should be suspended at once by international agreement. Besides, there is a touch of extreme cruelty in hunting them simply for the sake of pressing them into the service of the farmer, for whom, indeed, they may be a cheap, but not altogether desirable, compost.

There is another danger, of which the fisherman may not be conscious, and that is the destruction of the young of salmon, trout, and other very desirable fishes which have been placed in the Delaware and its tributaries, as well as in other great rivers near the coast. It was a known fact that the fry were deposited therein, but their non-appearance after reasonable time led to the belief that the enterprise was not a success. But recently the beautiful swimmers have been seen, having returned after a long absence, or else after having lingered in other streams or ocean haunts. More probably they went out to sea while developing into full growth, and they now return to spawn upon the grounds wherein they found their first home from the hatcheries. It is not for us to say whether they remembered their home or whether only the impulses of nature drove them up toward shallower waters. Suffice it that we are safe to claim that they belong to the society which so carefully propagated and deposited them or to the country for which it acts, and thus they become, as it were, wards of the government and subject to its protective legislation. This shows that national laws are absolutely requisite to their preservation from local fishing enterprises or from even individual fishermen.

Further, we are assured that the many valuable food-fishes are daring wanderers, roaming far out to sea, while they are not impelled toward the spawning-grounds. Thus the herring, mackerel, or cod of British Columbia may later become the supply for Maine and Massachusetts. Consequently both countries interested should make complementary rules regarding the protection of these fisheries, having unquestionable legal rights in the matter. That such is truly and reasonably requisite is evident in the lesser quantity and smaller size of the product of these fisheries. So, too, has the lobster deteriorated, until a large specimen is rather the exception than the rule, as it used to be. To-day salmon, cod, and other fish are wonderfully abundant, but unless Canada joins with the United States toward making strict laws regarding the time of fishing, the numbers taken, and economy of sparing the young and returning the living but undesirable fishes to the waters, there will come disastrous days for the salmon canneries of the Northwest, as well as for the fisheries of the Northeast. Just international protection is the only mode of preventing depletion.

Indiscriminate fishing should not be allowed at any time, and no corporation should use means by which great numbers of the denizens of the water may be captured for other purposes than to supply food to human beings. Fish laws, both national, State, and international, should insert warning clauses regarding wasteful destruction of the denizens of the sea, lake, or river. The public should be given to understand that the propagation of food-fishes is but in its infancy, and that it will take some years to attain great results, and strict care is necessary to insure success; but when the different species are established legal permission ought to be given for fishing in different streams and for different fish. We are confident that when pelagic sealing has become amenable to international laws the business will cease; and as surely when salmon, cod, herring, mackerel, shad, and all other far-wandering fish are protected by the same union of nations for their safety none but legalized fishing will be attempted, and thus the continuous success of all such fisheries will be secured and revenue for country and individual will grow proportionately.

Justice and right grant that man is the owner of all inferior animals and that for his food, clothing, and other necessities he has the unequivocal right to slaughter either animals or fish sufficient to supply his needs, but there is something repulsively cruel in the wholesale destruction of either one or the other for imaginary or artificial requirements. It is against this particularly we would lend both pen and voice, for truly nothing was created to be so ruthlessly demolished. That we have not discovered the use of every living thing does not prove that aught was given life in vain. Therefore let the Fish Commission raise its voice against the cruel destruction of any living thing over which its prerogatives may reach, thus securing safety not only for the wards of their hatcheries but for the food supply for them and other creatures.

That the waters of the partially settled Northwest teem with the most desirable food-fish does not insure their perpetuity against waste nor prove that they will not diminish in numbers when increasing population conjoins with the industries devoted to canning, salting, or drying, even if the business should be operated with economy. The swarming millions are the natural accumulation of centuries of almost uninterrupted reproduction, natives of the country catching only sufficient for their own needs and for the comparatively small trade with the outside world. As the settlement of the country increases there will be gradual diminution of numbers, however carefully the fishing interests are guarded. But if the plan of systematic economy begins at once, there will be no very disadvantageous falling off of the most valuable kinds.

We have used the Northwest as an example of the plenitude of nature's food supply only because the trend of business and commerce leads in that direction, but we could as readily use the Northeast with its former millions of valuable denizens of the bays and rivers and seacoast. Now the cod fisheries are disappointing, sometimes the mackerel and herring fail to appear in great numbers, and the fishing villages suffer in proportion. Once, too, the great Chesapeake became choked at seasons when many noble fish swarmed toward their breeding-grounds. It has been written that bushel baskets were filled and sold for no more than one fine shad would cost to-day. The stories of the abundance and cheapness of terrapin compare oddly with the enormous prices to which they have risen, making an expensive luxury of what was once a drug in the markets of Maryland. Bearing these authentic assertions in mind it is safe to say that the Fish Commission has not begun its work too soon unless the people were willing to have the best of all fish become extinct, for neither shad nor salmon, nor any other fish, could hold out against the enormous catches once permitted on the Delaware and Chesapeake, as they are now on the Columbia and Willamette.

The idea ought to be suggested that, though the interests of more than one or two nations might make international unity relating to the safety of the seal from destruction very necessary, it could not well include the true fish within that jurisdiction. A moment's consideration will show the mistake in this. The true fish are nearly as nomadic as the whale or seal and personal property is as readily assured in the one as in the other, in proof of which we may note the salmon before mentioned, the fry of which was placed in the Delaware and other rivers, whose total disappearance for about five years caused the belief that the planting had been a failure, when the discovery of well-grown healthy salmon in those rivers proves that they wandered out to sea, returning when nature directed them to the shallower and less tempestuous waters, presumably for the sake of reproducing their kind. The same can certainly be said of other fish, and doubtless the assertion is true that the mackerel, herring, cod, and halibut of the lower shores belong to the same shoals or schools as those that later swarm to the nets of the Canadian fishermen. Only international protection can secure immunity from future depletion if this be so; and this must not be a threatening attitude of one nation toward another, but a mutually amicable agreement, providing that a given number of vessels shall be permitted to fish during fixed legal seasons. At first this may look like a tyrannical blow to the men who depend upon these fisheries for a livelihood, but the result will soon show that such legislation would secure successful catches every season.

History will show that the times of disaster, when but few returns are obtained, have in nearly every case succeeded phenomenally enormous catches. Perhaps the bad season does not come directly after the good one; but examine the reports and they will show that large returns have induced a great number of vessels and men to engage in the business, prospect of gain being the incentive to the industry, until in a few years the overproduction results in a falling off, bringing trouble and distress to the towns and villages to which the enterprise naturally belongs. Since the fishermen of Galilee deplored their long nights of useless toil and waiting for nets to fill there have been men disheartened by failure and consequent distress. The days of miracles have passed away long since, but the increase of intelligence in late generations and the development of talent and genius were, no doubt, intended to supply their place. The law of humane justice must come to the relief and encouragement of our fellow-men, and in no way can this be secured with regard to the fisheries except through an agreement between countries whose contiguous possessions give them equal interests in the inhabitants of the sea or its tributaries. There must not only be laws limiting seasons, but vessels and men, so that no one nation possessing greater facilities for hunting shall take all the fish and leave little or none for their neighbors.

International consideration should have been directed to the seal fisheries as soon as the United States made the Territory of Alaska its own. Had that been done the animals would not now be so near extinction. It is sincerely to be hoped that the Fish Commission will not only take these universal protective measures into consideration, but that it will urge such legislation upon the intelligence of the proper authorities, else the efforts now made to propagate and greatly increase the number of desirable fish will be eventually futile, as the augmenting quantities will only tempt capital to hurry a war of extermination in the effort to secure all that skill can obtain in a given period. Neither threat nor watchfulness can secure protection half so easily as a friendly understanding upon the subject, which would unquestionably result in an international arrangement tending with equal favor toward the good of everyone engaged in any and every branch of the fisheries.

But the protection of fish and other useful water animals must extend farther than a legalized regulation of the fishing season or of the numbers taken; nor will returning unsalable fish to the water quite answer the purpose. Wise protective laws should also be made and enforced by neighboring nations against the pollution of bays, rivers, inlets, ponds, or streams by offal, garbage, chemicals, oil, or any kind of rubbish. Mills in which dye is used should not be allowed to discharge the refuse water into rivers or even small tributary streams containing food-fish, nor should any manufacturing enterprise use the waterways as waste-receivers. I note that the laws make mention of the northern logging season, when millions of logs float on fishing waters in Canada and in our own extreme Northeast and Northwest. This seems to be requisite, but it will not do to toss slabs of bark, decaying logs, or broken lumber, or sulphur-charged coal dust on neighboring shores to accumulate as rubbish until storms sweep them again into the streams with augmented power to annoy and sometimes destroy the fish, otter, beaver, or whatever may inhabit the waterways.

Nearly all safeguards for the inhabitants of the sea or river will be found to conduce to the general public good as well. Decomposing refuse, whether of animal or vegetable growth, is usually poisonous, working with subtle force upon humanity and breeding pestilential fevers. Dyes are often composed of poisonous material, and they may injure the water used for drinking without marring its transparency. Thus the thoughtful observer readily sees that the requirements of the Fish Commission and the boards of health conjoin, although one protects human health and the other the production of edible or otherwise useful animal life. As for interfering with manufacturers by legislating against dams, they could in every case be so constructed as to allow of a broad waterway for the fish when they enter the inland streams; but this needs vigilant watching. There can be no doubt that the plentiful supply of salmon and other wandering species is largely due to perfect freedom of action in their native haunts. They have spawned when they would, they have roamed at their will, and with little destruction except that resorted to by man. No nets, no weirs, no dams, no vast heaps of polluted débris have prevailed against their freedom in the northwest streams. Time was when Canadian and northeastern waters were equally prolific. The contrast shows plainly how carefully British Columbia, the United States, and South America should join in the preservation of a most valuable product of every nation with rivers and a seacoast.

To-day I would suggest legislation that would preclude the possibility of the beautiful and prolific waterways of our territory, no matter where, from being clogged with rubbish, poisoned with refuse, or blocked by dams and traps. A short time spent in selecting sites for manufacturing towns would secure the proper requirements without wholesale destruction to inferior life. If the effect of perfect protection can not be obtained, the next best thing would be to forbid the use of water polluted by factories as well as the fish therein. But the disastrous drawback to that would be a neighborhood poisoned with effete matter accumulating for years. There will always be fishermen, and there will also be people to consume the fish found by the sportsman; therefore the best way is to keep the waters pure and continue the hatcheries. Legislation will be of no avail, so far as a great part of the United States is concerned, if not agreed to by all States and contiguous countries. In fact the fishing, fur, ivory, whalebone, and oil interests of the whole continent demand international cooperation for the successful protection of the denizens of the sea and other waters extending into it from the shores. With this continental agreement and an American alliance with Russia, Great Britain, Japan, and China for the protection of the great animals of the Pacific, on the west and north, with a like agreement with the owners of Greenland and its island borders and Newfoundland and its neighborhood on the northeast, it would yet be possible to have abundance of all valuable products from the oceans and their tributaries which sparkle in a beautiful, silver network throughout the length and breadth of the lands adjacent.

Many wise individuals to-day deplore the dilatory attention to national interest that has resulted in comparative extinction of many really valuable creatures, whose abundance seemed but a few years ago to be inexhaustible. Should not everyone energetically lend his voice and influence to prevent further loss to both individual and Government? A war of extermination of the human inhabitants of remote corners of the country would justly be considered a heathenish, cruel outrage; but is not the destruction of lower animal life in vast multitudes equally cruel? If mankind has its sources of life necessities cut off, they pine and die. Thus we, as a congress, should urge full legal protection, through both home and international laws, for the food-fish upon which a vast number of human beings depend for all that makes life comfortable; while in some places, neglect to pass such laws actually results in suffering and death. We do not deem it right to propose the protection only, but should follow the proposition up by active, earnest work for the desired and needed results.

PHILADELPHIA, PENNSYLVANIA.

THE RESTRICTED INLAND RANGE OF SHAD DUE TO ARTIFICIAL OBSTRUCTIONS AND ITS EFFECT ON NATURAL REPRODUCTION.

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There is no species of fish more important to residents of the Atlantic seaboard than the shad, and none whose preservation so immediately concerns a larger number of persons—24,768 men being actively engaged in this fishery in 1896. True, the yield of codfish is heavier and sells for a greater value, but the fishery for that species is confined to one section of the coast, gives employment to less than half as many men, and its prosecution requires costly vessels and appliances, necessitating lengthy trips from port, with much exposure and loss; whereas, shad occur more or less abundantly along the entire coast, ascending the rivers as far as they permit, almost to the very doors of fishermen and consumers, several hundred miles from the sea, and are caught by all forms of apparatus, from the costly pound nets and seines near the coast to the roughly constructed bownets and falltraps in the headwaters. Yet, there are few species whose geographical range and local abundance are more easily affected by artificial agencies or which require greater attention for their maintenance, and as most of the important shad streams border or traverse two or more States and are thus subject to more than one jurisdiction, the agencies affecting their range and abundance present an appropriate subject for consideration in a gathering of representatives from the different States.

No river on the Atlantic seaboard appears too long for shad to ascend to its headwaters, provided they meet with nothing to bar their progress. They ascend the St. Johns in Florida a distance approximating 375 miles; the Altamaha, 300 miles; the Edisto, 281 miles; the Santee, 272 miles; the Neuse, 300 miles, and the Delaware River a distance of 240 miles from the sea. However, these distances do not equal the extreme ranges in the early part of the present century. Then shad ascended the Savannah to Tallulah Falls, a distance of 384 miles, instead of 209 miles as at present. They ran up the Pee Dee to Wilkesboro, a distance of 451 miles, whereas the present limit on that river is Grassy Island, 242 miles from the sea, and only one shad was reported from that point in 1896. On the James River the former run was 350 miles in length, while the present limit is Boshers Dam, 120 miles. The greatest decrease exists in Susquehanna River, in which shad formerly ascended to Binghamton, 318 miles from the mouth and 513 miles by water-course from the sea, whereas at present they do not appear to pass beyond Clarks Ferry, 84 miles from the mouth of the river.

From Table A, on page 270, it appears that in 23 of the principal Atlantic coast rivers, aggregating 8,113 miles in length, shad formerly existed throughout 6,052 miles, or 74 per cent of the length; whereas at present they are to be found in only 4,107 miles, a decrease of nearly 2,000 miles. This summary comprises only the principal rivers, and if minor streams and tributaries were included, the total length from which shad have been excluded would doubtless appear more than twice as great. In much of that length shad were quite numerous, the catch in many instances exceeding the yield in the portion to which the fisheries are now confined. The upper section of the Pee Dee is supposed to have yielded over 100,000 annually. In the James River, according to the late Colonel McDonald, the annual catch of shad in the 230 miles from which they are now excluded "was at one time far in excess of the now (1880) entire catch for the whole river." The present excluded length of the Susquehanna formerly yielded several hundred thousand annually. In a report of the special commissioners of Massachusetts appointed in 1865 to investigate the fisheries of that State, it was estimated that at the beginning of the present century the annual shad yield in the Merrimac River ranged from 500,000 to 1,000,000 in number, whereas none ascend that river at present.

The limitation in the range of shad in the rivers is the result of several agencies in addition to the size of the stream, the most important of which are (1) natural falls, (2) artificial dams, (3) pollution of water, (4) agricultural operations, and (5) extensive fisheries.

Natural falls exist at the escarpment line in all of the rivers having their sources above the coastal plane, but in only a few instances are they of sufficient height to form insurmountable obstacles to the range of the shad, among these being Great Falls on the Potomac and Bellows Falls on the Connecticut, which form absolute barriers to the further progress of shad that may reach these points, excluding them from the whole of the river above. Most of the other Atlantic coast streams having their sources above the coastal plane have been made impassable at a short distance above the escarpment line by means of artificial dams for developing water-power or for navigation improvements. In this class are the Savannah, the Santee, the Cape Fear, the James, the Susquehanna, the Housatonic, the Connecticut, the Merrimac, the Kennebec, and the Penobscot. The lengths from which shad are excluded appear in Table A on page 270.

Access to suitable spawning areas being a physiological necessity for the maintenance of the fisheries if natural reproduction is depended on, and as many of the spawning-grounds are located in the headwaters of the rivers, it follows that while the exclusion of shad from the upper sections is the immediate it is not the most important effect of those obstructions. It has been the common experience in all the shad rivers that whenever a high dam or other obstruction has been erected across the stream the fisheries above that point have at once ceased, and those immediately below have for a year or two flourished on the large number whose ascent has been stopped by the barrier and then they, too, have declined. It also appears that the extent of this decrease below the dam is largely dependent on the distance of the obstruction from the mouth of the river and the proportion of the spawning-grounds to which they are denied access, and if all the breeding-grounds have been cut off in a definite coastal region the shad have almost entirely disappeared.

This is clearly illustrated by the conditions on the Connecticut River. The erection of the Holyoke dam in 1849 prevented the fish from ascending above that point and as they strayed about in the river below the obstruction they were taken in greater abundance than formerly. At the Parsonage fishery near the mouth of the river and 40 miles below the dam, the average shad yield during the 20 years preceding the erection of the obstruction was 9,854 annually; during the 5 years following 1849 the annual catch averaged 19,490; during the next 10 years it was but 8,364, and for the following 6 years, 1864–1870, the annual average was but 4,482 shad, less than one-half the former yield. The record of the total catch on the Connecticut from 1853 to 1896 shows that the yield below the dam decreased from nearly half a million annually to an average of less than one-tenth of that number. In a few rivers the development of water-power has resulted in completely exterminating the anadromous fishes, this being the case in the Thames, the Blackstone, the Merrimac, the Saco, and other rivers. However, instead of the employment of a few hundred persons in taking fish each spring, the water-power on those streams affords employment to thousands of mill operatives.

Numerous attempts have been made by the erection of fishways to enable shad to pass above these obstructions, among the costly contrivances being those in the Savannah at Augusta, the Santee at Columbia, the Potomac at Great Falls, the Susquehanna at Clarks Ferry, the Housatonic at Birmingham, the Connecticut at Holyoke, the Merrimac at Lawrence, and the Kennebec at Augusta. The fishway in the dam across the Santee at Columbia, built in 1883, consists of 3½ sections, 36 feet long, with a total rise of 9 feet, and is of the type known as the McDonald fishway, consisting of two sets of buckets, straight wooden buckets to receive the water in its downward flow and curved iron buckets to direct this water back upstream, thus affording a comparatively quiet waterway. It is fairly efficient for certain species when kept free from trash, but shad do not appear to use it.

In 1882 an appropriation of $50,000 was made by Congress for the erection of suitable fishways at Great Falls in the Potomac where the river descends almost abruptly 35 or 40 feet. In 1885 the work of construction was begun, but it was soon abandoned, it being decided that "the fishways were not found sufficiently strong to withstand the effects of the violent floods of the locality in which they were placed."

The fishway over the Holyoke dam on the Connecticut River, one of the largest and most expensive in the country, was built in 1873 after the Brackett plan, a modification of the Foster fishway. It is 440 feet in length, so divided into compartments or bays, by means of T-shaped partitions extending at right angles to the sides, that the water winds through a long, circuitous course, running about 1,500 feet before it emerges at the lower end. As the height of the dam is 30 feet, the fall of the water averages about 1 foot in 50, with little momentum. But it does not appear that shad have ever passed through this fishway in any numbers.

An account of the construction of fishways in the Columbia dam on the Susquehanna River illustrates the difficulties of making these obstructions passable. This dam is only 7 or 8 feet high, and its disastrous effect on the shad fisheries of the Susquehanna has attracted very general attention to it. The original charter required that a rafting channel should be left in the obstruction. In 1865, in accordance with an act of the Pennsylvania legislature, the company removed a 40-foot section of the dam, and in that space built a new subdam, the top of which was about level with the water below. The lower slope of the subdam was placed at an inclination of 1 in 15, and the sides of the aperture in the main dam were dentated, so as to promote the formation of eddies in the current. This construction did not appear to answer its purposes, and in 1873 the State made an appropriation for another fishway at that point after plans modified from numerous designs submitted in competition. That also proved ineffectual, and in 1880 a fourth passageway was placed in the dam, this one consisting simply of an opening 125 feet wide, this plan being chosen because it conformed to a natural break, experience having shown that shad passed through such an opening more readily than through any regular fishway that had been constructed. But it is only in very low and little-used dams that such breaks can be made without injury to the original purpose.

Although the above-described fishways are modern constructions, designed by engineers of ability, familiar with the principles of hydraulics and the habits of fish, yet none of them appears to be successful for shad, this fish being so timid that it will not enter fishways readily used by salmon, alewives, and other species. True, a few individuals may pass through some of the fishways, but the number is not sufficiently large to be of any practical value, and in a majority of instances where shad are reported above a dam they have swum over the crest during freshets or have passed through breaks in the obstruction.

The utility of the spawning areas below the dams has also been impaired by chemical, sawdust, and other refuse from mills and towns on the river banks. In a number of small streams these have almost completely destroyed the spawning and feeding areas, but regulations against this practice now exist in most States.

Increased agricultural operations have also had some effect on limiting the range of shad up the rivers. At the time of the settlement of the river valleys most of those areas were covered with forests and the ground was carpeted with leaves and moss, which checked the surface flow of water and restricted its evaporation, thus tending to constancy in the flow of rivers; and freshets were rare and of insignificant proportions. With increase of population the forests were cleared away and large areas of land brought under cultivation, causing injurious meteorological changes and more numerous and destructive floods. During heavy rains the plowed soil upon the hillsides is easily washed into gullies, through which the water is quickly conveyed to the rivers, filling them beyond their capacity and bringing into them masses of earth and other débris, thus covering the spawning-grounds. The freshets are soon over, and the flow of water in the streams becomes so small that shad are not induced to proceed so far up as formerly.

On some of the southern streams decreased navigation has resulted in reducing the length of shad range. This is especially true of the Combahee, the Ashepoo, the Edisto, the Chickahominy, the Mattaponi, and the Pamunkey, the channels of which are now much encumbered with drifting logs, overhanging trees, brushwood, and shoals of loose, shifting sand, through which a passageway for the ascent of fish was formerly maintained by navigation and the rafting of timber.

The most important factor in reducing the inland range is the extensive fisheries near the coast. In the first half of the present century shad were caught all along the river course, every point yielding its quota for local use and the limited demand not warranting the prosecution of the fisheries so vigorously as to cut off the "run" at points above. But the profits derived from shipping shad to populous centers resulted in a concentration of the fisheries at points near the mouths of the rivers where most convenient shipping facilities exist, resulting in certain narrow streams in practically excluding shad from the middle and upper sections where the spawning-grounds are located. The effect is not so apparent as in the case of impassable dams and natural falls, for the latter form absolute barriers, whereas extensive fisheries merely limit the number of fish ascending to the extreme range of the river and not the length of that range; yet in many cases they affect the future abundance of the species even more than the dams and natural falls. This is particularly noticeable in those narrow streams whose fluvial characteristics extend nearly or quite to the sea, as in most of the rivers between the St. Johns and the Neuse, and to some extent in the Susquehanna, the Hudson, the Connecticut, etc. In the Ogeechee, Savannah, Edisto, Pee Dee, and Cape Fear, the great bulk of the catch is obtained in the extreme lower end within 30 or 40 miles of the sea, and comparatively few shad ascend as far as the spawning-grounds. In the Connecticut nearly all the shad are caught within 20 miles of the mouth. The dams in those rivers perform a very unimportant part in limiting the run of fish, for few shad ever reach those obstructions.

In the broad estuaries tributary to the sounds of North Carolina and to the Chesapeake and Delaware bays the effect of netting is not so apparent, yet even in those waters only a small percentage of the shad ever reach the spawning-grounds. Formerly the great bulk of the yield was obtained from the middle and upper sections of the rivers, while at present nearly all the catch is obtained in the lower section and in the salt water of the estuaries. The extension of the fisheries into the estuaries is of recent origin, dating only from the middle of the present century, and their development has been principally during the past twenty years. It requires large and costly apparatus to prosecute the fisheries there, and forms suitable have come into use only quite recently. With the exception of drift nets in Delaware Bay, New York Bay, and one or two less important places, and the mackerel purse-seines, which take a few shad on the New England coast, pound nets and stake nets are the only forms of apparatus employed in catching shad in salt water. Over 90 per cent of the shad caught in the salt water of the Chesapeake region are taken in pound nets, yet the use of that apparatus there dates only from 1865, and not until 1875 were they extensively employed. Stake nets and pound nets, which catch practically all the shad taken in the salt water of North Carolina, have been used in that region only since 1865.

At present nearly one-half of the total shad yield on the Atlantic seaboard is obtained in salt water, and those fisheries are becoming more extensive each year. Table B, on page 271, shows that in 1896, 6,252,464 shad, over 47 per cent of the total yield, were caught in regions which half a century ago yielded none whatever; this in some measure compensating for the 4,000 miles of river-course from which they are now wholly excluded and the lengths from which the exclusion is partial. It thus appears that the principal change in the fisheries during the past fifty years has been one of location rather than extent of the total yield, the great increase in the estuaries compensating for the decrease in the headwaters. This change in the fishing-grounds results in a large portion of the fish being taken before they reach the spawning areas in fresh water, thereby preventing them from adding their quota to future supply almost as effectually as though they were excluded therefrom by means of dams or otherwise. But the same result is accomplished when the fish are caught after they have reached those areas and before they have spawned. Furthermore, moving the seines and other apparatus of capture over the spawning-grounds disturbs and drives away the fish from those areas, and also destroys many of the eggs and young shad already there.

Access to suitable spawning-grounds in sufficient numbers to compensate for loss by capture and natural causes is a physiological necessity for the maintenance of the fisheries if dependence is placed on natural reproduction. But from the foregoing it appears that the construction of dams has excluded shad from a large portion of the spawning-grounds, notwithstanding the erection of fishways in those obstructions; sawdust, chemicals and other refuse and agricultural operations have greatly impaired the utility of the spawning areas even now available, and the extensive fisheries have very largely decreased the number of the shad reaching those areas. These adverse agencies have reduced natural reproduction to almost an insignificant factor in the maintenance of the present fisheries and have rendered artificial propagation essential to their prosperity. During the seventies the returns of the fisheries reached a minimum; then the results of artificial propagation began to appear, not only restoring the former abundance of shad, but even increasing the catch.

The total shad yield on the Atlantic coast and rivers in 1880 numbered 5,162,315; in 1888 it was increased to 10,181,605; in 1896 it was further increased to 13,067,469, 29 per cent greater than in 1888 and nearly three times as great as in 1880. While this increased yield was preceded by an increase in the quantity of apparatus used, yet it was made possible by the greater abundance of shad, due to artificial propagation. Comparing 1880 with 1896, it is observed that the increase in the yield numbered 7,905,154. At 20 cents each, which is the average price paid by consumers, this represents an increase of $1,581,030 in the value, over 50 times the expenditures for shad propagation; a result probably unsurpassed in any other line of public appropriation. The large number of persons employed in this fishery and the present inability of natural reproduction to maintain the supply make it essential that no decrease be made in this important branch of fish-culture.

A.—*Summary of the original and of the present limit of shad range in twenty-three of the principal rivers of the Atlantic seaboard.*

Rivers.	Distance of sources above coast line.	Original limit of shad run.		Present limit of shad run.	
		Locality.	Distance from coast line.	Locality.	Distance from coast line.
	Miles.		*Miles.*		*Miles.*
St. Johns	375	Sources	375	Sources	375
Altamaha	450	Macon	370	Hawkinsville	300
Ogeechee	350	Ogeechee Shoals	200	Millen	100
Savannah	425	Tallulah Falls	384	Augusta Dam	209
Edisto	300	Sources	300	Jones Bridge	281
Santee {Wateree	350	Great Falls	272	Great Falls	272
Santee {Congaree	410	Green River	374	Columbia	233
Pee Dee	497	Wilkesboro	451	Grassy Island	242
Cape Fear	290	Haywood	210	Stanley Falls	181
Neuse	340	Sources	340	Fish dam	300
Pamlico-Tar	252	Rocky Mount	157	Rocky Mount	157
Roanoke	457	Weldon	249	Weldon	249
James	420	....	370	Boshers Dam	140
Rappahannock	248	Falmouth Falls	155	Falmouth Falls	155
Potomac	400	Great Falls	190	Great Falls	190
Susquehanna	617	Binghamton	513	Clarks Ferry	279
Delaware	457	Deposit	256	Burrows Dam	....
Hudson	314	Glens Falls	209	Troy	164
Housatonic	202	Falls Village	150	Birmingham	92
Connecticut	409	Bellows Falls	204	Windsor Locks	89
Merrimac	140	Winnepesaukee	125	Lawrence	20
Kennebec	155	Caralunk Falls	108	Augusta	44
Penobscot	255	....	90	Verona	35

B.—*Comparative statement of the total yield and of the salt-water yield of shad on the Atlantic seaboard during 1896.*

Water areas.	Total yield.		Yield in salt water.	
	Number.	Value.	Number.	Per cent.
St. Johns River	456,281	$61,924	291,116	63.59
St. Marys River	10,193	1,754	....	0.00
Satilla River	1,500	240	....	0.00
Altamaba River	29,377	10,096	....	0.00
Ogeechee River	55,425	19,514	12,054	21.75
Savannah River	54,406	19,236	7,480	13.54
Combahee River	3,090	622	....	0.00
Ashepoo River	6,880	1,381	....	0.00
Edisto River	28,273	5,843	....	0.00
Cooper River	396	126	....	0.00
Santee River	7,309	1,547	....	0.00
Winyah Bay and tributaries	97,685	23,031	53,379	54.95
Cape Fear River	75,315	18,964	29,151	38.71
Pamlico Sound	448,089	109,727	448,089	100.00
Neuse River	207,052	39,067	82,238	39.72
Pamlico-Tar River	67,082	13,316	18,873	28.13
Croatan and Roanoke Sounds	169,541	33,201	169,541	100.00
Albemarle Sound	735,192	140,159	186,290	25.34
Roanoke River	169,409	20,489	....	0.00
Chowan River	183,545	34,422	....	0.00
Pasquotank and Perquimans rivers	41,579	7,898	....	0.00
Chesapeake Bay	1,638,844	167,929	1,428,327	87.15
James River and tributaries	495,762	51,247	100,379	20.25
York River and tributaries	546,548	50,361	182,375	33.69
Mobjack Bay	140,777	13,874	140,777	100.00
Rappahannock River	417,789	35,371	194,067	46.45
Potomac River	684,013	63,608	210,480	30.76
Nanticoke River and tributaries	216,288	20,667	42,405	19.60
Choptank River and tributaries	338,420	35,810	136,972	40.44
Susquehanna River	140,087	20,153	....	0.00
Miscellaneous	249,021	31,736	29,851	13.59
Delaware Bay	1,103,821	104,761	1,103,821	100.00
Delaware River	2,778,803	300,598	976,669	35.13
Miscellaneous rivers	134,838	21,147	....	0.00
Ocean Shore of New Jersey	16,240	3,518	13,765	84.75
New York Bay	216,425	30,941	213,925	98.89
Hudson River	602,858	83,237	....	0.00
Great South Bay and Gardner Bay	4,755	1,092	4,755	100.00
Long Island Sound	9,427	2,399	9,427	100.00
Connecticut River	51,690	9,508	....	0.00
Miscellaneous Rivers	13,202	3,324	....	0.00
Ocean Shore of Rhode Island	1,151	287	1,151	100.00
Narragansett Bay and tributaries	15,836	4,071	2,163	12.17
Buzzards Bay and Vineyard Sound	3,385	834	3,385	100.00
Cape Cod and Massachusetts bays	33,082	1,468	33,082	100.00
Casco Bay	64,490	3,580	64,490	100.00
Kennebec River and tributaries	290,122	26,357	55,987	19.30
Penobscot and other Maine rivers	12,126	941	6,000	49.48
Total	13,067,469	1,651,376	6,252,464	47.85

WASHINGTON, D. C.

THE GREEN TURTLE, AND THE POSSIBILITIES OF ITS PROTECTION AND CONSEQUENT INCREASE ON THE FLORIDA COAST.

By RALPH M. MUNROE.

Early travelers on the tropical coasts of America made much mention of the abundance of turtles which were to be seen in the waters at all times and on the beaches in the spring season engaged in laying their eggs. How many of these belonged to the species *Chelonia mydas* is mere conjecture, for, aside from the tables of the rich and the cabins of the mariner, to the latter of which it often came as a Godsend in times of hunger and scurvy, it was comparatively unknown, and as other species were edible and somewhat similar in appearance, the old chroniclers put them all under the one head of turtle. As a matter of fact, the loggerhead (*Thalassochelys caretta*), common now on our coast, when not oversized and when properly butchered and cooked, is not to be despised by a man even not hungry, and so also the hawksbill (*Eretmochelys imbricata*), from which comes the tortoise shell of commerce.

With the advent of steam vessels, penetrating as they do the labyrinths of the West Indian islands and adjacent coasts, enabling the perishable tropical products to be transported in safety, the green turtle has become a more common food and less of a luxury in our seaboard cities, and, as most people take kindly to it, the demand has increased with the usual result in connection with natural products, a growing scarcity and higher prices. Being, as it is, a nutritious delicacy, it is quite time that its habits, reproduction, and methods of capture should be looked into before its enforced classification with the extinct reptiles, even if this should be an event far distant; and it might be well worth our time and attention to reduce, by cultivation and protection, the present rather prohibitive price of a valuable food.

As is the case with very much of marine life, but little is known as to the habits of the green turtle. Its food is a marine grass growing on the bottoms of lagoons and bays more or less shallow. It mates on the Florida coast in the month of May, or thereabouts, the females with eggs, except in rare cases, at once disappearing from these waters, and, until recently, going no one knew where, but it may now be asserted that their hatching-grounds are the beaches of various isolated islands off Central America or the Bahama banks. How this migration is accomplished across the Gulf Stream for hundreds of miles is past comprehension. As high as four hatches of eggs, containing from 130 to 180 each, are believed to be laid by one female during the months of June, July, and August, and the process is not repeated until an interval of one or two years has elapsed. Incubation takes from ten to twelve weeks. We have little information as to where the young that escape the gulls and other birds on the beach, the fish and sharks, pass their time on entering the water again like their elders, until we occasionally see them in what is called the chicken stage of growth, so called from the resemblance of their flesh to that of the feathered barnyard favorite.

The foregoing few items are about all that is known as to habits, but sufficient seems to be established to form a reasonable hypothesis that much might be done toward protecting the young and possibly caring for them until of marketable size.

At present the probabilities are that but an exceedingly small number survive the first week of existence, as low, perhaps, as 2 to 3 per cent. To prevent this loss may or may not be an extremely simple problem, depending on whether turtles will mate and deposit eggs in suitably inclosed feeding-grounds, or if the female alone, in a condition to lay (these average about 20 per cent of the catch in May and June on one reef at present), will carry out her maternal functions in captivity. If these two points are negative, then is it feasible to import the eggs from the foreign depositories, considering the expense and possible complications as to ownership? And, lastly, would our supposed food areas prove sufficient and suitable? The latter point, I think, can be favorably answered, as our lagoons have long been known as feeding-places for the smaller turtles, and it is fair to suppose that the younger ones could find, in the same localities, a diet congenial to them; therefore, if no serious obstacles were found in their production, the subsequent existence up to the age of taking care of themselves seems assured, and at a trifling cost, after once hatched.

The statistics in regard to this branch of our fisheries are meager and of little value. The few at hand seem to show that the average catch of mature turtles along the reef by nets in the past twenty years seems to be but slightly diminished. When the fleet is augmented by boats and men, the catch per boat decreases and vice versa, but it is very evident, from personal observation covering the same period, that our feeding-grounds or inshore resorts for the smaller and more valuable sizes have become almost depleted. This results apparently not from excessive fishing, but probably from the gradual capture on the outer grounds of females which occasionally depart from the instinct of going to remote places for incubation and lay their eggs on home shores; for it is hardly possible that the young from the distant hatcheries across the Gulf Stream should find their way back until fully matured and able to cope with their natural enemies in transit.

For verification of some mooted points, and for additional information on others, I am indebted to Mr. B. Vincent Archer, a lifelong fisher and close observer of the green turtle in these waters.

COCOANUT GROVE, FLORIDA.

SOME FACTORS IN THE OYSTER PROBLEM.

By H. F. MOORE,
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The annual product of the oyster-beds of the United States is estimated to be worth $17,000,000, approximately one-third of the entire yearly value of our fisheries. Geographically this income is very unequally distributed, the eight maritime States between Cape Cod and Cape Henry receiving 90 per cent and the same number of States south of Cape Henry, notwithstanding their greater coast line, but 7 per cent.

While there are good economic reasons why the oyster yield from Virginia northward should be greater than from North Carolina southward, it may well be doubted if there be sufficient reason for the great discrepancy that now exists in the production of the two regions. The northern beds are, generally speaking, in the midst of our densest population and in the vicinity of our greatest cities. About 60 per cent of our population dwells in the compact area lying north of North Carolina and Tennessee and east of the Mississippi River. Such populous cities as Boston, New York, Philadelphia, Baltimore, and Washington are within a few hours travel of the beds, and the cities on the Great Lakes and in the interior of the middle West are scarcely a day's journey removed. Oysters are more commonly consumed in such places rather than in more sparsely settled regions. In rural districts the oyster is looked upon as a luxury rarely to be enjoyed, but in the cities and towns of the East they are a familiar article of diet even among the poor.

So far, then, as the near-by demand is concerned, the Northern oystermen are incomparably more favored than their Southern brethren, but certain advantages which the South possesses should to some extent offset this and enable the Southern growers to obtain more equitable distribution of the business and its accruing profits. It has been to some extent demonstrated that the distance of the Southern beds from the Northern market is not an insuperable bar to profitable competition, but, granting that the oysters from the Gulf coast can not compete in the markets of the Atlantic seaboard north of the Chesapeake, there still remains a large field which may be entered upon with advantage.

Dealing with air-line distances, Baltimore is nearly 400 miles nearer Chicago than is Mobile, the nearest important city on the Gulf coast; but westward of the Mississippi the Gulf States can compete on equal or superior terms, so far as distance is concerned, with any of the great oyster markets of the East. Geographically, therefore, they are more favorably situated with regard to 80 per cent of our territory and 40 per cent of our population than are the States of the North Atlantic coast. As many of you are aware, oysters have for some years been shipped from Gulf ports to Chicago and other trans-Appalachian cities, and dealers in several places are carrying on trade with the entire region west of the Mississippi, even as far as the shores of the Pacific, and there appears to be no sufficient economic reason why this trade should not be vastly increased.

After speaking of the arrest in the development of the canning industry at Apalachicola, Lieutenant Swift, in his excellent report upon that region, comments as follows:

That the canning business can not be carried on to any great extent for any length of time is due to the fact that the supply of oysters is insufficient to supply the demand, notwithstanding that the packers have used every means they could to preserve the oyster-beds by refusing to take oysters under proper size, or out of season, or not properly culled, as well as alternating the use of different beds each season.

This is perhaps an extreme case, yet sooner or later, corresponding with the wisdom with which the oyster question is administered, there must result a similar depreciation of the natural beds along the entire coast. I can see no hope of the continued productiveness of our natural beds if they are made to bear the brunt of the yearly increasing demand.

How to forestall the destruction of the natural oyster-reefs and how in a measure to prevent it by lessening the demands made upon them are the questions with which this paper sets out to deal. Those who have studied the problem are a unit in the belief that the solution lies in the general adoption of oyster-culture under private ownership and as a result of private enterprise. Government can do but little. Wise laws rigidly and judiciously enforced can stimulate private ventures and retard reckless waste of the public possessions, but our oyster-beds can never be repopulated by the methods which have in many cases proven so beneficial in restocking our streams with food and game fish. It is not my purpose to deal here with the methods and details of oyster-culture, as these subjects have been recently treated of in the publications of the U. S. Fish Commission,[1] but rather in a general way to point out the conditions which make for success and to consider in an equally general manner the extent to which those conditions are fulfilled on the Gulf coast from Florida to Texas.

The Gulf States present many physical and biological characters which render them especially favorable to oyster-culture, and they also present some serious drawbacks. In determining the qualifications of any given region six important factors have to be considered—(1) density of the water, (2) temperature of the water, (3) character and consistency of the bottom, (4) the quantity of oyster food, (5) the presence or absence of enemies, and (6) the character of the legislation and the success with which it is enforced. Each of these factors with its cognates will be considered in turn.

DENSITY OF WATER.

If a chart of the oyster-grounds of the Atlantic and Gulf seaboards were prepared it would show that the oyster is confined almost exclusively to bays, sounds, and estuaries, and that it is never found in places remote from inflowing streams. On the other hand, it is sooner or later killed when exposed to the fresh water or that which is nearly fresh, and it is therefore only where the fresh and salt waters blend that it is able to establish itself and thrive. It is customary to measure the salinity of sea water by weight, an equivalent bulk of distilled water being accepted as the unit of comparison. So expressed, the best conditions of salinity for our eastern oysters are met when the density measures between 1.009 and 1.020. Oysters will live indefinitely in a density 4 degrees below or 2 degrees above the limit stated, but they then rarely or never attain their best conditions of shape, flavor, and general excellence. Prolonged

[1] See Report U. S. Fish Commission 1897, pp. 263-340.

exposure to a density of less than 1.005 or more than 1.022, if not fatal to the individuals, is at least fatal to the species, as young are not produced to take the place of the old ones which are dying off.

In many places where the salinity is favorable during a large part of the year it happens that at certain seasons a heavy influx of fresh water produces a temporary reduction below the desired minimum. This appears to be particularly liable to occur on the Gulf coast, where many great streams and innumerable small ones become swollen by the rains and discharge large quantities of fresh water close to the oyster-beds. Two facts, however, tend to mitigate the evil which might result. In the first place the oyster is able to tightly close its shell when subjected to objectionable conditions, and thereby the fresh water may be for a time excluded, and Professor Washburn has recently shown that they will live for upward of ten days in the water of running brooks. Then, too, the fresh water, being lighter than the salt or brackish, tends to spread over the surface of the bays into which it is discharged, and it is usually found that the bottom density is greater than the surface density, even after long-continued freshets. The changes are therefore more gradual and less radical than if the salt water were driven out before the fresh, and the oyster finds conditions more favorable at bottom than it would be subjected to if it were a surface-dwelling organism. In selecting planting-grounds the question of liability to the influence of freshets should always be given consideration, as disaster may result from its neglect.

TEMPERATURE OF THE WATER.

Adult oysters are not ordinarily adversely affected by temperatures ranging between the freezing point and 90° F. Those upon flats exposed at low water are often frozen during the winter and subjected to the high temperatures of the direct rays of the summer sun, and yet many of them live to a ripe old age measured by the span of an oyster's life. During the spawning season, however, a temperature too low or too high, or changes too sudden and too violent, will either kill the spat or prevent spawning altogether. In the Long Island and Chesapeake regions cold rains and periods of low thermometer are not infrequent in summer, and multitudes of oysters in their swimming stage end their career in sudden adversity. On the Gulf coast such fatalities are of less frequent occurrence, and the probabilities of obtaining a set, other things being equal, is correspondingly enhanced.

CHARACTER OF THE BOTTOM.

To be suitable for oyster-culture the bottom should be of such consistency as will prevent the oysters becoming engulfed in the mud or covered by shifting sands or ooze. The several surveys that have been made of the Gulf coast by the Fish Commission indicate that suitable bottom, unoccupied by a natural growth of oysters, may be found with but little effort. These sections of our coast, however, appear to be rather more liable than the northern oyster-grounds to shiftings of the bottom by stormy seas, and the prospective oyster-grower should not be misled by deceptive appearances, as a loose sand in shallow water exposed to heavy or even moderate wave action may in a short time change its location in a manner disastrous to the planter. With large areas of suitable bottom open to occupation, it is not necessary to point out to the Gulf coast oyster-grower the means by which his Connecticut brother has made available to his purposes many thousand acres of bottom by nature wholly unadapted to the oyster.

ABUNDANCE OF FOOD.

That the nature of the food supply is a consideration of the utmost importance requires no demonstration. The conditions which make an abundant food supply are complex, depending upon density, temperature, and especially the supply of inorganic materials in solution in the water. The bulk of the oyster food consists of diatoms, which, although endowed with powers of locomotion, are nevertheless plants, and acquire their nourishment from the same class of substances as do the common plants about us. It is true that they have no roots penetrating the soil in search of saline solutions, and they spread no broad foliage in quest of atmospheric oxygen and carbon dioxide, but the whole plant is bathed in the nutritive sea water, from which they receive their supply of liquid and gaseous food. If the water be impoverished of salts the same adverse conditions obtain as in barren and exhausted fields and the growth of plant life is in the same manner diminished. Now, how is the Gulf coast situated as regards this inorganic material, indirectly, but no less imperatively, necessary to the growth of the oyster? Along the entire shore line there are numerous streams of all sizes which bring down mineral matter derived from the soil and nitrogenous substances from the decomposition of the rank vegetation of marshes, swamps, and fertile fields. Some of these materials are in solution, and at once available for conversion into oyster food through the medium of the microscopic plants already mentioned, but a large quantity is held merely in suspension, to be deposited on contact with salt water and slowly passed into solution through the lapse of time. With the abundance of food thus furnished, and nurtured by the warmth of semitropical waters, it is not surprising that microscopic plant life should flourish.

The rate of growth of the oyster depends upon the rate with which it is supplied with food. When well fed its growth is rapid; when poorly fed its increase is slow. In one locality an oyster may reach a growth of 6 inches in two years, and in another place the same size is not attained under four or five years. On some of the more profitable beds in Long Island Sound the latter is the case, while last summer, in Plaquemines Parish, Louisiana, I saw oysters 6 inches long which, from known data, could not have been over 23 months old and may have been slightly less, and there are doubtless many places on the Gulf coast where the growth is equally rapid. This rapidity of maturation is an important matter to the oyster culturist. He is able to receive quicker and greater returns for a given area and a given investment of capital, and his beds are less liable to disaster and recuperate more rapidly than if the growth be slow. Large oysters are less readily covered by deposits of mud and sand than smaller ones, and are more rarely destroyed by enemies, the latter usually proving more destructive before the shells have become thick and the adductor muscle strong. The drill is comparatively harmless to an oyster after it reaches a length of 3 inches, and the starfish opens and the drumfish crushes large oysters with much less facility than small ones. It follows that the mortality on a bed of well-grown oysters is less than when they are small, and the more rapid the growth the less the death rate from extrinsic agencies. The value which an oyster possesses in the market is dependent largely upon its fatness and flavor, and both of these are principally and primarily dependent upon its food. Oysters may reach a large size, yet not become fit for the market, and in certain parts of the Atlantic coast the difficulty has been keenly felt by those engaged in oyster-culture. The United States Fish Commission is now experimenting with a view to enable planters to fatten their oysters at will, but definite results have not yet been reached. It may be stated, in passing, that these experiments have nothing in common with the pernicious process of plumping through the osmotic influences of fresh or brackish water.

ENEMIES.

The Gulf coast is fortunate in its comparative immunity from enemies of the oyster. Two of the most destructive inhabitants of oyster-beds in the North, the starfish and drill, are practically harmless in the South, and to those familiar with the vast amount of money and energy annually expended in protecting the beds of Long Island this fact is very significant. In six years the vessels of one deep-water planter caught nearly 10,000 bushels of starfish, and another in a single year is said to have expended $90,000 in protecting his beds from the same pest. There are, however, certain enemies on the Gulf coast which do more or less harm. The drumfish is apparently more destructive than in the North, and the sheepshead is said to also do considerable harm. Should either of these fish prove troublesome it would be quite feasible, as has been demonstrated on the Pacific coast, to protect many of the planted beds by stockades or fences. The economic practicability of the plan, however, would be conditioned by the price of oysters and the location of the beds which it is sought to protect. The conch and a somewhat allied gasteropod, the crown shell, known to naturalists as *Melongena corona*, are said to cause more or less harm to oysters in the Gulf. Mr. Joseph Wilcox, of Philadelphia, says in regard to the latter that they are able to insert their long tongues or proboscides between the valves of the oyster and then leisurely destroy it. He further says that upon one occasion he picked up on the west coast of Florida a cluster of oysters with 20 *Melongenas* attached. Owing to the comparatively large size of these forms it is probable that by exercising care to destroy the animals and their egg capsules whenever found much could be done toward securing some immunity from their inroads.

Summing up, we find that the Gulf coast possesses both advantageous and disadvantageous features from the oyster-grower's point of view. The advantages are principally biological; the disadvantages, economical. The physical conditions are mainly favorable, but occasionally disastrous. The temperature and density are both suitable over a large part of the region, enemies are comparatively few, food is abundant, and the growth and recuperation of the beds rapid; labor is cheap and the weather is less likely to interfere with operations than in the North, where oystermen are often compelled to work in intense cold and on boisterous seas. The disadvantages have principally to do with the freshets and crevasses which at certain seasons are liable to lower the density and deposit sediment upon the oysters, the occasional severe storms and tidal waves which tear up and destroy the beds, and finally the distance from the centers of population and the principal markets of the country.

LEGISLATION AND ITS ENFORCEMENT.

In most of the maritime States the statute books are burdened with lengthy oyster laws, and a large part of the time and energy of the legislative bodies are occupied in the discussion of these laws and their enforcement. In all of these laws and in most of the discussions the close season is an important factor by which it is hoped that the natural beds may be preserved from destruction. It is invariably designed to prevent the capture of the oyster during the breeding season on the hypothesis that when taken at that time there results not only the destruction of the adult but also of the progeny which that adult is capable of producing, and it never occurs to the advocates of this form of legislation that the same objection applies to the capture of an oyster at any other time. If the oyster were more easily captured during the spawning season, as are certain species of fishes, or if it were a timid creature fleeing from alarm and easily driven away, or if it cared for its young after the manner of the higher animals, there would be perhaps some warrant for the present belief in the all-sufficiency of the close season as a protective measure. But the oyster does none of these things; it stays where it first lodges and there passively awaits such fate as may be in store for it, doing nothing of its own volition, either to defer or expedite its capture.

Bearing these facts in mind, let us examine the effect of the close season upon two hypothetical beds, one of which is closed during the period when the oyster is spawning, the other when it is not. We will suppose, for the sake of definiteness, that each of these beds contains 10,000 bushels of oysters; that spawning takes place only during the six months between the 1st of April and the 1st of October; that the oystermen have the skill, industry, and purpose to remove every oyster during a working period of six months, and finally that the dead shells are culled out and returned to the beds. Let us first consider the case of the bed which is closed in the usual manner during the spawning season. The oystermen will begin on the 1st of October and labor unceasingly until the 1st of April, when, *ex hypothesi*, there will not be a single oyster left to spawn and the reproductive capacity of the beds will be zero. Compare with this the bed which is closed during the six months when the oyster is not spawning. At the beginning of reproductive activity the bed is intact; it contains 10,000 bushels of oysters, each, we will say, capable of producing its kind. At the end of the six months, as in the former case, not an adult oyster is left, but the condition of the two beds is not otherwise comparable. In the first place not an oyster has spawned; in the second case, supposing the daily catch to be approximately constant, one-half of the spawn has been given opportunity for discharge and a considerable portion of the spat should have attached itself to the culled shells and other material returned to the bed. In the one case, if the bed be isolated, absolute extermination has been accomplished; in the other case the bed still contains the elements of recuperation. In practice, of course, the extreme conditions mentioned never obtain, but the principle is the same whether the oysters be taken in whole or in part.

In practice also, where some oysters always remain on the beds, even after the most thorough working economically possible, the close season has a utility not yet touched upon. In its early attached stages the oyster is not the hardy, heavily armored animal that we see in the market. Its shell is thin and fragile as an eggshell, and closely adherent to the foreign body which furnishes its place of attachment. Tongs, and especially dredges, however carefully handled, must crush them by multitudes, and the impact of the oysters against one another as they are thrown into the boat costs the lives of many more. A large proportion of the young spat is often attached to marketable oysters, and however well-intentioned the oysterman may be in his efforts to comply with the culling law, it is quite impossible to detach the spat without killing it. When the close season ends immediately upon the cessation of spawning a very large proportion of even the earliest set is subject to the perils pointed out. If the young oysters could be protected until such times as the shells become strong enough to withstand the mechanical effect of capture and culling, a distinct advance would be made in the administration of our natural reefs. The prolongation of the close season for a period of six weeks or two months would, in a region of rapid growth, permit the shells to attain a strength sufficient to prevent crushing, and a size that would allow some of them to be culled from the marketable stock. Economic objections may be well offered to this proposition, for in many cases it would cut off the fisheries at a time when the financial inducements are large. It is a matter, however, worthy of consideration by those engaged in framing oyster laws; and I believe that in some localities a close season beginning, say, two months after the commencement of spawning and extending two months beyond its cessation will have a better result than an equal period adjusted to the spawning season only.

Another plan would close the beds, each in rotation, for a term of years sufficient to allow them to recuperate from the effects of the fisheries. Doubtless this would be the most efficient type of close season, but it presents alternative difficulties in administration. If the areas closed be large, those deriving their living therefrom must either travel long distances to prosecute their calling or temporarily abandon it; if, on the contrary, the areas be small and correspondingly numerous, the regulations would require a large oyster police for their enforcement. Another plan, on our extensive oyster-grounds still more impracticable than the preceding, is to limit absolutely the number of oysters to be taken from the beds. This has been the only regulation able to protect the oysters in certain parts of France and Germany; but it involves elaborate governmental machinery, officers for administration, guards for protection, and scientific men for determining the condition of the beds and estimating the number of oysters which may safely be removed. Such elaborate measures are possible where the beds are few in number and limited in extent, but are entirely inapplicable to the conditions prevailing in our waters.

Another almost universal feature of oyster regulation—and, in my opinion, a more important one than the close season—is the requirement of culling upon the beds from which the oysters are taken. Most States have in this respect good laws, but unfortunately they are often neither enforced nor voluntarily observed. It is not difficult to prevent young oysters from being put upon the market, and there is but little temptation to so dispose of them if the limit be fixed, as is common, at 2½ inches; but as seed such oysters may be sold without the limits of their native region, and to its great detriment. Then also, when the beds are distant from the places of sale, there is always a strong temptation for the oysterman to save time by culling them on the way to market. In some cases this may produce no harm, and may even result in the establishment of new beds, but in general the practice is to be deprecated from the probability that young oysters thus culled would fall upon soft or shifting bottoms, or be otherwise placed under adverse conditions.

It is self-evident that if the young oysters and the objects to which they may become attached are systematically and persistently removed, there must follow a scarcity of adults, and in time economic if not biological extinction of the beds will result. In due course such beds may, and often do, become restored and regenerated, but the process is usually slow as compared with the demands of our markets. I regard it as a misfortune in some respects that the vast spawning capacity of the oyster is so generally understood. The knowledge that the female emits annually millions of eggs has begotten an impression that the beds need no protection, and that when they fail it is due to starfish or drills or mud or any one of a dozen other factors, rather than to improvident management. It must be remembered that but a modicum of these eggs reach maturity, else our bays and estuaries would long ere this have been converted into beds of limestone. Broadly speaking, nature provides for the perpetuation of her species either by means of a few eggs well protected, or many eggs left, as it were, to chance. To the biologist the simple fact that the oyster is so prodigiously prolific is ample indication that its existence from the egg is a precarious one. Its life is a constant passive struggle with physical conditions, its enemies, and its brethren, and fortunate indeed is the oyster region where, of every million eggs produced, one reaches marketable dimensions.

An important, in fact an essential, element in the oyster's salvation is the presence of a solid body to which to affix itself when it is ready to settle down at the conclusion of its free-swimming condition. It is then so exceedingly minute that a film of mud not thicker than a sheet of paper is sufficient to stifle it. It will attach itself to almost anything fairly free from sediment, but on the oyster-beds such objects are almost exclusively living oysters or dead shells. A depleted bed differs from a vigorous one in two particulars: In the scarcity and scattered distribution of spawning individuals, and, perhaps more disastrously, in the paucity of suitable places of attachment for the young. From both causes the reproductive capacity of the bed is reduced, but were the culled and dead shells returned to the bed both conditions would be ameliorated. Under any system, however, even with good culling laws and close seasons, it is hopeless to expect to supply the demand for any length of time wholly from the natural beds. The only way in which to prevent their ultimate depletion is to supply our markets largely from other sources; that is to say, we must resort extensively to oyster-culture; and the character of legislation and the success with which it is enforced are determining factors in the success or failure of the undertaking.

Liberal measures must be adopted, and opportunities, if not inducements, must be offered. Private ownership must be established, and more especially the rights of property in the planted beds must be vigorously enforced. More than this the State can not well do. The methods of fish-culture are not now, and probably never will be, available in propagating the oyster. Fish-culture in many of its phases is a legitimate and proper function of government, as all members of the community, whether they be catchers or consumers of fish, partake of its benefits. In most cases, owing to the nomadic character of the species propagated, private enterprise has no inducements for engaging in it except those of philanthropy. Not so with oyster-planting as at present practiced, for only he who sows reaps. Dr. Ryder once said "Oysters are like potatoes, they stay where they are planted." All that the planter need ask of the Government is to be placed on an equal footing with every other citizen; to be permitted to acquire, without prejudice to others, property adapted to his calling, and to be protected in his rights after acquirement.

With this understanding the first question to arise is how and where he may obtain such property. In some cases he may go into the markets and purchase lands conveying to him the ownership of coves or salt ponds, but such cases are rare and oyster-culture so confined would be unimportant indeed. Again, he might buy land on tide water and excavate ponds, but oyster-culture has not reached a stage where such methods would in general prove profitable. The only course left him, then, is to occupy tide lands, which in most cases are held by the State. To enable him to do this legislation is necessary, and the lawmakers at once ask, What shall be the character of his tenure and how is it to be acquired? Shall he be granted a leasehold for a term of years or shall he be permitted to occupy it in perpetuity, the State retaining only the right of taxation and its related powers? Whichever policy be adopted no impediments should be unnecessarily introduced in the way of a *bona fide* planter. The returns from oyster-culture are often large, though not exorbitant, but the risks are many and disaster not infrequent. Those who undertake the work and thus add to the State's resources should be treated with every consideration to which their courage, enterprise, and industry entitle them.

The tide lands in most cases are worthless and doubtless will ever remain so for purposes other than oyster and sponge culture, and they can be occupied without prejudice to any other business whatever. The policy of the State should be to encourage their occupation, and in this connection a lesson may be learned from the liberal policy which has induced the rapid settlement of our vast agricultural estate. The logic of our history would dictate the throwing of the tide lands open for occupation, yet in how many States are the laws, and more especially public opinion, practically, if not intentionally, prohibitive? A policy far different from that in land above tides is supposed to be justifiable in dealing with that portion of the State's domain lying beneath the sea. There is reluctance to part with the tide lands, and it is thought preferable to allow them to lie barren rather than to permit individuals to acquire permanent possession. There can be no doubt but that the best results are to be obtained when the oyster-grower holds his lands in fee simple. Under proper management the bottom becomes more favorable the longer it is cultivated. It yearly becomes firmer and freer from extraneous organisms and the miscellaneous rubbish which accumulates in shore waters, and the man who improves it is the one who should reap the benefits.

It is to the advantage of the State to interest a thrifty class of citizens in the subject, and such persons are the very ones who will hold aloof if they are to be subjected to the frequent possibility, if not probability, of dispossession. The land should be granted under the freest possible terms. If revenue be desired it should be derived from the subsequent increase in taxable value rather than from sales or rentals. The primary function of government is the welfare of its citizens, and, contrary to the apparent standpoint of some legislators, taxation is but an incident which the first consideration renders necessary. The first cost of the oyster-lands granted by the State should be little more than enough to defray the expenses of survey and registry, and not such as would debar those of small means from partaking of the benefits. In Connecticut the State lands are sold for $1 per acre and the additional payment of 10 cents per acre, the estimated cost of surveying and recording, when the tract applied for is not, in the opinion of the shellfish commissioners, of an unreasonable extent. Under these provisions over 71,000 acres, owned by almost 300 persons and giving employment to thousands, were under culture in 1896, the amount of material deposited thereon in planting and improving the beds being over 8,000,000 bushels. Other States are still more liberal, permitting the occupation of oyster lands under provisions practically similar to the United States homestead laws. But Connecticut has so far been easily first in the development of oystering in naturally unproductive waters. This is largely due to her advantageous geographical position with regard to the markets, but it can also be attributed in part to the natural industry and enterprise of her citizens and to the enlightened public opinion which places planted oysters on a par with other property and respects the right of the planter to reap the fruits of his labors.

Of enterprise and industry Connecticut has no monopoly, but unfortunately there are many parts of our seaboard where the oyster-planter is regarded as the usurper of the common rights to the fisheries and his legal rights are interfered with by an adverse public opinion. This is one of the greatest difficulties with which he has to contend. Theft of property beneath the tide is palliated by some as an act of retributory justice against a common enemy, and men will steal oysters who would scorn to enter their neighbor's poultry-house. This peculiar moral obliquity is rooted in ignorance and must be combated by education, supplemented by more than occasional salutary castigations from the strong arm of the law.

Summarizing: Those who wish to perpetuate and extend our oyster wealth should procure a rational culling law rigidly and intelligently enforced; the close season should be at such time and of such duration as will protect, not so much the spawning oysters, but the delicate spat during the period when it is especially susceptible to injury from the ordinary working of the beds; public opinion must be formed to regard oyster-planting in its true light, as a benefit to the whole community; liberal laws must foster and encourage the occupation of the tide lands not natural oyster-beds; the oyster-planter should have the same treatment as the cotton-planter, sugar-planter, or the market-gardener, with liberty to hold or dispose of his property as he pleases, paying a just proportion of the taxes and no more.

WASHINGTON, D. C.

THE OYSTER-GROUNDS OF THE WEST FLORIDA COAST: THEIR EXTENT, CONDITION, AND PECULIARITIES.

By FRANKLIN SWIFT, U. S. Navy,
Commanding United States Fish Commission Steamer Fish Hawk.

The oyster-grounds of the west coast of Florida extend the whole length of the coast. Oysters are found growing in great abundance in the waters between the mainland and keys, and are particularly noticeable clinging to the roots of the mangroves which fringe the mainland and keys along the southern coast. These oysters of the extreme southern waters of Florida are mostly of the raccoon type and are not very palatable, being "coppery" and of poor quality.

The oyster regions of the central and northern part of the coast are found in the many inclosed bodies of water, and are located in the vicinity of the mouths of rivers in waters where the density is affected by the fresh water of such streams. The question of density is of prime importance in connection with oyster growth, and edible oysters can only grow where the salt water is influenced by that of less density. If the normal sea water is taken at 1.026, then 1.016 represents the most favorable density for oyster life. However, the densities in which oysters seem to thrive cover a great range, and in nearly all beds oysters are subjected to the extreme ranges between the different stages of the tide. In freshets oyster-beds are sometimes destroyed, owing to the long-continued prevalence of fresh water.

The oysters of the west coast of Florida are all found in very shoal water compared to those found in the Central and Northern States, and a glance at the chart will show the comparative shallowness of all the inclosed bodies of water along the west coast. Marketable oysters are taken in water from 10 feet to 1 foot in depth, and in less than 1 foot and above low-water mark are found the raccoon oysters. Large beds of the latter type lie exposed at low water and thrive, even in their exposure to the hot sun or cold air, during the low ranges of the tide. The shells of these oysters are long and pointed quite sharply, and the oysters are more flat than those of the marketable type. These oysters, culled and transplanted, often do well on cultivated grounds.

The bottoms of the coast waters which contain oysters are almost invariably very soft mud, and it appears remarkable how the solid beds are ever formed on such yielding material. The mud is often of the nature of ooze, and a pole may be thrust down many feet before finding any resisting strata. An examination with a steel-pointed probe usually shows the following strata on the beds: The crust of the bed, composed of shells to a depth of 2 or 3 feet; a layer of soft sand, extending down about 5 feet, and then hard sand or hard mud. The beds are almost entirely long and narrow in extent, and rise precipitately from the muddy bottom, forming reefs dangerous to navigation, as no warning of their presence is given by the soundings. On these reefs there is usually 2 or 3 feet of water at low water. In some localities the oysters are scattered over the bottom, forming beds like the northern beds, but it may be said generally that the oysters of the natural beds grow on the densely packed reefs before mentioned.

In the oyster regions of Apalachicola Bay the survey made in the winter of 1895–96 by the *Fish Hawk's* party showed the condition of the beds with great detail. The oysters there were found in clusters, and ranged in size from very small to full size in each cluster, the crowding of the oysters in the clusters being a serious retardation to their growth. In addition, the whole mass was invariably thickly covered with mussels, so that without doubt great good would result in breaking up and separating the oysters of the clusters. In the Apalachicola work the average number of oysters to the square yard was taken on the different beds, with a view to forming a comparison at a future survey, and thus determine the increase or decrease of each bed.

The questions of temperature and food supply are very important; the former affects the spawning season directly, and the latter depends to a great degree on the currents. Generally speaking, the spawning season extends from the middle of April to the middle of July, but these limits of time vary with the temperature to a considerable degree, a cool spring causing a late spawning season. However, it is probable that in the waters under consideration the oysters spawn to a greater or less degree all the year around. This is evidenced by the fact that the spat is observed in all stages of development during the year. It is generally considered that oysters reach a spawning age at the end of three or four years.

The current concerns the food supply materially; the bottoms most favorable to oyster growth, as those over which there is gentle flow, changing in direction as the tide changes from ebb to flood. The long, narrow reefs which form the beds are almost invariably at right angles to the direction of flow of the current, and the banking up of the water caused by its meeting an obstruction in the form of the bed gives it an increased velocity, so that usually the locality of the bed is at once shown by the tide rip. Of course, at slack water no such material aid is given in finding the beds. It is a singular fact that almost without exception the beds are crescent-shaped, with their concave surfaces all on the same side of the areas of the beds.

The enemies of the Florida oysters are few in number. The starfish, the pest of oysters in Long Island Sound and other localities, is rarely found, and the loss from injury by drills is very small. Parasitic growths, in the form of mussels and barnacles, are injurious; but they may hardly be classed as enemies, as their harmful effects are indirect. It may be said that the Florida oysters are singularly free from exposure to enemies that oysters of other sections are subjected to.

The three great natural conditions that work destruction to the beds are the freezes, hurricanes, and freshets that occasionally occur, and the first two take place principally in the northern sections of the coast. The cause of the deterioration of the beds other than from natural sources is almost invariably due to overworking. The demand is too great for the supply, and the beds are worked until they no longer yield profitable results, and usually until they are so depleted that years are required for them to recuperate. Add to these causes the facts that the oystermen are so shortsighted that they pay little attention, as a rule, to the laws regarding culling and taking undersized oysters, and it can readily be seen that there is a small chance for the productiveness of the beds to increase. Fortunately, dredging is prohibited by law, and it is the one law that is usually observed, and only because the use of dredges would be immediately noticed and complained of. Again, dredging as practiced in the North could not easily be carried on advantageously, on account of the shoal water.

As measures for the improvement of the beds, I would recommend that no oysters be taken from April 15 to October 15; that the law now in force regarding the culling of oysters on the grounds and the law regarding the taking of undersized oysters be strictly enforced. Oystermen as a rule pay little attention to the laws that affect them so materially, but it is noticeable that the more enlightened men of larger interests, as, for example, the canners, are much in favor of having proper laws and having them enforced. The fact of such intelligent men being anxious for the enforcement of the laws seems a strong argument in favor of such enforcement.

All that has been said applies to the natural beds. Oyster cultivation has become a great industry in the Northern and Central States, and is now beginning to extend to the Southern coasts. Florida has been far behindhand in this industry, but it is hoped that the great importance of it can be proved to those interested, and that in the near future Florida shall have her share of the great sums brought into the State treasuries of some of the States from taxes alone, not to mention the advantages accruing to individuals. The United States Fish Commission has already done much to encourage the cultivation of oysters in Florida. The section of the coast about Apalachicola Bay was surveyed, as already mentioned, and a chart showing the exact delineations of the natural beds and the areas of good planting-grounds made. By means of this chart any person of average intelligence can locate himself on the best ground possible for planting. Having such knowledge, a mere scattering over the bottom of shell to form a cultch to which the spat may attach itself, with the necessary overhauling from time to time, would result in profitable beds. Or, again, seed may be taken from the best natural beds, as it is known that the beds differ very materially. In connection with the cultivation of oysters the United States Fish Commission's Manual[1] on the subject will furnish the best possible suggestions, and all those new to the business will do well to study it.

All natural conditions are favorable to the planter, and as for the seed, as already mentioned, the beds vary greatly even in the same locality, but there are beds all along the coast where the oysters are of the very best quality and compare favorably with the finest-flavored oysters of the most famous d stricts on the Atlantic seaboard.

The one great impediment to oyster cultivation in Florida is that the laws protecting planters are not enforced. There are instances where men have been obliged to give up the work of cultivation on account of the lack of protection. The laws are perhaps sufficient, but it is imperative that they be enforced. First of all, the oystermen must be brought to a realization of the fact that the protection of oyster cultivation does not in any way infringe upon their rights, and that on the contrary it is directly for their best interests. All have equal rights and any man having sufficient thrift and energy may without doubt better his condition by undertaking the cultivation of oysters and uniting with others to respect the laws. The moral sentiment among oystermen is not in favor of protection, and this is due principally to their misunderstanding the subject. The law makes a distinction between cultivated beds and natural beds and relates wholly to the cultivated beds, but oystermen think that any protection given to the planters is of the nature of a monopoly and is an encroachment on their rights. Of course such is not the case, as the laws protecting planters do not in any way interfere with oystering as now carried on on the natural beds. All the oyster cultivation would be carried on away from the natural beds, and in some cases in localities entirely remote from them.

WASHINGTON, D. C.

[1] Oysters and Methods of Oyster-Culture. By H. F. Moore. Report U. S. Fish Commission for 1897, pp. 263-340.

THE OYSTERS AND OYSTER-BEDS OF FLORIDA.

By JOHN G. RUGE.

To treat this subject properly one should be prepared to consider it in all its aspects, relatively and otherwise. I do not offer you anything new, and I even confess plagiarism, yet hope it is so shaped as to engage your attention.

I may observe that oysters of many species are found nearly all over the world: the British Isles, the Mediterranean, Holland, Belgium, Germany, Denmark, Norway, and part of Russia, Australia, China; nearly all parts of the eastern coast of America from Canada to Cape Horn; also the northwest coast of the American continent. Oysters are plentiful in the Hawaiian Islands, and are quite numerous, at least as to variety, on the Asiatic shores. Efforts made to acclimatize the oysters of the Atlantic coast in California waters have been only partially successful.

The oyster no doubt furnished a large part of the food of man while in the primitive era of cave-dwellers, and we have evidence, not only in history but in our own day and generation, that it is sought for food both by savage and civilized man, as well as by the fishes of the sea; even the quadruped animals find it a toothsome morsel. You can prove this at your doors near Tampa Bay, where "coon" oysters grow plentifully, even upon trees and bushes. They derive their name, perhaps, from a fancied resemblance to the tongue of the raccoon, as well as from the habit these quadrupeds have of seeking oysters when the tide is out, cracking the shells and eating the oysters almost as the squirrel does nuts. I have often chased them from the oyster bars.

Plato, some 400 years before the Christian era, regarded the oyster as the typical know-nothing of creation, and he judicially consigned the soul of the ignorant man at death to the occupancy of the oyster. Oysters are unquestionably among the oldest of foods of mankind. Going back into history, we find that they are written of by the ancients as of prime importance in their accounts of feasts of the wealthier Romans, where they figured prominently in the lavish luxury of imperial Rome. Over 1900 years ago one Sergius Orata turned Lake Avernus, in Italy, into an oyster-bed. Sallust, before the Christian era, some 2,000 years ago, seems to have thought the oyster the only good thing that Britons had. Pliny, who died in the year 79 A. D., gives an account of the use of oysters, and mentions that Æsop's son was fond of them. Juvenal, A. D. 60, speaks of the British oyster, which was then in high repute among the luxuries of that day. The oyster has honorable mention in classic song and story and is a favorite theme for naturalists, but is not mentioned in the Bible. A physician, Dr. Baster, as quoted by Dr. Johnson, was of the opinion that the Roman predilection for oysters was a sanitary one, and he says:

> Living oysters are endowed with the property of medicinal virtues. They nourish wonderfully and solicit rest; for he who sups on oysters is wont on that night to sleep placidly. As to the valetudinarian afflicted with a weak stomach, oppressed with phlegm or bile, raw oysters are more healing than any drug or mixture that the apothecary can compound.

This mode of quieting the appetite for dinner appears to continue to the present day. A diet of raw oysters is an excellent remedy for dyspepsia.

The Pilgrims landing on the shores of what is now Massachusetts found oysters in great abundance and used by the Indians, and oysters were served at the first Thanksgiving dinner on this continent. The oyster industry of the world is chiefly in the United States and France. A few natural beds yet remain in Great Britain and France; the latter country has the best conducted oyster-culture, and seems with Holland to monopolize the trade of Europe, especially in oyster seed and the culture thereof.

In the census of 1890 the United States, in a comparative statement, is credited with an annual catch of 5,550,000,000 oysters, France 680,400,000, Great Britain 1,600,000,000, and Canada 22,000,000; the catches of the rest of the countries of the world are comparatively small, with Holland and Italy in respective order, the total for Europe being 2,331,200,000. The eastern coast of North America produces as much as all the rest of the world combined, and this very fact is full of importance to us in the consideration of the matter before us.

About 100 years ago the French and English oyster supply was supposed to be inexhaustible, yet it was not long before they were fighting for legislation, just as we are doing to-day. The first legislation respecting oysters seems to have been during the reign of James I, about 1606. The features of this legislation, cooperated in by both countries on account of the contiguity of their oyster-beds in the English Channel, and in effect to-day, is largely what we have learned by our own experience, not only in the northern waters but in Florida, viz: No dredging, except in private beds; a closed season, May 1 to September 1; oysters less than 2½ inches thrown back on the reefs; no ballast thrown on any oyster-bars. The customs officers are authorized to enforce these laws.

Such are the avarice and cupidity of man that through all these thousands of years he has not learned that it is the greatest folly to attempt to live on Nature's bank account without providing some return for the drafts made. All America, and Florida especially, with all the experience of the past to profit by, is destroying her natural wealth in every direction.

As before stated, oysters are found along the North American coast all the way down to the western end of the Gulf of Mexico. They are apparently much of the same nature, but some naturalists claim that the southern oyster is different from the northern; yet both varieties are found not only in Long Island Sound but in the Gulf of Mexico, and while growth changes their appearance it is owing to the nature of the surroundings—the bottom, the water, and the food. The principal oyster-grounds of the world are in the Chesapeake Bay. The abundance with which Nature blessed that region may not endure through the next half century without further protection by legislation, yet it is likely that there will be at all times public oyster-grounds in the United States, as in England and France, although any attempt to interfere with the so-called rights of fishermen on the oyster-banks has always met with strenuous opposition.

A hundred years ago oysters were plentiful from Maine to the Delaware Capes, and while some few are still found about the northern coast of New England, they are not sufficient to make the business profitable in that section. Along the Connecticut and Rhode Island coasts and down into Long Island Sound the oyster interests are managed in an energetic and systematic manner. New Haven is the pioneer in European shipments, and that section yet holds that trade, the bulk of their oysters being sold as barreled stock. The oysters there were threatened with the same extermination as their northern neighbors, but the dealers finally realized the condition and successfully propagated and transplanted oysters from Chesapeake Bay. Some of the wealthiest and most extensive oyster firms of the world are located in Connecticut. The first shipping ventures were failures, as the oysters would not keep their valves closed long enough. This was remedied, however, by placing them deep side down or "right" side up, and in some cases the oysters were wired. The industry has increased yearly, and will no doubt continue to increase in that section so long as other sections consent to sacrifice their own oyster farms for the benefit of their rivals. The true secret of their success, however, is that the people respect the rights of others and confide in and respect the courts.

When a reputation has been made for a certain class of oysters in the North, it never dies out. For example, take the "blue points" and famous "saddle rocks." The latter were discovered in the neighborhood of a submarine rock of that name, and the "trade-mark" became famous in the northern metropolis some thirty years ago. The beds were cleaned up in two seasons, yet New York has never lacked "saddle rocks" from that day to this. The term is now only a name for large oysters, as "blue point" is for any small oyster.

The oyster planters of Long Island Sound must continually wage war against that terrible enemy in those waters, the starfish. These pests, like the "borer," will not live in fresh or brackish water. They require a strong ocean brine as their natural home. They are the enemy of the oysters on the ocean front as the army-worm is to the crops on land. The "borer" or "drill," as well as the starfish, murders thousands of oysters in a season and causes a constant demand for fresh seed or plants from other localities. It is no infrequent occurrence for oystermen to dredge up as many as 75 bushels of these pests in a single day's work, and a steamer has hauled up several hundred bushels in a day.

Some years ago our Connecticut friends found that the use of bare bushes planted on the beds greatly increased the yield of oysters, as young spat clings to the branches and develops rapidly; but it was claimed that oysters caused typhoid fever, and that it was due to the presence of these bushes, so a law was enacted which prohibited this method of cultivation. The best evidence that this was a mistake is found in the fact that typhoid fever developed in this section after the bushes disappeared, and the blame was then given to the oyster per se rather than to the manner of cultivation. But an expert commission of medical scientists has recently investigated this matter and found that typhoid fever was not traceable to the use of oysters.

The oyster business of the Chesapeake Bay, according to the last census of the United States, represented the larger part of the entire value of the whole American fisheries—more than double the entire value of the cod fisheries of the Newfoundland banks. It employs many thousands of people and is the perennial source of an immense business. There is no question, however, that the catch of oysters of the Chesapeake Bay region has fallen off lately. Just as in Florida, the tide-water counties of Maryland and Virginia look upon oysters and fish as public property. Human nature is the same in the frozen north or the tropic seas. If the State properly managed the matter it would yield revenue enough to pay a large part of the expenses of the State government. Yet adjoining States should cooperate in this legislation.

The oyster catch of Maryland and contiguous waters has in the past decade shrunk to about half of what it once was, but the steadily increasing population of this country and the consequent increased use of oysters, together with the decreasing yield of Chesapeake oysters, have of late years resulted in creating a demand from other fields; so Virginia, North Carolina, Georgia, and especially Florida, Mississippi, and Louisiana, have come into prominence in this industry. There was a time in the history of the oyster trade of the Chesapeake when the catch was so considerable that the oyster-canning plants of Baltimore were really the salvation of prices to the oyster shippers and dredgers. Such is the case no longer, as Baltimore has now numerous competitors, not only in raw, but cove oysters, and not only in Maryland and Virginia, but in all the Southern States that border on the Atlantic and Gulf. I think that no State south of North Carolina has been more successful in this respect than Mississippi and Florida. The Mississippi oysters from Biloxi and those from Louisiana seem in a fair way to take possession of the western markets along the Mississippi River. Chicago has become especially interested. The sounds and bayous that border on the American coast all the way to the mouth of the Rio Grande are more or less productive of oysters, but many of them are of so delicate a nature, on account of the warmth of the water, that when steamed they seem to evaporate, and the shells in some cases are so soft and thin that they will not stand transportation. Where oysters grow naturally in localities which are favorable as regards salinity, lime, warmth of water, and abundance of food, the flavor and firmness are finer than when they have to be changed, and this is the spot on which to transplant and which should be cultivated.

There is nothing of interest, as I understand, to be said of the Pacific coast in respect to oysters other than that already spoken of; but some authorities say that excellent oysters are found on the coast of Bering Sea, so that at no far-distant day Alaska—besides her gold and salmon—may yet become the oyster region of that great Northwest.

Oysters are commonly believed to be unfit for food except in the months containing the letter R. This comes from the idea—and the fact also—that it is usual to find most oysters in spawn from May to September. As a matter of fact, oysters spawn at different times on different beds, according to the depth and temperature of the water. In deep water the temperature is less, hence the spawning begins later in summer and ends later in fall. On the other hand, the shoaler or warmer the water, the earlier the spawning takes place. Although wholesome oysters can almost always be found at some point from May to September, yet it is safest to be governed by this direction of the "R."

NATURE AND GROWTH OF THE OYSTER.

This palatable and nutritious animal, while apparently very simple, has a complex anatomical structure, manifestly a beautiful adaptation to the creature's necessities. There is no certain method of telling the age of an oyster from its appearance, but it can be approximated quite closely by those accustomed to handling them. It is said that they have been found twenty years old. Dr. W. K. Brooks, of the Johns Hopkins University, of Baltimore, and the late Professor Ryder, of the United States Fish Commission, are recognized authorities in the United States whose researches as to the anatomy and physiology of the oyster are accepted and followed by those interested in the propagation or culture of this bivalve. Their observations and conclusions are set forth in a recent article in the United States Fish Commission Report for 1897, by Dr. H. F. Moore, to which students of this subject should refer.

It has been estimated that a large female American oyster in perfect condition can furnish 60,000,000 eggs in one season, yet it is possible that only a dozen of these will reach adult age. The European oyster produces only about 2,000,000 eggs. Oysters are fond of the tranquil waters of gulfs formed by the mouths of rivers. They are sensitive to light, as is proven by their closing the valves when reached by the shadows of a boat.

ENEMIES.

The oyster has many enemies. The starfish and borer are not found in Florida, but the oysters of this State are exposed to storms that cover them with sand; to freshets that deposit mud upon and kill the young as well as the mature; to freezing, which destroys those exposed by the tide, yet if the tide covers frozen oysters before thawing they will not be killed; to droughts, which starve them. Mussels grow with such rapidity, wedging themselves closely between the shells, as to starve the oysters to death by preventing them from opening their mouths to take food. The adult oyster also feeds upon the spawn. The drumfish, the sheepshead, the crab, the oyster bird, are all destructive influences and tend to prevent the development of more than a minute percentage of the fertilized eggs. Even a heavy storm, as well as thunder, checks spawning and often destroys the spat.

OYSTERS IN FLORIDA.

The first landing of white men in this State found the Indians acquainted with the edible value of oysters, which had no doubt always furnished food for the aborigines, as evidence has been found showing the prehistoric use of oysters in this State. The principal oyster-beds on the Atlantic side of Florida are found at or near Fernandina, where oysters are plentiful; the Indian River region comes next, with the best condition at the southern end of the river. New Smyrna, at the mouth of Mosquito Inlet, is especially adapted to oysters, but very few are found in Lake Worth, and none of any consequence until the gulf at Hillsboro Bay is reached, where the natural conditions are excellent; then Sarasota Bay and Charlotte Harbor; then Cedar Keys and Crystal River, in which vicinity the physical features are preeminently favorable for oyster cultivation. Experiments in transplanting were tried near here some few years ago and with some success, but were abandoned on account of depredations. Some oysters are found near St. Marks and in Ochlocknee Bay; none in St. Joseph Bay; St. Andrews furnishes a fine oyster to a limited extent, but they will not bear shipment on account of their soft thin shells. Escambia Bay has some good oysters and here transplanting was also tried, but failed on account of depredations. Oyster-planting can not flourish in any community where the moral rights of the owner are not respected. Favorable oyster-grounds formerly existed in Perdido Bay, but a hurricane in 1896 virtually destroyed the oysters in this region. There are also isolated beds along the Atlantic and Gulf coasts. The more extensive beds have been of late years near Apalachicola, but they have been impaired by gales, freezes, and freshets. The extent, conditions, and peculiarities of the oysters of the west Florida coast I shall not comment on, but leave to Lieutenant Swift, who has carefully studied the region.

The influences threatening the permanency of the oyster supply of this section, as elsewhere in Florida, are not so much the consumption of full-grown oysters as the destruction of the young and the failure to protect the spat in the spawning season.

It is every man for himself and it is no man's business to protect the young and spawning oysters. Oysters are sold throughout the entire spawning season. This is like plucking the blossom and expecting full ripe fruit to appear. Oysters from a tropical climate have usually less firmness, but generally equal in flavor those of a more temperate zone. The southern oyster seems to develop more rapidly when transplanted to northern waters. The Florida Gulf oysters have a more massive shell and are of a more rapid growth than those on Atlantic shores. Prof. G. Brown Goode says oysters are here found fully equal to those of the North. The bottom favorable to the growth of oysters must not be too sandy or too muddy. The water must contain enough of lime to grow the shell and enough vegetable matter for food and nutriment. There should be a flow of fresh water carrying additional lime and food. The most favorable temperature during the spawning season is from 60° to 80° F.

CANNING.

The first record we have of hermetical sealing is about 1810, by Appert, whose successful experiments were made under the auspices of the French Government. We owe to him not only the discovery but the demonstration of principles at the bottom of preserving processes; yet his methods are not followed by the practical canner of to-day.

Maine, I think, claims the credit for the first success in canning fish in the United States; yet I am quite sure it is a mistake. Oysters were first packed in Baltimore by Thomas Kensett in 1825, who then opened them by hand, cooked and packed them in cans, sealing hot and boiling in water, to which was added salt or pearl ash to get an increase of heat. These sold at the rate of $6 per dozen; to-day they can be bought for $1.25. From 1860 to 1865 began the opening of oysters, inaugurated by Louis McMurray, by placing in boiling water. After this, oysters were opened by the present method of steaming. They were until about 1880 preserved by heating the water with calcium to give 240 degrees heat, which experience demonstrated was sufficient to destroy the germs of fermentation. The closed retort or process kettle was first used about 1880. The first attempt at canning in Florida was made in Apalachicola in 1860 by one Stacy, whose experiments were a failure, owing to the fact that no knowledge was had as to the proper heat required to destroy the germs of fermentation. At that time the packers kept their knowledge secret. Stacy worked on the assumption that 212 degrees, the boiling heat, was sufficient. The war came on during the next oyster season, so the experiments were abandoned. The thousands of tin cans served as cups for soldiers and fishermen.

Again in Apalachicola in 1883 James Hunt, from Baltimore, put in a small plant and started a business of what is now a favorite and popular brand, but gave it up as it was not profitable. He then established a plant at Fernandina, and has since that time started other canning plants. Other canneries were built at Apalachicola, but not continued. A small plant was built at St. Andrews Bay, but never operated. Recently a plant started on Manatee River at Gulf City, and there are two at or near Fernandina. Canned oysters are not only found in the Tropics, but explorers have carried them as far as man could go to the North Pole. The tin cans do duty in decorating huts away from civilization, and are even worn by natives as ornaments. Canned oysters are used in the lumber camps of the forest, the mining regions of the mountains, on ships at sea, and in the parching deserts.

SHELLS.

These have always been an item for consideration—usually given away, but in some cases used at a profit. The uses are increasing—for roads and filling in land, for making lime, making coal gas, for beds of railroads, ground up for chicken food, and for fertilizers, employed in making some grades of iron, and as "cultch" for spat.

MEANS OF PROTECTING AND PRESERVING THE NATURAL AND ARTIFICIAL BEDS AND PROMOTING AN INCREASE.

While the natural beds can and should be protected to a certain extent, yet protection is a very perplexing problem, as the requirements of one set of people in one part of the State differ from those of the other parts. Still, there can be no question that efforts should be made to not only protect and preserve oysters but to encourage and promote their cultivation as a separate industry. To secure good results in this direction will require the efforts of more than one generation. The oystermen who are directly dependent on the public oyster-beds for food for themselves and their families must be educated to the idea that any protection of natural and artificial beds is not an infringement upon their rights, but for their interest and ultimate benefit. While they recognize that such laws are made as a rule in their interest, yet the moral sentiment of the oystermen in some sections, North and South, is not in favor of protection because they do not understand the subject. They feel and believe that any law to promote, encourage, and protect the natural oyster or the cultivation thereof is a monopoly and an encroachment upon their rights.

In considering the question of oyster protection it should be borne in mind that oyster-beds are the property of the State and that the legislature can make any regulation concerning them as may seem for the best interests of the State at large. Yet the conditions of nature in the extended bodies of water are so varied that it is very difficult to secure a general law which will suit all sections and do injustice to none. Local laws are equally uncertain, as some legislators may be affected by local influences, even to the injury of the State, as is shown elsewhere. Let the commissioners of fisheries of the State, as the law now contemplates, regulate this subject. The statutes on oysters are in the main very favorable and commendable, with some slight amendments, but not properly constructed in some cases and never enforced in any part of the State. It is not possible, in my opinion, to convict anyone under the law, for the reason, no doubt, that the fishermen feel that it is against their procuring a living. Take, for instance, the catching of oysters for "home consumption" in the closed season. It is a wide loophole and used as an infringement of the law; so the laws are of practically no value.

There is one other and more serious legal defect relating to the planting and cultivating of artificial beds. This is the matter of riparian rights, which is not uniform in different parts of the State, and is yet open for judicial determination by the supreme court. Inasmuch as no claim for rights can be made for something which does not exist, in the cases where the suitable grounds are outside of any riparian interest (that is, between the low-water mark and the public highway or ship channel, and beyond any but the State's control) the law must be formulated for the absolute control by the State. No man at present will put his money in oyster-beds. In my opinion the laws and system in force in Connecticut are the best in the world, but they will not in all cases apply to Florida, owing especially to the riparian privileges and the land tenure, which are very uncertain and liable to be changed by any legislature. Without specifically outlining any law, I beg to suggest that from my extended practical experience and special personal observation within and without the State, as also my observation in legislation on this subject, a statute is required that will do the greatest good to the greatest number in protecting the natural beds or reefs.

The State should exercise exclusive jurisdiction and control over all fisheries. A positive and lasting definition should be made as to natural reefs and barren bottoms. In this it must be determined precisely by metes and bounds what areas can be used for cultivation. It takes an investment of money with energy and labor to engage in oyster-planting.

An oyster and fish inspector should be appointed in the coast counties without the influence of local politics, requiring a graded license tax for boats, as well as a tax on the catch to defray the expenses of inspection and the due enforcement of laws.

The use of dredges should not be permitted.

If a bar is exhausted it should be closed to all fishermen for a time.

No oysters under 2½ inches should be marketed. The practice of the older States is to permit not exceeding 5 per cent of small oysters or culls when marketed.

Oysters should be culled on their natural beds, small oysters or culls and shells being returned to the water.

Last, but not least—in fact, the most important of all—no oysters should be permitted to be used for any purpose whatever during the closed season except for transplanting. Although the spawning season varies, depending on the depth of the water and temperature of the air as well as conditions of food, a fair and reasonable limit is from April 15 to October 15. I will tell the oystermen it is folly for them to attempt to cure these ills by law, for they know by experience it can not be done without their aid. I do not see any other way to bring it about except by public sentiment. The State can not do anything on this line without the cooperation of the oystermen, for it has so far in other States proved a failure. At no time has this subject received so much attention as now. It has for many years been a subject for legislation, yet no system has been established equally satisfactory to oystermen and the public at large.

An opinion prevails that the State should sell the natural reefs and let the owners thereof look to the protection or improvement. This would be against the interests of those dependent on the oyster industry for support, and it would not promote or encourage peace and good order and should not be considered.

APALACHICOLA, FLORIDA.

THE LOUISIANA OYSTER INDUSTRY.

By F. C. ZACHARIE.

The great resources of Louisiana, in its large production of sugar cane, cotton, rice, lumber, and fruits, have hitherto kept in comparative obscurity what are generally deemed the minor, and wrongly considered the less remunerative, fields for the employment of capital and intelligent labor. Many of these are so regarded simply because the best locations for their development have been until recently remote from the centers of trade and great waterways and, in many instances, difficult of access by quick transportation. This possibly accounts for the general ignorance of the great opportunities which these industries offer for highly remunerative investment.

Prominent, if not the principal, among these neglected interests are the vast fishery interests of the State which, under energetic labor and scientific cultivation, would in a few years equal, if they did not surpass, in the way of pecuniary profit, the aggregate value of the entire agricultural product of the State. The extent of the oyster territory is so vast, the supply so abundant and cheap, and so little labor and capital are required for development, that, once known, capital and labor will inevitably seek employment in what must eventually become a leading industry, far surpassing that of any other State in the Union in this respect.

On the eastern boundary, starting from the Rigolets, the small gut or strait connecting Lakes Borgne and Pontchartrain, and following the shore line southward and westward around the mouths of the Mississippi River to the Texas line, there is a coast of about 600 miles in length, if measured on straight lines from point to point. Making an allowance for the curvatures of the coast, the shores of salt-water bays, bayous, inlets, lakes, and islands, which fret this part of the State like network, the littoral line will not fall short of 1,500 or 2,000 miles. Taking into consideration the shelving, shallow beach adjacent to it, experts well acquainted with its geographical features estimate that the area suitable to planting and growing oysters is equal to the amount of acreage available in all of the other States of the Union combined. By far the larger part of this extensive coast was dotted by extensive natural oyster-reefs, originally—that is, in a state of nature—only distant from each other a few miles. Those most accessible to speedy transportation to market have been in some cases almost entirely denuded, and others seriously impoverished by the constant fishing in and out of season. In still other instances the fresh water from river crevasses has occasionally, but only temporarily, injured the productive capacity of the beds. These injuries are, however, but occasional and temporary, as we have just said. The fecund, recuperative power of nature, in no way more strikingly illustrated than in the immense reproductive capacity of the oyster, soon replenishes the stock, whenever the depredations of fishermen or the overflow of fresh water cease, and the beds are allowed to rest for a time.

Besides these natural beds, the coast abounds in suitable places in which the mollusk can be transplanted from the seed bed and under proper care developed into an oyster which, for the delicacy of its flavor, can not be excelled the world over. East of the Mississippi River these natural beds are still numerous, and transplanting is carried on to but a limited extent. Not only do these beds supply the wants of the people of the lower coast, but small quantities are shipped to the New Orleans market, and poachers, or "pirates," so called, from Mississippi carry away annually hundreds of schooner loads of the shellfish. A fleet of lumber schooners, said to be capable of carrying from 1,000 to 2,000 barrels and supplied with shallops and dredges, effectually comb the beds of St. Bernard Parish. In addition to those thus gathered large numbers are crushed and broken by the dredges, while others are buried in the mud, which covers and smothers them. These oysters thus removed are not culled on the banks, but are carried and sold in the rough, just as they come from the water, to the canneries on the Mississippi Sound for prices varying from 30 to 60 cents per market barrel.

The flavor of these bivalves here taken, although of excellent quality compared with those of the Atlantic States, is by no means equal to those taken from the choice planting-grounds across the Mississippi, going west from the great river. Bayou Cook, Grand Bayou, Bayou Lachuto, Timbalier Bay, Last Island, Barataria Bay, Wine Island Lake, Vermilion Bay, and the Calcasieu grounds furnish the best, those of Bayou Cook having the highest reputation in the markets of Louisiana and the neighboring States and bringing a correspondingly higher price.

The manner of cultivation, if it can be dignified by that name, and the methods of fishing and forwarding to market are of the most primitive character, and the capabilities of production have as yet been hardly demonstrated. The fishermen are mostly uneducated Austrians from the Slavonic provinces, commonly known as "Tackoes." Small colonies of them "squat" on any available shore, generally along some stream, bay, or lake emptying into the Gulf, regardless of the ownership of the land, erect their huts, and with the capital of a pair of oyster-tongs, a skiff or two, and a small stock of rough provisions, usually advanced by the dealers in the city, embark in the trade of oyster fishing. Few of them own luggers or engage in the business of forwarding their oysters to market. From time to time they recruit their helpers from the freshly arrived of their countrymen, who, knowing neither the language nor the country, go to "learn the trade" at nominal wages as a sort of apprenticeship, receiving board and lodging, such as it is, as part compensation for their labor. The master fisherman or "captain," as he is termed, thus equipped and assisted, starts out in the planting season and transports from the natural bed skiff-loads of the shellfish, which he deposits in the brackish bayou or lake which he has selected near his cabin, marks his beds of "plants" with stakes to designate his ownership, and keeps "watch and ward" over his possessions until his crop is ready to ship to market. Others do not plant at all, but only fish the natural oysters from the bed and sell to "luggermen."

The planted oysters transferred from the natural beds, where the sea water is very salt, soon feel the beneficial effect of their changed condition. The fresh-water streams, draining the rich alluvial highlands, bring down in profusion infusoria and other low forms of vegetable and animal life on which the young oysters thrive. They commence immediately to fatten and alter the shape of their shells gradually from the lank and slim form somewhat similar to an irregular isosceles triangle, broad at the hinge and diminishing in breadth, until they narrow down to what is commonly, but erroneously, called the mouth, forming somewhat of a wedgelike contour, to a more rotund or parabolic shape as they grow larger. The rapidity of growth of the Louisiana product is marvelous. In the North Atlantic States it takes nearly three years, as we understand, for the fish to mature from the seed, so as to be marketable. In the Louisiana waters it takes hardly more than one-third of that length of time.

When sufficiently matured, say to an average length between 4 and 6 inches, the time of fattening and growth depending to a great extent on the size when transplanted and the richness and abundance of the food in the locality, the crop is ready for marketing. During the fattening process, however, the plants are subject to a variety of diseases, although not so numerous or so fatal as those in the colder waters of the North Atlantic, nor are they exempt from other destructive agencies. Schools of drumfish and sheepshead prey upon the beds, crushing the shells easily and devouring at times in a single night hundreds of barrels of oysters. Crabs also devour the young oyster, while a number of crustaceous borers and starfish find their way through the shells and kill the young brood. To guard against these depredations, although ineffectually in most cases, pens formed of stakes driven in the bottom of the stream are erected around the plants.

The planting we have alluded to consists in strewing the natural young oysters in thin layers over a hard bottom, which has previously been selected and located, or at times artificially created by deposits of old shells. In gathering or "tonging" the oysters from the natural beds, 20 barrels per day is considered a good day's work per hand. This, however, is rarely reached, owing to the unreliability and inferiority of the labor. The "Tackoes" are not by disposition an industrious people, and, like all the people dwelling near the shores of the Mediterranean and Adriatic, they are inclined to the *dolce far niente*, and are peculiarly sensitive, from their former habitats, to the effects of the cold northers of the Gulf. Moreover, they are timid sailors and dread the sudden storms of our southern waters. They are careless and heedless of waste, and it is a common practice, although contrary to law, to "cull" the natural oysters, and for that matter the plants as well, on shore or while under sail from the beds. The fatal effects of this practice will be readily perceived when we state that it consists of scraping and knocking off the myriads of embryos of young oysters which adhere to the older ones, and which should be dropped back into the water upon the beds, to be thus preserved and matured, but instead are dropped on land or in the water away from the beds and there left to die. This is but one example of the ordinary run of the "Tacko" oyster fishermen. Nor is this confined to the people of this nationality alone. It may be said to be general among nearly all the fishermen.

The report of the United States Fish Commission of 1880 says:

> The shipment of oysters from New Orleans has hitherto been very small, and principally of fresh oysters. * * * Work is irregular because of the difficulty of getting oysters in sufficient quantity and when needed, owing mainly to the indisposition of the oystermen to work in bad weather.

There are no statistics at hand by which the total of the gathered crops can even be approximately estimated. Prices vary considerably, according to the weather and the season. Small, natural, unplanted oysters, commonly called "coons," suitable for planting, can ordinarily be purchased at from 25 to 60 cents per barrel, delivered free on board at the beds. Fully matured plants vary in price at the plant beds from $1 to $2 per barrel, according to the reputation of the place from which they come. These "barrels," however, are what are technically called "bank measure"; that is, 2 "bank measure" barrels make about 3 barrels when sold in market. When the planter finds that this crop is sufficiently matured and fat, ready for market, say six or eight months after being transplanted, he bargains and sells to the "luggerman" on the ground. A few planters own or have their luggers and ship for their own account. The "luggermen" transport their purchase to market, generally to New Orleans. The trip to the city usually takes from two to three days, a part of the journey consisting in threading narrow, shallow, and tortuous bayous. Adverse head winds sometimes delay the passage so long that the cargoes are unmarketable on reaching their destination. Sometimes, where practicable, "cordelling," or hauling the luggers by horse or man power, is resorted to, and at times steam towage, when accessible, is employed, all of which, of course, is an element of further expense.

Arrived at New Orleans, the luggerman disposes of his load to the dealers, who supply the local trade and ship to neighboring cities. Prices range according to the supply. Favorable winds may serve to bring in on the same day a large fleet of oyster-laden craft to "Lugger Bay," as their landing opposite the French Market is called. The market consequently becomes overstocked and glutted. If to this is added simultaneously a sudden change of weather from cold to warm, a not unusual thing in this climate, the luggerman is forced to sell at a very heavy loss on purchase price or unload his cargo into the river. Besides these adverse contingencies, there are the ordinary accidents of navigation, such as grounding and remaining so for several days in the low tides in the shallow lakes and bayous, and storms of several days' duration, when the timid luggerman, who shortens sail ordinarily on the slighest rise of wind, now anchors or "ties up," and awaits its cessation. Then, too, the cargo is in considerable risk of being killed while in transit. A violent collision with the bank or another vessel, a violent hammering on the deck, and even heavy peals of thunder, have been known to "deaden" the whole cargo, and if the weather be warm and the market not close at hand there ensues a complete loss.

With all these disadvantages, however, which could easily be obviated by prudent and proper precautions, and in spite of the heedless, thriftless, and primitive manner in which the trade is carried on, these Austrians amass, in nearly every instance, considerable profits, make what are to them handsome sums and respectable fortunes, and usually retire to their native land, there to live, with their few wants and the Continental cheapness of living, the balance of their lives in comparative affluence for people of their class. These fortunes are ordinarily realized in a few years, seldom more than ten or twelve. On retiring, the fisherman disposes of his hut and outfit, oyster-beds, tools, boats, etc., with the good will of an established business, to some relative or friend whom he has imported to the country for the purpose, or perhaps to some of his helpers who have saved a little money. In some instances good round sums are realized by these sales. In others, the retiring vendor retains a share in the business and draws a portion of the profits, occasionally paying flying visits to this country to look after his interests.

Most of these men can neither write nor read English or any other language, nor do they speak or understand any tongue save Slavonic, and when dealing with those other than of their own nationality require the services of an interpreter. These small fortunes, which they amass in so short a time, generally consist of sums varying from $5,000 to $15,000 or more. Considering the smallness of their operations, the lightness of the labor, the exceedingly limited character of their business in every respect, the utter want of scientific or practical knowledge of oyster-culture possessed by them, the acquisition of such sums in so short a time is marvelous. And yet when we consider their manner of life and their immense profits, hereafter shown, it is easily comprehended. They "squat" on any lands, public or private, for which they pay no rent. Hitherto they have paid no rent or taxes of any kind. They pay nothing for their oysters if they tong them themselves. They subsist on fish, which are plentiful and easily caught at all seasons, supplemented with poultry, which they raise, and game of all kinds, which abounds at proper seasons. In some cases they reclaim a portion of the marsh land in the neighborhood of their cabins by filling it in and cultivating vegetables thereon. During the "close" season, when only a small quantity of oysters are illegally or surreptitiously marketed, they engage in other profitable pursuits. Their expenses are almost nil, outside of a small account for store provisions and rough clothing, and their proceeds are almost clear profit.

In addition to the sale and shipment of fresh oysters, large profits have been realized by the canneries, which have been established from time to time; but as the oyster supply in their neighborhood has been diminished by indiscriminate and unseasonable fishing, and as the prices have increased, some of these establishments have removed to more favorable and lower-priced localities where their materials could be purchased almost on their own terms. The canned oysters shipped from Louisiana until recently have always been of the poorest and cheapest quality, subjected to the "bloating" process by continued "floating" in fresh water, and then canned by some imperfect process which imparts to them an unpleasant and "woody" taste. All these practices have combined to give Louisiana oysters an unfavorable reputation in markets outside of the State, though when properly prepared connoisseurs have pronounced them equal, if not superior, to the best of Chesapeake Bay or those of any of the other eastern fisheries.

If we turn from this primitive, loose, and careless method in which the oyster industry of Louisiana is at present carried on, and compare it with the skill, industry, and science with which the industry is conducted in the Eastern States and in Europe, and then consider the vast area that the Louisiana oyster-grounds present, the warm waters of the Gulf, the richness of the food, and the numerous other superior advantages which their situs affords, there dawns before us a field for investment, with such rich returns therefrom, as is scarcely presented anywhere else in the wide world in this or any other employment of men and money.

Let us for a moment illustrate the enormous profit accruing to these primitive planters and luggermen. A bank barrel of coon oysters will, when transplanted for six or eight months, increase to 1½ barrels by reason of growth. The coon oysters can be obtained free from the natural beds at no cost except the price of labor. If purchased, they cost 30 cents per barrel. This 1½ barrels is sold to the luggermen at from $1 to $2 per barrel at the plant beds. When the luggerman sells at the city market he obtains from $3 to $4 per market barrel, 2 bank barrels making 3 market barrels. Thus the bank barrel of fish which the luggerman has bought at $2 brings him 1½ barrels (market), or from $4.50 to $6 per bank barrel. If the planter himself ships he would obtain $6.60 for what he has paid 30 cents, or obtained for nothing if he fished for them. The same would be relatively true, only with a smaller amount of profit, where natural oysters are transplanted and so kept a few weeks simply to improve their condition by fattening before shipping.

As the trade is at present carried on the planter gets the benefit of the first difference in growth, and the luggerman the advantage of the difference between the bank and the market measure. Thus a person who both plants and markets his oysters, as we have said, would pay 30 cents a barrel bank measure, and from that barrel he would gather 1½ bank barrels of mature, marketable oysters, which, selling at, say, $3, he would get $6.60 for what he originally paid 60 cents. In other words, 1 bank barrel of coon oysters worth 30 cents expands into 1½ bank barrels of plants in six or eight months, which is 2¼ market barrels, worth from $3 to $4 each. At $3 per barrel the 30-cent purchase becomes worth $6; at $4 per barrel, $9. Of course, these prices are predicated on the lowest buying and selling rates, and on the basis of large purchases and sales in an ordinarily favorable market. These profits would be immensely increased if the spawn were scientifically protected, and the immature oysters were preserved from disease and numerous enemies by proper precautions now universally in vogue in the older countries and fully described in The Oyster by Professor Brooks; Oemler's Life History, Protection, and Propagation of the American Oyster; the reports of the United States Fish Commission; the reports of the oyster commissioners of many States, and other American and European literature on the same subject.

That the field for investment is an inviting one, and is gradually becoming recognized as such by investors both within and without the State (and must become still more so as the subject is investigated and studied), is shown by the formation of several incorporated companies now engaged in the development of the industry. Outside of many small individual efforts in that direction, several associations have been formed, prominent among which are the Gulf and Bayou Cook Oyster Company, Limited, which owns the major portion of the lands in Bayou Cook and the valuable planting-grounds thereunto appertaining, and also the Louisiana Fish and Oyster Company, the latter of which is now in active operation, and the former will soon be, having just successfully terminated a long litigation with some of the Tacko "squatter" fishermen.

The legislature of the State has just recently passed prudent acts for the protection of the fisheries, reserving the natural beds not heretofore granted for public use during the "open" season, providing for a somewhat proper police, as well as the leasing and selling of the State lands suitable for planting at moderate rates, and exacting a minimum tax to execute the law. The right of fishing for oysters is reserved to the citizens of the State alone. This law—which is imperfect in not closing for a longer period in each year the natural oyster-beds, which have well-nigh become exhausted, so as to allow them to recuperate and to be restored to their pristine fruitfulness—will probably be amended and perfected by future assemblies as the legislative mind becomes more educated on the subject, as it has been in the older States that have undergone the same experience in this respect.

The Louisiana legislature at its last session passed a resolution (No. 136 of session acts of 1896) that—

> The United States Fish Commission be requested to investigate the oyster-spawning season and report to this general assembly before its next session the exact season of the oyster spawning in this State, and all other facts respecting the same, and whether or not the present existing laws are not injurious to the oyster industry of this State.

Of course such improvement will be strenuously opposed by the uneducated fishermen and the avaricious luggerman and dealer, who look no farther than the present profits of the day and care not for the future, although if they did but know it they are more vitally and immediately interested than all others in the prevention of the ruin of the fisheries. In pursuance of this resolution the United States Fish Commission steamer *Fish Hawk* will, we are informed, immediately on the adjournment of this Congress proceed to make the investigation requested, and will report thereon to the next general assembly of the State, which meets in May of this year. Without trespassing on or unduly anticipating the recommendations which will then be made, we venture to suggest consideration of the following points:

(1) The establishment by the State of a fishery commission to protect and regulate more effectively the oyster fisheries as well as the fin fish, both salt and fresh.

(2) The establishment of a station by the United States Fish Commission on the Louisiana Gulf coast convenient to New Orleans as a distributing-point for the Gulf and interior States.

(3) The closure for several years of those natural reefs and beds which are now on the point of exhaustion.

(4) A prolongation of the ordinary close season from April 1 to October 1, as it has been shown that this interval of time is used for spawning, which is not confined to May, June, July, and August, as heretofore thought. During the six months of close season suggested the sale of oysters of any kind should be prohibited, whether from private beds or public reefs. Dealers, common carriers, and others should be punished for transporting or dealing in them during the close season, the same as under our game laws. The present law allows the sale from private beds, although ordinances of the city of New Orleans prohibit the sale of oysters of any description from May 1 to September 1 of every year. The allowance of sales from private beds during the closed season opens the door wide to indiscriminate selling and renders the law inoperative and incapable of execution.

(5) Persons found with unculled oysters in their possession in any other place than on the banks should be severely punished.

(6) Every incentive and inducement should be held out by legislation to encourage the culture of the oyster and the use of natural reefs should be confined, as far as possible, to supplying seed, to be planted and improved by cultivation. To that end liberal sales and leases for terms of years should be granted on the public lands and waters suitable for oyster-culture. Riparian proprietors should be given and granted the right to plant and cultivate oysters to a certain distance on their water front and other means should be resorted to, in order to offer inducements and accord liberal treatment to capital to develop this enormously valuable industry, which has as yet hardly been touched.

Perhaps obstructions to improvement are always to be expected from the ignorant. In New Jersey, where such extended closure of seed beds was similarly opposed (as it was in France and other countries), the commissioners tell us "all the opposition offered at the outset of this proposed system of protection has now disappeared, and those who were loudest in their protestations have acknowledged their unfounded prejudice and error. All of the seeding-grounds of Delaware Bay enjoy a rest of 9½ months each year. As a result the beds have increased in area and new beds are continually forming, and the supply is increasing to a wonderful extent." If the legislature of Louisiana will follow the wise example of those older communities and also prevent the use of natural beds except for seeding purposes, and thus compel and induce the proper cultivation of the oyster, a mine of untold wealth will be opened both for her own exchequer and the people.

The difficulties, dangers, and delays of transportation are being rapidly overcome by railways and canals—some already built and others projected—penetrating many of the best oyster regions; and if capital be properly encouraged and protected in its investment, as it assuredly will be, the day is not far distant when the product will be immeasurably increased, the price for home consumption greatly reduced, and an export trade established which will supply the whole of the Western territory of the United States, from the Mississippi to the Pacific coast, at reduced prices. Not only to the capitalist is the field open, but to the skilled oyster-culturists of Chesapeake and Delaware bays, Long Island Sound, and the Connecticut shores the State offers cheap oyster-lands for sale or rent, and a free supply of seed. To all such, with a minimum of capital but with skilled industry and energy, she opens her arms to welcome them to a home on the verge of her "summer sea," beneath skies which hardly know what winter is, and to cheer them on to fortune and her own industrial development. This is no fair-seeming but false promise, but one tendered in all sincerity and based on facts which the writer has been careful to understate rather than to overestimate.

NEW ORLEANS, LOUISIANA.

THE OYSTER-BARS OF THE WEST COAST OF FLORIDA: THEIR DEPLETION AND RESTORATION.

By H. A. SMELTZ, A. M.

One of the greatest benefits the State of Florida shall receive from the assembling of this Fishery Congress is the good influence on public opinion, and from the closing session of this assembly our people will not only know more about oysters and fishes and sponges, but they will realize that all these things are being exhausted, so far as the natural supply goes, and also realize that something must be done, and at once, in order to preserve these bounteous natural gifts so lavishly poured out by nature's hand. The fact is, the natural oyster-bars are a magnificent inheritance that has cost us nothing, and we are not only using but abusing nature's providence by the most extravagant wastefulness and improvidence, and it is only by the education of the masses along these lines that we may hope for success in the restoration of our depleted oyster-bars and sponge fisheries.

In 1876 I came to the west coast of Florida from one of the largest oyster-growing sections in the world, Chesapeake Bay. I landed at Cedar Keys and at once became interested in the oyster-beds of Florida. After spending three weeks at Cedar Keys, I cruised southward, examining the most prominent oyster-beds, such as Crystal River Bay, the bars of the Cootie region, Clearwater Harbor, Point Pinellas, Hillsboro Bay, Old Tampa Bay, and on to a hamlet I found at the mouth of the Hillsboro River known as Tampa; thence I continued southward to the Alafia River, Big and Little Manatee, Sarasota, Boca Grande oyster-bars and 100 miles farther south, and on every hand I found the same condition—oysters, oysters everywhere. How little did I then think that in less than twenty-five years every one of these bars would be partially or totally depleted. On every hand I found these immense reefs and beds of oysters in such seemingly inexhaustible supplies that it frequently occurred to me that the great God of nature must have gone ahead of me and, with hands wide open, scattered right and left and out into the depths so far that I failed to find their limits. On the shores, as we landed from time to time, I found for about 150 miles, at short intervals, great mounds of oyster shells, often 25 feet high and 200 feet long, monuments of a magnificent oyster supply antedating all records and traditions, feeding races so far back that ethnology shakes her head and declares, "I never knew them."

But I hear someone ask, "If this west coast of Florida be so thoroughly adapted to the growth of the oyster, how is it that these wonderful bars should all be either partially or totally depleted?" Let us ask a second question: How is it that every oyster-growing section in the United States has had to meet and settle, in one way or another, this identical question of depleted oyster-bars? The answer in each and every case is: As long as any of the oyster-growing States were in the hands of a few Indians the demand never approximated the natural supply, and even during the early occupation of the country by white men, with its sparsely settled communities, the demands were insignificant, and the oyster-bars increased and multiplied; but when the tide of immigration set in, and the sparsely settled communities became thriving villages, and mere hamlets became splendid cities, and in the place of the Indian's canoe and the early settler's bateau, came the sloops, schooners, steamers, railroads, and even the ocean steamers, demanding these oysters to distribute them to the east, west, north, and south, to say nothing of the increased home demand—when we consider all these constantly increasing demands, we see very readily that the answer to the question is simply that the demand is an hundredfold in excess of the natural supply, and the artificial supply amounts to nothing, and never will amount to anything, in Florida, as it never has amounted to anything in any other State, until by proper legislation oyster-raising is put on a business basis, the State giving every citizen who wishes to engage in the oyster business the same opportunities, the same rights, and the same protection she gives her citizens to conduct any other legitimate business.

As matters stand to-day in Florida, the oyster interests (I mean their protection and propagation) are everybody's interest, and on the west coast of Florida there are thousands of acres of land covered with water that are more valuable for food production than the best hummock lands, and yet neither the State nor its citizens get one farthing's benefit from them, whereas, by proper legislation, these oyster lands now lying idle could be sold or leased and put under the head of taxable property, and thus immensely increase the revenues of the State. Then, and not till then, will public opinion respect the property a man has in oyster-beds.

On this west coast of Florida we have all of the natural conditions—climatic, geographic, and hydrographic—and the extent of territory to establish an immense oyster industry, which would pay into the treasury of the State such revenues as would appreciably reduce all other taxes, and in this way I believe public opinion can most readily and most speedily be educated on the oyster question. Show a man (and the same is true of a State) that you can and will make money for him, and immediately you enlist his interest and his sympathy, when all your moralizing and sentimentality fall flat as a flounder.

But let us come to the practical and tangible part of the subject. Here I have hundreds of specimens of oysters brought from these partially depleted beds of the west coast, by which I wish not only to show the wonderful processes of nature in adapting itself to the various circumstances and often peculiar conditions under which the eggs attach themselves to any suitable object they may find in their wanderings, but also to demonstrate that there are still on many of these beds enough oysters left to furnish seed for their restoration by proper protection and timely aid, either by the State or its citizens individually.

In order to understand the subject before us more thoroughly, let us look at the oyster himself. Here we have an animal living in a limestone house which he builds for himself. He begins this house-building when he is four days old, and he continues to build and, as necessity requires, to repair this house as long as he lives. In the ages past the oyster was a swimming animal, as he now is for the short period of from five to ten days. At this period his two shells are equal; but after the period of attachment, which is by the left shell, the lower shell becomes cup-shaped and the right or upper shell becomes the lid.

The oyster makes his shell out of the gummy secretion of his mantle, which catches and fixes the lime of the sea water by some special process not yet thoroughly understood, thus creating a substance out of which he not only builds his shell, but repairs very neatly all damage done any part of his shell, even to the making of a new hinge; or, should any foreign substance enter his shell which he can not expel, he covers it with this substance, and so rapidly does he work that he will put on the first coat or film in about 24 hours.

Lime for shell making is one of the prime necessities for the rapid development of the oyster, and all waters deficient in lime are by just so much unfit for the perfect development of the oyster. Oysters in waters deficient in lime have shells so thin (in both young and mature oysters) that they fall an easy prey to their enemies, and for the same reason are ill-suited for shipping to any distant market. Here, again, the west coast of Florida, with its coral sea foundation and its wonderful phosphate deposits along the shores, sending additional lime to the oyster-beds by every inflow of fresh water, presents very great advantages for the most rapid and perfect development of the oyster. This inflow of fresh water from the many springs scattered along this coast is of peculiar advantage to the oyster, because it reduces the specific gravity of the sea water to a point generally admitted to be most suitable for the rapid development of the oyster.

As to its anatomy: The oyster has a heart and blood circulation, as we find in other animals. He has a pair of lips, and a mouth situated in the back or hinged part of the shell (and not, as popularly supposed, in the front or open end of the shell). He has a full set of digestive organs—stomach, liver, intestinal canal, etc. His food consists of about 90 per cent of vegetable matter, about 5 per cent of mineral matter, and 5 per cent of a mixture of the reproductive organs of seaweed, etc. This vegetable food is chiefly diatoms (a low form of vegetable matter having the peculiar quality of great activity in the water). These diatoms are much more active during a bright, sunny day than on cloudy or foggy days, and this is another of the many reasons why the oyster in Florida (the land of sunshine) grows more rapidly than in other sections subject to cloudy and foggy weather, to say nothing of snow and ice and a general temperature of the water frequently below the point of advantageous feeding.

The natural food for the oyster, found in all sea water, can be supplemented by many land products. The two most desirable in Florida are the pollen of our pine trees and the bloom of our palmetto. By using the bloom of both saw and cabbage palmettoes this food can be furnished them for about five months of the year.

The oyster has not only sensory organs of smell, but eyes also to see. These eyes are, however, not highly developed, self-focusing eyes, as we find in animals of higher order, but rather a rudimentary eye or eyes scattered all over the body of the oyster, and so constituted that they serve the oyster in or out of the water as admirably as do the eyes of animals of a higher organization. The oyster has also nerves and brains, not highly developed, but sufficiently so for all his needs and purposes. The reproductive organs of an oyster are simply wonderful as to their capacity for egg-production.

Unlike the European oyster (*Ostrea edulis*), which is hermaphrodite, our American oyster (*Ostrea virginica*) is unisexual. By this I mean that every oyster lays each season either (and only) male eggs or female eggs; but I believe that it is an established fact that the same oyster that lays male eggs one season may lay female eggs the next season, or vice versa. The female, according to size, age, and vigor, will lay from 1,000,000 to 40,000,000 eggs annually. This calculation is based on the size of the egg as compared with the size of the ovarium at the time of laying. Both male and female eggs at the spawning season are swept out of the ovarium into the water, where the female egg becomes fertile by contact with male eggs. It is highly probable that not more than 10 per cent of this vast number of eggs ever become fertile. The eggs not fertilized are either dissolved by the action of the sea water or are eaten by fish or other sea creatures. As soon as the oyster egg is fertilized changes take place very rapidly, and in less than 24 hours it begins to swim and is drifted about by tides, currents, or winds, but is always ready with its hair-like tentacles (cilia) to catch hold of any clean object with which it may come in contact and remain there for life.

This now brings us to the answer of the second part of our subject, "How can we restore the oyster-beds on the west coast of Florida?"

(1) By utilizing the eggs from the oysters left on these bars. On all these bars there are still enough oysters left for egg production, and by scattering over these bars from year to year, and just before the laying season, clean oyster shells (or, what is better, the small shells found in great abundance on this coast) to catch this spat, our bars will, if left undisturbed for a few years, be so restored that a reasonable amount can be gathered annually, and if not unreasonably drawn upon they will soon recover themselves.

(2) As, however, we have all along this coast and in the neighborhood of these depleted bars thousands of acres of raccoon oysters,[1] that are in every way adapted for seed, to plant on these bars, we can restore them in a comparatively short time by combining the two methods. The latter method is the one used in restoring the depleted bars of our Northern States. It is a simple matter of history that when our Northern oystermen found their bars depleted they sent vessels to the Chesapeake Bay and as far as the James River and bought small or seed oysters and scattered them over their bars, and from year to year not only take up and sell those of marketable size, but continue to import and scatter about a regular amount of seed oysters annually. Now, then, if it pay the Northern oystermen—and if it did not pay them they certainly would not continue to do so from year to year—to buy oyster seed and transport it several hundred miles, will it not pay the oystermen on the west coast of Florida to simply pick up, free of cost, and transport only a few miles this seed from the raccoon bars?

Inasmuch, then, as this coast by nature is so admirably adapted for oyster-growing, and as the natural bars still contain enough oysters for spat production, and as the oysters and many other kinds of shells are here in greatest abundance to be used as a cultch, and as there are thousands of bushels of good seed oysters in the immediate neighborhood of the depleted bars, I see no reason why, with proper State legislation and an enlightened public sentiment, these oyster-bars on the west coast of Florida could not be restored to their original splendid condition and in a few years be the means of considerable revenue to the State.

TARPON SPRINGS, FLORIDA.

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[1] It is an established fact that we have but one species of oyster on the Atlantic coast (*Ostrea virginica*) and that the raccoon oyster is identical with the regular commercial oyster.

NOTES ON THE FISHING INDUSTRY OF EASTERN FLORIDA.

By JOHN Y. DETWILER.

EXPERIMENTAL OYSTER-CULTURE.

It is a well-known principle that flourishing animal life depends on special factors, the most important of which are the facility for obtaining food, the proper temperature of the medium in which the animal lives, and the indefinite continuance of the favorable conditions. Nature in her attempts to bring about the necessary conditions is pre-eminently successful, and only when man interferes or other disturbing elements exist do her efforts prove abortive.

The peninsula of Florida, with its coastwise resources, from the evidences remaining to us at this time, has in the past been teeming with food products that sustain human as well as animal existence. Modern investigation has proved that it is no less prolific under the existing conditions. Modern civilization, through the medium of scientific researches, aided by improved means of communication and transportation, has demonstrated that, by a judicious and thorough examination into the causes that bring about a certain result, nature's food supply can be greatly increased as well as preserved for the use of the present and future generations. Recognizing this fact, his excellency, Governor Bloxham, of the State of Florida, issued a call recommending that the sections of the State interested in this important subject be represented at a national congress of the fishing industries, to convene in Tampa on the 19th of January of the present year, to promote and advance this important industry.

As a delegate to this body, engaged in so laudable an undertaking, I feel highly honored in representing the locality embracing the Halifax and North Indian rivers of the east coast of Volusia County, Fla., a section of country once occupied by a race of people who subsisted mainly on the food products of the water, as is clearly demonstrated by the existence of shell-mounds located at many points on the peninsula and on the mainland, showing the great importance of the salt-water lagoons, bays, and estuaries, as well as the ocean, to keep up their existence.

It is useful to refer to the past merely as an indication of what has been accomplished by those who preceded us; our purpose is with the present, and how we can best advance the interests of mankind, increase our sea products, and preserve our present advantages. With this introduction permit me to advance a few thoughts on this subject in relation to the propagation and culture of the oyster, an industry of vast importance to all sections of the United States, for but few places exist in the civilized world where oysters, in some form, can not be procured.

Oyster-culture on the southern seaboard, compared with the sections embraced in New York, New Jersey, Maryland, and Virginia, has not been as productive as could be desired by those interested in that pursuit, and for this reason, among others, we are assembled. That the proper conditions exist in localities no one doubts, but the successful propagation of the oyster under all circumstances, either natural or artificial, is to be considered and discussed, and some definite conclusion arrived at, if possible. The environments and advantages possessed by individuals have much to do with their powers of observation, and I speak to you after a residence of fifteen years near New Smyrna Inlet, undergoing the trials that attend those who, with unbounded hopes and limited resources, emigrate to a new country, leaving behind all with which they were formerly associated, and relying on the natural food resources to a great extent for sustenance. These conditions bring mankind in close relations with nature, and through the necessities of the case nature's mysteries are unveiled.

The utilization of the salt marshes of the coastwise country for the propagation of the oyster is, in my opinion, the solution of this most important problem—not to ignore the planting of oysters in the creeks, bays, and open waters of the State, but to introduce an intensive system, as it were, that will ultimately insure success. There can be no success without effort, and to the brains and brawn of our land are we indebted for all we possess. The same effort expended in labor or capital in reclaiming a portion of our salt marshes for the planting of the oyster I sincerely believe will result in greater financial returns than in any investment that could be made in either orange, vegetable, or tobacco culture, all conditions being the same. I may be assailed as an extremist, but it certainly will cost no more to prepare the ground in one case than in the other. The cost of fertilizer, the packages necessary for transportation, destruction by frost, and the necessity of securing a market at once or meeting an entire loss—these considerations, with many others, are ever present with the agriculturist. The independence of the oyster-culturist arises from knowing that his product will keep until it can be disposed of advantageously, with no loss by frost or decay; and instead of seeking a purchaser, the purchaser seeks the product and pays a satisfactory price, and the producer only has to bag or deliver the goods. The conditions that now govern the transportation of Florida products are in favor of the oyster, for water communication renders competition possible and the industry profitable, which is not so in vegetable-culture except in special cases.

Again, the natural enemies of the oyster in the open waters of the Southern States are neither so plentiful nor so destructive as in northern localities, nor are the vicissitudes of seasons so apparent, causing destruction by freezing, ground ice, and severe storms, often entailing great losses upon those investing in the industry. The climatic conditions of the South are in favor of the speedy maturity of the oyster by promoting the culture of the diatoms and infusoria upon which they subsist. In fact, but one serious objection exists to the propagation of good oysters in all localities, and that is the extreme density of the water in which they abound, on the one hand, and a periodical drowning out by a superabundance of fresh water by excessive rainfalls in certain localities, on the other hand. Were these two extremes so modified, either by natural or artificial means, the coastwise territory of the Southern States would exceed in productiveness the output of the North, producing larger and finer-flavored oysters in the same space of time without the attendant suffering from the rigors of a northern winter.

Briefly stated, this can only be accomplished by utilizing our vast salt marshes and reducing the density, wherever required, by the use of surface water elevated by mechanical means, or the advantages obtained, if practical, by artesian wells to perform the same functions. Whether the sulphureted hydrogen usually present would prove detrimental, I am unable to state. I have been experimenting on that line for some time, but I can not say positively that it would prove injurious to the oyster in the quantities necessary to bring the salt water to the density required for its successful culture. I am satisfied that the oyster will live even when exposed to undiluted artesian water, at half tide, but whether the propagation of the animalculæ which constitute the food of the oyster would be retarded, can only be decided after great experience and by extended research, and I therefore suggest that this feature be made the subject of experiments by experts of the U. S. Fish Commission.

I have during the past year been taking observations relating to the salinity of the water near the New Smyrna Inlet with a set of salinometers kindly loaned by the United States Fish Commission. These observations, recorded daily with few omissions, have been submitted to Washington, and from them we hope to ascertain the necessity of utilizing fresh water in artificial ponds or trenches to reduce the salinity. I have under construction at present an experimental area of about 1,000 square yards where the salt water can be diluted to any desired degree of density by the use of surface water, elevated into a tank of 10,000 gallons' capacity and shut off by a drain from the river. Personally, I believe this method to be the key to artificial oyster-culture, utilizing the coon oyster, everywhere present, for the purpose of planting. Though comparatively a novice in this important branch of food production, observation, experiment, and a diligent research into the practical experience of others have impressed upon my mind most forcibly that the field for further investigation is a wide one and prolific of good and profitable results to those who persistently and diligently labor therein.

PROPAGATION OF THE SOFT CLAM.

Nowhere in the South do we find the soft clam, as known to the residents of the New England States. Among the Puritan fathers the clambake was an institution that brought into social relations the members of a community, and the waters bordering on the coast furnished the necessary products for these festive occasions. Down through succeeding generations the clambake has been and is now a time-honored institution, and is enjoyed by the residents of the coast and interior towns in near proximity to the ocean. The soft clam as an edible is far superior to the hard clam or quahog, and is also used for bait in the fishing industries of the section where it abounds. It is more fixed locally than the round clam and is much more prolific. On the southernmost shores of the Atlantic if at all present it is comparatively rare, and then occurs possibly only by being transplanted from its northern habitat. Our Florida lagoons and rivers, by reason of their shallow nature, abound in numbers of sand flats, exposed more or less at the various conditions of the tide. These could be profitably utilized for the culture of this desirable variety, which would prove a valuable acquisition to the locality, as well as a support to the inhabitants when once satisfactorily introduced. A preliminary consideration would be the necessity of protecting them from the depredations of parties having nothing but the present in view.

The soft clam has been introduced into the waters of the Pacific coast with the oyster, and has proved prolific and a desirable accession to the resources of that region. In referring to this branch of the shellfish industry it might be well to state to those having in charge these important problems of introducing the different varieties of fish, clams, etc., into new localities, that private enterprise is apt to labor under an immense disadvantage, by reason of unnecessary delay and carelessness on the part of the railroad companies during transit, and in many instances discouragement and disappointment follow. Were it not presuming unnecessarily, I would offer to plant and care for, to a certain extent, any consignment of soft clams for experimental purposes and distribute them to suitable localities, if provision be made for their protection.

There is also a species of mussel that is indigenous to the salt marshes in the vicinity of New Smyrna Inlet. This mussel is not edible, but at times has been utilized for bait. The taste is of an astringent coppery nature and unfitted for consumption for the above reason. The edible mussel also might become a valuable acquisition to this section if it could be satisfactorily propagated.

PROTECTION OF FISHERY INTERESTS.

The disadvantages that the State of Florida now labors under, by the reduced temperature experienced annually and the destruction of her valuable timber interests, without provision for renewal by the Government, necessitate the utilization of all available methods to develop her resources for the support of her inhabitants, and no better work can be done in this direction than to protect, to the fullest extent, the food-fishes and the oyster and turtle industries, including both the green and loggerhead varieties. The malicious slaughter of the female loggerhead should be punished to the fullest extent of the law, as well as the wanton destruction of fish by drag seines and gill nets. Since the law protecting the fish by preventing seining has gone into effect, the catch of sheepshead by hook and line has been greater than ever before, which makes the fishing-grounds about New Smyrna especially desirable for those who desire legitimate sport or those who rely on fishing for a livelihood. Heretofore the sheepshead were taken by hundreds in a drag net at night, which entirely eradicated in a short time the leading game fish in this vicinity. The same was largely true of the bass and trout. In these cases one or two persons monopolized the fishing business with drag or gill nets, and not infrequently the entire catch was wasted by no market or from lack of ice to ship. Nowhere in this section of the State is the fishing as good by line and rod as at this place at this time. Therefore, the protective clause in the fish laws of the east coast of Volusia County, Fla., has been productive of great good and should be continued, notwithstanding the efforts made to repeal it.

Of other prospective industries which might prove profitable, the propagation of the diamond-back terrapin, which abounds to a certain extent in the southern coast country, is suggested. The dissemination of knowledge by which the blue crab could be kept alive, in both the soft and hard shell condition, to enable it to stand transportation to a distant market, as well as practical information relative to the propagation of the stone crab (the lobster of southern waters), are subjects which deserve consideration. In the interior of the State are many ponds and lakes in which desirable fresh-water fishes could be successfully introduced, thus enhancing the value of those bodies of water and furnishing food and sport for many who are unable to visit the coast country for their supply of fish. A due consideration of these important subjects, resulting in effective effort, would greatly increase our food products and better the condition of the interior and coast country embraced in the waters of the Halifax and North Indian rivers of Volusia County, Florida.

NEW SMYRNA, FLORIDA.

OYSTERS AND OYSTER-CULTURE IN TEXAS.

By I. P. KIBBE,
Fish and Oyster Commissioner of Texas.

The subject of oyster-culture is an old one, yet its importance demands our earnest consideration. While it has been agitated in Texas for many years, experiments have been limited, though small ones have been made which have proved profitable.

About the year 1890 the Galveston Oyster Company transplanted a large quantity of oysters, removing them from Matagorda Bay to Galveston Bay. It is reported that this effort proved a failure, and that they lost not only the plant but also the spat of that season. The total destruction of this bed has never been satisfactorily explained, though several theories have been advanced—a mud deposit from the Gulf, drainage from the creosote works at Galveston. Another plausible theory is that the bed was maliciously destroyed by persons opposed to the enterprise. The fact that oyster-beds in the same bay, less than 10 miles from this bed, were not injured in any way, points to the latter conclusion.

While this experiment was unsuccessful, it is no proof that oysters can not be cultivated in Texas as well as elsewhere, for it is a fact that they have been profitably cultivated in a small way in this State for more than forty years. These results were obtained by transplanting in the spring into bayous, channels, or coves, which offer a better supply of food than the natural reef or bed. Oysters handled in this way grow much larger, fatten sooner, and bring much better prices in the market.

The Tiger Island Oyster Company, of Port Lavaca, Texas, planted over 4,000 bushels of seed oysters in March, 1897, and in November these oysters were in fine condition. More than one-fourth were average-size, marketable oysters, which, if left on the reef, would not have been utilized at any time, as oysters from this reef had not been found in a marketable condition for years. The price of transplanting being less than 15 cents per barrel and the market price of good oysters being from 75 cents to $1.25 per barrel, a good margin is left for the work of gathering and marketing.

It is claimed by some that oysters will grow in almost any locality and upon any bottom, a collector for the spat being the only essential. While this is true to some extent, my observation does not bear out this theory altogether. Food supply, as well as a limited amount of fresh water, are necessary elements. While they do well on some mud bottoms, on others they die as quickly as on sand. A deposit of foreign soil or mud will often kill out a bed, although a good bed will sometimes be entirely surrounded by a natural mud bottom. I am of the opinion that many failures can be attributed to this cause.

In changing oysters from one locality to another, depth and temperature of water should be observed as well as other natural surroundings. If any great change is necessary, it will be found that the young oysters will stand it much better than the grown.

Regarding the best artificial bottoms and collectors, I would say that these depend entirely upon the original bottom. If in deep mud and but little or no current or sea, brush, brush mats, old shoes, and leather can be used. If in current or sea, the mats would have to be anchored and the brush stuck in the bottom as a stake. Upon hard bottom oyster shells are considered the best and cheapest collectors, but will not do in soft mud unless fine shell be used as a foundation. In the planting of oysters, as in other things, the nearer we approach nature the more certainty there is of success.

Owing to the mildness of the climate and long growing seasons in this State, the oyster is very prolific. The spawn being less liable to injury from cold, a good spat for each year is more certain.

Many inquiries are made as to the maturity of a marketable oyster. Under favorable circumstances some mature in three years from the spat, but four years will ordinarily produce a good marketable oyster where favorably located on any part of our coast.

In this State the oyster has but few enemies, the drumfish being the only one dreaded. There are no starfish and but few worms or conchs.

Our present law gives to any citizen of the State the right of locating as much as 50 acres of land covered with water for an oyster-bed. The locator pays a surveying fee of $10 and a rent of 10 cents per acre for the first five years and 25 cents per acre thereafter. As long as the rent is promptly paid he is amply protected. He is allowed to gather seed oysters from certain reefs for planting without culling.

We have along the coast of our State about forty bays, lakes, and coves. But few if any of these are without a natural oyster-bed. Hence, there is no lack of seed oysters within easy reach of good grounds.

The above facts, with the climatic advantages and over 300 miles of coast, enable Texas to offer inducements in the oyster industry equal if not superior to any other State in the Union.

PORT LAVACA, TEXAS.

THE METHODS, LIMITATIONS, AND RESULTS OF WHITEFISH-CULTURE IN LAKE ERIE.

By J. J. STRANAHAN,
Superintendent of United States Fish Commission Station, Put-in Bay, Ohio.

In a paper of this character it will not be possible to go into details as to the methods pursued in whitefish-culture, nor do I deem it necessary, since the subject has been so often and so ably treated; but I will rather confine myself to what I conceive to be some comparatively new and interesting features of the work.

To summarize, it is only necessary to say that the mode pursued at the Put-in Bay station of the United States Fish Commission is the same as that generally followed, dry impregnation being the starting point—that is, the eggs and milt are brought into contact as they come from the fish and well mixed, after which water is added, the mass gently stirred and allowed to stand about 2 minutes, when the eggs are washed and placed in wooden kegs holding 15 gallons each.

In this connection it will be proper to state that a series of experiments made at Put-in Bay station the past season demonstrates that in water the milt loses much of its vitality at the close of 1 minute. In fact, at the close of ½ minute it has done its best work. In one test only 49 per cent of the eggs were impregnated by milt which had stood in water 1¼ minutes, and in another 47 per cent where it had been 1½ minutes in the water; while eggs from the same lot showed 98 per cent and 97 per cent impregnation, respectively, where milt was used from the same lot which had stood but ¼ minute in the water. It is therefore obvious that reliance should not be placed in milt which has stood over 1 minute in water, and it follows that eggs should be washed at the close of 2 minutes, as the longer they stand in the milt after impregnation has taken place the worse for the eggs, as shown by Professor Reighard and other writers.

After being brought to the station, some 2 to 10 hours after taking, the eggs are kept in the kegs in running water and carefully stirred once an hour until the next forenoon, it being our belief that while "harding"—that is, while the investing membranes are filling with water—they should not be submitted to even the gentle motion which they undergo in the jars.

It is evident to all observant fish-culturists that the eggs must be treated in the most gentle manner possible from the time they are taken up to the period when they are sufficiently cushioned by water to protect them from injury.

As is well known, many whitefish and lake-trout eggs are annually lost through lack of males at certain times, especially near the close of the season, when large numbers of ripe females are taken from the nets with very few or possibly no males. With this fact in view, experiments were made at Put-in Bay the past season to demonstrate practically how long the milt and eggs can be held separately and still retain their fertility. It was shown beyond question that both may be held at least 48 hours, and practically as great a percentage of impregnation procured as if applied immediately after they are taken from the fish.

I will quote from the records of the station the results of a few experiments which will fairly illustrate the whole. One lot of eggs taken on December 6 was impregnated on December 7 with milt taken on December 4; percentage of impregnation, 98. A lot taken on the same day and impregnated immediately with milt just taken showed the same percentage of impregnation—a mere coincidence so far as exactness is concerned. Another lot, where the spawn and milt were both taken on December 6 and impregnated on the 7th, showed 97 per cent impregnated. Still another lot taken on the 7th and immediately impregnated with milt taken on the 4th showed 95 per cent impregnation. Fourteen tests were made, and it may be inferred from them that neither the eggs nor milt can be carried past the third day with good results. With all those carried past that time the percentage of impregnation ran from 0 up to 6.

In this work care was taken that the eggs and milt should be kept entirely free from water and other foreign substances. The eggs were held in pans and the milt in corked vials, both being kept in running water at the then prevailing temperature of the lake—about 35° F. One lot of milt, where a very small clot of excrement had entered the vial, was used as an experiment 48 hours after it was taken and failed to impregnate any eggs.

One of the important problems in whitefish-culture in Lake Erie has been the successful penning of adult fish in order to hold them until their eggs are sufficiently developed or ripe. Up to the past season this has been a failure so far as practical results are concerned, for the reasons that the pound nets are so scattered and so few fish are taken from each on each day that under the usual methods sufficient fish could not be procured, and that when penned in stationary inclosures in landlocked bays—the only place where the crates can be held during stormy weather—the water, during specially warm periods, gets so warm as to render the fishes unhealthy and the eggs become congested, or what is called "caked," in the abdomens of the females. Both these causes have been removed at Put-in Bay station the past season.

A supplemental net 3 feet in diameter and 7 feet long, held open at the top and bottom by iron rings, is placed at each pound net by fastening one side to the down-haul stake and the opposite to the rim line of the pot, thus holding the top about 3 feet above the surface of the water. When the pound is lifted all the whitefish are singled out and lifted by a net made of coarse, open cloth—an ordinary net is too harsh on the fish and injures their delicate scales and fins—and dropped into the supplemental net, from which they are taken and placed in special tanks on the deck of the station steamer and removed to the crates located near the station. It will be readily understood that by this means the fish can be procured from a large number of nets, while otherwise only such can be saved as are procured by one lifting boat, accompanied by the steamer, as all the boats in a given locality lift at about the same time, generally early in the morning. After the fish are in the supplemental nets they can be collected by the steamer at leisure, taking all day for it if necessary.

To avoid the danger of too warm water the pens or crates are secured between long pine-boom logs, the whole making a substantial raft, which can be towed outside and anchored where good currents and safe temperature can be procured until danger is past. The crates are surrounded on all sides by walks for convenience in sorting and handling fish. The compartments of the crates are 8 feet square and 7 feet deep, with false bottoms guided by upright standards used in raising and lowering the false bottoms for the better examination of the fish. Each compartment will carry about 250 fish at a time, or about twice that number during the season, as the numbers are continually being added to and taken from, as new arrivals come in and the older ones are stripped and sent to market.

The fish are sorted into three classes, which are denominated soft, medium, and hard, and are handled as little as possible. The softs are examined the next day after being sorted, the ripe ones stripped, and the others reclassified if necessary—the mediums on the third day and the hards in about a week, it having been found by experience that very little spawn is lost by thus holding and very much unnecessary handling is obviated.

Although large numbers of fish were not penned at Put-in Bay the past season, owing to almost continuous gales, the experiment proved a complete success, as showing what can be done in an ordinary season. Over 10,000,000 eggs of good quality were taken, and it should be remembered that but for the penning the eggs would have gone to market in the abdomens of the fish and been lost. The fish, notwithstanding the adverse circumstances under which they were taken, did remarkably well, and only seven were lost because of becoming diseased, and they had been injured in the pound nets before coming to our hands. The last fish turned over to the fishermen were in as fine condition as if just taken from a pound, and some of them had been in confinement for a month.

As to the limitations and results, they must be largely a matter of speculation. With penning successfully carried out there would seem to be practically no limit to the number of fry which can be turned out, and then comes the question, To what extent is the hatching of whitefish beneficial? The statistics do not answer the question in a manner entirely encouraging to the fish-culturists, and yet I believe I am safe in saying that there is not a commercial fisherman on Lake Erie who does not think that the hatcheries have done much to increase the take of whitefish, many of them openly asserting that but for the work of artificial propagation whitefish would be practically extinct in the lake. They cite in proof of this that while the increase has not been what they might hope, the whitefish has reasonably held its own, while all other commercial fishes have rapidly fallen off.

There is another encouraging feature to be noted. If common report is to be taken for anything, the catch of whitefish has been greater in Lake Erie the past season than for several years past. This is especially the case with the gill nets in deep water, also with the pounds at the head of the lake, so the writer is informed on what seems to be trustworthy authority. Of course it is too early yet to have reliable statistics as to just what the catch was. The fish were small and of quite uniform size, which lead the fishermen to the conclusion that at least a considerable portion of them were the result of the large hatch of the season 1895–96, when 121,000,000 fry were planted in Lake Erie from Put-in Bay station, and when the Detroit hatchery of the Michigan Fish Commission and the Sandwich hatchery of the Dominion Government of Canada made specially large plants, all of which found their way into Lake Erie.

In common with other fish-culturists the writer believes that the work of artificially increasing the number of whitefish in Lake Erie and the other waters to which this fish is indigenous will be greatly improved when some practical way is found for holding and feeding the fry, if only for a few weeks, or until they are large enough to care for themselves. Nor do we believe that such a hope is wholly illusory, for the experiments of Mr. Carl G. Thompson, of Warren, Ind., who succeeded in rearing this fish from the fry in considerable numbers in comparatively small ponds by feeding them on fine wheat middlings, at least gives encouragement that the problem will yet be solved. It is true that experiments at feeding whitefish fry at Put-in Bay the past season were not successful, but the work is new and it may yet be brought to a successful termination.

MORTALITY AMONG FISH EGGS.

As is well known to fish-culturists, there is a considerable mortality among fish eggs between the stage where the embryo is formed and the time of hatching. Can this be prevented? To answer this question intelligently we must first know the cause, and to this end I have carried on a series of investigations, making them as thorough as I could with my very limited knowledge of the several sciences called into action and the appliances at hand.

Dead and dying eyed eggs, generally easily detected by the naked eye, were examined from time to time, generally in hundred lots, and where the cause of loss could be determined the results were kept in memorandum. In many cases the cause is easily ascertained; in other cases, with my limited knowledge, it could not be determined at all. I should here state that, having no microtome, all the work was done in gross, simply by the aid of the microscope, and that without doubt one well versed in the work and with suitable instruments could determine the cause of death in a large percentage of those where I failed. I should also state that the percentages here given are not absolute, for the reason that with dead eggs considerable numbers were in such a condition that no opinion could be arrived at, although if examined a little earlier the cause might have been apparent, and in the case of aneurisms and ruptured blood vessels most of them were discovered while examining apparently healthy eggs, the embryo being not yet dead but dying, and the egg therefore not yet so changed as to be detected by the unassisted eye.

By far the greater loss of the whitefish eggs in embryo, the only ones examined, is caused by insufficient food supply, the yolk being undersized, and when the store is exhausted the embryo dies of starvation, this occurring at all stages from the early formation of the embryo up to the time of hatching, those with very small yolks dying first and others later on. Taking an average of all my data, this amounts to 31 per cent of the total loss of eyed eggs, but for reasons already stated this is not strictly accurate, and I am of the opinion that it is too low rather than too high.

The next greatest loss is caused by abnormal development, and here I am less certain of my percentage than in the former case, for the reason that the diagnosis is more difficult to the unscientific eye. It may, however, be safely stated that the loss is not far from 20 per cent, and extends over the whole period of incubation up to the time of hatching, and doubtless far beyond.

In some cases there is not the semblance of an embryo, and yet life goes on up to a certain stage. The cell mass spreads out over the yolk in an irregular way, perhaps a brain and a heart forming with a rudimentary spinal column, while in other cases the egg dies before any of the organs are discernible. I have never observed eyes in any of these more imperfect ones; in fact, the eyes are among the organs first to show abnormality, while crooked spines are well-nigh universal. Often one of the eyes is rudimentary or missing entirely, and sometimes both.

Twins and double-headed monsters, common with trout, are so rare with the whitefish that I have discovered but few, except in the case of the eggs of a single fish, where they amounted to over 10 per cent of the whole.

Next come aneurisms and ruptured blood-vessels, probably between 5 and 7 per cent. Aneurisms are much more common than ruptures, and, contrary to the rule with the higher animals, they cause death without the complete rupture of the artery. The red corpuscles form a clot in the enlargement, the serum filtering through the mass, and only a straggling red corpuscle being seen here and there coursing through the vessels of the body. The clot seems to collect them all. The heart beats feebly, and death ensues. Aneurisms are most common in the side of the embryo about the middle of the body, and it seems that most of them are on the right side.

In the earlier stages, that is, up to about two months from the taking of the egg, there is a small loss occasioned by the rupture of the yolk-sac. In these cases the embryo generally lives a few days after the rupture. I have not computed this loss very closely, but it does not probably exceed 1 or 2 per cent.

In all these cases, where the embryo is far enough advanced to show the pigment cells, or "color stars," and is approaching death, the branches of the cells become shortened, and usually at death only the nucleus remains.

For the remainder, I have not been able to determine what is the cause of death. In many cases I find what seem to be small patches of a fungoid growth on the body of the embryo. I can not see that they do any harm, and have not discovered them on the bodies of dying embryos more than those in an apparently healthy condition.

It seems to me that these deaths are the result of the natural weeding out of the weakly individuals, "the survival of the fittest," the same as in the higher forms of life, and that no amount of care on the part of the fish-culturist can prevent it, except, possibly, in reducing the number of abnormalities by exercising great care in the taking and handling of the eggs, eminent biologists holding that monstrosities are often caused by injuries sustained at certain stages in the development of the individual.

In this connection I would state that, so far as my observation goes, this loss of eggs after the embryo is formed varies greatly from year to year. It is also certain that eggs taken near the close of the season suffer a greater loss in this respect than those taken at the flood. With eggs taken near the close in small lots this loss may amount to a fourth of the whole, or even more.

PUT-IN BAY, OHIO.

A BRIEF HISTORY OF THE GATHERING OF FRESH-WATER PEARLS IN THE UNITED STATES.

By GEORGE F. KUNZ.

The gathering of pearls from the fresh-water shells of North America, although a matter of comparatively recent date among the present inhabitants, really goes back very far into the unrecorded past, and early attracted notice among the first European explorers. In the prehistoric period the mound-builders of the Mississippi Valley gathered immense quantities of these pearls, as is amply shown by the stores of them found on the "hearths" of a number of mounds, especially in Ohio, by the recent explorations of Prof. F. W. Putnam and Mr. W. K. Moorehead. By age, burial, and in some cases funeral or sacrificial fires, these pearls have lost their luster and beauty; but they were evidently highly prized by these ancient people and gathered by the hundred thousand. The finding of two bushels in a single series of mounds is an evidence of their abundance.

The first explorers who traveled among the Indian tribes speak frequently of the number and beauty of the pearls in possession of the natives. Especially marked are these accounts in connection with the great expedition of De Soto, from Florida through the present Gulf States to Mississippi, in 1540–41. Garcilasso de la Vega and other narrators give minute accounts of pearls as worn by the Indians; and from the accounts given by them to De Soto at various times, and as taken by the Spaniards from burial-places of native chieftains, it is quite evident that perhaps all of these referred to were not marine, but fresh-water pearls. De Soto's narratives, which undoubtedly referred to the latter, seem exaggerated, but the recent finds substantiate them. The process is described, moreover, of gathering the shells and opening them by heat, which was shown to De Soto, at his request, by a friendly chief. In the same way several early English travelers, from New England to Florida, refer to the Indians as having pearls, undoubtedly from the fresh-water Unionidæ.

No particular attention, however, was given to the subject until about forty years ago. The natives had been dispossessed, and the white race, occupied with other interests and necessities, took little note of the hosts of fresh-water shells inhabiting the streams and lakes, and did not suspect their power of producing pearls. In the rivers of Saxony and Bohemia, indeed, and those of Scotland and Ireland and the lakes of Finland, such pearls have long been known and valued, although Unio life is far less abundant there than in our great river systems of America; but not until the middle of the present century was a search begun or any important discovery made.

NOTE.—This article is chiefly an abstract of a more comprehensive report on pearls by the same writer, which will appear hereafter in this volume. The present paper was prepared for the Fishery Congress by special request, for the purpose of calling the attention of delegates to the latent resources, in many parts of the country, in pearls and pearl-bearing shells.

This was all changed, however, by the first great pearl excitement in 1857, when large and valuable Unio pearls were first obtained in New Jersey. First, a pearl of fine luster, weighing 93 grains, was found at Notch Brook, near Paterson. It became known as the "queen pearl," and was sold by Tiffany & Co. to the Empress Eugenie of France for $2,500. It is to-day worth four times that amount. (See colored plate No. 8, Gems and Precious Stones of North America.) The news of this sale created such an excitement that search for pearls was started throughout the country. The Unios at Notch Brook and elsewhere were gathered by the million and destroyed, often with little or no result. A large, round pearl, weighing 400 grains, which would doubtless have been one of the finest pearls of modern times, was ruined by boiling to open the shell. Within one year pearls were sent to the New York market from nearly every State—in 1857 fully $15,000 worth. In 1858 it fell off to some $2,000; in 1859, about $2,000; in 1860, about $1,500; in 1860–63, only $1,500. The excitement thus abated until about 1868, when there was a slight revival of interest, and many fine pearls were obtained from Little Miami River, Ohio.

Some of the finest American pearls that were next found came from near Waynesville, Ohio, $30,000 worth being collected in that vicinity during the pearl excitement of 1876. Since 1880 pearls have come from comparatively new districts farther west and south, the supply from which is apparently on the increase. At first few were found, or rather few were looked for, west of Ohio; but gradually the line extended, and Kentucky, Tennessee, and Texas became the principal pearl-producing States, and some pearls were sent north from Florida.

A few years later the interest extended to the Northwestern States. During the summer of 1889 a quantity of magnificently colored pearls were found in the creeks and rivers of Wisconsin—in Beloit, Rock County; Brodhead and Albany, Green County; Gratiot and Darlington, Lafayette County; Boscobel and Potosi, Grant County; Prairie du Chien and Lynxville, Crawford County. Of these pearls, more than $10,000 worth were sent to New York within three months, including a single pearl worth more than $500, and some among them were equal to any ever found for beauty and coloring. The colors were principally purplish red, copper red, and dark pink. Within the past eight years probably over $200,000 worth of pearls have been sold from this district.

These discoveries led to immense activity in pearl-hunting through all the streams of the region, and in three or four seasons the shells were almost exterminated. In 1890 the search extended through other portions of Wisconsin, especially Calumet and Manitowoc counties, and also in Illinois, along the Mackinaw River and its tributary creeks, in McLean, Tazewell, and Woodford counties.

In 1889 the exhibit of American pearls received an award of a gold medal and the collaborateur a silver medal for the literature. At the Columbian Exposition at Chicago, in 1893, large and beautiful exhibits of pearls of great variety of tints, set in the finest jewelry, were exhibited in the Manufactures building, and formed notable features in the Wisconsin State building and the Mines building.

The northwestern pearl excitement subsided in a few seasons, as the others had done in turn before, by the exhaustion of the mussel beds and the consequent cessation of product. About every ten years or so a new wave of interest arises in connection with fresh discoveries at some point where the shells have lain long undisturbed; it again absorbs the attention and excites the imagination of the community around and spreads to other parts of the country; a fresh campaign of ignorant extermination is carried on for several summers, then the yield is exhausted, and there is nothing more but to leave nature to recuperate, if possible, and slowly to restore, in limited amount, the abundant life that has been destroyed.

During the season of 1897 the pearl fever has broken out in various parts of the country, the particular scene of discovery and excitement being the hitherto undisturbed streams and bayous of Arkansas. These waters teem with Unios, and pearls have at times been found by the rural population for years past; but there has been, usually, no knowledge of their nature or their value. They have been simply regarded as "pretty stones," and used as playthings by the children—like the first South African diamond, that attracted the notice of a trader in 1866 as he saw it in the hands of the children of his Boer host at the Vaal River.

Several valuable pearls, however, were this year found by persons from St. Louis and Memphis, who at once sent them to those cities and ascertained their reality and value. The same parties then searched for more, and took steps to lease the land where pearls were found abundant. Ere long the facts became known, and a wild excitement set in and spread through large portions of Arkansas, extending into Missouri, Kansas, and the territory of the Choctaw Nation. The first important discoveries were on small lakes or bayous, formed by affluents of the White River, in White County. The subsequent activities prevailed along the general valley of White River and its branches, then on the Arkansas, the Ouachita, and the Black, Cache, and St. Francis rivers, thus affecting almost all sections of the State. In one district an entire lake was leased, guarded, and fenced for its pearl contents alone.

The newspapers took up the subject and published highly sensational accounts of the treasures to be had in what was largely proclaimed as "the Arkansas Klondike." These articles were copied all over the country, and led to a great amount of pearl-hunting in many States, both east and west. Iowa, Tennessee, Georgia, New York, and Connecticut were all more or less stirred up to activity. The former pearl region of Tennessee was less affected than a new section in the eastern part of the State, along Clinch River, where great crowds have been searching for pearls, and large quantities were obtained. The Georgia interest has been chiefly along the Oostenaula, near and above Rome. The New York activity has been in the northwestern angle of the State, along Grass River, in St. Lawrence County. Connecticut has yielded some good results to the searchers on the Mystic and the Shepaug rivers, at almost opposite ends of the State.

REASON FOR THE PEARL INVESTIGATION.

In view of the great interest and possible importance of discoveries from time to time made in various parts of the United States, particularly in the Mississippi Valley, of pearls yielded by the fresh-water bivalve shells (*Unionidæ*) so abundant in many of our inland waters, I was invited, in 1894, to undertake a systematic inquiry, for the United States Commission of Fish and Fisheries, to ascertain, as far as possible, the facts relating to the occurrence and distribution of the pearl-bearing species, and the extent and conduct of the pearl industry as thus far developed. The value and elegance of many of the pearls, especially as shown in exhibits made at the Columbian Exposition in 1893; the popular excitements or "pearl fevers" at times arising in districts where a few pearls have been found, and characterized by wholesale and reckless destruction of the shells over large areas; the total lack of system in the search for pearls, as contrasted with the methods that have been developed on a smaller but far more profitable scale in Europe, all seemed to call for a careful investigation by the Commission, with a view to better knowledge and wiser direction in the matter of inland American pearl fisheries.

Undoubtedly, for a considerable period after the first explorations, the pearl resources of North America seem to have attracted little attention. The Indian race was contending with the whites for the possession of the country; it was a time of uncertainty and strife for both races; and not until the great waterways of the Mississippi Valley had been won by the whites, the region occupied, and settled communities established, do we again begin to find any indications of the search for fresh-water pearls. For some two centuries the Unios lived and multiplied in the rivers and streams unmolested by either the native tribes that had used them for food, or the pioneers of the new race that had not yet learned of their hidden treasures of pearl.

It is with some surprise that one notes that so few American conchologists have paid attention to our native pearls. It is probably accounted for by the fact that the pearls are contained in old, distorted, and diseased shells, which are not so desirable for collections as the finer specimens. Collectors who have opened many thousands of Unios have never observed a pearl of value. Pearls are usually found either by farmers, who devote their spare time to this industry, and if no result is obtained suffer no loss, or by persons in country villages who are without regular occupation, but are ever seeking means for rapid increase of fortune. Multitudes of shells that do not contain pearls are destroyed in the search.

HABITAT OF THE FRESH-WATER MUSSELS.

From the many inquiries sent out, the general indications from the answers are quite plain, to the effect that the shells are chiefly found in rather rapid streams, in which the bottom would naturally be sandy or gravelly and the water clear. Other species, however, occur on muddy or clayey bottoms, where the current is slower. The references to rock bottom do not concern so much the immediate surface where the shells are found, as the underlying bed on which the softer materials rest. In the matter of depth, also, the large preponderance of answers in favor of shallow streams may mean, not so much that the Unios greatly prefer shallow water, as that they are more readily found and gathered there. The frequent allusions to "hard" or calcareous water seem to confirm the general impression that streams of this kind are favorable to the development of molluscan shells, both in size and in abundance, and the greater proportion of calcareous matter in the water tends to induce the prolific secretion of the pearls.

A Florida writer states that the best Unio growth is found in lakes with outlets, the water pure and fresh; but adds that it is sometimes sulphurous. A Texas pearler (Colorado, Concho, San Saba, and Llano rivers) refers to the water as becoming slightly alkaline in dry times; and another Texas pearler (Colorado and Llano) makes a similar statement. A New York pearler (De Grasse River and Plum Brook) mentions the water as brown or black—the clear, brown water of the hemlock districts, familiar in northern New York.

The general conclusions most clearly brought out may perhaps be summed up as follows: The shells are most abundant in swift and clear water where the bottom is sandy or gravelly and the country rock calcareous. While still numerous in many streams, they have greatly diminished within a few years past, wherever the pearl-hunting enterprise has extended, and are at some points nearly exterminated. The pearls found are few, and those of marketable value represent the destruction of thousands of shells for every one obtained. No use is made of this often beautiful material, which is simply thrown away and lost; although for buttons and ornamental articles it would be admirable. The methods of gathering the shells and extracting the pearls are the simplest and most primitive, and the activity of a few seasons generally exhausts the beds.

This state of affairs is one that calls loudly for reform. The wealth of Unios that filled our rivers is rapidly being destroyed by ignorant and wasteful methods of pearl-hunting; and either some form of protection is important, or, if that be not possible, a wide diffusion of information as to better methods, and particularly the introduction of tools used in Germany for opening Unios far enough to see if there are pearls contained without destroying the animal, which may then be returned to the water.

PEARL-HUNTING AS AN OCCUPATION.

As to the principal occupations of the pearl-hunters, or pearlers, as they are called, this was answered by 64 papers. Of these, 13 say merely that their occupations are various, or that people of all callings are included. The remaining 51 papers state more or less definitely as follows: Farmers and farm hands, 23; laborers, 12; fishermen, 8; and as making pearl-hunting a regular business, 7. Three papers speak of loafers, and one or two each specify as follows: Stockmen, hunters, trappers, tradesmen, roustabouts, boys, and negroes, and the Maryland paper, oystermen. The term "laborers" as used in those answers probably means, in most cases, farm-laborers, as stated in a few instances; and the indication is that two-thirds of the pearl-hunting is done by agricultural people who search the streams when not otherwise occupied, "in off times," as two or three of the writers say. Fishermen are naturally much in preponderance, who gather the mussels for bait.

METHODS OF EXTRACTING PEARLS.

The inquiry as to the mode of extracting the pearls when found received 72 answers. A large proportion of these are general, merely saying "by hand, "with the fingers," etc., but about one-third give more or less description of the process. When the shell has been opened, the pearls, if loose and near the edge, may be readily seen, and sometimes even drop out. These are, of course, easily taken out with the thumb and finger, or, if small, with tweezers, or on the point of a knife. If more embedded in the mantle and gills, they are detected by feeling for them, passing or rubbing the thumb or finger along and around each valve and about the region of the hinge. The pearls may then be pressed or squeezed out "like the seed of a cherry"; but if attached to the shell, must be removed with a pair of nippers. Care is required in opening, not to scratch or injure the pearl. A very few describe different methods; thus one Arkansas pearler speaks of breaking the shells, and a Florida pearler tells of piling the mussels in a dry place to decay, the Oriental method of opening the true pearl-oyster and finding the pearls in the emptied shells later. This method is evidently practicable only where little or no "pearl hunting" is generally carried on, and the pile of shells would not be liable to inspection and search by other parties than the original gatherers.

TREATMENT OF PEARLS WHEN FOUND.

Concerning the treatment of pearls when found, definite answers were received in 52 papers, which, in some respects, show considerable diversity of usage. The pearls are first thoroughly washed to remove all adhering animal matter, and two papers speak of using alcohol to complete the cleansing. After this the essential point in keeping or carrying them is to prevent injury to the surface from friction, and the majority of those who describe what is done tell of wrapping in cotton, or soft paper, cloth, flannel, or silk. Several speak of drying them, or keeping them dry. But others would keep them in a liquid, six specifying a bottle of water and one sweet oil or coal oil. Several speak of putting them into a bottle, but with no account of its contents, or whether even dry, though an Indiana paper mentions cotton in a bottle, and hence, in the cases just referred to, it is impossible to judge as to what is the probable meaning. Two papers mention keeping pearls in starch, and one "in Irish potato." The effect of sunlight is curiously alluded to by two papers, one stating that pearls should be kept from it, and the other that they should be kept in it.

Six Tennessee papers make interesting references to "peeling" dull and unpromising pearls, merely saying that this is sometimes done "with a sharp knife," and a nice pearl obtained thereby. Alcohol, whiting, chamois leather, etc., are mentioned as employed to produce a good surface of luster. Two other papers allude to polishing or cleaning pearls, one specifying that it is done "with Irish potato." Two papers say nothing under this head, save that there is no way to improve nature.

DESTRUCTION OF THE MOLLUSKS.

As to what, if any, use or disposal is made of the shells after being examined for pearls and the animals destroyed, the papers give a painful record of the utter waste of an enormous amount of material valuable for many purposes in the arts. The question is answered in 74 papers, with a melancholy uniformity. In only 12 of them is there any suggestion of utilization of the shells, and in only 1 of the use of the animals other than as fish-bait, manure, or food for hogs. Twenty six answers say simply that there is no use made of them, or that they are "wasted" or "thrown away"; 9 say that they are thrown in the water, and 6 add that the fish eat them and also the muskrats and tortoises; 7 speak of their being used for fish bait; 6 for feeding hogs, and 2 for manure. Several merely say that they are left on the banks or shoals for rats, minks, and crows to dispose of.

An Iowa pearler states that the shells are utilized for button-making, and that some people use the animal for soup. The actual use of the shells for buttons is also referred to by two pearlers, and their possible value for that purpose is noted in four other papers, though they are not so used as yet. One says that a few are polished for ornamental purposes, and another makes a similar statement, adding that they are also used to pave garden walks and burned for lime. This latter use, for lime, is referred to also by three Tennessee papers as actual or possible, and one says that they might be "ground to cement," and one Wisconsin writer notes that some are ground up for poultry.

AS A FOOD PRODUCT.

There would seem to be a strong presumption that the mound builders must have used the Unios quite largely for food, as we know that the later Indian tribes did, as will be referred to further on. They naturally were thus led to the finding of pearls, and accumulated large stores of them in the course of time. The ancient tribes of Brazil have left shell heaps along rivers tributary to the Amazon, composed of fresh-water shells of that region (Hyria and Castalia); and though no such stores of pearls have been found, yet the shells themselves have been much employed as ornaments among these people; so they also were in the United States.

When it is remembered that the native tribes of both North and South America made large use of the river mussels as an article of food, it seems extraordinary that only one instance of any attempt so to utilize them should appear in these accounts; although Canadian lumbermen catch them by allowing bushes to drag after their rafts in shallow streams, using the mollusk for food. They could, perhaps, often save life, if explorers or hunters knew of their existence; while the shells, which are so capable of being wrought and polished into an immense variety of beautiful objects of ornamental art, should command a remunerative price, instead of being thrown away and wasted. The small ones are often as brilliant as an opal in color.

UTILIZATION OF UNIO SHELLS FOR BUTTONS.

Several references, from time to time, have been made to the valuable possibilities of the abundant shells of the Unios for various purposes of manufacture, and some few instances noted of their being polished as ornaments or cut into buttons. It is highly interesting to learn that this latter use has at last attracted attention and is developing into an important industry. A correspondent of the St. Paul (Minn.) *Dispatch*, under date of November 13, 1897, gives an extended account of the shell-button manufacture at Muscatine, Iowa, where already a number of factories are in operation. No dates are specified; but the statement is made that it was begun within a few years past by Mr. Boepple, a German, who recognized the possibilities of such an industry and established a factory at Muscatine, soon employing 200 operatives, besides a number of outside people gathering shells from the Mississippi River at that point. The enterprise proved profitable, even under an unfavorable tariff, and several other factories were established; but since the recent protective legislation has gone into effect the business is increasing largely. Eleven or twelve factories are now in operation, running 300 saws and employing 1,500 people. One of these was working on double time to fill orders for 20,000 gross of buttons for the "holiday trade" of 1897. The business is already an important element in the prosperity of the town; and as the supply of shells is enormous, it is expected to increase in extent. Other works exist also in Iowa. There are also eastern factories referred to that cut the shells into "blanks," i. e., unfinished disks, and send them to Muscatine to be polished and perforated.

The shells have been gathered by men and boys wading in the shallow water and working from boats in the deeper parts with rakes provided with a wire net or basket. Now, however, steam dredging is to be employed. One such boat has been built and another is under construction. The dredge will take up a ton of shells in an hour, and the steam will be used to cook the animals and clean the shells—a process now slowly conducted in small furnaces. As the gathering can not be carried on in winter, when the river is frozen, prices rise in autumn. Several species are capable of being used, of which two are particularly mentioned; these are "nigger-head" shells, which have risen with the approach of winter from 35 cents per 100 to 70 cents, and "sand" shells have advanced correspondingly from $1 to $2 per 100.

PRESENT ABUNDANCE OF FRESH-WATER MUSSELS.

Out of 83 papers which respond to this inquiry 7 describe the shells as at present very abundant; 36 as plentiful; 25 as scarce, and 3 as absolutely exterminated; 28 papers refer to the fact of diminished and diminishing numbers within a few years past, some of them with great emphasis. Three of the Tennessee papers estimate the numbers as reduced to about one-tenth of what they were ten years ago, and the same general fact is stated, of former abundance and present rarity, and attributed to the pearl-hunting destruction of a few years past. Several papers say that the shells are now scarce in small streams and the shallower parts of larger ones, while still abundant in deep water and where the currents are strong.

NATURAL ENEMIES.

In regard to natural enemies, 84 papers are varied and interesting, and in some respects quite contradictory. The chief natural enemy of the Unios appears to be the muskrat; 65 papers refer to it, 26 reporting large destruction from this cause, 38 in some degree, and one denying any. Hogs come next, and are referred to in 47 papers. Of these, 7 hold them responsible for large destruction, 35 for some, or a little, and 5 assert that there is none. Of other animals, raccoons are stated, in 13 papers, to destroy some shells; mink in 5; mud turtles in 3; crawfish in 2; aquatic birds in 2; and cattle, by trampling, in 3. All the animal depredators deal only or chiefly with Unios that are either young, small-sized, or soft-shelled, and hence not largely pearl-bearing. The only exception to this general rule is the statement in one paper that many pearls have been found where shells had been taken ashore by muskrats and left to open in the sun.

INJURIES DUE TO PHYSICAL CAUSES.

With regard to physical causes of injury, the most serious, no doubt, is found in freshets. Of 31 papers that refer to these, 17 report great destruction thereby; 13 say "some" or "a little," and 1 denies that there is any. Some papers say that their injury is small, and that they only shift the beds and redistribute them; but a number describe the burying of beds by the washing down and caving in of banks in flood-time, or the stranding of great quantities of young shells when the water subsides. Two papers that do not mention freshets should doubtless be included here, however, as they speak of destruction caused to the shells by "covering with mud," and by "change of bars." On the other hand, low water and droughts are reported as seriously harmful in 5 papers, and drift ice in 3. Two papers allude to disease as a cause of injury, and 3 to boring parasites.

EXTERMINATION OF THE MOLLUSKS.

The question as to exhaustion of the mussel-beds, its causes and its rapidity, has called forth a very suggestive body of replies in 57 papers; the remaining third make no response, or none that is at all definite; 9 papers report extermination of the shells, either actual or imminent, within a very few years past; 20 speak of rapid diminution in their numbers; 16 of decrease as noticed and in progress; 8 are uncertain or report little or no change; 6 describe them as abundant or "inexhaustible," and 4 refer to partial recovery or replenishment after reduction. In 45 out of 59 papers, therefore, approximately three-fourths, the process of exhaustion is recorded, at times already complete. Of these, 26 state the cause as pearl-hunting, mainly or wholly, and 10 refer to other agencies, one or two each to high or low water, deposits of sand or mud, ice, boats, hogs, and rats. Of 7 answers from Wisconsin, where so many pearls of remarkable beauty were found in the early "nineties," 5 report the shells as nearly or entirely exhausted, and 2 refer to rapid reduction, due to ignorant and careless persons taking the small and young shells as well as those more likely to contain pearls.

A Tennessee paper alludes to the same reckless habit, and estimates the shells remaining as about 5 per cent only of the number in former years. The destruction of young shells is also mentioned in Indiana. In New York it is stated that a good pearl-fisher can "clean out" a bed of 500 shells in a day. The Ohio paper speaks of hundreds being opened daily. In Iowa one states that the river will be exhausted in two years. Of those that speak of little change, several remark that not much is known or done in regard to pearls at their localities. Of the probability of recovery, one, Tennessee, says that the beds are cleared out about every two years and renewed in four; one that they exhaust yearly and bed again in one or two years; another that the shells return every year, but in less numbers, and a Texas paper reports that many beds that had been worked out are recovering, through the growth of the young shells that were left unmolested.

NATURAL AND ARTIFICIAL REPLENISHMENT OF FRESH-WATER MUSSELS.

The inquiry as to whether exhausted beds recover, and in what time, is closely connected with the preceding one. It is unanswered in 22 of the papers, and 7 others report no knowledge or opinion on the subject; 64 replies are given, of which several are indefinite or conjectural. Out of about 60 papers, therefore, or two-thirds of the whole, the following data are taken: 16 report the belief that the beds are replenished from year to year; 4, in one or two years; 3, in two or three years, and 4, in four years; 4 name periods between four and eight years, and 6 between eight and twelve years; 1 gives twenty years, 1 gives twenty-five, and 2 estimate the recovery as requiring a century or more; 3 papers say that many years are necessary; 5 say "a few," or "soon"; 2 report no exhaustion as noticed, and 6 report no recovery; 4 papers are indefinite or uncertain. Two of the papers that give estimated dates for recovery do so with an expression of doubt ("if at all," "if ever") as to whether it really occurs.

The Tennessee paper before referred to says that the shells return each year, but in less numbers. As it is customary, more or less, to leave the young and small shells, the questions are resolved largely into two, viz, how far they have been carefully spared, and how long it takes them to attain their growth. This probably differs in different species, as is intimated in some of the answers, and it may also be influenced by various external conditions. The Tennessee paper estimates the recovery as slow, from the fact—previously brought out very markedly—that the young shells are those that are most exposed to all natural enemies and accidents. The New York paper, which thinks that there is no recovery, states that few young shells are found. A Texas pearler says that young shells are found in two years, but contain no pearls. One (mentioned under the last head) says that many beds are recovering by the growth of the young that were left before. On the other hand, in Indiana, one states that when a bed has been worked out, plenty are found the next season, and an Iowa pearler reports young shells abundant everywhere. One Tennessee answer probably gives a very fair average statement, to the effect that the beds recover somewhat every season, and would perhaps recover entirely in a few years if not molested.

NATIONAL AND STATE PROTECTION.

The concluding inquiry, as to whether State protection of the beds is desirable or necessary, is answered with more or less definiteness in 73 papers, and, as might be expected on such a subject, with much diversity; 46 of the responses see no need or advantage from protection and 23 favor it. One or two fail to understand the purpose of the question clearly, and some hold that while not necessary now it may be so in the future. Two or three say that it would be difficult or impracticable. Of those that do not favor protection two (Michigan and New York) think it not desirable to preserve the Unios, the latter curiously remarking, "The water would be purer without them." And one Tennessee fisherman seems to hold a similar view, saying that protection is not desirable, though it is necessary to the preservation of the shells. Another Tennessee pearler, failing to appreciate the question involved, opposes protection, "because pearls bring in a great deal of money, and the mussels are of no use." Two or three think that the shells are inexhaustible and in no danger of extinction. Of those that favor the suggestion, an Indiana pearler says it would be well if no shells were taken for five years. The Ohio paper advocates it "if the mussels are to be preserved." A Tennessee paper alludes to the value of the shells for pearl buttons as a reason for protection, and two other Tennessee papers advocate a limitation as to not opening young shells.

The whole question is curiously suggestive of the similar conditions in respect to forestry and lumbering—the apparently inexhaustible natural supply; the reckless prodigality and waste of such resources by man; the rapid diminution and impending extinction, which it would require years of labor to restore; the foresight and remonstrance of the few, and the indifference or opposition of the many, as to any limitation or protection designed to preserve the natural resources; and the ease with which they could be preserved by a few simple and intelligent modes of management, once established and made familiar to the people; and the pressing importance of some such action.

APPROXIMATE YIELDS OF PEARLS.

Only a few approximate figures can be given. The total production of pearls may be summed up as follows: In the 1856 excitement $50,000, worth to-day at least four times that amount; in the 1868 excitement $50,000 worth; in the 1889 Wisconsin excitement perhaps $300,000 worth; the Tennessee fisheries $100,000; Kentucky $20,000; Texas $20,000; Arkansas produced single pearls in the past year of a total value of $35,000, some selling for over $1,000 apiece, and many for over $100 and $200.

The great importance to a rural population of obtaining ready money easily by pearling can not be overestimated, the pearlers being aided in the payment of taxes, interest, and for such things as only money will buy; and the protection of the pearling interests is, therefore, very desirable, as the industry, if properly regulated, yields a product which can always be sold for cash.

NEW YORK CITY.

THE RED SNAPPER FISHERIES: THEIR PAST, PRESENT, AND FUTURE.

By ANDREW F. WARREN.

The subject assigned to me is one whose breadth covers the whole of the Gulf of Mexico, and whose history extends from the times of myth, commonly designated "before the war." This history must be based mostly on fishermen's tales, which are of proverbial authority, but whose credibility no disciple of Saint Peter would deny. During the little time I have been able to snatch from other duties I have interviewed such old-timers as still survive, and have compiled this history from their accounts.

Somewhere in the late forties or early fifties some New London fishermen ventured into the Gulf of Mexico in pursuit of snappers. They sailed in small sloops, such as were used in the cod fisheries on the Nantucket shoals for New York market purposes, none being over 15 or 20 tons measurement, and carrying in their wells loads of live fish of not more than 5,000 or 6,000 pounds. The catch was sold at New Orleans at a price commensurate with the dangers of the passage from the home port and with the scale of values that then governed the markets of New Orleans in all lines.

Capt. Leonard Deskin, of New London, seems to have been the pioneer. He suffered shipwreck on one of his outward voyages and never returned to his home. He settled on the Florida coast, near East Pass, Pensacola Bay, where he lived during the war, and died some fifteen years since, leaving a family who still pursue the same industry.

During the later years of the war the fishery was pursued by other vessels, some of Southern build and others from Connecticut. They mostly disposed of their catch in New Orleans, the fish often selling for from $1.50 to $2 per "bunch." The "bunch" was a varying quantity, ranging—as the state of the market might seem to justify—from 16 to 20 pounds, no "bunch" being considered marketable unless it contained at least two fish; so that only purses filled by the depreciated currency of the day could afford the luxury of a baked or boiled snapper.

The rumors of these prices, together with the allurements of our summer seas, induced some fishermen whose apprenticeship had been served on the Georges Banks and amid the whirling tide rips of the Vineyard Shoals, to wet a line on the Snapper Banks. Some adventurous fishermen, mostly from Noank, Conn., were enticed to make winter voyages to the Gulf of Mexico. Having better and more fully equipped smacks than the natives, they did well, and for some years held the monopoly of the trade in Mobile and New Orleans. This trade, however, was a local and mostly retail trade—the difficulties of transportation, not only in time, but in price, together with the high cost of ice, averaging nearly 2 cents per pound, making a shipping trade impossible. About 1872 the first venture in the snapper business at Pensacola was made, the Pensacola Ice Company being forced into the business by the establishment of ice factories in the interior of Alabama, where they had before done a considerable business in ice, which was cut off by the new competition.

As is the case with most successful industries, the beginnings were small. During the following five or six years the trade was pushed into every market that could be reached by express or freight, without much regard to present profit, but looking to the future trade for compensation. During this time the business was suspended in the summer months, the principal dependence for supply being on contracts with northern smacks, which came every fall from the North and East and returned home at the end of Lent. This proving unsatisfactory, a beginning was made in 1879 of a fleet owned by the dealers, and so under their control. One vessel was bought. From this single vessel the fleet has now grown until it numbers some 35 vessels owned in Pensacola, 4 in Mobile, and 2 in New Orleans, the latter belonging to retail dealers, who use them for the local trade. This fleet is of many sizes, ranging from 20 to 50 tons measurement, and of varying ages, from 50 years to those which were launched this last year. The old ones are of all descriptions, some having been Boston and New York pilot boats, others eastern bankers, and many were built for the New York and Fulton market fisheries. The new ones are of the most modern design and construction, being the product of the best designers, whose plans have been executed in the shipyards of Massachusetts and Maine by some of the best builders of the Eastern States. Very recently one of this design has been launched from a Pensacola shipyard and built of Florida woods, which it is believed will prove the pioneer of a large fleet, and that thus a new industry will grow up on Florida soil.

At first all smacks were provided with wells for the bringing of live fish and ventured only a short distance from port, seldom going east of Cape San Blas and being satisfied with loads of 5,000 to 6,000 pounds weight. In those days fish seemed more plentiful than now. It was not uncommon for a smack to make a trip every week during favorable weather, landing what was considered a good load on every voyage. As the demand increased and the price of ice became lower the taking of ice to sea in connection with the well fishing was begun. It proved so successful that it soon superseded the well fishing, and for some years only two vessels supplied with wells have been in use, even these depending on ice the most of the year, only bringing fish in the wells during the favorable time in the summer. It has been found that better and sounder delivery to the consumer can be made with the use of ice than in any other way. The introduction of ice has broadened the boundaries of the fishing-grounds so that snappers are now caught as far as the region of Tortugas on the one side, in latitude 24, longitude 83, and at the extreme western end of Campeche bank, in latitude 20, longitude 92, some 700 miles from Pensacola. These voyages are usually made without the use of chronometers, dependence being put entirely on the dead-reckoning as furnished by the aid of the patent log and observations for latitude by the sextant.

The skill that has been developed among the skippers is little less than marvelous, they being able to beat back and forth across the whole breadth of the Gulf of Mexico, making their landfalls with precision, and often being spoken both by sailing and steam merchantmen, who correct their observed position by the aid of the illiterate fishermen, to whom the more exact methods of astronomical navigation are unknown. Masters of dead-reckoning, they are also expert seamen and are able to bring their craft, having a freeboard of only a foot or two, through gales and hurricanes that cover the Gulf with the wreckage of merchantmen of a thousand tons.

In July, 1896, one of the most destructive hurricanes that have swept the Gulf of Mexico was encountered by the smack *Clara*, of only 26 tons register, with her decks not over 18 inches above the water. She rode out the gale in perfect safety, although her decks were swept by the seas, washing overboard all movable articles, and staving her boats, but with no damage to hull or rigging, and able to resume her voyage as soon as these trifling losses were made good. The same storm proved the death of many a staunch ship, and for weeks the public was thrilled by stories of disaster and loss of life. So staunch are these vessels and so skillful their handling, that when danger signals are displayed and winds howl we are in the habit of giving thanks that no more of the fleet are in the harbor, considering those at sea much safer than those in port. In fact, the same July gale above mentioned sunk and disabled six fishermen that were in port, and damaged none at sea.

The crews are of as various lineage as the vessels. Some are from Norway and Sweden, some were subjects of the King of Denmark, some were born under the flag of the Kingdom of Greece, and not a few of these hastened home to assist their country in its late war. The sunny skies of Italy shone over the birthplace of many others; while, of course, Yankees and Nova Scotians are present in great numbers.

In the methods of finding and catching the fish, little change has occurred since the inception of the fishery. The fish are found by the continual throwing of a lead line, carrying a baited hook. A man standing on the weather rail, supporting himself by a hold on the main shroud, swings the line, to which is attached a 9-pound lead; he releases it as it swings under and forward, and lets it swing to the bottom, and 40 fathoms depth is reached as the hand of the leadsman comes over the lead, although the vessel may be moving forward 3 or 4 knots per hour. If fish are present and are hungry, they snatch at the hook, and one is brought to the surface. As soon as a bite is announced, a dory, with one man, provided with fishing gear, is at once launched, and if the fish bite well the smack is brought back to the spot and either anchored or permitted to drift broadside across the ground. When she drifts away from the fish, she is again worked to windward, and the same process repeated until the fish cease biting or the fare is completed. This process of sounding is sometimes followed all day without success; and again, the fish are quickly found. Sometimes six men will catch a thousand fish in a few hours, and at other times two or three hundred fish will be the limit of a day's hard sounding and patient fishing. When the snappers are spawning, they often are so abundant around the smack as to color the water, but refuse to take the hook, and in such times the only recourse is to search for other schools.

Once a load is secured no effort is spared to hasten along, and only the most severe of adverse winds will cause the skipper to lay to and await a more favorable chance. The fish after landing are either repacked in vaults and deeply covered with freshly broken ice or are forwarded at once to market. The conditions of marketing differ from those in any other fishing port, so far as is known. All the vessels being the property of the shipping firms, there is no haggling about prices. For some years past there has been a stable and constant price which is allowed the vessel and which remains the same in times of scarcity or abundance. Out of the price of the fare of fish is first deducted the cost of the ice taken on board at the beginning of the voyage. Then the crew receive a fixed percentage of what remains, out of which their provision bill is deducted and the remainder divided according to the rank and skill of the individual fisherman. This system, or "lay," as it is called, is the result of many years' experience and of some trials of strength between the fishermen and the owners, and has proven the most satisfactory and fair method of dividing the proceeds of the fishing voyage.

The prices being uniform at all times to the shipper, it has been found expedient to establish a scale, varying with the size of the fish and the shape in which they are forwarded, as round, with entrails removed, or with all waste parts cut away. The sparseness of our Southern population, the great distances which separate the sea from the consumer, and the high price of telegraph tolls, have all tended to discourage any effort to vary prices with the supply, and to encourage the maintenance of standard prices, with some concession to larger dealers. That the prices have been fairly fixed, as a result of years of experiment and many bitter wars between the rival Pensacola shippers, needs little confirmation, in view of the fact that only two considerable shippers have survived the strain and stress of unrestricted competition, although a half dozen other firms have entered the field, only to be absorbed by the older houses after an unsuccessful attempt to realize their hopes of profit. The market reached by the existing houses is one that covers most of the country, reaching from Boston, Mass., to Denver, Colo., and from the shores of Texas to the borders of the Great Lakes. In fact, as one dealer aptly remarked, "No man who is willing to buy a red snapper has lacked the opportunity."

The future of the fishery can not be readily foretold. That the cost of production can be reduced seems unlikely. Climatic conditions compel the marketing of the red snapper in a fresh and unfrozen state. It does not take kindly to freezing; its color fades and its flesh, in the dry atmosphere of cold storage, shrivels and wastes. In fact, it has come to be recognized that no fish can be thus preserved except with considerable loss of flavor and of marketable value. It is almost impossible to distribute frozen stock in these latitudes. No market, either in North or South, has been found that will consume such quantities as might be economically transported and stored in a frozen state. The crude and wasteful methods of the retail dealer also work to raise the cost to the consumer, so that it bears little relation to the price the shipper receives, and the retailer's profit is so large that the consumer finds a mess of fish a costly luxury, in which he indulges only at long intervals. Canning has been tried and found wanting. Preservation with salt is unprofitable, owing to the great loss of weight it entails and the high cost of the raw material, which makes profitable sale out of the question.

The dearth of skilled cooks is also an almost insurmountable obstacle in the way of the introduction of our fish into such general use as is enjoyed by the products of the packing-houses of the West. Another difficulty is that the larger red snappers, which cost least by the pound, can not be conveniently used in a single household, being excessive in both cost and quantity. Great effort has been made, with only partial success, to introduce the custom of selling sliced fish.

The supply afforded by the fishing grounds, while not threatening immediate failure, seems to be comparatively less than twenty years ago. Before 1880 it was common for smacks to make weekly trips, and they were seldom compelled to go far for good fishing; now they go far and consume more time on every trip, although most of this time is employed on the outward passage and in search of productive grounds. On the other hand, the men earn about the same wages, and the market is kept fully supplied, interruptions by stormy weather excepted. The supply seems to vary from year to year, some seasons finding fish abundant on one ground, and others showing the fish to have moved their feeding-grounds to other portions of the Gulf.

Many matters relating to the red snapper, its life-history, its feeding and breeding grounds, how quickly it reaches maturity, and its duration of life, have never been sufficiently studied, and we shall be indebted to the officials of the Fish Commission when they have time and opportunity to prosecute to a conclusion researches which will require years of intelligent labor. So far they have had no such opportunity; but it is earnestly to be hoped that they may yet be able to take up the subject as carefully and patiently as it deserves.

It will be noted that statistics have borne no part in my remarks. Inquirers for such information may obtain it in the reports of the Fish Commission.

PENSACOLA, FLORIDA.

SOME BRIEF REMINISCENCES OF THE EARLY DAYS OF FISH-CULTURE IN THE UNITED STATES.

By LIVINGSTON STONE,

Superintendent of United States Fish Commission Station at Cape Vincent, New York.

About a third of a century ago a strange story began to be spread abroad in this country that a man in western New York was hatching trout eggs—thousands upon thousands—and that he was rearing the fish and feeding them in ponds, and that there was literally no end to the number of fish he could hatch. The story naturally made a decided sensation throughout the country, but of all the people who heard the story there were very few at first who believed it. The present age of almost daily recurring marvels had hardly begun then, and people were more incredulous and slower to accept apparent miracles than they are now; and then again, the country being in the throes of civil war at the time, it followed that discoveries in peaceful arts did not attract the attention that they would have done in quieter times. But the story about the man who was hatching thousands upon thousands of trout steadily gained ground. Presently the great New York dailies took it up, and soon after it came to be an accepted fact that something very wonderful was certainly being done by this New York trout-hatcher.

In the meantime the man himself, quietly working away in Caledonia, had succeeded in actually proving beyond a doubt that the hatching of trout on an immense scale—not as an experiment, but as a practical industry—was within the easy reach of human skill. It was the first time that this had been accomplished. Amateur and scientific experiments on a small scale had been made by various persons at various times, and the method of hatching fish artificially had been known for a century, but it remained for Seth Green to introduce into America the hatching of fish as a practical and valuable industry, and to him belong the credit and the honor of opening the way to the vast practical work that has since been accomplished in this country in hatching and rearing fish, and to him eminently belongs the title, justly earned, of the "father of American fish-culture."

A year or two after Seth Green had inaugurated American fish-culture at Caledonia, the writer established the Cold Spring trout ponds at Charlestown, New Hampshire, but strange to say, up to this time, although Seth Green's operations in New York had been so fascinating and so promising, no one else in this country had taken up the breeding of trout at which he had been so successful.

The time, however, was now ripe for the spread of trout-culture, and very soon after the establishment of the Cold Spring trout ponds trout-breeding places sprang up in all directions. Raising trout suddenly became fashionable and popular. During the first two years of his trout-breeding experience the writer received letters from almost every State in the Union, written by persons actually engaged in, or more or less interested in trout-culture. The interest in trout-breeding became universal, and everything written about it was eagerly read by all who were interested in fish at all. These were the palmy days of trout-breeding in this country. Prices were high. Trout eggs brought $10 per 1,000 and young trout fry $40 per 1,000. Trout large enough for the table brought $1 a pound at the ponds, and the city hotels paid 75 cents a pound for regular weekly consignments. There was a large demand for trout eggs and a fair demand for young fry and for trout for the table. Trout-breeding prospered, and with it all there was a novelty about the work which had not then had time to wear off, and the business of trout-breeding, for it had now become a legitimate business, came to be a pleasant, prosperous, and profitable occupation.

It would be interesting to describe more minutely the rise and decline of private trout-culture in the United States—for, alas! the decline came only too soon—but that would not come within the scope of this paper. Suffice it to say that competition soon brought prices of eggs and fry down too low to make the business profitable generally, and the market price for table trout falling at the same time, many who engaged in the business fell out for want of sufficient pecuniary encouragement, while others who raised trout for the enjoyment of it gave it up because of the many risks and difficulties which stood in the way of success.

It is a fact worth recording, and one that seems very strange in the light of present events, that while so many at first went to raising trout, no one seemed to even think that it was worth while to hatch any other kind of fish; and it is also a fact worth noticing that if artificial fish-culture had been confined to the raising of trout, as it was the first three years of its career in this country, the vast and beneficent work that is being done at present would have been unknown.

It again remained for the bold and adventurous spirit of Seth Green, with his far-reaching vision, to enter the larger and more important field of hatching fish that had a standard commercial value. Everyone knows of his attempts, his failures, and his final success in hatching shad. These efforts of Green, in demonstrating that other and more valuable fish could be hatched as easily as trout, did indeed open up a field for fish-culture so vast and beneficial to mankind that the previous trout-cultural work shrank into insignificance beside it. Thus it was that Seth Green earned a second time his claim to the title of "father of American fish-culture." All the present magnificent work of our State fish commissions and the United States Fish Commission owes its origin to Seth Green's shad-hatchery on the Connecticut in 1867.

In 1868 the writer, in connection with Mr. Joseph Goodfellow, erected a salmon-breeding station on the Miramichi River, in New Brunswick. This was on a large scale and was the first effort at systematic, practical salmon-breeding in America. As illustrating the high prices for fish eggs that prevailed then, I may mention that the writer received over $1,000 for a good-sized water-pail of salmon eggs from the Miramichi in 1869. This station would have been a valuable source of supply for salmon eggs had not public sentiment in Canada been so strong against exporting Canadian salmon eggs to the United States that the enterprise had to be abandoned; but the Canadian government took it up soon afterwards and sold salmon eggs to this country for the enormous price of $45 per 1,000, or nearly $1,000 per gallon.

I must not forget to mention, as among the most important events of the early days of fish-culture in this country, that the State of New Hampshire, with singular foresight, established a fish commission in 1864, the same year that Seth Green began operations in Caledonia. New Hampshire was soon followed by Massachusetts and other States, and in 1871 the United States Commission of Fish and Fisheries, through the efforts of Prof. Spencer F. Baird, was created by Congress, and the same year, also, the American Fish-Culturists' Association was formed, now the American Fisheries Society. By this time there were also innumerable trout-culturists in the field, and fish-culture in the United States may be said to have passed the days of its infancy and to be fairly on its feet.

In looking back over those early years and contrasting them with the present, when such an immense mass of information is available, one is forcibly struck by the almost universal ignorance on the subject that prevailed at that time. This was true not only of people generally, but of well-informed men also, for even scientists who rightly deserved the name, and university graduates and accomplished scholars who prided themselves on the variety of their knowledge, and reading men who kept up with the magazines and newspapers, could tell you nothing of this new art of fish-culture. Yet this was not so very surprising, for books had not then been published in this country on the subject, magazine articles about it had not appeared, cyclopedias did not contain the information, or at most only the merest outlines of it, and unless one happened to come across the not easily-accessible reports of specialists there was no avenue open to the public by which more than a superficial knowledge of the subject could be reached. People generally were so utterly ignorant indeed of the whole subject that almost any story told about fish eggs would pass unchallenged. How different from the present day, when the minute fish life of the very bottom of the oceans is closely and thoroughly studied, and the fish food furnished by the microscopic life of the fresh-water lakes is measured and classified.

To go back in memory to those early days is not only to enter the enchantment that distance brings, but it is also to return to what was a real enchantment then. It seems as if we should never feel again—I know I am expressing the feelings of all the early experimenters in hatching fish—it seems as if we should never feel again, and we probably never shall feel again the thrill of excitement that tingled to our fingers' ends when we first saw the little black speck in the unhatched embryo, which told us that our egg was *alive.* It was one of the dearest sights on earth to us then. And when the first little trout emerged from his shell and wriggled in the water, why were we so excited and elated? Was it because we unconsciously felt that we were sharing with others in a great discovery? Was it because that little fish opened up to us a new world of promise, and because we had a dim vision of the countless multitudes of living creatures that this little embryo was the insignificant forerunner of? I suppose it was something of the sort, and now after those long years have passed and we coldly watch under a microscope, with half-scientific interest, the development of this little black speck, named by scientists the "choroid pigment," but which will always be dear to us as the "eye-spot," we can hardly believe that such a commonplace, matter-of-fact affair could ever have stirred our feelings and our imagination as it did once, when the sight and the sensation were both new, and the world of promise before us was untried and unknown.

Recalling those early years, two figures stand out in memory more prominently than all others. One is the figure of a strong-featured, broad-browed man, of a rugged frame and a rugged countenance. He had the bearing and the look of a man who thought no struggle too severe for him and no foe too formidable. He looks the strong man that he is. He is of the Zachary Taylor "rough-and-ready" type, but withal he has a hearty and genial manner, and a frank and honest nature looks out of eyes that show that no shallow mind lies behind them. Every fish-culturist knows whom I mean. I had previously visited Seth Green at his home in Caledonia, but it was not till I met and assisted him at Holyoke, in 1867, that his strong personality impressed itself on me. He was there conducting his first experiments in hatching shad. He was entirely alone when I visited him, and his first attempts at hatching shad had just ended in signal failure. The peculiar character of the eggs and the peculiar treatment required for them had baffled for a time even his keen-sighted genius, and he had in despair almost decided to give it up and return home. The fishermen he had hired to help him were laughing at him for what they called his "foolishness." But, although alone and depressed in spirits, and with no one to offer a word of encouragement, Seth Green kept on and, with dogged persistence and determination, fought and overcame one difficulty after another, as they met him, until at last he was rewarded, as the world knows, with overwhelming success. Perhaps I may be allowed to add that a warm friendship sprang up about this time between Seth Green and the writer, which continued to the day of the former's death.

It was a pleasant thing to see the change in Green's spirits that came with his first success in hatching shad. It seemed a little thing—nothing but some little delicate living embryos appearing in the frail eggs that he was working over. Little it was, but it was the herald of almost illimitable possibilities, which perhaps the man himself did not fully realize. But however that may be, it restored his spirits and made him almost instantly a changed man.

The writer once asked Gen. Phil. Sheridan what was the most thrilling moment of his career during the war of the rebellion. General Sheridan answered laconically, "When the tide turned at the battle of Winchester." I think that perhaps Seth Green's feelings at Holyoke, when his first shad eggs showed signs of life, might have been somewhat similar. He was attempting what no one else had ever thought of accomplishing and vast results were depending on his efforts. The eyes of all the fish-cultural world were on him. Thus far he had failed. He was for the time being defeated. Then the tide suddenly turned, and almost literally in a moment the whole thing was changed and he was victorious in a great battle, the far-reaching results of which will doubtless survive even the great nation that Sheridan fought for.

Green's strong traits of character were not the only things about him that called attention to the man, for united with these were a sound judgment and many rare gifts of genius. He had the happy faculty of seeing and fixing his mind on the one essential point to be attained, to the exclusion of everything else, and he had the fine discrimination which enables one to retain all the means necessary to accomplish his object and to eliminate all others. This enabled him to reduce his inventions and methods to the utmost simplicity without impairing their efficiency—the sure sign of genius. Green's famous shad-hatching box, than which nothing more simple and effective has ever been invented for the hatching of fish, is a good illustration of this genius, and his world-renowned skill at fly-casting, rifle-shooting, and fish-catching are only further illustrations of the same thing. I regret that time and space forbid my giving anything more than this very imperfect sketch of this remarkable man, but I must hasten on.

The other figure which stands out prominently in my memory, as I recall the early days of American fish-culture, is that of one who has been called a plain man. He was a plain man, indeed, but one who was made after nature's largest pattern of men. He was large in mental caliber and large in physical frame; large in his broad sympathies and in his wide scope of vision; large in his comprehensive grasp of great aims and large in his capacity for great undertakings; large in everything, but small in nothing. You at once, I know, recognize Spencer F. Baird, the first United States Commissioner of Fish and Fisheries.

The mere mention of his name strikes a chord of dear memories in the hearts of all who knew him. No man of our time has left a purer memory, a more stainless name, or a more animating and enduring influence over his special field of labor than Professor Baird. He was loved by those who knew him when he was living. He is revered by those who have survived him. He lived in a higher plane of thought and life and breathed a purer atmosphere than most men. Quiet and unassuming, with a nature as gentle as a child's, his natural superiority never failed to show itself when he was with other men, not even among the distinguished men who gather in the winter at the nation's capital. Yet he was thoughtful and considerate of his subordinates and always ready to give its meed of praise to any work well done by his humblest employee.

Professor Baird had the enviable gift of not only endearing to him all who came in contact with him, but of inspiring them with his own enthusiasm and energy. This made Congressmen vote all the appropriations that he asked for, for it was a common saying at Washington that Congress always gave him everything that he wanted. Like a good general, he had the personal welfare of his men at heart while he was Fish Commissioner, and they in turn wanted to do everything in their power for him, which, doubtless, was one of the secrets of his great success. It is a fact that his employees in the Fish Commission would voluntarily work a great deal harder for him than they would for themselves. It was the inspiration of this patient, disinterested, tireless, kind-hearted, and lovable man that made them work so well and also made that work a pleasure.

It is unnecessary to say that Professor Baird possessed extraordinary mental endowments, but I may perhaps mention one or two, as they are so rare. He had a quickness of apprehension that sometimes seemed almost supernatural. For instance, he would glance down along a printed page and comprehend in a moment what would take others several minutes to read. He had a marvelous memory, not only retentive of everything intrusted to it, but quick to call up anything that was wanted *when* it was wanted, a quality that most of us know well how to appreciate. His mind was also of the clearest type. No complications ever seemed to confuse him; he never became involved during his conversations, no matter what were the intricacies of his subject. His mind, like his placid temper, never seemed to be ruffled or disturbed. Extraordinary as his mental faculties were, he had evidently added to their efficiency by severe discipline, for he possessed that infallible mark of a well-trained mind, of having all his great and diversified stores of knowledge classified and grouped together in his brain according to subjects, so that he could call up his whole knowledge of any subject at a moment's notice. Another remarkable thing about his mental composition was that with a thoroughly scientific cast of mind were united qualities of the most practical character. He was a scientific man by nature. He loved science and scientific studies, but at the same time no man had a sounder judgment or a clearer head in the management of practical affairs. It is very rare to see scientific and practical qualities of mind united in such an eminent degree as they were in him.

Professor Baird was gifted with still another unusual mental endowment, which reminds one strongly of one of the traits of the first Napoleon. With that comprehensiveness of mind which takes in the broad features and large, general outlines of a great enterprise, he combined, as Napoleon did, a capacity for close and thorough attention to all the details of a subject, down to the minutest items necessary to success. This combination, as we all know, is a rare one. As an illustration of his wonderfully retentive memory and easy grasp of details, as well as his remarkable gift for a rapid dispatch of practical work, I may mention a little incident that occurred at Calais, Me., where I visited him in 1872, and which has fastened itself on my mind ever since. He had received twenty-seven letters by the mail of the day before—I remember the exact number that he told me he had received—and the next forenoon, after breakfast, he called in his stenographer for the purpose of answering them. As I, very naturally, rose to leave the room, he kindly invited me to remain and be seated, and I shall never forget the impression which the subsequent answering of those letters left on me. Assuming his customary attitude, when on his feet, of holding his hands behind him, one wrist grasped by the other hand, he leisurely walked up and down the room, dictating to the stenographer the answers, one after another, to all his letters. He did not, to my knowledge, once refer to one of the letters he had received, either to ascertain its contents or to get the address of the writer, but proceeded from one letter to another until all were finished. And, further, during this time he never showed the slightest hesitation, nor did his countenance betray any signs of mental effort or confusion. It was a remarkable feat of memory and of the methodical dispatch of business details which I can not forbear to mention.

In our subsequent acquaintance and correspondence, which was very extended, both personal and official, his letters were always marked by great kindness of heart and thoughtful consideration, which, it is needless to say, warmly endeared him to the writer. It is a great pleasure to me now to think that the United States Fish Commission station that I located and built up three successive times, on the McCloud River, in California, has kept the name which I gave many years ago to the little post-office on the river, and, as Baird station, contributes its mite to perpetuating the name of the great first United States Commissioner of Fish and Fisheries.

I said that there were two figures which early associations with fish-culture called up very forcibly to my mind. There is also a third. It is of a man who never has been in America, yet whose love for America, whose admiration for American fish-culture, and whose influence on fish-cultural work in America have been very marked. I mean the Count von Behr. With a thorough love of fish-culture and devoted to it, with an unusually enthusiastic nature which specially fitted him for inspiring others with his own love for it, Herr von Behr was to Germany in this field of labor what Professor Baird was to America. He was for many years the president of the Deutsche Fischerei Verein, the national fish-cultural organization of Germany, and during his whole connection with it he was the life of the association. He was also the animating spirit of the great International Fisheries Exposition in Berlin, which will forever remain memorable in the annals of the world's fish-cultural history. Though of a wholly different type from Professor Baird, he nevertheless possessed qualities which caused his influence to overshadow all other fish-culturists in his own country, as Professor Baird's did in this country, and made him *facile princeps* in conducting the cause of fish-cultural development in Germany.

It was the writer's privilege to carry on a delightful correspondence with Herr von Behr for several years. Dropping all official forms and, indeed, all formality whatever, his letters were earnest, confidential, and full of enthusiasm. They expressed the same love and admiration for Professor Baird that Americans felt for him at home, and never lacked in expressions of his great admiration of American fish-culture. They also record his sad domestic bereavements, and told how, after the loss of his three sons, he had resolved to devote the remainder of his life to the cause of fish-culture in Germany. I am aware that much criticism has been expressed because Von Behr's name has been given by Americans to a European trout since its introduction into this country; but whatever may be said of the judiciousness of the act, no one can deny that it was a fitting compliment to a man who richly deserved the honor, nor can anyone deny that it reflects credit on the kindly feeling which sought in this way to recognize America's indebtedness to Von Behr, and to perpetuate in America the name of the distinguished German fish-culturist.

The Count von Behr was a generous, warm-hearted, lovable man, and his contributions in labor and in influence to the cause of fish-culture can never be measured. He was one of those who formed the great triumvirate of the early history of practical fish-culture—*Green*, *Baird*, *von Behr*. Hopeful as we are of the future fish-cultural work of the world, we nevertheless confess to feeling a presentiment that "we ne'er shall look upon their like again."

I regret that this disjointed and imperfect sketch must suffice for the present for a subject that deserves better treatment. I would like to speak of Frank Buckland, of England, who did so much to encourage fish-culture in Great Britain; of Professor Milner, the zealous and conscientious colleague of the writer; of Robert B. Roosevelt, who edited the first newspaper column in this country exclusively devoted to fish-culture; of Theodore Lyman, of Massachusetts, the leading spirit in the first fish-cultural movement in New England; of Judge Bellows, of New Hampshire, who took the first steps in this country toward the public recognition of fish-culture; of Governor Horatio Seymour, of New York, who gave his powerful influence to its support, early in the seventies, and of many others who contributed more or less prominently to its early development. But both time and space preclude the possibility of this, and I can only congratulate my brother fish-culturists that there are so many devoted workers in the cause still living to fill the places left vacant by their faithful predecessors who have gone to their reward.

THE RELATIONS BETWEEN STATE FISH COMMISSIONS AND COMMERCIAL FISHERMEN.

By W. E. MEEHAN.

It must be obvious to every person engaged or interested in the work of fish-culture that the relations between the mass of the commercial fishermen and the State fish commissions are not as cordial as they should be. In fact, to put it plainly, in many places these relations are strained to such a point as to practically amount to open antagonism on the part of the former against the latter. It is also undeniable that there is a large class of citizens—some of whom can not be regarded in many respects as unprogressive—openly opposed or indifferent to the work of the fish commissions, and some even go the length of actively opposing the enactment and enforcement of stringent laws for the protection of fish. This antagonism is so potent as often to exercise a sinister influence on legislation.

In many States it is difficult and often impossible to secure the passage of efficient fish-protective laws, while measures to legalize the employment of the most destructive devices for taking fish find numerous supporters and comparatively easy passage. Few States grant liberal appropriations for fish-cultural work, and I know of none that grant as much as could be profitably expended. In Pennsylvania the last legislature adjourned without making any appropriation at all; and in Michigan, where fish-cultural work is carried on with exceptional effectiveness, if I have been correctly informed, the last legislature cut the usual appropriation in half. These are not encouraging signs for the future of fish-cultural work, and it behooves those interested to find out the cause of the trouble and remedy it if they can.

It has been less than thirty years since the establishment of fish commissions, but in that time they have returned to the people many hundredfold the moneys which they have expended. They have in countless instances prevented the extinction of valuable food-fishes and have successfully introduced others equally valuable; they have in many cases largely increased the supply and made fishing waters profitable that were for years before financially unprofitable. But these things seem to weigh very little with the mass of the commercial fishermen and those who demand the right to catch fish when, how, and where they please.

By the united action of New York, New Jersey, and Pennsylvania, all destructive devices were torn from the Delaware River at an expense of some $5,000, and through heavy stocking on the part of the United States and the Pennsylvania fish commissions, the shad industry of that stream was brought from a value of between $60,000 and $80,000 to nearly $500,000 at the nets every year—a consumers' value of more than $1,500,000. This magnificent result is well known throughout Pennsylvania; yet it did not prevent the commercial and semi-commercial fishermen in other parts of the

State from introducing and carrying through both branches of the legislature a section of an act which permitted the use of fish-baskets, and which act was only prevented from becoming a law through Governor Hastings interposing a veto. The situation in Pennsylvania is practically the situation in most of the States where the fresh-water fisheries are or should be large.

The path of fish commissions is not strewn with roses. On the contrary, it is beset with difficulties calculated to discourage the most ardent. An investigation of the causes which produce the strained relations between the commissions and the fishing interests reveals so many that to remove them all seems almost a hopeless task; nor is the apparent hopelessness of the task materially lessened by the conviction that many of the complaints against the methods of the commissions are trivial, and that in other cases the complainants are utterly in the wrong. I believe there would be a better prospect for an earlier settlement of the troubles were it not for the undoubted fact that the relations between the sportsman angler, and the commercial fisherman are anything but harmonious. Each seems to regard his interests as paramount to those of the others. Little consideration is shown by each for the other. One charges the other with trying to ruin his business or pastime. In the controversy the commissions suffer; and as long as the bickering continues, the work of fish-culture must be hampered. This lack of harmony is greatly to be deplored, because both the commercial and sporting fishermen confer huge benefits on the States. The financial returns of the commercial fishermen are more readily reckoned than those of the sportsmen, because more direct; but should those of the latter be fairly gathered and tabulated, the total would be startling. There are many counties in a number of the States where trout, bass, or other game fishing is considered good, in which the people, outside the towns and large villages thereof, owe the chief means of their livelihood to the visiting sportsmen.

Putting aside the question as to which brings in the greatest financial returns in the course of the year, it may be stated with positiveness that both interests are essential to the good of the State. It is the duty of fish commissions to guard and further both, and I believe that as a rule they perform it to the best of their ability; unfortunately, however, in the performance of this duty to its fullest extent, as they see it, they are often apt to give apparent cause for grievance on the part of commercial fishermen that the sporting interests are guarded at the expense of theirs. For example, in Pennsylvania the commercial fishermen complain that they are practically debarred from the unrestricted catching of certain of the commoner food-fishes, like the eel and sucker, through the severity of the laws formulated at the instance of and enforced by the fish commission. In effect the laws in question forbid, under heavy penalty, the use of any device whatever for the catching of fish, other than rod, hook, and line, in any of the waters of the State except Lake Erie and the Susquehanna and Delaware rivers. In Lake Erie pound and other nets may be used under certain restrictions; and in the two streams named, seine and gill nets of a prescribed mesh may be used during certain months, provided the latter be not fastened in any manner; in other words, they must float with the tide or current. By this it will be seen that fyke, dip, cast, and, in fact, all other forms of nets, including fish-baskets, are prohibited.

There is not the slightest doubt that a strict enforcement of this law, or the faithful compliance with it on the part of the fishermen, together with the heavy and persistent artificial hatching and planting of fish, would result beneficially to the fishing interests, both sporting and commercial. The results in the Delaware River prove this beyond the possibility of dispute. This being the case, other things being equal, there is no question of the propriety of forbidding the use of any device which will in any manner tend to depopulate the streams. Fish like the shad, herring, and striped bass are of far greater consequence than eels and suckers. Unfortunately, "other things" are not equal. The element that exclaims against the severity of the laws and demands the right to employ devices to catch eels, suckers, and commoner food-fishes, is strong enough in Pennsylvania and in other States to check the efficiency of the fish commissions and in some instances to shape vicious legislation.

After some years' thought on the subject and as a result of investigating the demands of the commercial fishing interests and of personal struggles to secure the passage through the Pennsylvania legislatures of efficient fish-protective laws or the defeat of bad ones, I have about come to the conclusion that true fish protective work, as advocated and attempted to be carried on by fish commissions, is in advance of the times. If I am correct in this assumption, it then becomes not out of place to consider whether or not it is expedient to yield something to the present demands of the commercial fishermen, even though by so doing their interests are not truly served, and wait for time and education to bring about a better state of affairs. I am inclined to believe that the commissions can accomplish more in the long run if they adopt this course. The pulling of the commercial fishermen one way and the fish commissions another is not calculated to advance the cause of fish-culture.

I think Professor Baird advanced the idea that it is better to so increase the supply of fishes by artificial propagation that protective laws should not be necessary; that it is cheaper to make fish so abundant that the fisheries need not be restricted than to spend large sums of money in preventing people from fishing. Theoretically, this is an ideal proposition, but, unfortunately, under existing conditions it does not and can not work. If State legislatures would appropriate money enough to carry on the work of artificial fish propagation to an extent eight or ten times what is now done the experiment might be worth trying, but anyone who has attempted to get a moderate appropriation through the legislature knows how hopeless such an effort is. The tendency of those who control legislatures is rather to interject politics into the commission than to assist them to advance the cause of fish-culture. Under these circumstances it is necessary to have fish protective laws; but to what extent in order to produce the best present results for fish-culture?

It may be considered heresy to surrender any part of a principle for the sake of expediency, but when fighting for a great object it seems to me that the greatest advances are made by adopting a give-and-take policy, to gain and retain the regard and respect of the other side, and to take what can be got from time to time with a feeling that it is a step toward the final objective point. As matters now are, I can not see that the fish commissions have advanced much, if any, in popular estimation in the last four or five years. On the contrary, it appears, in some States at least, that they have had as much as they could do to hold their own. In Pennsylvania, as I have already noted, the legislature adjourned without making any appropriation for fish-cultural work during the next two years; and out of the popular subscriptions, amounting to some $15,000, which have been made to supply this neglect or oversight, only $1,000 came from the commercial fishery interests, and that from Lake Erie. In

Michigan the annual appropriation was cut down one-half, and in West Virginia the office of fish commissioner was abolished entirely. Under such conditions it seems not only the part of wisdom but of necessity to make some concessions.

I believe the time will come when commercial fishermen generally will recognize the injury to their interests by the use of overdestructive devices, whether they be fish-baskets, pound nets, salmon wheels, or their allies, and that the fish commissions are working for and not against them; but such conditions do not exist now, and it is the present aspect which must be faced.

I believe that certain devices prohibited by law in many States, such as set or out lines, fyke nets, dip nets, and even set nets, while they ought not to be used, would not, under certain restrictions, materially injure the work of fish-culture. I believe that fish-baskets are the most destructive device in existence for taking fish, with the possible exception of explosives. Under no circumstances should they be permitted in streams into which shad come to spawn, and nowhere else ought they to be allowed without being guarded by severe restrictions or without a license being first paid therefor.

But, above all things, it is important that the commissions and the commercial fishermen come to a better understanding; that they work more in harmony for the advancement of fish-culture. It is also essential that the sporting element and the commercial fishermen cease their jealousies and suspicions of one another and, each recognizing that the other forms an important link in the State's welfare, join hands in hearty support of State fish commissions and their work.

PHILADELPHIA, PENNSYLVANIA.

POSSIBILITIES FOR AN INCREASED DEVELOPMENT OF FLORIDA'S FISHERY RESOURCES.

By JOHN N. COBB,
Statistical Field Agent, United States Fish Commission.

During the course of my various investigations of the fisheries of Florida the fact was brought very forcibly to my mind at different times that there were numerous opportunities for an enlargement of her trade in fishery products. Nearly all of the fishery products of Florida are either sold fresh or in a salted condition, very little canning being done. During certain seasons the markets are crowded with fish in the fresh state, and fishermen are compelled to suspend fishing until this glut is over. This means a heavy loss at frequent intervals. If there were smoking-houses and canning-factories convenient, there would always be a steady demand for certain fishes, which would largely prevent such gluts in the fresh-fish markets.

The State has a great variety of animal life along her immense coast line, but lack of energy and capital with which to prepare and market what are commonly known as "secondary products" prevents her occupying a much higher place among the States as regards the fisheries. Even in marketing fresh fishery products she does not utilize all her resources. I will first take up the question of fishery products sold fresh, and show where I think an expansion could be had.

FISHERY PRODUCTS IN THE FRESH STATE.

Catfish.—One of the commonest varieties of fish in the waters of Florida is the catfish. At nearly all seasons of the year they are found in the rivers in incredible numbers. The people of Florida have always considered them unfit to eat, but this opinion is not universal throughout the country, the people in the States bordering on the Mississippi, Missouri, and tributary streams being especially fond of catfish. St. Louis is a very good market for this fish. At present a small quantity is shipped from Apalachicola, and one firm at Jacksonville does a considerable business, but there is room for an immense development of the fishery. It should be understood that reference is made to the river catfish and not to the sea catfish; the latter does not appear to be popular anywhere.

Sturgeon.—This valuable fish is very common in the rivers tributary to the Gulf of Mexico. Spasmodic attempts have been made at times to carry on a sturgeon fishery, but they soon died out. During 1896 a party fished on the Suwanee River with gill nets and secured a number. There is an excellent chance for carrying on this fishery in most of the rivers north of Tampa Bay.

Crawfish or spiny lobster.—This crustacean is very common in Florida, especially around Key West. It has an excellent flavor and would doubtless meet with a ready sale if it were shipped North in a fresh state. It would be a good substitute for the lobster, which is growing scarce and expensive.

Clams.—The hard clam, or quahog, is very common on the Florida coast, particularly on the lower west coast. A few are gathered and sold locally at Key West and Tampa. These are very large and of an excellent flavor, and by a little effort on the part of the dealers a more extended market for them could be found in the inland towns among people who could not afford to buy oysters.

Frogs.—One of the most delicate and popular of fishery products is obtained from the frog. During the winter, especially, frogs' legs command a very high price in the northern markets. There are plenty of frogs in Florida waters and the fishery could be profitably prosecuted in the winter. The expense for apparatus would be slight, either a small rifle or light spear being required.

FISHERY PRODUCTS IN THE SMOKED STATE.

One of the best and cheapest methods of preparing fishery products is by smoking. This can be done with very cheap appliances, which are within the reach of almost any fisherman. At certain seasons there is a glut in the fresh-fish markets, and unless the catch can be prepared in some such manner fishing must either stop or considerable loss must ensue. There are a number of Florida fishes which can be utilized in this way, and among them may be mentioned the following:

Alewife.—Large quantities of these fish, locally known as "herring," enter the St. John's River for the purpose of spawning, about the same time as the shad, but, owing to the poor prices realized, very few are caught. If properly smoked they would make a good cheap food for the poorer classes of the inland towns of the South.

Mullet.—The above remarks apply to this common fish. Some smoking is at present done by individuals for their own use. A little capital invested in the business would soon develop a good trade.

Sturgeon.—There is an excellent demand in numerous markets for sturgeon in the smoked state, and it would be profitable to smoke what could not be sold fresh.

Crevalle.—These fish, which are rather insipid when in the fresh state, are said to be excellent when smoked. As they are very common it would undoubtedly add to the fisherman's income if he prepared his catch in this way.

FISHERY PRODUCTS IN THE CANNED STATE.

With the exception of the canning of oysters and a small business in the preparation of turtle soup, no fishery products are prepared in this manner. A number, however, could be profitably utilized, and I would mention the following:

Fishes.—The fishes locally known as "sardine," "pilchard," "herring," and "anchovy" exist in very large quantities along the Florida coast, especially at Key West, Biscayne Bay, and the lower west coast. The only use made of these fish at present is for bait in the Key West line fishery. A number of firms in Maine have developed a large business in the canning of the small herring as "sardines," and it is very probable that the fish mentioned above could be prepared by the same process as the Maine packers use, and would prove an acceptable food product. If a sample lot of these were prepared and placed upon the general market the question of their adaptability would soon be settled.

Crawfish.—These can be easily prepared by the method used in canning lobsters. They would make an excellent substitute for the popular canned lobster, and there ought to be very little difficulty in building up a market for canned crawfish, especially in the Southern States, where its excellence is well known.

Shrimp.—Shrimp are very common in Florida, but very little attention is given to their sale in other than the practically fresh state, and in many coast towns the fishermen throw them back into the water when found in the nets. A shrimp-canning factory at some good locality would undoubtedly be a paying investment if in the hands of experienced persons.

Green turtle.—An excellent opportunity exists for the development of the business of preparing green-turtle soup. One person is now engaged in this business at Key West, but he is so overrun with orders that he has restricted himself entirely to supplying the foreign demand. There is at present a considerable domestic demand, and this could easily be enlarged should the business be taken up by experienced and energetic persons. There is no apparent sign of a decrease in the number of green turtles landed at Key West, and if the factory were located there a supply could easily be secured during the season. A factory, possibly at or near Miami, might be successful if the turtle fishermen, who work on the east coast and sell their catch at Key West, could be induced to land their fare at the factory. There is hardly a doubt of this, as it would save them the long journey to Key West. Turtle meat can be canned in the same way as other food products, and this would be a good method of disposing of green turtles too large for shipment to northern markets in the shell.

Clams.—In the North clams are frequently put up in cans the same as oysters, and this would be an excellent method of utilizing those that could not be sold fresh.

MISCELLANEOUS PRODUCTS.

Porpoise oil and leather.—The securing of oil and leather from this mammal is a profitable business in several sections of this country. As porpoises are very common along the Florida coast a remunerative fishery might be established.

Crab.—The horseshoe or king crab is said to be very common in Tampa Bay. While not an edible product it makes a fine fertilizer. Thousands of pounds of these crabs are used each year by the farmers along the Delaware Bay and other waters. As fertilizers are especially valuable in Florida, the utilization of this crustacean for the purpose mentioned is suggested.

Seaweed.—This common substance makes excellent and cheap manure, and owing to the very large extent of coast possessed by the State is easily within the reach of all. When buried in the earth around the roots of plants and trees it acts very rapidly, softening and decomposing in the soil so quickly that the effect is confined altogether to the special crop to which it is applied.

Shells.—Numerous and beautiful shells are constantly thrown up on the beaches in Florida by the storms, and if these were more generally gathered and shipped to northern points they would find a ready sale, and thus add a considerable amount to the yearly income of the fisherman without much inconvenience or trouble to himself, as the season when they are generally found is the time when he is compelled to remain at home on account of the storms. New York City and the various seaside summer resorts of the North are the best markets for these shells.

In conclusion I would state that, owing to the necessarily restricted length of this paper, I have not taken up the details of the processes necessary in preparing the various fishery products mentioned, but any information in the possession of the United States Commission of Fish and Fisheries will be placed at the disposal of anyone who may be moved to proceed on the lines suggested.

WASHINGTON, D. C.

THE UTILITY AND METHODS OF MACKEREL PROPAGATION.

By J. PERCY MOORE.

The esteem in which the mackerel is commonly held as a food-fish and the great importance of its pursuit and capture to a large part of the population of certain sections of New England have naturally caused the welfare of the fishery to be jealously guarded. During the past decade the frequent failure of a season's fishing to earn profits has given rise to a fear that the supply is in danger of speedy exhaustion. It was this supposed danger which several years ago led those who have labored in the interests of improved fisheries to experiment with the artificial propagation of the species. It was hoped that the method which had repeopled so many depleted streams and lakes, which not only saved from extinction but extended the shad fisheries, and which is no doubt destined for still greater triumphs in the future, would be capable of rejuvenating some of our decrepit sea fisheries. Though the evidence is by no means unequivocal, these hopes appear to have had a certain warrant in the cases of two sea fishes, for which suitable apparatus and methods have been devised. It is the purpose of the present sketch to point out what appear to be the possibilities and limitations of the method when applied to the mackerel.

The subject may be stated as two principal problems, viz: (1) Is the alleged scarcity of the mackerel a sufficient reason for believing that the supply is becoming exhausted? (2) If so, can the supply be increased and maintained by recourse to artificial propagation?

A glance at the statistics covering the last twenty years may seem to confirm the gravest fears, for from 350,000 barrels in 1880 and 395,000 barrels in 1881 the catch inspected in Massachusetts fell to 75,000 barrels in 1886 and 18,000 barrels in 1891, since which year there has been some slight increase. Fortunately statistics of the catch covering a long period are available for several of the New England States. The late Dr. Goode has presented, in his "History of the mackerel," a curve showing the number of barrels of salt mackerel inspected in Massachusetts annually from 1804 to 1881, and this exhibit has been extended in the annual reports of the Boston Fish Bureau. The frequent and great changes in the course of the curve, corresponding to variations in the number of barrels, are very striking. But a remarkable regularity in the periodicity of the more important fluctuations is apparent. Thus, great catches were made at intervals of about twenty years, in 1831, 1851, about 1870, and in 1881; the smallest catches alternate with these, namely, in 1814, 1840, 1859, 1877, and 1891. Smaller variations of shorter and less regular duration occur between the larger.

By eliminating these minor irregularities, the great movements and the general tendency of the fishery become more evident. This elimination is accomplished by averaging the annual figures for overlapping periods of ten successive years, beginning with each year from 1820 to 1882. The curve plotted from these results is much more uniform than that exhibiting the annual inspection; it rises and falls regularly and gradually at long intervals above and below a line representing the mean annual inspection of about 230,000 barrels. It also shows that the fishery has not, on the whole, diminished in productiveness. We are therefore justified in assuming, though the hope may prove delusive, that the present period of scarcity will, like all similar ones in the past, be succeeded by a time of plenty. The conclusion follows that the evidence does not point to any necessary or immediate danger of the commercial extinction of the mackerel.

This conclusion may be questioned, on the ground that the catch has held its own only through the increased efficacy of the methods employed. A careful study of the results which have followed some of the more important innovations does not lead to the acceptance of this objection. Many competent authorities have expressed the opinion, which is supported by an array of convincing evidence, that man can exert but little direct influence upon the numbers of those species of fishes which inhabit the open sea. Professor Baird, in writing of the bluefish, shows conclusively that the numbers of this fish have increased and decreased quite independently of the methods adopted by man for its capture, and that man exerts an indirect influence upon its movements in but one respect, namely, by decreasing, through excessive fishing, the available food supply which it derives from the shore fishes. The mackerel, owing to the character of its food, consisting of sand-eels, small crustacea, and other forms not subject to man's direct influence, would seem to be even more independent of the methods of the fisheries than is the bluefish.

It may also be supposed that the greater or less quantities of fish annually captured have been determined by the energy with which the mackerel industry has been pushed. That some of the smaller fluctuations have been due to this cause seems evident, from the fact that during certain years, when the average fares have remained about the same, the catch has been proportional to the number of vessels employed. It is, however, also evident, from the statistics bearing upon this point, that the number and tonnage of vessels employed bear no constant relation to the quantity of fish captured. On the contrary, a very successful year has always stimulated greater interest, and has led to the employment, for several years thereafter, of an increasing number of vessels, while a year of marked failure has diverted vessels and men to other employments. This fact tends to overcome and obscure the evidence which the statistics convey of great and sudden movements in the body of mackerel.

The problem is, however, only shifted. We may feel satisfied that there are no indications of the speedy exhaustion or material reduction of the mackerel supply; but the fact remains that there have been periods, sometimes extending over a number of years, during which the fishery has not paid the cost of operation. It becomes, therefore, extremely important that the cause or causes of these fluctuations should be determined, in order to obtain, if possible, a constant and uniform supply of the fish. It is manifestly just as important to the fishing as to the manufacturing interests that economical regulation of supply and demand should be accomplished. The great evil of the present state of affairs is uncertainty. Capital and labor are attracted or repelled by the appearance of conditions which can not at present be calculated upon beforehand, with a consequent loss in the long run to the fishermen and an increased price to be paid by the consumer.

When the effective causes are fully known the remedy will be indicated; and should it prove to be one impossible of application, it may at least be possible to foretell the prospects of a season and thereby save those interested much disappointment and loss. Many suggestions have been made to account for the fact. Of these we shall consider but four of the most important.

I. It has been contended from time to time, during periods of scarcity, that overfishing or the employment of particular apparatus or methods was to blame. That this theory was advocated even as early as colonial times is evidenced by legislation affecting the methods of taking mackerel which we find recorded in the colonial laws of Massachusetts. With each succeeding period of wane this theory is revived, but its advocates become silent with the advent of prosperity, when the very methods complained of are plied with renewed vigor, or perhaps replaced by more effective methods. The fact that there has been no continuous diminution in the quantity of mackerel taken during the last eighty years, together with the fact of the regular alternation of large and small catches having no casual connection with the employment of new methods, seems to sufficiently dispose of this theory as the sole or even an important explanation. We may quote the weighty opinion of Dr. Goode. He says of the mackerel:

> It seems quite evident that the periods of their scarcity and abundance have alternated with each other without reference to overfishing or any other causes that we are prepared to understand.

The area within which the mackerel is subject to man's influence is but a small part of the vast expanse over which it roams, and the time but little more than half of the year. To one who appreciates the magnitude of the struggle for existence which rages in the ocean, the constant dangers and many natural enemies which beset the mackerel at all times and during every period of its life, the numbers which fall to man must seem but the merest trifle compared to the multitudes which are destroyed by other causes. We may arrive at a reasonable estimate of how insignificant human influence sometimes is by an examination into the history of man's conflicts with the rabbits in Australia, the mongoose in Jamaica, the sparrow in our own country, the locusts and other injurious insects everywhere, etc. On the other hand, there are the cases of the bison, the fur-seal, the great auk, and many other birds and mammals, as well as fresh-water and shore fishes, to bid us be cautious; and we may yet learn that the small numbers (relatively to those which naturally succumb) of mackerel taken by man may turn the balance in the direction of that fish's numerical decline.

II. Infectious diseases may decimate the ranks of the mackerel hosts periodically. This is a possible explanation for which there is absolutely no evidence. Fresh-water and anadromous fishes have been known to be thus destroyed in vast numbers by fungous and other diseases, and a great fatality among the bluefish in the beginning of the century may have had a similar cause; but the subject is an untilled field with regard to sea fishes. The mackerel is almost invariably affected by large numbers of parasites, but these appear to produce no ill effects. No bacterial or other diseases are known. That slight changes in the physical conditions of the sea may destroy life on a stupendous scale is evident from such observed cases as that of the tilefish. If such destruction of the mackerel has taken place the fact has escaped notice.

III. A third and perhaps more worthy suggestion would lead us to seek the solution of the mystery in the effect of environmental influences on the fertility of the species, the relative abundance during one season being the result of greater or less fertility in previous seasons. Or, the actual fertility of the parent fish remaining the same, the physical and other conditions may be such as to destroy the eggs and young in greater or less numbers, resulting in subsequent times of scarcity or plenty. Though there is no direct evidence of variable fertility in the case of the mackerel, many analogous instances are known of seasons of greatly increased or diminished fertility in other groups of animals, of which every observant naturalist has met with many. The young of some of our shore fishes are well known to appear in great swarms during certain seasons and to be unusually scarce in others. In some cases these swarms of young have been observed to appear as larger and larger fish for several successive years, but in other cases their very abundance has proved their destruction by attracting schools of bluefish, which very quickly depleted their ranks.

Besides the lemmings, locusts, army-worms, and many other species among land animals, we may also mention the great swarms of jelly-fishes, salpæ, etc., which appear periodically on our coasts, and the oyster, which, even aside from the question of the fixation of spat, differs greatly in this respect in different seasons. Some of these cases can be proved to be owing to the production of eggs or young in greater or less numbers, others to the greater or less destruction, through unfavorable circumstances, of eggs or young. The records of surface towings made in the neighborhood of Casco Bay show that the number of mackerel eggs present varies greatly. In 1894 they were very plentiful, while during the summer of 1897, although the eggs of other species were present in great numbers, those of the mackerel were almost entirely absent. And this was in spite of the fact that schools of mature fish entered the bay during that time. This result may have been due to the mackerel having spawned further off the coast in 1897 than in 1894. The winds influence the distribution of the eggs by moving the surface waters, but this and similar factors were eliminated in the investigations of 1897.

IV. The last theory to be considered in this connection is one deduced from the well-known wandering habits of the mackerel. Besides periodic movements toward and from the shore, and coastwise migrations which occur in spring and fall, this fish, like many other active pelagic organisms, is in the habit of wandering far and wide over the broad expanse of the North Atlantic Ocean. How extensive these more irregular movements may be in the case of particular schools of fish is not known, but it is supposed that during the periods when our fishermen meet with a scarcity the great body of fish may remain in some region hitherto unknown or inaccessible. They may either be in the open sea far off the coast or remain submerged and hidden.

Everyone knows that within the actual limits of the fishing-grounds the schools are very sensitive to changes in conditions, and so long as many of the influences which affect them remain unknown their movements seem to us to be mysterious and capricious. The fishing, both with line and seine, may be exceedingly good in certain localities for a few days, when suddenly, even in the midst of their abundance, the fish may "strike off" almost without warning, and either totally disappear, or apparently the same school reappears at some distant point.

Mackerel may be present in abundance, but refuse to school or to take the hook; or no mackerel may be visible at the surface, yet the occasional rush of schools before the onslaughts of larger predaceous fish or mammals, or other signs, may betray their whereabouts, and though plenty, none will be caught. These conditions may characterize a part or the whole of a season. During particular seasons the best fares may be taken in the spring; during others, in the fall or in midsummer. Sometimes the great catches, which have made the total for a season large, have been taken in a few weeks; sometimes the entire season has been uniform in its results, either good or bad, as the case may be.

Again, seasons may be characterized by marked differences in the distribution of the fish. One time the best catches will be secured in the Gulf of St. Lawrence; at another time in the Gulf of Maine, and, again, in the waters about Cape Cod. Sometimes the best fishing may be inshore, and the trap-owners will reap a harvest; sometimes it will be farther off the coast, and the seiners will enjoy a monopoly. It has frequently happened that for a period of years one part of the coast has been affected very differently from others. For many years the Gulf of St. Lawrence was a favorite resort of American mackerel men, but it now seldom repays the trouble of a visit. The Bay of Fundy, though formerly productive, has not supported a mackerel fishery for twenty years.

All of these facts and many others show that the movements of the mackerel are as changeable as the weather and in the present state of our knowledge just as uncertain. The success of the fleet in any given year is no certain criterion of the abundance of mackerel during that year, and it is only by taking the averages for a number of successive years that the real state of the fishery can be apprehended. There is also some direct evidence of the existence of large numbers of mackerel even in seasons which have been failures. The summer of 1877 will be remembered as one of the most disastrous that the mackerel men have known since the beginning of the century; yet in that year was seen what was probably the greatest single body of mackerel ever recorded, estimated by an experienced captain to contain 1,000,000 barrels, a number about twice as large as the entire fleet has ever taken in one year. This would seem to indicate that instead of the schools being scattered so as to come under the observation of fishermen, many of them were congregated into this vast, roving body. A few similar bodies, which might easily escape observation, would explain the apparent scarcity that year, and the successful spawning of these would account for the great host which visited Massachusetts Bay in 1880 and spread along the New England coast in the following year, when the catch was unprecedented.

Now, it has very justly been pointed out that these known facts respecting the more local movements of the mackerel, which are the cause of many of the minor variations in the catch, argue forcibly that similar fluctuations of larger degree are explained by migrations of greater scope. When the center of distribution of the mackerel hosts falls within our waters, there is a plenty; when it falls elsewhere, the degree of scarcity corresponds with its remoteness. In this connection it remains to point out that the mackerel, unlike anadromous species, is not constrained to visit the coasts by the impulse to spawn, but that this process may and frequently does take place in the open ocean, far from land.

Some of the factors which determine the movements of the great body of mackerel are known, some are unknown. Of the known factors the most important is the distribution of the pelagic organisms which serve as food for the species. But this again is determined by temperature, winds, currents, precipitation, and many other factors. Though the incompleteness of our knowledge leaves the question of variable numbers still open, we are probably safe in the tentative conclusion that migrations and variable fertility are two of the more important factors which enter into the solution of the problem. If these are among the causes, have we the remedy? We can not hope to control the migrations, though we may learn how to follow the mackerel in its wanderings or to take it from the depths. The possibility of developing new local schools by artificial means may be suggested, but this would be a weighty task, and, moreover, the same influences which led the old schools to migrate would probably affect the new. But if we set this supposition aside it remains for us to inquire if there is any probability that the desired result of uniformity in the supply can be effected by artificial propagation.

The problem is a complex one and difficult of adequate treatment. In the first place, if the truth of the above contention, that the mackerel has probably adjusted itself to the fisheries and that its numbers have in consequence maintained a fairly even balance be admitted, then it follows that each generation must produce a number of eggs sufficient, when all deductions for casualties are made, to give rise to an equal number of mature breeders. That is, the number of breeders must remain practically constant in successive generations. As in the mackerel the two sexes are about equally divided in numbers, it also follows that from all of the eggs annually produced by a female but two on the average grow to be breeding fish. The total number of eggs produced by a mackerel during the spawning season has been variously estimated at from 363,000 to 680,000. Let us fix the average number near the lower limit. There results the conclusion that about 200,000 eggs are required, under natural conditions, to produce one breeding fish.

The average annual catch of the Massachusetts fleet is about 230,000 barrels, representing roundly, according to a somewhat hasty estimate, about 32,000,000 fish of three years and older, 23,000,000 of two years, and 12,000,000 of one year. The first are all fish of breeding age, and perhaps some of the two-year-olds also are. The poor catch of the year 1877 fell below this average to the extent of about 21,000,000 fish of the largest size and 8,000,000 two-year-olds, while of younger fish the average was just equaled. Suppose that the problem is to make good this deficit by artificially propagated fish and that for the sake of clearness we leave out of consideration any disturbing factors. In order to produce this result, a sufficient number of eggs must have been handled in 1874 to produce, three years later, 21,000,000 mature fish; and in 1875 to produce, two years later, 8,000,000 fish of the size usually classed as No. 3's. And this leaves out of consideration the number of fish which would have been destroyed by the fisheries and other causes in the interval between 1874–1877, as well as the obvious fact that of those which survived only a small part would be taken by the fishermen. To make good this shortage for 1877 by the natural processes of spawning, under average conditions would require a number of eggs equal to 21,000,000 multiplied by 200,000.[1]

The year taken (1877) is, of course, an extreme case, though the present decade has seen much worse; but the goal which should be aimed at in our fishery development is to supply the entire quantity consumed in this country. Besides, the year 1874, when this hypothetical experiment in practical propagation is supposed to have been begun, was particularly favorable to its successful issue. The Massachusetts inspection passed 180,000 barrels of Nos. 1 and 2, or about 50,000,000 of fish large enough to be breeding. Now, suppose that one-half of these were males and that one-third of the fish were taken in actual spawning condition. Let us further assume that all of these 8,500,000 spawning females were actually stripped and the entire yield of eggs utilized. It is peculiar of the mackerel and many other active fishes that only a portion of the eggs produced in the season mature at one time. The mackerel yields on the average, when stripped, about 40,000 eggs. This would give a total number of eggs secured of 8,500,000 multiplied by 40,000, or 340,000,000,000.

[1] It is, of course, understood that the 21,000,000 includes fish of several ages. In the calculation all are regarded as being 3 years old, owing to the absence of any data upon which to base a separation among those of 3 years and older. The writer's personal examinations of mackerel for several years past convince him that the number of mackerel of 3 years of age captured is at least equal to all those of greater age combined, making a very liberal allowance in favor of the latter. The result of the calculation would not, therefore, be materially affected.

Now, suppose that all of these eggs were hatched, which would be a triumph of fish-culture beyond our wildest dreams, and that the 340,000,000,000 of larvæ were liberated under the usual conditions; it is evident that from now on they must be beset by the same dangers and suffer the same losses as their fellows hatched under natural conditions. In the latter case it has been shown that it takes 200,000 eggs to produce one breeding fish. As we do not know just in what period of life this destruction of 199,999 out of every 200,000 takes place, we are forced to make a guess. Let us make one which can be proved to be liberal, and suppose that 75 per cent of it occurs while the embryo is developing in the egg, during a period at most of six days, and only 25 per cent during the remainder of the three years. According to this, 50,000 newly hatched larvæ would produce one mature fish of the average spawning age. Dividing the 340,000,000,000 by 50,000, we get 6,800,000—a figure which, even under a series of hypothetical conditions ridiculously favorable, is below the desideratum. The figures given are, of course, only approximate, and in one case a liberal guess, but they give some idea of the magnitude and difficulties of the undertaking.

Let us now see what has actually been accomplished. Repeated experiments have been conducted—both abroad and especially by the United States Fish Commission for several years past—in the hope of successfully propagating the mackerel. The eggs, like those of the cod and other marine fishes, are buoyant in water of the density of the open ocean, and the same apparatus has been used in this country as for the very successful cod hatching. The several forms of Chester and McDonald tidal boxes have been used with results which have been practically uniform for all. For the purpose of automatically changing and freshening the water, the principle of a tidal rise and fall induced by an intermittingly acting siphon is used. The eggs after fertilization are placed in a receptacle, either an open box the bottom of which is made of cheesecloth, or a cylindrical jar the open end of which is closed by cheesecloth, while the bottom is perforated by a hole which permits the ingress and egress of air. The cheesecloth end of either box or jar is supported on a frame fixed at a proper point (about 2 inches below the lowest point to which the water falls) in one of the tidal boxes. By this arrangement the water within the jar or box containing the eggs is made to partake of the same movement, and part of it is drained off and replaced by fresh water with each complete tidal oscillation, while the buoyant eggs float in a layer at the surface. They do not, however, long remain so, but during the course of development become—apparently because of the gradual absorption of the oil drop—gradually heavier, and sink slowly toward the bottom. Here they lie in the midst of a mass of filth, which quickly collects, and, cut off from the light and air, sooner or later succumb. A few will usually hatch, but the larvæ do not long survive. Attempts have been made to overcome this difficulty by increasing the density of the water, or by the use of shallow dishes in which the eggs are more directly exposed to the light and air. Both of these methods gave somewhat encouraging results, but the experiments could not be carried to a conclusion. Experiments with the ordinary tidal apparatus have been frequently repeated under varying conditions, but have almost always resulted in complete failure.

The only important exception to this statement is to be found in the results reported during the past summer by Mr. Corliss, of the United States Fish Commission station at Gloucester. According to this statement, out of about 1,000,000 eggs handled 450,000 were hatched. To explain the mortality it has been suggested that this result is due to imperfect fertilization, itself the outcome of some lack of vitality in the egg or spermatozoan; and while this is generally attributed to injuries received in capture, attention may be directed to the suggestion that the periods of scarcity may be in part due to lowered vitality and fertility of the fish. In this case it is obvious that to attempt artificial propagation while the condition lasts would be a waste of time.

But this explanation probably fails to reach the root of the matter, as a study of the spermatozoa and eggs before and immediately after fertilization indicates, by the activity of the former and the response of the latter, a good vital condition. Fertilization is very easily accomplished, and the rhythm of development is strikingly constant and simultaneous in all of the eggs of a batch. The unfavorable condition must be sought in the method of propagation, and many facts point to the conclusion that the shore waters utilized for the purpose lack the physical qualities, and the apparatus fails to supply certain important conditions requisite to the healthy development of the eggs. To this conclusion are opposed the results reported from Gloucester Station, and these, together with the partial success of experiments with water of increased density, lead to the hope that the mackerel may some day be successfully hatched.

There is, however, a further serious practical difficulty to be encountered. Even were artificial propagation as successfully accomplished with the mackerel as with the cod, and 50 per cent of the eggs handled turned out as fry, could the demands imposed by the figures given above be met? During the season of 1896 the collection of mackerel eggs was pushed with great vigor by the United States Fish Commission, with the result that about 23,000,000 eggs were taken, a number which, even if all were hatched and deposited under the most favorable conditions, would fall many times short of producing 21,000,000 fish three years later. In 1897 less than 4,000,000 were obtained, although every effort was made to conduct operations on a large scale.

These difficulties have led to the proposal that suitable arrangements be made with the captains and owners of seining vessels by which one or more spawn-takers (probably members of the crew would serve) would accompany each vessel during the spawning season. Upon the capture of a spawning school vast numbers of eggs could be taken, immediately fertilized, and turned overboard under the best natural conditions for further development.

The method has several obvious advantages—(1) great numbers of eggs which would otherwise be destroyed would be started on the way to future usefulness; (2) it could be applied at small cost, and (3) in one respect it would be a gain over the natural deposition of eggs, in that more certain fertilization would be insured. The facts upon which this last statement is based are founded not upon investigations of the mackerel, but of the cunner, where the gain is about 30 per cent.

One disadvantage of the method would be that the eggs would be endangered by contact with the waste thrown overboard during the splitting operations, and from predaceous fishes thereby attracted. Moreover, in view of the above figures, it seems futile to hope that operations could be conducted on a sufficiently large scale to be of any considerable benefit. If it ever becomes possible to confine the fry until they reach a considerable size, say until after they have assumed the adult form, then it may be possible to secure the supply of eggs in this way, to transport them to a station of great capacity and operating under conditions most favorable to the development of the species, such as would be obtainable upon an ocean-going steamer or an outlying island, and thus to bring about the desired result. But in view of the great area covered by the wanderings of the mackerel, of the vast numbers which inhabit the ocean, and of the peculiar difficulties which have to be overcome, it seems unlikely that propagating operations conducted at a few points along the shore can ever reach that magnitude demanded in order to make them effective.

The conclusions arrived at may be summarized in the following propositions:

1. The total mackerel supply has not been proved to have diminished materially within the present century.

2. The abundance of mackerel has varied greatly within the area of operation of the American fishing fleet.

3. The minor annual variations in the catch are in part due to the local migration of the schools, and in part to the activity with which the fishery is prosecuted.

4. The more important fluctuations are of long interval, and may be represented as waves of elevation and subsidence having a period, during the present century, of usually 20 years. They are normal, in the sense of being independent of the fisheries.

5. The causes of these more important fluctuations are not fully known, but the most probable which have been suggested are, *first*, extensive migrations which carry the body of the fish to and from our shores, and *second*, variable fecundity. These, again, are the result of complex cooperating factors, some known and some unknown.

6. The need is, therefore, not to increase the total number of mackerel, but to render available a uniform portion of the supply each year, or at least to furnish a means of forecasting the prospects of each season—that is, to determine the laws of this periodicity.

7. The method of artificial propagation, even if successfully conducted, is not of proved utility for the mackerel.

8. If artificial propagation is to be of any benefit, it must be practiced on a vast scale, commensurate with the great area over which the American school of fish roams.

9. Owing to the capricious roving habits of the mackerel, it is doubtful if local schools could be established and maintained by the deposition of artificially-hatched fry in the desired localities.

10. With our present knowledge of the subject, the mode of procedure which promises the best practical results with the least expenditure would be to deposit in the water immediately after fertilization the enormous numbers of eggs which can frequently be obtained from spawning schools captured in purse seines. This would at least avoid the most serious injury which falls upon the mackerel as a result of the modern methods of fishing.

11. The problem of the mackerel can not be divorced from the problems of pelagic life in general. When the latter are solved the former, together with many other practical fishery problems, will disappear. The scientific labors of the Fish Commission and of individuals have accomplished much toward this end, but much more remains to be done. In the specific case of the mackerel there is scarcely an important question of its economy upon which fuller knowledge is not required for the practical benefit of the fisheries.

UNIVERSITY OF PENNSYLVANIA, PHILADELPHIA.

THE LARGE-MOUTHED BLACK BASS IN UTAH.

By JOHN SHARP,
State Fish and Game Warden.

This excellent fish was first introduced into Utah September 8, 1890, when a carload of black bass, red-eyed perch, crappies, and sunfish (many of them spawners) was received from the Illinois River. About a fourth of these were put into the Weber River at Ogden and the remainder into Utah Lake. Of the lot planted in Utah Lake, 2,000 were large-mouthed black bass. Of those planted in the Weber River at Ogden little has been said or heard, but the Utah Lake fish have developed very satisfactorily. They were not allowed to be taken in any manner for three years after their introduction, and at the expiration of the legislative period of protection it was evident that the large-mouthed bass had increased very rapidly and grown to a fairly good size. A few were taken in the fall of 1893, the largest weighing 3 pounds, the average being about 1 pound. In 1894 they began to be taken regularly for domestic use and commercial purposes—about 30,000 pounds per annum being reported by the commercial fishermen and dealers—and, including those taken by sportsmen and others for family use, I believe I would be within conservative bounds in saying that Utah Lake has produced annually 40,000 pounds of Oswego bass since 1894, without taking into consideration those taken for propagating purposes in this and neighboring States. I am told that they are increasing rapidly and that there are many millions in the lake.

The annual growth of the largest specimens taken seems to be about 1 pound. The largest fish taken in 1895 weighed 4½ pounds. In 1896 the largest weighed 5¾ pounds and was about 18 inches long. In 1897 the heaviest fish taken weighed 6½ pounds and was about 19 inches in length. Not having had any experience with this fish before its introduction here, the larger sizes seem to me to grow extremely stocky, their length not appearing to be more than about twice their depth. This is no doubt a marked characteristic of the species where favorable conditions exist for its perfect growth and development.

This Utah lake, which has proven to be such an excellent nursery for the Oswego bass, is situated near the center of the State and has an area of about 200 square miles, with an average depth of 10 to 15 feet, and lies at an altitude of 4,499 feet above mean sea level. The surface temperature of the water during the summer months I estimate will range from 60 to 65° F. I have not learned of any extended temperature tests of the water having been made to determine the average temperature.

The lake has an approximate length of 20 miles north and south, with an average width of about 10 miles east and west, and is fed by a number of springs and mountain streams of varying size, with one of considerable volume, the Provo or Timpanogos River. The water running into the lake comes from streams draining from the Wasatch range of mountains immediately on the eastern side of the lake, and in consequence the lake bottom on that side is of a mud or silt character from deposits of inflowing streams.

The lake is abundantly supplied with native common fishes, chub, mullet, some mountain herring (Williamson's whitefish), three or four varieties of sucker, and minnows, with, unfortunately, an ever-increasing supply of carp, introduced here in 1886. It is also fairly well stocked with a large-growing native trout which frequents the inflowing and connecting streams in April, May, and June to spawn, and which I believe is classified as "*Salmo mykiss virginalis*." In the early settlement of the State this grand fish was almost phenomenally abundant in the lake and connecting streams. It is authentically reported that as much as 3,700 pounds of it have been taken at a single haul with a seine not exceeding 200 yards long, with many individual specimens weighing 25 pounds each. We do not now find any of these trout so large, but some are taken weighing 15 pounds, and since the taking of trout and bass is confined by law to the usual method of angling or trolling with hook and line only, I hope to again see some of these native Utah Lake trout attain to their old-time size.

The rapid increase and growth of the large-mouthed bass in this lake are no doubt due to the abundant supply of the native common fish together with a varied supply of fresh-water crustacea upon which they prey, with a depth of water and with water vegetation suitable to their requirements. I believe that all the conditions favorable to the perfect growth and development of the Oswego bass exist naturally in this lake, especially after they have attained the first year's growth. I have noticed, however, that the fry for the first year do not grow so rapidly in this lake as in some other smaller bodies of water to which they have been transplanted from this lake. Of four or five thousand fry which I had taken before the spawning season of 1897 for distribution in different parts of the State, the very large majority were from 2½ to 4 inches in length only. These were no doubt hatched the previous season and could not have been less than six to eight months old.

In marked contrast to this apparently slow growth of the bass fry in Utah Lake the first year, in the Mount Nebo reservoir an almost phenomenal growth of the fry from the first planting was shown the first season. This reservoir is situated about 15 miles south of the lake, and was created by the construction of a masonry dam across Salt Creek at its exit from the Nephi Valley, through which it flows into Goshen Valley and thence finds its way into Utah Lake, or did so before being appropriated for irrigation purposes. This is a small sluggish stream of clear and slightly brackish water, averaging about 10 feet wide and well supplied with native minnows before the reservoir was created. This reservoir is about 5 miles long with an average width of ½ mile, and of varying depth from nothing to 15 feet in places, the water covering entirely new ground with the exception of the old creek channel. About the 1st of May, 1896, the parties controlling this reservoir made application for and received 90 large spawning bass and planted them here in this small body of water. These fish evidently began to spawn soon after being planted, for in about four months after the planting the place seemed to be alive with bass fry of very large size. It was estimated that there could not be less than 500,000 of these young fish. Having heard of this wonderful plant, I visited the site seven months after the plant was made, but unfortunately for my investigation a cold snap had partly frozen the pond over and driven the fish into the deep water so that I could not have an opportunity of making a personal estimate as to numbers. I was fortunate, however, in having a close inspection of about 50,000 which had escaped through the dam gate and were penned in the channel immediately below. A dozen of the largest of these were taken with an improvised dip net. In contrast with the fry of the same or a greater age in Utah Lake, these had attained a superior growth of at least twice the length and ten times in weight. They would average 6 inches in length and weigh nearly ½ pound each, being very stocky. I can not account for this vast difference in the growth of the young bass the first year in these two places, unless it might be that in the new reservoir there are no large fish of other species to interfere with or disturb them; and the new ground perhaps furnished abundant food in the development of worms and other minute animal life exactly suited to their age and condition. I shall watch this reservoir plant with considerable interest to see how long the superior growth may continue.

Recognizing the superior adaptability of this splendid fish for the lakes and ponds of the lower valleys of this State, I recommended a legislative appropriation to stock these waters with large-mouthed bass, and the general assembly in March, 1897, appropriated a sum sufficient to stock all the suitable waters of the State. Arrangements were therefore made to catch the fish out of Utah Lake and place them in small ponds near the railway, preparatory to shipment to the various places of planting, and by May 4, 1897, enough had been taken to make a large carload, which was shipped on that date to Bear River and Bear Lake in the northern part of the State. This consignment consisted of 2,500 fish in all, 450 being large spawners averaging close to 2½ pounds each. Of this lot, 100 spawners and 600 yearling fry were deposited in Bear River at various points in Box Elder and Cache counties, and the remainder taken to Bear Lake and planted at a number of places on the eastern side of the lake embracing a range of about 25 miles in length. This beautiful sheet of water has approximately the same surface area and dimensions as Utah Lake, with the elongated axis north and south in a similar manner, and both lakes are flanked on three sides by majestic mountains. The southern and main part of Bear Lake has a beautiful sandy, gravelly, and rocky bottom and shores, with water as clear and limpid as glass, and attaining a depth of 250 feet in places, with the summer temperature on the surface ranging quite 10° F. below that of Utah Lake. It lies in the extreme northeast corner of the State, about 300 miles north of Utah Lake, and at an altitude of 5,911 feet above mean sea level, and is fed mostly by short cold streams flowing into it from the snow-clad mountains on the west. The common fishes are more numerous here than in Utah Lake, with two species of large growing trout, locally known as salmon trout (which frequent the inflowing streams to spawn) and the bluenose trout, which I am told spawns in the lake. Some of these trout in early times, before the use of seines and gill nets for commercial purposes, are reported to have attained the weight of 30 pounds.

This lake is about equally divided between Utah and Idaho, the east and west dividing line of the two States cutting the lake in about equal proportions, so that in stocking it with the black bass, Idaho receives as much benefit as Utah, which we do not at all begrudge. Theoretically this lake should produce a better quality of bass than Utah Lake. It apparently has equal if not superior food and spawning facilities, with a much purer quality of water that should impart a better flavor to the fish. The question of the considerably lower temperature of the water may and perhaps will prove to be an important factor for good or evil in the growth and development of this valuable food and game fish in this lake, which the next few years will no doubt demonstrate. I feel quite sanguine, however, that this goodly plant of the Oswego black bass will prove successful, and of incalculable benefit to the northern part of Utah and the southern portion of Idaho.

This being the largest and most important individual plant to be made in the State, it received the first attention; and after its successful accomplishment, it was deemed advisable to defer the plantings in the southern part of the State till the cool weather in the fall, and for the further reason that the spawning time was dangerously near for successful catching and transportation. Further stocking of the State waters was therefore postponed until the 30th of October, when I took a shipment of 130 large spawners, ranging from 1 to 5 pounds weight, and 1,100 yearling fry to Richfield on the Sevier River in the central-southern part of the State and planted them in a clear, sluggish stream of spring water tributary to the Sevier River. This spring stream is 15 to 20 feet wide and has its source in a succession of connected spring ponds and lakelets of varying moderate depth, fringed and interspersed with tules, flags, water-cress, moss, and other vegetation, and covering an area of probably 200 to 300 acres. It is an ideal small place for the bass, and the whole shipment was planted here and designed as a stocking plant for this section. Most of the water to be stocked is of a pond character, with generally small and slowly flowing streams, the Sevier River being perhaps an exception.

This stream, although the main drainage avenue of this part of the State, can hardly aspire to the dignity of a river, its channel being from 30 to 50 yards wide only. For one or two months in the spring of the year, however, the melting snows from the mountains along its course and the mountain streams tributary to it swell its volume to the dimensions and character of a torrent or a small river, but in the summer months the channel is drained almost dry in places for irrigating purposes. Nevertheless the water drains and seeps back again into the channel, giving long stretches of water with hardly a perceptible current. The bass might do fairly well here, as the common fish abound everywhere in these waters, and the upper portion of the stream has a goodly supply of the same species of trout found in Utah Lake, and all the streams tributary to it and where its source originates are thronged with mountain trout.

Sevier River has its source in the mountains forming the rim of the Great Salt Lake Basin, near the southern boundary line of the State, and flows thence 200 miles in a northeasterly course to a point at Gunnison in Sanpete County, where the course changes to northwesterly for about 40 miles, and again to westerly and southwesterly for about 50 miles; then, after flowing through the entire length of the Sevier Valley and passing through six counties, it finally discharges into Sevier Lake in Millard County. This lake has no outlet and contains too much saline matter for the existence of fish life; but there are a number of square miles of connected lagoon lakelets near the mouth of the river on either side before reaching the main saline lake, where the water is fairly good, with an abundant supply of all the native common fishes, and carp innumerable. Here I have high hopes that the bass will do well; and these waters, together with a few other smaller patches in this locality, were the next and last to claim our stocking attention for this season.

On the 12th of November our last carload, consisting of 200 large spawners and 1,800 yearling fry, was started over the Oregon Short Line Railway from Utah Lake at Provo. At Juab station, 60 miles south from Provo, 45 large spawners were taken out and sent by wagon to Scipio Lake, 20 miles southwesterly from this point. The lake has an area of 1,000 to 1,500 acres, well supplied with native common fish and carp. Chicken Creek Lake, 3 miles south of Juab station, is a patch of clear spring water covering an area of 500 acres or more, with every indication of being an ideal small place for bass, with excellent spawning conditions and plenty of food. The railway passing close to the shore of this lake at one point, I had the train stopped a few minutes in passing and set 16 large spawners at liberty here. Passing on about 6 miles farther, to where the Sevier River is first encountered on this line, a plant of 400 yearling fry was made, after which the bulk of the shipment was taken on to Deseret and planted in the lagoon lakelets, near the mouth of the Sevier River. Forty-five large spawners were planted in Clear Lake, about 15 miles south of this point. This lake contains only about 2,000 to 3,000 acres of water suitable for bass culture, but I expect to see larger bass produced here than at any other place in the State. The water, issuing from large springs bordering the lake, is very slightly brackish and clear as crystal, with a fairly uniform temperature of 55° to 60° F. throughout the year. Minnows and common fish are superabundant here, and carp planted here six or seven years ago have grown very large, some of them, I am told, weighing 30 to 40 pounds.

This being our last stocking shipment for the season of 1897, a recapitulation will show that nearly 800 large spawners, averaging nearly 2½ pounds each, and 5,000 yearling fry were distributed by the State fish and game department in the public waters, covering a longitudinal area of about 450 miles, giving a long, if not a wide, distribution throughout the State to this superior food and game fish. In addition to the State plantings, 750 large spawners were furnished to applicants for private pond cultivation throughout the State during the season, and 5,000 yearling fry to the State of Colorado for distribution in public waters of that State, making a total of over 11,000 bass distributed for propagating purposes from Utah Lake during the season of 1897.

A few words as to the method of transportation and care in transit may not be out of place. As we had no specially constructed tank car for the purpose, barrel receptacles had to be resorted to; 50 barrels of 40 to 50 gallon capacity each were placed in a large baggage car, kindly furnished by the Short Line Railway Company. The fish were taken with small nets from the ponds close by, put into barrels of fresh water in wagons waiting to receive and convey them a short distance to the car, where they were again transferred from the barrels in the wagons to the barrels in the car, which also contained fresh water to about four-fifths of their capacity. From 10 to 15 of the large spawners were all that was deemed advisable to put in a barrel, and 300 to 400 fry in barrels of the same capacity. Everything was timed to make as close connection as possible with the north-bound express train. This was our first experience in transporting the fish in carload lots such a long distance; the undertaking was therefore largely experimental, and at this season of the year (May 4) was attended with considerable hazard.

Air-pumps and hand-bellows with rubber tube attachments to reach the bottom of barrels for aerating the water had been provided, together with buckets for the same purpose. We soon learned that the buckets were of far greater practical utility than all the other contrivances. When the fish showed signs of discomfort by coming to the top of the water, a few applications of the bucket would send them down again. This was done by dipping the water out of the barrels and pouring it back again from as great a height as possible by the attendants, and I observed that a quick and violent return of the whole bucketful had a much better effect than a slow and gentle pouring. Sometimes if a barrel chanced to be overlooked a little too long and the fish were particularly uncomfortable, it would take from 8 to 12 bucketfuls dipped out and poured back as rapidly and violently as possible to make them easy again. I found that this performance had to be repeated with each barrel once every 30 minutes to be safe, showing that these large fish especially consume the air out of the water very rapidly.

After an all-night run of fifteen hours in the car, the nearest station to Bear Lake was reached, and here eight wagons were waiting to take the cargo to the lake, the nearest point being about 12 miles south of the railway. The barrels containing the fish were soon transferred to the wagons and the lake was reached about noon, and some of the fish planted at the first favorable place and opportunity. Three-fourths of the lot, however, was taken to the extreme southern end of the lake and planted there at 9 o'clock p. m., after a 40-mile wagon-haul and thirty hours in the barrels. The only change of water was during the first four hours of the trip, at Salt Lake City and Ogden, where less than half the water was taken out and replaced with a fresh supply. The lack of fresh water, therefore, had to be compensated by the vigorous application of the water-buckets to supply sufficient aeration. An observation made during the long wagon-haul should not be omitted. Wagons with springs and some without springs were used, and I noticed that the fish in the wagons without springs seemed to be in a better condition than those in the spring wagons; and in going over rough places in the road the water showed less tendency to slop over and spill out.

After getting the last of this consignment of bass into the waters of Bear Lake with a loss of not to exceed 7 per cent in transit, and all in good lively condition, I felt very greatly relieved, for I expected to lose a much larger percentage. The shipments to the southern part of the State in the cool months of autumn were made with less than 1 per cent loss, thus showing that the cool weather in the fall of the year is the best time to transplant and distribute this fish in Utah. From the high parental instinct and other good qualities of this great fish, I am strongly of the opinion that it is the coming fish for pond cultivation in this State.

I wish to express the highest appreciation of the conduct of our local railroads, the Oregon Short Line and the Rio Grande Western railways, in furnishing cars and free transportation for this State distribution of the black bass, and also to acknowledge the important service rendered by the United States Commission of Fish and Fisheries at Washington in first introducing the large-mouthed black bass in Utah.

SALT LAKE CITY, UTAH.

FLORIDA FUR-FARMING.

By J. M. WILLSON, Jr.

In discussing the water products of Florida fur-farming is worthy of consideration. That Florida produces a fur of high grade will doubtless be a surprise to many, yet thousands of dollars' worth of otter skins are shipped from the State annually. As a subject for water-farming the American otter occupies a position distinct and wholly his own. Terrestrial and aquatic, he is an interesting anomaly.

From the beginning of time the skins of animals have contributed largely to the comfort of mankind. The first garments ever worn by the human race were made of skins and fashioned by the hand of the Creator. "Unto Adam also and to his wife did the Lord God make coats of skins, and clothed them." (Genesis iii, 21.) In latter days the employment of so much fur for personal adornment has led to the wanton destruction of the teeming millions of fur-bearing animals. From the constant reports of the work of the deadly pelagic sealers and the consequent extermination of the seal many questions arise and many theories are advanced as to the furs of the future.

Leading furriers in New York say that the price of furs during the past few years has advanced at least 150 per cent, and that the time is rapidly approaching when seal will be a luxury which only the very rich can procure. Either the sealing-grounds must be repleted or the future wearers of fine fur must pay fabulous prices for the privilege of being kept elegantly comfortable, or else they must resort to cheaper skins.

This is a scientific age and the domain of investigation is visibly broadening. The main idea of the majority of mankind seems to be to discover new fields for labor and investment, and the sequel to the "story of the seal-skin sack" is yet to be revealed.

The fur of the American otter ranks among high-priced furs, of which, too, any quantity can be sold, quotations on Florida otter skins (cased) ranging from \$5 to \$8 each. In anticipation of a coming deficiency in the supply of fine furs the subject of breeding the Florida otter for its fur has been investigated; and Florida, as the natural haunt of the little animal, offers a field for experiment. The subject bewilders, then fascinates.

The Florida otter is fast being exterminated; but in the swamps of the Everglades, where none but the daring hunter or the stealthy-footed Seminole wanders, the little animal is still found. Very little, if anything, of the habits of the otter is known to science. Every effort has been exhausted in attempts to collect useful data on the character of this quaint little denizen of the swamps. Scientific journals and the encyclopedias add little to the research. From the trapper and from the hunter, who in pursuit of their callings have observed the wary otter, the most valuable information has been gleaned.

Many objections have been raised by the incredulous as to the practicability of raising the otter for a pecuniary benefit, but each objection in its turn has been met. Neither the excessive rains nor the long droughts, the hot summer suns nor the frosts of winter, will affect the industry; neither would the products have to be rushed to market. The pelts, after casing, are non-perishable; the demand for the fur is greater than the supply, and a maximum price could always be obtained by the fur being taken only at its prime, while the transportation charges for conveying the product to market would be very small. In the manufactured garments the quotations on seal are only about 25 to 30 per cent higher than on the natural otter.

While the impression is abroad that the skins of southern animals have a decided disadvantage in the market as to quality, it is learned from leading New York furriers that the Florida otter compares favorably with the furs of more northern latitudes; and, further, that any quantity of Florida pelts may be sold in New York, and that even during the past depression in business otter fur held its own, which is the best proof of its stability.

The otter is most easily domesticated, having a marked degree of intelligence and acute perceptions; he is cunning and affectionate, and as playful as a kitten. In his native haunts he is one of the shyest of wild animals, but in the domain of civilization is bold, venturesome, and ever ready to make friends and foes alike. Few animals equal the otter in agility; his long, flexible body is enveloped in a skin so loose that he almost seems able to turn himself over in it; he can dart or turn in the water with as much celerity as a fish, and is therefore an expert swimmer. Small fish he eats in the water, while large ones he brings out on land to devour.

In raising the otter for his fur, every arrangement should be perfected to conform to the natural surroundings of the animal, the idea being simply to assist nature. Here in Florida the otter will grow and flourish with little or no attention. At the age of twelve months he is full-grown, and the fur is at its prime. The weight of a full-grown otter varies from 20 to 25 pounds. The female has young once a year, the number varying from three to five, although instances are known of eight young having been found with the mother.

It is confidently believed by those who have studied the subject, that the semi-domesticated otter, when well fed and cared for, will mature faster and rear a larger number of young than in a wild state. With the success attending the experiment of raising the otters which are now on exhibition at this Congress, the mind may quickly picture a ranch for this amphibious herd, both ideal and picturesque. The rich tropical foliage, the bird notes, and the dreamy southern sky are there; on the north shore of the large fresh-water lake are dense cypress forests; whitecaps play upon the waters; wild duck, crane, and quail are numerous. One side of the lake is covered with weeds and grasses reaching back and extending over a low, marshy ground, which is thickly dotted with clumps of bushes and cypress trees. The cypress knees, being very large and hollow, form ideal breeding-homes for the otter, which they enter by a passage underneath the surface of the water, forming a safe harbor and a secure retreat from all enemies. An abundance of food supply at small cost is an important point to be considered; and, after investigation, German carp has been decided upon as the most desirable fish for that purpose. In 1895, a supply of scale and leather carp was procured from the U. S. Fish Commission, and deposited in two fresh-water lakes, covering an area of about 60 acres.

While carp have recently been pronounced by the fish commissioners of several States an unmitigated nuisance, compared with which all the plagues of Egypt were but a mild chastisement, the very objection to the aquatic stranger—that it multiplies like some miserable species of insect—only adds to its value as a food supply for otter-farming. The otter being aquatic, his natural prey for the most part is found in the water—fish, frogs, snakes, etc. In his domesticated state he learns to eat almost anything—meat, cooked vegetables, fruits, bread, etc. Carp may be fed if necessary on different kinds of vegetables; thus between the carp and the otter all surplus crops could be utilized.

According to statistics, the young carp, with plenty of food, will attain the large growth of from 3 to 6 pounds in one year. Nature has supplied the food for carp in Florida waters in the greatest quantities; the water-lily, bonnet-pad, grasses, and tender roots, which European waters do not possess, abound in the lakes. The water hyacinth, which has become such a menace to navigation in the St. Johns River, if propagated in a carp pond, would supply food for all time to come. In order that the carp shall be provided with a variety of food, a quantity of wild rice (*Zizania aquatica*), may be sown around the edge of the lake and in the muddy bottoms. To clear the lake of alligators would be a necessary precaution; and with fish, turtle, etc., this aquatic herd of fur-bearing animals would grow and flourish.

The otter is a great climber, and, from the experience gathered from the study of the captive otter, it has been demonstrated that a particular kind of inclosure is required. The fence should be a combination of wire and plank, or a solid wall fence, set below the surface of the ground and extending beyond the lake on all sides. With a large inclosure (a space of 20 to 40 or 60 acres being desirable) conforming to the natural haunts of the animal, this aquatic herd need not feel their captivity, but fish and leap and play and rear their young as naturally as if they were in their Everglade haunts.

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