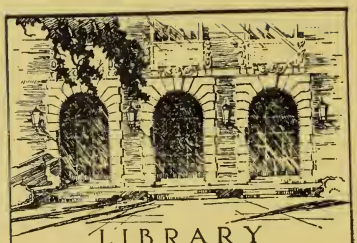

TRANSACTIONS

—OF THE—

AMERICAN FISH CULTURAL ASSOCIATION.

Ninth Annual Meeting,

Held at the Directors' Rooms of the Fulton Market Fish-Mongers' Association, in the City of New York.

March 30th and 31st, 1880.

9-13

New York.

1880. -84

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NINTH ANNUAL MEETING

—OF—

THE FISH CULTURAL ASSOCIATION.

TUESDAY, March 30th, 1880.

THE meeting was called to order in the Director's room of the Fulton Market Fish-Mongers' Association, in the City of New York, by the President, Hon. ROBERT B. ROOSEVELT, at 11.30 A. M., who made a short introductory address.

The minutes of the last meeting were read and approved.

The following gentlemen were proposed for membership and duly elected :

H. P. Dwight,
Erastus Wiman,
Wm. P. Raynor,
Theodore E. Leeds,
Robert J. Kimball,
W. C. Mathews,
Thos. D. Townsend,
J. W. Simonton
C. B. Reynolds,
T. B. Stewart,
H. C. Harris,
John Whipple,
Charles Mallory,
G. L. Feuardent,
Fred. Habershaw,
Wm. M. Habershaw,
John Foord,
C. Van Brunt,
A. G. Lawrence,
H. N. Munn,
H. W. Gray,
H. B. Hollins,
F. C. Lawrence,
H. J. Nicholas,
O. K. King,
W. L. Breese,
W. F. Wharton,
W. Post,
Isaac Townsend,
Henry F. Crosby,
Perry Belmont,
W. B. Hopson,
George Ricardo,
R. U. Sherman,
H, R. Worthington,
Sumner R. Stone,
Wm. M. Hudson,
Gilbert E. Jones,
Harris Bogert,
Alfred N. Lawrence,
Asa B. French.

The Corresponding Secretary, BARNET PHILLIPS, read the following paper, in memory of the late Professor JAMES WOOD MILNER.

The sad duty devolves on me of announcing to you the death of Professor James W. Milner, who, at Waukegon, Ill., on the last day of December, 1879, passed away from this world.

Many of you here must remember what interest Professor Milner took in our proceedings. Thoroughly grounded in all the scientific data, perfectly at home in the practical details of fish culture, there were no questions of an icthyological or other character we could put to him that he did not respond to it at once in a singular terse and clear manner. He had the power of stripping the husk off of matter, and presenting you the perfect grain. This society owes a great deal of its prosperity to the labors of this man. Many of its plans, and especially the widening of its scope—the effort to make it more than local, to extend its influence—were suggested by Professor Milner. If ever any one had his whole soul in the work, it was that man, whom death has now taken away from among us. His quick, nervous manner, his intensity, the power he possessed to make any question lucid, his easy method of explanation, we can hear no more. His place will be one, in this Association, not easily filled. Fully trusted by the Smithsonian Institution, he took charge of some of its most important missions, and there are here some present who can testify to the thoroughly conscientious manner in which his task was fulfilled. There are, in this world, many ways of doing one's duty. It was Mr. Milner's ambition to leave no stone unturned that might be an obstacle in the way of scientific progress. You have often heard that saying, that "if war has its heroes, so has science its martyrs." The repetition of this has perhaps become trite, but it is none the less true. It was as much overwork as anything else; an excess of zeal which, early in Milner's life, as late in his career, shortened in such an untimely way his days. Brimful of his work, I have seen myself how careless, how utterly indifferent, Mr. Milner was of his person in the prosecution of his labors. It was my good fortune to have been with Mr. Milner as his guest on more than one occasion when he was engaged in

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his professional duties. I remember when on a cold night on Chesapeake Bay, when his men were out on the water taking the shad eggs, that a sudden storm arose. There was no danger to the numerous boats' crews, but the chances were that if his presence were wanting, that some millions less of eggs would be the result. Indifferent to the rain, I have seen him hurry from out his berth (it was in the floating hatching-house), and, but half clad, spring into the nearest boat, at midnight, and spend all that night until dawn, going from boat to boat, encouraging the men in their exertions. The United States wanted to have the rivers teeming with fish, and there was enthusiasm enough in Mr. Milner to think himself the instrument for thus furnishing food to millions, and he was perfectly willing to lay down his life for what other men would have been languidly indifferent about. I have myself frequently remonstrated with Mr. Milner as to what I deemed to be an unnecessary exposure, and had warned him of possible fatal results, but his reply was, I remember his words distinctly, "I do not think I fulfil my duty thoroughly, conscientiously, in any other way." This somewhat explains the character of the man. The last time I saw him was some two years ago at Gloucester, where he was busy arranging apparatus for hatching the cod. The novelty of this duty excited his enthusiasm, and quite possibly the cold he had taken some time before was augmented by the chill dampness of a New England fall.

I can but briefly describe this useful life. Mr. Milner was born in Kingston, Ont., January 11th, 1841, and came to Chicago when he was five years old. As a boy he was a hard student, and developed early in life a taste for natural history. He was but a lad when he travelled through Minnesota making collections. At the breaking out of the war he volunteered in an artillery company, and served with distinction to almost its close, having been noted for conspicuous courage and gallantry. After an honorable discharge, he obtained a position in the Chicago Post-office. Still retaining his love for natural history, he thoroughly filled his position, but, combining with it the study of his favorite topics, this double work became too much for him, and his health broke down.

Retiring from his postal duties, he made explorations in the

peat beds, and exumed the skeleton of a moose, which he supposed belonged to an extinct species. Having written to the Smithsonian Institution in regard to it—describing the remains of this creature—the singular terseness and scientific instinct displayed in his letters attracted the attention of the Smithsonian Institution. This led to Mr. Milner's services being engaged by the Smithsonian. He was first employed by Professor Baird, in 1872, to gather together the statistics of the fish of the Great Lakes. Shortly afterward he joined the United States Fish Commission in Washington, and was in their employ up to the day of his death. Successive publications of the Fish Commission fully attest Mr. Milner's work and services. In addition to this, he was in close communication all the time with the present distinguished Secretary of the Smithsonian in collecting general statistics, and arranged the literary material for fish propagation in the reports, of which he was most especially editor. Milner's work was wide and extended. At different times he planned various fish-hatching campaigns in North Carolina, Virginia, on the Potomac, on the Susquehanna, at Havre de Grace, and at Holyoke. He had under his charge the cod-hatching at Gloucester, in 1878. The Secretary of the Smithsonian writes in his honor: "He was very methodical in everything, and as keeper of that portion of the archives under his charge, was a notable example of industry, care and precision."

There is some information more than touching which I have received, descriptive of Milner's last days. He was so enthusiastic in his work, that he went beyond his strength. He believed that with such a mission as was his, that he was invulnerable to the attacks of malaria or overwork, under which so many of his friends had succumbed.

When advised by Professor Baird, in the summer of 1878, to seek his home and take a needful rest, he still lingered at Washington, perfecting his plans for the steamer *Fish Hawk*, which he never was to see afloat—which vessel was the great triumph of American fish culture, and was only called into commission last month. Coming at last home to his wife, he refused to be thought even ill. In a month he was again at his post at Gloucester, entirely forgetful of himself, absorbed as he was in his work. When

his task there was concluded he became so ill that he was forced to take to his bed. As soon as he could travel, he hurried on to Washington. Though confined to his room, still, with untiring energy, he conducted the business of the shipment and planting of the California salmon into Michigan waters, by means of the telegraph. His cough continuing, his physician ordered him at once to Aiken, S. C. But finding he could do no work there, but slightly improved in health, he went to Western Florida. Mrs. Milner having met him in New Orleans, she informs me that any idea of rest was even then the farthest from his mind. Florida might do him good, but that was secondary to the fact that he might conduct some work in Florida—there were collections to be made there. Mr. Milner remained in Florida until May, but was no better. It was with a terrible struggle that he then gave up the hope of future usefulness. I cannot imagine any more dread conflict than that which is sometimes waged between a man's active brain and his perishing body. It was in May that this devoted man went home to die. Life was gradually ebbing, but still the mental powers had lost nothing of their force. He could not bear to think that his work might stop with him for ever.

A bare chance of life was possible. It might be found in Colorado. Thither he went last September; still he refused mental rest, for life was to him as worth nothing save enhanced by work. He rallied for a while, but then became more physically feeble. The vitality in the man was immense. If he was too weak to write letters, he dictated them. When, in October, the doctors told him that his time was short, then his resignation was supreme. Even then he remembered many of his friends, members of this Association present here to-day, and wanted to send them his last word and greeting. He said—these are his very words: "I am dying without a feeling of ill-will toward any man;" "and could you (writes to me, Mrs. Milner) have seen his loving-kindness toward all who came under his notice, you could better understand the noble qualities, the untold goodness of this man."

Let us, then, respect the memory of James Wood Milner, who was not only of singular service to this world, but who was

honest, sincere, and endowed with many wonderful gifts. It is to the disinterested efforts of such a sterling man as was Professor Milner that we are beholden for the present position we enjoy, and though he be lost to us, I am hopeful that the memory of one of our leading officers will always be reverenced by the American Fish Cultural Association.

Mr. Blackford offered the following resolution :

Resolved, That the President appoint three members of this Association to prepare suitable memorials on the death of Professor Milner, a copy of which should be forwarded to Mrs. Milner.

The President appointed as said committee Mr. Blackford, Mr. Phillips, and Mr. Green.

The President then read the following paper on Hybrids :

Hybrids.—Since the creation of the New York Fishing Commission, particular attention has been paid to crossing different breeds, and even species of fish, as we hoped that valuable results might be obtained from such interesting experiments. Curious as it may seem, these experiments have rarely been abortive, no matter how dissimilar the families, the eggs have been impregnated often to a large percentage, and have hatched. The following varieties have been crossed :

FEMALE.		MALE.
Salmon-trout	with	White-fish.
" "	"	Brook-trout.
Brook-trout	"	Fresh-water Herring.
" "	"	California Salmon.
" "	"	" Mountain-trout.
Shad	"	Striped Bass.
"	"	Herring.

Of these we have the young now at the hatching-house of the salmon-trout brook-trout ; the brook-trout California salmon ; and brook-trout California brook-trout.

It is observable of all hybrids that they are shy and wild ; more so usually than either of their parents, and that in appearance they favor their larger parent. The cross between the brook-

trout and California salmon looks much more like the salmon than it does like the trout, being quite silvery on the sides and long and slim in shape, as you will see by this specimen which I have had preserved. There are some sixty of these now living, from eight to twelve inches long, and they are so shy that they can hardly be examined, and dart hither and thither when any one approaches the pond in which they are kept, in the utmost terror and uneasiness. The young of the salmon-trout and brook-trout have the square tail of the brook-trout, that of the salmon-trout being quite forked, and although they have no carmine specs, have smaller spots than the salmon-trout, and are quite stocky in shape. These bid fair to be a fine fish; those at the New York hatching-house being six or eight inches long on January, 1880.

The cross of the shad and herring was made in order to save the eggs of ripe shad when no ripe males were to be had. Although the male was an inferior fish, the cross was not expected to be an improvement over the mother, still such as it was, it was so much clear gain. There is in consequence a fish, although not the best kind of fish, where otherwise there would have been none. The young have thriven well, and we hear of their being caught on the rocky shallows of the Hudson river. They probably are not migratory, and can be taken with rod and line. It would seem from all accounts that they are quite numerous, and I give a letter from Mr. Van Wyck, about them at the close of this article. The cross of the shad and striped-bass has never been heard from, so far as we can affirm positively. As some of these were hatched in the autumn of 1876, and quite a large number in the succeeding year, we hoped that some of them would have been taken full grown before this time. A reward was offered in 1879 for any specimens, but none were presented. The final outcome of this experiment is left entirely in the dark. Such care and pains were, however, taken when the impregnation was effected, to make sure that no germs of shad-milt were in the water that was used, or could by any possibility come in contact with the spawn, that there can be no doubt of the fact of the cross. Whether so odd a fish had the power of sustaining itself, obtaining its food, and holding its own in the struggle for

existence, is another question that the future has still to solve. This curious combination of the long-finned and soft-finned races of fish, varieties which are wholly separated in the scientist's classification, were undoubtedly hatched, but that they lived after the food-sac was absorbed, is at present undetermined. They may have perished like the two-headed monstrosities which are often born. In September, 1879, the young of the brook-trout and California salmon were seen to be maturing their eggs. This was the first time in the history of fish culture that hybrids gave evidence of breeding. It is asserted that among animals, mules are occasionally known to produce young, but this is a most unusual exception to a general rule. We had expected no more from the experiments in crossing varieties than the production of combinations which might be valuable in themselves, like the capons among fowls, or the mules among draught animals, but which must of necessity be purely ephemeral, and perishing with the lives of the individuals. But when these hybrid trout-salmon were opened and found to contain eggs quite large and well forward in maturity, it seemed possible that new species might be created and made permanent. The eggs were already larger than the mature eggs of the trout, although it was then early in the season, and seemed perfectly healthy. As time passed the parents were watched with care, and were soon seen to be going into the spawning-race. They apparently made all their preparations for spawning, began digging their nests, stayed about them, and proceeded in the regular way, except that they were never in pairs, but always single. This was not natural, and led to a careful examination of them individually. After examining some fifty out of the sixty, the conclusion was reached that they were all females, which eventually turned out to be the case. This was in the latter part of November, 1879. Some dozen male brook-trout were then placed among the hybrids, to see if they would induce the latter to spawn. Everything soon appeared favorable for this result, the trout paired with the trout-salmon, they entered the race-way together, and occupied themselves with parental duties, but no results were perceived. For some reason the spawn was not deposited. Then some of the fish were selected to be stripped

by hand, and were found to be ripe, but the eggs were all crushed in passing from them. The vent of the ovaries or ovaduct was too small to allow the eggs, which had delicate shells, to pass. Attempts were then made to enlarge the vent, and some thousands of eggs were finally obtained in this way uninjured. To impregnate these the milt of the male trout was used. The parent fish were left in their pond and seemed to be uneasy. They are doubtless incommoded by the eggs which they cannot pass, and move about slowly with their heads towards the bottom, their tails upward, and their bodies at an angle to the surface. The eggs which it was hoped might be impregnated by hand, were retained until January 25th, 1880, when it was found they were unimpregnated and dead, and they were thrown away. No eggs have yet been deposited in the regular way, and hybrids have not yet hatched. But two most extraordinary facts have been ascertained : one, that the eggs may be too large for extrusion ; this may only be the case when the father is the larger fish ; and the other that the entire body of one hatching may belong to a single sex. It is said that the shad-herring hatched on the Hudson are all males. This may be the end of the perpetuating of new breeds of fish, or it may be only the beginning. It does not follow that every batch of a cross, especially when taken in different years, will be of the same sex, nor that the eggs will be too large when the male is the smaller variety. As was mentioned before, the hybrid takes most points from the larger parent, and may do so even in the size of the eggs, so that where the cross is reversed there may be no difficulty in their extrusion. It was hardly to be expected that so wonderful a discovery as the creation of a new species could be made without trouble, and we should rather be surprised at the success already achieved in hatching the young of the cross at all. The number of combinations possible is very large, and the pains and care expended on improving plants, vegetables, and land animals, may yet succeed with fish.

We have again this year crossed the eastern brook with the California mountain-trout, both ways, and have impregnated about eighty per cent of the eggs so used.

The following is the letter in reference to the young of the cross of the shad with the herring of the Hudson river :

Some few years since I heard the shad fishermen on the Hudson were taking a new variety of shad, called by them rebel shad, some calling them Seth Green shad ; on investigating the matter I found at the shad-hatching station on the Hudson, in stripping the fish off-hand, sometimes the ripe male shad was not to be had in quantities to suit, and that in cases of this kind the small herring was sometimes substituted ; hence the hybrid, or cross. These fish have all the characteristics of the adult shad, and average from one and a quarter to two pounds each. Having formerly heard so much on the subject of fly-fishing for shad at the Holyoke dam, I concluded to give them a trial in the Hudson, and had procured some of the Holyoke shad-flies, and tried for them long and faithfully for two seasons, without success ; but about five years ago I was fishing for white perch, on a fine day in October, and was much surprised by taking about ten of these new shad. I was fishing on the bottom, and the fish would take the bait when the line was being rapidly hauled from the bottom ; live bait was used (small shiner). I sent a couple of specimens to Seth Green, who pronounced them these herring-shad of about two years of age. I have taken them regularly since, every fall, with a light fly, or any dark fly will do ; the season generally commences October 1st, and lasts about five weeks. The time to fish is at daybreak or sunset, and then you have to fish on the middle of the tide, half ebb or flood, it don't seem to make any difference ; they begin to feed at half-tide and can't be caught on the surface at any other time. They present a beautiful sight when feeding, the water seems alive with them, darting and jumping everywhere ; some of them jump a foot clean from the water. They feed on small shad about one and a half inches long. They feed from about twenty to twenty-five minutes, and then the "jig is up" till next tide. Twelve to fifteen is a good catch on a tide ; they average about one pound each ; the largest I have caught weighed 1 $\frac{6}{16}$ pounds. It is no use fishing for them on a bright sunny day, as they will not bite. I have had a number of my friends go out with me fly-fishing for

these shad, and they all say it is the finest sport they ever had in fly-fishing. They are very gamey, make rapid runs, and will break from the water like a black bass.

P. A. M. VAN WYCK.

MR. GREEN then read the following paper :

When I speak so highly of the California mountain-trout, I do not wish to be understood that I have gone back on our speckled beauties ; on the contrary, I think our brook-trout one of the handsomest and best fish in the world, and that we can have both kinds, and the mountain-trout will live in many streams that our trout will not live in.

For some time previous to this meeting I have been racking my brain to think of something on which to address you, and I find it a very difficult matter to think of anything to say that has not been said before. The fact of the matter is, that the American people, and especially the members of this Association, are getting so well educated on the subject of fish-culture, that I find that the ground has to be looked over very closely to discover a new idea to advance.

The New York State Fishery Commission being the first to introduce the California mountain-trout into eastern waters, I will give you our experience with them. We have at the New York State Hatchery 16,000 two-year olds, and 34,000 yearlings, the product from 500 spawn which we obtained in 1875. We find them a much more easy fish to raise than the eastern brook-trout, and they grow almost twice as fast. A brook-trout at three years old will weigh about one-half pound, and a California mountain-trout will weigh about one pound. For sporting purposes they are in my opinion superior to the brook-trout, being a much stronger fish and full of pluck, and in regard to their qualities as a table-fish they must necessarily be fine, as they inhabit pure-water streams and live upon the same food principally that brook-trout do. They are an excellent fish for the headwaters of our large rivers—the Hudson, Susquehanna, Delaware, etc. We have as yet been able to supply only a limited number to any of our waters, being anxious to preserve as

large a quantity as possible for breeders; but we have tried them enough to know that they will do well with us.

In the year 1878 we supplied a few thousand for the head-waters of the Genessee river for the sake of the experiment, and last season they were heard from to such an extent, and in such fine condition, that we are justified in the belief that but a small proportion of them perished, and that they had found the food suitable for them.

I received a letter from Mr. John Hyland, of Danesville, who caught a few for examination, saying that he had caught them in California many years ago, and found the same kind of food in them here that they lived upon in California. We also put 2,000 in Caledonia Spring creek, and I have no difficulty in catching twenty inside of an hour. They spawn in March and April, but this season we observed them at work in February, and took the first spawn February 23rd, which is about fifteen days earlier than we have ever taken it before. This is probably due to the change of climate and temperature of the water, and it is not improbable that when they become thoroughly acclimated they will commence spawning in the fall, as our brook-trout do. A female California mountain-trout produces, at five years old, about 1,500 eggs, and at this age some of them weigh as high 3 1-2 pounds.

We find them a very difficult fish to take the spawn from without injury, as they are so strong that it is almost impossible for one man to hold and strip them without damaging them. To overcome this we operate with them the same as with shad and other large fish: have one man hold them by the head, while another does the stripping. By so doing the fish is less liable to injury.

When their spawning season arrives, the males are very ferocious. The first season that we got them that they were old enough to spawn, I was somewhat troubled to know how they became bruised and cut so severely, but was not long in discovering the cause. I had holes cut in the coverings of the spawning-races, and by lying down and covering my head with an old coat, watched them, and saw the most furious battles I have ever witnessed with fish. A few received such injuries that they died,

and those that survived had the skin torn off so that the flesh was laid bare in many places. I subjected all the injured ones to a strong salt and water bath daily for some time, and succeed-in saving most of them. We have never before saved any other kind of fish that was injured half as badly. The scars can now be plainly seen upon them. Their spawn in size is between that of the brook-trout and salmon-trout, and hatches in Caledonia Spring creek water in about fifty days. The young are vigorous from the start, and by exercising good care and feeding them regularly, there is no difficulty in raising them.

Last season we procured from J. B. Campbell, McCloud river, Shasta county, Cal., Baird P. O., 7,000 McCloud river trout-spawn, 2,000 of which were dead on arrival. We have now on hand 4,742 yearlings in fine condition; they are equally as easy a fish to raise as the California mountain-trout, and resemble them closely in appearance.

This season we procured from R. Burgess & Sons, Bennington, Vt., 100,000 brook-trout spawn, for the purpose of mixing them with the brook-trout at the New York State Hatchery. My object in so doing is to see if the breed cannot be improved by putting trout together that have no relation to each other, as we know that constant inter-breeding of animals makes them inferior both in size and intellect.

I am anxious to improve fish in both these respects; and as I contend that fish have reasoning powers, I do not see why they cannot be improved upon on the point of intellect. If we can breed a trout that has sense enough to avoid the nets of the poachers on Long Island, I am under the impression that some clubs that I know of would be willing to give somebody a chromo.

We have been distributing fresh-water shrimp and other insects from Caledonia creek to many waters. There is no better food for trout than the fresh-water shrimp in which Caledonia creek abounds. They resemble the salt-water shrimp in shape, and grow to about three-fourths of an inch in length; they are great feeders; they carry their spawn under their tails, and hatch them in the same way that the lobster does. They impart a flavor to trout such as no other food gives.

Waters can be stocked with fish in proportion to the food they contain, and as much attention should be paid to stocking our waters with food as with fish, as it is impossible for fish to thrive unless they are supplied with the proper food. We have also stocked some waters with crawfish for food for the black bass. I have observed that bass thrive much better and are a finer table-fish in all waters containing this food, and would advise parties interested in waters containing black bass to examine them and see if they contain the crawfish, and if they do not to put them in. I can furnish the stock for any public waters in this state. They increase very fast. One or two thousand breeders would soon stock almost any waters. A cheap way to get them would be to set the boys to work in the vicinity of some streams containing them. Of course the nearer to the water you wish to stock the better; two or three boys, in the course of a few days would catch all that is necessary.

It is a wonder to me that more attention is not paid by farmers to raising frogs. There is scarcely a farm but has in some portion of it a soft springy or marshy spot which is not utilized in any way. If the farmer would dig out a place twenty or thirty feet square and from one to five feet deep, and build a tight board-fence around it about three feet high, and put in a hundred or so mature frogs, he could with little trouble raise all he wanted for his own table, and perhaps furnish a few for market, and if he learned to raise them on a large scale, could realize more than from regular agricultural pursuits. There is still a great deal to be learned in this direction, and whoever first learns to raise them successfully on a large scale, will be rich. I have given my experience with them in "Fish Hatching and Fish Catching, by Mr. Roosevelt and myself."

I have, in some articles that I have written, referred to the crawfish, or fresh-water crab. They are being sold in many of our markets, and have become one of the articles of food in this country. I will give a short sketch of my observations of their habits and how they can be raised. They are natives of very many waters nearly all over the United States, and can be raised easily if the pond is properly prepared. Dig a pond five or six feet deep, and have it cover a space equivalent to fifty feet

square, the sides sloping, and put a tight board-fence around the pond a few feet from the water, and nail a board across the top of each corner of the fence, to prevent the crawfish from climbing out at the corners, leaving room so that they can get out on the land, as they like to in the night, for when they wish to move they will travel a great ways during the night. If the soil is soft care should be taken to have the bottom of the pond and the sides clear to the fence lined with some kind of material that they cannot dig through, as they travel in the ground like a mole. Their skeletons and their holes can be seen all over the western prairies, miles from any water.

There should not be any other kind of animals or fish in the pond, as they have many enemies, of which I will mention a few: frogs, snakes, toads, lizards, owls, cranes, coons, muskrats, mink, and many kinds of fish. The pond should have some earth and flat stones in the bottom, so that they can burrow in the earth or get under the stones. You can stock your pond by going to a stony brook and turning over the stones and slabs and catching the crawfish with your hands or a small scoop-net. A few hundred mature crawfish will bring you many thousand young the first year. They are great breeders; they carry their spawn under their tails until they hatch. They are also great scavengers; they will eat any kind of animal matter, or any formation between animal and vegetable. They mature in about three or four years.

I take pleasure in reading the following letter, as it gives actual results of fish-culture. I am constantly in receipt of letters from all parts of the state, showing the appreciation of the people of our labors:

FISH STOCKING.

WHAT IT HAS DONE FOR OTSEGO LAKE.

The following letter speaks for itself. It is from the beautiful village which was the home of James Fennimore Cooper, and refers to the lake which he has made famous for all time:

COOPERSTOWN, March 10, 1880.

MR. SETH GREEN—Again I am happy to say that the 100,000 salmon-trout you sent us were successfully put into our lake (Otsego). And again I sincerely thank you for your personal attention to our order. We have but little trouble now in raising funds to pay the expense of getting fish. A few years ago it was different, but when you convince the people that restocking lakes, rivers, and streams again with fish is surely a success, there is little trouble in raising funds to pay expenses. I would like to have some one tell me in what way a person can invest a few dollars better to benefit the poor than to put in a lake suitable for them 100,000 trout. To show you, two men on our lake two weeks ago, both fishing in a little shanty, caught twenty-three trout that weighed over sixty pounds; one of them weighed eight pounds. At fifteen cents per pound, for which they sell readily, you have $4.50 for each man for his day's work. This is only one instance of the kind. Last June two men out of one boat caught forty-three trout that weighed eighty-four pounds, in one day. A little over a year ago myself and wife caught out of one boat in one day seventeen trout that weighed fifty-six pounds; one weighed six pounds and nine ounces, and my wife caught that. Now these are all facts I know to be so.

So again I would ask in what way the people of this country could invest money for the benefit of the poor that will do them more good than by restocking our waters with fish? Poor people, as a rule, are most all fishermen, and when they are out of work, or after their day's work is done, take their hook and line and in a short time catch a meal, although but a small amount is invested by them in fishing-tackle. My experience has been, give a boy a good strong cord and a good-sized hook to match, and a fifteen-foot beech-pole, and he will land you more fish with less trouble in a day than all the fancy tackle and fancy rod and expert fishermen can land in a week.

There is no danger of a famine in this country. We have in the village of Cooperstown a great many families that get the greatest part of their living from fishing, and so it is all over the country.

While travelling through the southern part of the state of

New York I found that the Susquehanna and Delaware rivers, and nearly all of the other rivers, have been restocked with black bass and such other fish as would live in rivers, and the people were perfectly delighted, all saying that they were catching large quantities of fish.

We have protected our lake from net-fishing for three years; two years have already passed and we find that all kinds of fish are increasing. The two hundred black bass we got of you five or six years ago have increased wonderfully, and also the rock-bass. I don't believe there is a lake in the state of New York where a man can have better sport in fishing than in Otsego lake. We shall always point with pride to such men as yourself, Hon. Horatio Seymour and R. B. Roosevelt, who have spent their lives in this great enterprise and made it a grand success.

I remain as ever your friend,

A. W. THAYER,

Fish Committee.

Mr. Samuel Wilmot, of New Jersey, the oldest shad fisherman on the Hudson, being present, gave his views on the destruction of the shad in the river.

Mr. Hugh D. McGovern submitted a paper on the curious habits of eels:

Though there has been much said about the eel by eminent men, such as Professor J. J. Beard and our worthy President, Hon. R. B. Roosevelt, I cannot refrain from mentioning some facts which have come within the knowledge of our absent friend and associate, one of the editors of the *Chicago Field*, Mr. Fred. Mather, and myself.

On the 2nd day of June, 1879, I invited Mr. Mather to take a trip on Long Island, with a view to capturing a few trout which inhabit our island waters.

We took it leisurely, not being very successful, and walked along the banks of Spring Creek, a small stream in the township of Jamaica, which empties into Jamaica Bay. We continued along the creek until reaching the conduit of the Brooklyn

Water Works, where it passes under the conduit. On the south side a pool forms in which some boys were bathing. The stream contained many eels, the largest being about the size of a No. 4 needle.

The buttresses of the conduit-house have two square openings, or arches, through which the waters of the creek pass very rapidly, at no time reaching within twelve inches of the top of the opening. It was our wish to possess some of these small eels; one of the small boys, anticipating our wish and perhaps desirous of a reward, proposed to catch some for us. No sooner said than done. The boy at once procured a handful of damp moss from the upper portion of the opening, containing about ten young eels. We suspected that the boys had a vessel hanging in the aperture whence they had taken the eels, wherein they had placed them previous to our arrival. I proceeded to solve the mystery. Procuring a fence-rail that crossed the pool, I walked over and thrust my arm into the aperture expecting to find the vessel, but without success. I raked the top with my fingers, and drawing forth a handful of moss, discovered the eels. We both knew, when young eels are barred off by a rapid current or dam, they could climb a perpendicular wall when wet and covered with vegetation, but were unwilling to believe they would cling like a fly to the ceiling.

"Well," said my companion, "we can tell our story, and let others believe or disbelieve us as they please."

I can say that after this experience we are more skeptical concerning waters that are inaccessible to eels. I have seen them on land at night, in the wet grass, and in shaded places, taking advantage of inclines and crevices, and now squirming their way through a stream by clinging to vegetable matter on the sides of stones, but nothing like this has ever before come under my observation.

The next paper read was by Mr. Livingston Stone, U. S. Assistant Fish Commissioner, on the Transportation of Fish:

One very peculiar and exceptional characteristic attends the transportation of living fishes, namely, that they must be pro-

vided during all the time of their separation from their natural habitat with an artificial atmosphere ; and not simply this, but the atmosphere provided them must be constantly in process of creation. I need hardly say that this characteristic does not belong to the carrying of other creatures, birds, animals, insects, nephtes, or plants. Put a bird in a cage and set the cage in the express car of your train and nature will provide all the atmospheric conditions required. Secure an animal on the deck of a vessel, or shut him up in a cattle-car, and nature furnishes his lungs with air enough without any trouble or thought on your part. So with other creatures, until you come to fishes ; then a radical change takes place in the requirements of the situation. Place half a dozen pound-trout in July in as many gallons of water, and put them aboard the train, and they will all be dead in ten minutes, if indeed they live to get on the train at all, unless you keep constantly at work over them creating the atmospheric conditions just mentioned as being indispensable to their existence ; and it must not be forgotten that you must not only provide them at the outset with an artificial atmosphere, but you must keep creating it every moment as you go along, till they reach their journey's end. It is this peculiarity about the transportation of living fishes that makes it so laborious, so difficult, and often so unsuccessful. It is this that makes such care, such painstaking, such watchfulness necessary. For not a moment, day or night, can the water in the tanks be left to take care of itself, and if you are travelling with any considerable variety of species, hardly a moment can the temperature be left to itself. If, after days and nights perhaps of almost incessant labor, you are overcome with sleep, and unconsciously let the temperature pass the fatal limit, you wake to find your fishes dead beyond recovery, and all your past labor on them gone for nothing. Or, if in an unguarded hour, perhaps exhausted from labor and want of sleep, you let too great an interval pass without aerating the water, you find to your dismay that your fish that you have worked over so long and faithfully are hopelessly lost. Such is the painstaking and watchful character of the work of transporting living fishes, imposed upon it by this peculiar necessity of having a constantly renewed atmosphere artificially pro-

vided for them. This, however, is the discouraging side of the subject. There is another side to it which, on the other hand, is quite encouraging, and that is that if you provide properly for the fishes at the start, and do give them the care they need, you are almost certain to be rewarded by success. It is not a matter of vague uncertainty. It is a foregone conclusion that if you start right, and give the fishes the correct treatment *en route* they will go through alive. I wish to emphasize this point, because in the transportation of fish, as it has been with the raising of young trout and the shipping of ova, there seems to be a vague idea in the minds of many, I might say generally prevalent, that the fishes die without a cause, from chance perhaps, or necessity. There is no such thing possible. When we take a fish from a native habitat and put it into a tank to carry it somewhere, and it dies, it does not die by chance or necessity. We have killed the fish ourselves, either from ignorance of its needs or from not attending to its wants when known. Now if all those who travel with living fishes would always bear distinctly in mind this truism, which seems almost like a platitude, that every fish that dies on the journey dies from an adequate and definite cause, it would have a variety of good effects. It would help remove this vague notion that the dying of the fishes is a matter of chance, it would help clear the minds of fish culturists as to what the requirements of traveling with fishes are, and it would make them inquire more minutely into the causes of loss in transit, and endeavor more intelligently to remove these causes of loss before starting off with their precious loads. I go even farther than to say that no fish die in the course of their journey without a distinct cause, and state it as my confirmed opinion that in the care of cold-water flshes at least the cause of death can be removed, and that almost any species, if not every species of cold-water fish, including both inland and ocean varieties, can be transported successfully over long distances in tanks. I know this statement will be received with a great deal of skepticism, but I thoroughly believe it, and shall feel much surprised when the cold-water fish is discovered that cannot be taken a journey of several days and nights on the cars. To go back a little to what I was saying: when a fish dies in our travelling tanks, since

we know that it had good cause for dying, and particularly since we know that we are responsible for its death, we should go to work and discover what the cause is, and then remove it. If we do this, and continue to do it until we have eliminated all the causes of loss, what can there be, I should like to know, to prevent our fish from going through to their journey's end happily and triumphantly alive? Having stated in general the requirements of the successful transportation of living fishes, and having expressed the opinion that most if not all the cold-water varieties of fishes can be successfully transported, perhaps I cannot better employ the time which remains to me than by enumerating some of the causes of loss in travelling with fishes, and the first of these which I shall mention is,

(1.) Transporting fish at wrong seasons of the year. An inexperienced person would think at first that fish that could be carried at all could be carried at one season of the year as well as another. But this is far from the truth. There are many species of fish that can travel with the greatest impunity at one season of the year, when it is utterly impossible to move them at another. To take a very well-known illustration: a brook-trout (*salmo fontinalis*) caught in midsummer, when he is very fat and the water is warm, will sometimes give his captor great trouble to keep him alive at all, while every one knows that trout in midwinter, when they are lean and the water is very cold, can be carried any distance with very little trouble and perfect safety. Of the truth of our remark, the whitefish (*coregonus albus*) is an excellent illustration. In June, when he is fat and the water is warm, he will almost die in being taken from the net, but in winter when properly treated he gives his attendant no trouble. The same is true of many other species, though these two examples are sufficient to illustrate the principle, and it becomes obvious that great loss may result from carrying fishes at a wrong time of the year.

(2.) Another common cause of loss is in starting with uncleanly or unsuitable tanks. I could name many instances that have come to my knowledge where a valuable lot of fish have been lost by neglecting to clean the tanks they were carried in.

This stupid blunder hardly deserves to be mentioned, because no one nowadays ought to be guilty of making it ; but it is closely allied to another which it is very easy for any one to slip into, namely, using a tank that has some injurious properties about it, after it has been thoroughly washed. As an illustration, I should consider a new oak-tank decidedly dangerous to carry ocean-fish in during a long journey. The oak-wood will impart some of its peculiar taste to the water it contains. Now in carrying fresh-water fishes through a country where the water can be frequently changed with safety, this may do no harm, but in taking a long journey with ocean-fish, when the water cannot be changed at all, and when the fish are shut up in this tannin-tainted water for perhaps a week, I should say it would be exceedingly dangerous. In this case the injurious agency becomes cumulative, and as it increases every day, certainly no one can say how soon it would become fatally poisonous. Unsuitable tanks, therefore, may often be a cause of loss.

(3.) Taking too many fish for the amount of water with them. This is too obvious a cause of loss to require much to be said on the subject, so I will simply remark that there is a limit beyond which fish can be so crowded that no amount of aeration and no reduction of the temperature will keep the water in a wholesome condition. Then, of course, some must die ; but it is to be hoped that no one's desire to carry a great many fish in a small space will cause his ambition to run away with his judgment, or blunder into this stupid source of injury to his fishes.

(4.) Not providing for the necessities of the journey before starting This is a more excusable mistake to make, and one which even careful fish-culturists are liable sometimes to fall into. It is not likely to be made on short trips, or when travelling through a settled country ; but on a long journey and in an unsettled region there is often great danger if all emergencies are not foreseen and provided for. Permit me to give two illustrations from my own experience. When we were about to cross the Rocky Mountains with shad, in 1873, I relied upon there being a stove in the express or baggage car, with the help of which we could keep the temperature of our cans beyond all

danger. There proved to be no stove in either car, and although it was almost July, it was snowing when we reached Bryan, in Wyoming Territory. The temperature of the shad-cans went down with frightful rapidity after nightfall, and the only way in which we could save our fishes was by heating some irons in the furnace of the engine, very much to the engineer's disgust, and with them warming some water in a tub. We placed the shad-cans in the warm water, and thus kept up the temperature at a safe point. In taking out the first aquarium-car, in 1873, I let my stock of ice run down to almost nothing on the evening that we were to cross the Detroit river. On reaching the river the conductor found that the train was so long that he must either leave our car or one of the sleepers. He ought to have left one of the sleepers, as the passengers could have kept alive well enough until morning; but the conductor thought differently, and concluded to leave us instead of the Pullman-car. It was a hot night. We had a whole car as full of fishes as it could safely be, and only three utterly wornout and exhausted men to take care of them. Our ice was soon gone, and before midnight the situation became decidedly alarming. It was made all the worse by everybody assuring us that there was no chance to get any ice before morning. But this would not do. It was very obvious that if we did not get ice before morning we should not need it at all for some of the fishes. After great exertions, and after waking up, if I remember rightly, seventeen railroad men in succession, I at last got an engine and a flat-bottomed car, and succeeded in getting some ice from the Windsor ice-house, a mile and a half distant from where we were finally deposited. The fish were saved, but it was a close call, and illustrates what danger there is when travelling with live fishes in not providing for every possible emergency.

(*a.*) Using a wrong transporting medium. It is true that water in some form is the only medium in which fish can be carried, but there is a variety of kinds of water to choose from, viz: fresh water, salt water, brackish water, muddy water, snow water (or snow-slush), pure water, and alkaline water and it is very important in carrying live fishes to choose the right kind.

For instance, striped-bass (*Roccus lineatus*), although an ocean-fish, will not carry well when young in ocean water. They will also soon die in fresh water, but in slightly brackish water they become nearly as manageable in confinement as their hardy cousins of fresh water, the black-bass (*Grystes nigricans*). The white-fish of the Great Lakes is an extremely delicate fish to handle in water simply, but in a thick slush, made of snow and water, he gives his attendant no trouble at all. Young eels, although a fresh water fish, are perfectly unmanageable when travelling in pure fresh water, and will die in four or five days, notwithstanding the utmost care and most diligent aeration of the water; but put them into a tub with a few inches of muddy water, two or three grass-sods for them to crawl out on, they will prove the toughest travellers of all fishes, and require no care at all. They can, without doubt, in this way be sent anywhere over this country with perfect safety. All of which goes to show that it is very essential to take the fish you travel with in the right kind of water.

(6.) Keeping the water at a wrong temperature is a very fruitful source of disaster in carrying live fishes. If I were asked to name what I thought was the most important of all considerations in travelling with fishes, I should say keeping the temperature of the water right. Air-breathing animals can sustain life through a very great change of temperature. Bears can live in a temperature ranging anywhere between 30 deg. below zero and 140 deg. above zero. Human beings can sustain a temperature in the sun of 130 deg., and when sufficiently clothed will endure the extreme cold of 50 deg. below zero; but I do not know of a fish that is not limited to a range of 50 deg. or less. Trout life is restricted to a range of temperature included between 30 deg above zero and 75 deg. above zero. Shad do not possess a much greater range, and so with most if not all the fishes we are best acquainted with. Consequently the matter of temperature is a far more important consideration with water-animals than with land-animals. This is perhaps best exemplified in the carrying of the fish just mentioned, trout and young shad. The safe carriage of either fish for a week or so is re-

duced almost to certainty if the temperature limits are rigidly observed ; but the situation becomes exceedingly perilous if the water containing the shad gets very cold, or the water containing the trout becomes even moderately warm. Here I wish to mention, by way of a caution, a fact that I have only recently noticed, and that is that fishes not only increase the warmth of the water that they are carried in, but the warmer the water becomes the more their presence increases the warmth. For instance, in carrying any fish, if you let the temperature rise five degrees without checking it, it will rise the next five degrees much quicker, and the next five very much quicker still. If a tank of large trout stands at 4 deg., it shows no marked tendency to rise in temperature, but let the temperature go up to 65 deg., and it will go on to 70 deg. with surprising rapidity unless it is checked. This is natural enough, as the increased heat produces a corresponding increased rapidity in the breathing of the fish. This creates greater animal heat, which in turn shows itself immediately in its effects on the water. It is very well to bear this fact in mind when travelling with fishes, because if not aware of it, the temperature at which the fishes are kept will, if rising, sometimes rise beyond the fatal limit before the attendant is conscious of danger.

(7.) Irregular aeration of the water is a very common though a very thoughtless source of loss in transporting fishes. This is a fault which no experienced person ought to be guilty of, and yet I think it is not an uncommon one. *Regularity* in aerating the water is what is needed, and not an alternation between extreme zeal and reckless neglect, which is just as fatal to the fish as thoroughgoing neglect. For instance, if you are carrying a tank of trout at a temperature which requires aeration every fifteen minutes, of what avail is it to aerate the water every minute for forty-seven hours, if during the last hour you let them go uncared for ? The effect is no less fatal than if you had not aerated the water at all. Yet the ignorance of this simple fact, which every fish-culturist really knows, has been the cause of many deaths to the unfortunate fish. The best way is to ascertain just how often the water in each tank needs aeration, and

then leaving a good margin for safety, of course aerate the water so often and no oftener. You then insure the lives of your fish and spare yourself unnecessary labor.

(8.) Changing water during the journey is a dangerous thing and is the snare that the beginner most easily and most often falls into. Except when travelling with young shad or other fish that require change of water for the food it contains, there is very little need of changing the water much during the journey, and as a general rule there is danger in doing so. The more any one travels with live fish the less he changes the water on them. This lesson was impressed upon me in my very earliest experience in fish-culture fourteen years ago, in attempting to bring live trout from Monadnock Lake to Charlestown, N. H. The original lake-water which I took them in would have carried them a week, but I changed it three times in going the first ten miles. The fourth time I changed it the water proved to be bad and killed every one of the trout within twelve miles of our starting point. I have no doubt most fish-culturists could relate a similar experience. At all events, I can say for myself, that now I change the water less and less every time I travel with fish. This course commends itself to reason. In changing the water the risk becomes cumulative. Suppose that there is but one chance in fifty of getting injurious water at such change. In changing twenty-five times there are twenty-five chances out of fifty, or an even chance of killing your fish. On the other hand you are sure the water you start with is good, and as long as you keep it so it will not hurt the fish. Now in a journey of almost any length, when you use ice, the melting of the ice together with the dripping of the water for aeration, is usually quite sufficient to keep the water in good condition. Ice is almost always safe to use for two reasons: ice-cutters do not get their ice from impure water, and then besides, the freezing of the water generally frees it from such impurities as there may be in it. But it is not the ice alone that keeps the water good, but the friction of the constant dripping of it back and forth freshens and purifies it like a running brook. Indeed, if you dip the water continuously in the fish-tank it becomes practically a run-

ning brook, and works off its impurities, and for this reason I wish to urgently recommend the use of the dipper in aerating the water. There is nothing like it. I have carried fish of all sizes short journeys and long journeys, hundreds of miles, and thousands of miles, and I have never seen any contrivance yet that could begin to take the place of the dipper. One reason of this undoubtedly is that the friction resulting from continually pouring the water back into the tanks, cleanses, purifies and invigorates it. You can aerate the water beautifully by forcing a quantity of finely-divided air through a pipe perforated at the end with pin-holes, but I would not give half as much for the water to carry fish in, as for the water that is dipped up and turned back with the dipper. We had an exemplification of this on the trip to California last spring with lobsters and other fishes. Not supposing that the lobsters could survive the long overland trip without change of water, I arranged to have one hundred gallons of Pacific Ocean water meet us at Winnemucca, Nevada. We started from Boston with three forty-gallon tanks of lobsters and a small reserve of about thirty gallons of ocean-water, only enough, by the way, to supply the waste in transit. On reaching Winnemucca the reserve was almost entirely exhausted, and the water in the tanks showed an increasing tendency to become foul, and we looked forward to the fresh ocean-water at Winnemucca with the avidity of thirsty travellers approaching a spring in the desert. Imagine our dismay and disheartenment when we found every drop of the Pacific-water spoiled and converted into the most sickening kind of bilge-water. But—and this is the point—by energetic and almost incessant dipping, night and day, for the rest of the journey, we restocked the water in the tanks and kept it comparatively sweet till we were enabled to gladden the hearts of the lobsters with the water dipped up fresh from the Pacific Ocean, just outside the Golden Gate; while I firmly believe that with an air-forcing apparatus we shouid have lost every lobster. To bring out more prominently the value of the friction-force created by dipping the water, I will say that during the overland trip last spring we lifted up about three feet above the surface of the water and poured back into the tanks 75,000 gallons of water, being equiv-

alent to 1,800,000 pounds of water falling a foot, producing a friction-force as effective as that of a good-sized running stream of water. I ought to add here that the lobsters did not get the benefit of the melting ice as the fresh-water fish did, it being of course impracticable to put ice in the lobster-tanks on account of its freshening the water, a result rapidly fatal to lobsters. In place of ice for cooling the ocean-water, I kept two immense freezers in constant operation on the ice-cream freezing principle, and by frequently exchanging the water between the tank and the freezers, succeeded with much difficulty and labor in keeping the water cold enough for safety. I have endeavored in the above remarks to call attention to some of the not too obvious dangers that one is liable to fall into in travelling with living fishes, and if some of my suggestions have seemed superfluous, I hope it will also be remembered that too much care cannot be exercised in transporting live fishes, and that infinite precaution as well as eternal vigilance is the price of success at our journey's end.

The Secretary, Mr. Phillips. then read the following paper from C. J. Bottemanne, M. D., Superintendent of Fisheries for the Netherlands.

Do Grilse Spawn?

Of the entire lot of grilse that enter the Dutch rivers, about seventy-five per cent of them, I calculate, are males. All have full milt. By the middle of August the hook (which the male salmon has in spawning-time on the point of the lower jaw) is developing fast. The females are always in the minority, but in the first part of the season there are more than towards the latter part. All have spawn, and towards the end of October they are so far ripe that when one is lifted by the head the spawn is running out.

Another thing observed in Holland is, that when there has been a good grilse season one year, two years afterwards there is a good season of so-called summer-salmon, viz: salmon of 10 to 16 pounds. About two years later there is a good catch of winter-salmon, viz: of 22 pounds and upwards.

Often the next year shows already an increase in the catch of the summer-salmon.

SALMO QUINNAT IN HOLLAND.

The California salmon-eggs, which, through the kindness of Prof. Spencer F. Baird, were presented by the United States of North America to the Netherlands, arrived per the Rotterdam steamer *Schiedam*, on three of Mr. Frederick Mather's improved refriger-ating boxes, on November 7th, at Brouwershaven.

During the passage, which lasted seventeen days, they were kept in the ice-house, and cared for by the chief officer.

Next day I met the steamer at Hellevoetsluis, transported the eggs to the zoological gardens at Amsterdam, and had them a little after midnight on the trays in splendid condition. Although not a single egg was picked out on the passage, the loss in bad eggs was only about two per cent.

During the hatching process the loss was far less than last year, and amounted to about fifteen per cent.

December 21st the last egg was burst. The fry are doing exceedingly well, and there are very few of those Siamese-twins and crooked-backs among them. The loss in fry was in the first days, about forty per day, gradually diminishing, and is now at the highest eight per day, a very low figure compared with that of 1878, when it ran as high as twelve and fourteen hundred in the first days.

I expect that when the sac is absorbed the loss in fry will be less than one per cent.

Of last year's lot 5,000 fry were put in a small pond and left to themselves, only taking care there was no lack of water. They were put in in January, 1879, when the sac was very near gone. All the food they got were the water insects from the brook by which the pond was supplied, and a few crushed mussels (*mytilus edulis linne*). which were taken greedily. In the summer the wire-grating was carried away at the outlet and a good many escaped. In November last the pond was drained, and what was left consisted of about 1,478 nice pairs of different sizes, the largest measuring sixteen centimeters.

One peculiarity of the young of salmon *quinnat*, observed in

the ponds, is that they always swim in a school. As soon as they are disturbed you see a whirl, and there is not one more to be seen. By waiting only a short time one after another comes forth out of their place of refuge, and the school is formed again in no time.

Not so the young of the salmon *salar;* when they are a couple of inches long, they never congregate; are always single (on the look out), and stand with the head current-up, while the quinnat swim up and down the pond from one end to the other.

The pairs on hand will be put in the river Maas, near Venlo, as soon as the water opens, all being frozen up now, as I have singled out that river for my experiments, as having been for years almost destitute of salmon.

Last January I put in at the same place 51,000 fry, but as I did not hear anything of them, I intend to keep all the fry in ponds till next fall, and have them well fed with mussels, so as to have not quite so much cannibalism among them.

C. J. BOTTEMANNE, M. D.

THE PRESIDENT then announced the Annual Fish Dinner for Wednesday evening, at the Metropolitan Hotel.

The following letter was received and read by the Secretary.

SANDUSKY, March 25th, 1880.

Mr. ROOSEVELT, *President, and members of the Fish-Cultural Association:*

GENTLEMEN—As business compels me to stay here, and I therefore, am not able to be present at the meeting of the Association, I take the liberty to propose the following in regard to pound-net fishing.

1. Pound-net fishing ought to be regulated by Congress as it is in Canada.

2. The meshes of pound-nets should be enlarged to protect the young and ungrown fish by giving them a chance to slip through the meshes.

3. Every pound-net should pay a revenue of between five

and ten dollars, and receive license and a certain ground to fish on, which will prevent crowding each other.

4. One person shall not get license for more than six (6) pound-nets.

5. It shall not be allowed to fish more than six (6) pound-net on one string.

6. Inspectors should be appointed for each of the large lakes to enforce the above, license the nets, and make out the grounds for same.

7. The inspectors should be paid out of the above-mentioned revenue.

8. For the balance of the revenue, hatcheries for all kinds of fish should be opened all along the four large lakes.

Now, gentlemen, these propositions I make on a very careful study of the pound-net question, and I therefore respectfully ask you to consider the matter and take the necessary steps in regard to it, and I am convinced it will, if well managed, turn out profitable for everybody.

Very respectfully yours,

THEO. REINECKE,

Pound-net fisher.

The following telegraph from W. F. WHITCHER was then read:

OTTAWA, Ont., March 24th, 1880.

Fish-Culture Association, Fish-Mongers' Rooms, Fulton Street, New York.

Excuse long silence. Illness and business reason. Neither self nor Wilmot can attend meeting this year, which we much regret. Parliament sitting, and we are under orders to attend special committee. Present best wishes and official regards to all our friends.

W. F. WHITCHER.

The order of proceedings for the afternoon was then given by the Secretary, and the meeting adjourned for one hour.

AFTERNOON SESSION.

The meeting was called to order by the Vice-President, Mr. Geo. Shepard Page, who announced that the nomination of officers for the ensuing year was now in order, and appointed as a nominating committee Dr. W. M. Hudson, Asa French, and Geo. Lamphear.

The report of the Treasurer was then read and accepted.

The following resolution was offered by Mr. Phillips :

Resolved, That in case members do not pay their fees and are delinquent for two years, they shall be notified by the Treasurer, and if the amount due is not then paid within a month, that they be, without further notice, dropped from the roll of membership.

The resolution was accepted.

Mr. James Annin, Jr., gave a practical illustration of stripping eggs from live brook-trout, and impregnating them with milt obtained in the same way from the male. The fish were brought alive in cans from Mr. Annin's ponds at Caledonia, New York.

Mr. Hallock then read a very interesting paper entitled "The Shore-Fisheries of Labrador."

The Canadian salt-water fisheries yield an annual revenue to the Dominion of about twelve millions of dollars, of which fully one-half is derived from the coast of Labrador.

Within the single district lying near the eastern extremity of Belle Isle Strait, and embracing only about fifty miles of coast line, the produce of the cod, salmon, and herring fishing, is valued at fully $5,000,000. A summer trip to this locality of busy, and by no means fragrant operations, is one of the most interesting that can be undertaken by the student, rambler, or curiosity hunter.

From Belle Isle to the Moravian Missions on the North Atlantic Coast, in lat. 56 deg., a stretch of nearly 600 miles, the fish-

ing interests are strung all along shore; the low-lying, barren rocks, the fleets of vessels in the little harbors, and the drifting icebergs, diversifying the otherwise forbidding landscape, divides the attention of the observer.

In 1860 this industry employed some 1,500 souls. Now, twenty years later, it includes 5,000 persons, a nearly quadruple increase; which is significant, not only from a commercial and financial standpoint, but encouraging as respects any apprehensions which may have existed as to the ultimate extinction of the fish and the failure of the fisheries.

In 1860 there were but few permanent residents. There were few men hardy enough to brave the rigors and isolation of a nine months' winter, and the constant deprivations which the absence of almost any kind of communication with the rest of the world entailed. Aside from the vessels of the fishing-fleets, their only visitors were occasional trading-schooners, which dropped in clandestinely to pick up furs and any chance merchantable commodities, in exchange for meagre assortments of indifferent goods at exorbitant prices. The arrival of an excursion party was an event long to be talked of and remembered.

Now, and especially since the establishment of an efficient Government Fishery Commission, there are regular supply ships, as well as a coast-guard steamer, which keep up frequent stated communication in the open season, and afford timely provision against distress during those months when the coast is hermetically locked and sealed. Under these improved conditions of existence, with their added comforts, and the assurance of relief when the fisheries fail and assistance is needed, a large permanent population has been invited, which must contribute very much to the development of the fisheries by furnishing those mechanical appliances which could not be profitably employed when they had to be transported annually to the fishing-grounds by the fishing-vessels themselves.

There are several varieties of cod, but this paper has only to do with the shore-fish of the East Atlantic. Their range is from Cape Cod to the Arctic seas. They generally strike into the Gulf of St. Lawrence in May; and the voyager bound to the "norrud," who has succeeded in working his vessel through the

Gut of Canso, and laid his course up George's Bay at that time of year, will perchance find a seafog making on a favoring wind, and as the foggy atmosphere grows dense and envelopes him, the warning blare of fish-horns sounds ominously through the murk; the lookout on the jib-boom discovers here and there a fishing-boat tending trawls, or possibly a schooner at anchor which his own craft has barely missed as she slips by with that gentle ripple under forefoot which indicates a vessel under easy way.

This is the first opening of the fishing season.

Trawls, or bull-tows, are common at the entrances to the gulf, but open boats of from twenty to twenty-five feet often go out full thirty miles to sea, where the chances of a catch are better, and there encounter storms which larger vessels could not weather. Trawls have been objected to as unnecessarily destructive to breeding-cod; but it having been ascertained that cod deposit their eggs in the high seas as well as off shore, it becomes a matter of little consequence whether the breeders are caught with trawls or the ordinary hook and line. Most of the north-shore fishermen, from Cape Gaspe to Newport, who carry on the banks as well as the inshore fishing, use trawls. Everywhere else the fish are caught with hook and line.

As the fishing season advances and May gives place to June, the great mass of the fishing-fleet have arrived upon the coast, and are strung all along from Whale Head, Mecattina, and Bloue Sablon, on the Gulf, through Belle Isle, to its eastern entrance, bearing eastward and northward. It is a glorious sight, and very much like a regatta, to see the white-winged craft, single, in braces, and in clusters, sometimes two hundred in all, wholly becalmed on a silent sea, or overhauling each other with a stiff breeze blowing from the westward.

But fish do not always make their appearance in June. There is no stipulation in the bargain as to when they shall strike in. If bait is absent, there will be no codfish; and the absence of bait depends very much upon the temperature of the water. If the ice remains late upon the coast, the caplin keep in deep water, where it is warmer. Besides, stormy weather keeps all

kinds of fish away from the coast, as they do not like being knocked about and battered on the rocks by the waves.

Fish are always more abundant in some localities than in others; their well-known voracity and the instinct of conservation causing them to prefer those spots where small fish, mollusks, sand-lances, and crustaceans, most abound. Their movements and migrations are also governed by other natural causes, such as suitability of certain places for reproduction, and these favorable conditions not only present themselves near the shore, but also upon the banks of the high seas, in both of which it has been indubitably ascertained that the cod breeds.

After their summer visit to the Gulf of St. Lawrence and certain localities off shore, the cod seek the northern seas and the profound depths adjacent to the Newfoundland Banks.

Cruising along shore in the busy midsummer, the rocks and the water everywhere appear animate with life. Grampuses, whales, and predatory porpoises patrol the coast in quest of food, rolling their huge bodies up to the surface, blowing off small jets of water, and surging into the incoming schools of fish. Sly seals forage among the salmon nets, poking their round bullet-heads above the water in all directions, take a momentary survey and then disappear.

It is the breeding season for wild-fowl, and the outlying cliffs swarm with gannets, murrs, auks, puffins, gulls, sea-pigeons, and nameless birds. The air above and around these islands is filled with myriads constantly hovering, and the whirr of their rapid circling flight sounds like the hum of a factory. To and from their feeding-grounds foraging parties constantly wing their pathless way; keen-eyed sentries patrol the topmost crags; scouting parties and videttes, ever on the alert, wheel and hover about each approaching vessel, screaming at the intrusion. Bunches of eiders and shell-drakes float upon the waves, take wing when disturbed, and skim away to places more secure.

In every little bight and bay fleets of vessels lie quietly at their moorings, with bait-seines triced up to the mast-heads to dry. Moss-thatched cabins are scattered all over the granite boulders on shore, as if stranded there by a receding flood. Rude fishing-stages cling to the rocks on every side, supported on piles, the

water beneath stirred by the splash of the constantly falling offal from the splitting-tables above. Fishermen in oil suits are pitchforking fish out of loaded boats up to the stands, and boats laden and empty constantly arrive from and depart to the fishing-grounds. Gaunt dogs stroll along the landwash in search of food, and uncouth sculpins, with mouths as wide as their shoulders, try and tussel with each other for choice bits of tempting offal drifting with the tide. On every available space upon the rocks codfish are spread out on "flakes" to dry, and myriads of delicate caplin are curling and curing in the sun. These choice little fish are much relished by the resident settlers, who always prepare and lay by a good stock for winter consumption. On a warm day the air is redolent with innumerable stenches of curing and decaying fish, and noisesome exhalations from huge vats of livers trying out for oil. The occupation is by no means savory, and he who has once watched the process for ever after eats his codfish-balls with some compunctions of stomach, knowing that they are seasoned with something besides salt.

Women as well as men take part in the business of dressing fish, and in the recesses of the moss-thatched hovels the voice of the maiden may often be heard singing gleefully as she heads and splits, while the unceasing splash of the offal dropping into the water beneath chimes in befitting unison. An expert will split six thousand fish per day, or head twice that number.

Every fishing-station comprises a large salting-room, or store, where the prepared fish are temporarily housed. This building is always conspicuous among the stages and lodging-shanties. The latter are constructed of spruce poles or studs, like the stages, generally boasting but a single apartment, which both sexes occupy in common, the only division being that imaginary one which excludes all objects outside the line of vision. Sunday in Labrador is always a day of rest. The mornings are generally spent by the Catholics in humble devotion and prayer, and the afternoons in ball and card playing, music, drinking, and dancing. Other denominations observe the day in like manner, save that the morning services are omitted.

Many of the fishing-vessels cure their fish on board. The outfit of each vessel includes a cargo of salt, a supply of lines

and hooks, bait-seines, several puncheons for oil, and from four to eight boats. The crew is either hired or they go on shares, the fare of fish in the latter case being divided among them, after deducting a one-twelfth for curing. Your experienced and initiated fisherman almost invariably goes on "sheers;" for if fish are to be caught, he can catch as fair a "jog" as any man. He is one of those knowing chaps who predict the weather by the moaning of the sea, or by the "loam" or "glim" in the air. He never mistakes a catspaw for a "skull" of fish "briching." His labor always gives zest to his toil, and when his hard day's task is done, he can punish his "whiggin" of grog and a full allowance of "jo-floggers," "lobscouse," and "doughboys," to say nothing of "duff" on Sundays.

It is customary for the seine-boats to go in quest of bait in the early evening; these carefully search the little coves and inlets, and creep along the shores, and when the ripple of a passing school is detected, the lookout ahead or astern gives due warning. Overboard goes the seine smoothly and noiselessly, and with a rapid circuit the bait is imprisoned and quickly secured. One cast is generally sufficient, for the caplin swarm in millions, swimming so densely that often a dip-net can be filled from a passing school. They keep near the shore to avoid their finny pursuers, and are left floundering on the rocks by every reflex wave. The cod often leap clear of the water in their pursuit, and at such times may be taken by the hook with scarcely three feet of line almost the instant it touches the water. The caplin has very much the appearance and size of a smelt.

Hand-fishing for cod is not the high art of angling. Rapidly, one after another, the fish come floundering over the sides of the boat, and are dexterously slatted off the hooks upon the crotch-irons provided for the purpose, when the hooks, as quickly baited, are tossed overboard again, to be seized the instant they sink below the surface. In time the hands not toughened to the business become sore and water-soaked and skin off, and the arms and shoulders grow painfully lame. The thick lines draw up buckets of water, which run down the sleeves despite the protection of an "ile sute." Most fishermen handle two

lines. But good luck does not always reward the patient toiler, and many a vessel has often returned home without a fare.

After the cod-fishing is over, come the mackerel and the herring. Herring are taken with seines; mackerel with both seine and hook; with the seine early in the season, and later with the hook.

The migrations of mackerel are very irregular, and cannot be depended on. They will visit certain localities one season, and then disappear for several years together. But they are always to be found in the vicinity of the Magdalen Islands, in the Gulf of St. Lawrence, which appears to be one of their favorite spawning-grounds.

The yield of the salmon-fishery of Labrador is about eighteen hundred barrels per year.

Halibut are found in great abundance along the whole north coast, but are seldom fished for except by American vessels. They generally sell in the States at from fifteen to twenty cents a pound, while in Canadian markets they are so little valued as to seldom realize more than $6 per barrel.

There is good trout-fishing all along the Labrador coast, and I have myself taken a great many heavy fish with fly in the months of June and July.

I do not know that I have communicated anything new to the gentlemen of this Association, many of whom must know far more than I do about my subject; but never having seen any descriptive paper published giving an inside view of the Labrador fisheries, excepting one written many years ago by myself, I thought I would venture to introduce the subject here. I trust my recital has proved interesting, if not new.

The Vice-President, Mr. Page, read the following letters:

Rochester, N. Y., Feb. 19, 1880.

Friend Phinney—Yours of the 17th is received. In regard to the land-locked salmon, the reason I gave my opinion that they would not do well in Otsego Lake is because in the waters they inhabit in Maine the lakes are fed by large streams flowing directly into them, into which they go up to cast their spawn,

and from what I have heard of them, this seems to be one of the greatest essentials to their welfare. It would do no harm to try the experiment, if we had the fish. I have been expecting some spawn of this variety, and if they come can undoubtedly send you a few thousand if you desire it.

The Ontario salmon do not take the baited hook like the salmon-trout; they are caught with the artificial fly when in rivers; never have heard of one being caught except with net in Lake Ontario.

Yours, SETH GREEN.

I should like to visit you very much and enjoy fishing with you in Otsego Lake, and may do so next summer if I get time.

S. G.

COOPERSTOWN, March 22, 1880.

MY DEAR SIR—Please read the enclosed, and after confering with the members of the Association on the 20th, let me know your joint opinion as to the probable success of the experiment alluded to in our lake. The fish were planted (say 4,000) in June, 1877. Our lake is the source of the Susquehanna river, and is mainly supplied by bottom springs. At the head of it are several good-sized brooks, one of them a mill-stream upon which a boat may be rowed for a quarter of a mile. These streams are, I presume, too small for salmon to run up. So, if Mr. Green is correct, we may fail. It is, at any rate, an interesting question. Are any similar cases recorded in which this fish, being *strictly land-locked*, has matured or propagated?

Can you give me Mr. Ricardo's address, and tell me how many smelt Mr. Hartson started with from New Jersey?

Yours truly, E. PHINNEY.

HON. E. G. BLACKFORD,
State Commissioner of Fish.

DR. W. M. HUDSON gave the experience of the Connecticut State Fish Commissioners with the land-locked salmon, and stated that whether they would spawn or not he was not as yet decided about.

Some discussion here followed on the spawning habits of the trout family, as "To whether they always run into the streams to spawn, or whether they did not deposit their eggs as frequently in lakes."

The discussion was entered into by Messrs. PAGE, HUDSON, HALLOCK, MCGOVERN, and ANNIN.

MR. PHILLIPS read a short paper or article on the importance of getting at the statistics or figures in the results of fish-culture.

A valuable statistical paper was then read, prepared by MR. GEO. LAMPHEAR, on the number of pounds of each variety of fish sold in Fulton Market during the last year, as compared with the year preceding.

This short paper was prepared at the request of Professor SPENCER F. BAIRD, and MR. LAMPHEAR had been at great pains and trouble to prepare it. Its object was to determine whether the catch of any particular fish had increased or decreased from year to year. Massachusetts and Connecticut require of their fishermen a sworn return of their catches. The requirement is still rather new, and the fishermen are not quite used to it, but they were getting into the way, and the returns were coming in in better shape every year.

SALES OF FISH IN FULTON MARKET.

	March 1, 1878. to March 1, 1879.	March 1, 1879, to March 1, 1880.	Increase.	Decrease.
Flounders	1,544,842	1,795,980	251,147	.....
Halibut	3,327,790	3,549,121	221,331	.....
Codfish	8,636,479	8,719,574	82,095	.....
Pollock	222,908	315,879	92,971	.....
Haddock	1,857,790	1,813,820	.....	43,970
Frostfish	53,792	77,871	24,079	.....
Blackfish	188,981	199,530	10,549	.....
Spanish Mackerel	275,163	310,970	35,807	.....
Weakfish	510,022	801,017	290,995	.....
Kingfish	38,090	38,447	357	.....
Sheepshead	82,474	67,325	.....	15,149
Porgies	2,198,780	2,388,863	190,083	.....
Sea Bass	446,695	255,688	.....	191,007
Striped Bass	716,642	678,423	.....	38,219
Bluefish	3,843,983	3,570,543	.....	273,440
Smelts	1,560,541	1,589,268	28,727	.....
Salmon	436,623	394,220	.....	42,403
Herring	942,145	1,052,891	110,746	.....
Eels	1,202,414	1,292,917	90,503	.....
Sturgeon	70,633	68 858	.....	1,775
Black Bass	79,850	85,011	5,161	.....
Pickerel	508,131	744,566	136,435	.....
Yellow Pike	173,367	129,251	.....	44,116
Siscoes	629,661	624,438	.....	5,223
Whitefish	741,943	693,085	.....	48,857
Brook Trout	6,522	8,139	1,617	.....
Salmon Trout	84,262	96,160	11,898	.....
Catfish	98,562	52,847	.....	45,715
Small fresh water	506,719	446,411	.....	60,308
Green Turtle	6,103	8,189	2,086	.....
Lobster	1,625,655	1,737,224	111,569	.....
Salt water fish	912,199	670,131	.....	242,068
	33,529,960	34,276,666	.....	.....
INCREASE, 1879–80.			646,700	.....
	COUNT.	FISH.		
Mackerel	2,317,763	3,827,324	1,509,561	
Shad	661,594	953,439	291,845	GALS.
Scollops	46,451	36,445	.....	10,006

Mr. Blackford thought that a law should be passed so that all fishermen would be obliged to take out a license for each net put into the water, and be obliged to make returns or figures to the number of fish or pounds of fish caught by each and every net. In this way statistics could be obtained which would be of great benefit to the United States Fish Commission, and we could see whether fish were on the increase or not.

The thanks of the Association were offered Mr. Lamphear for his very carefully prepared statistics.

The meeting then adjourned until 11 a. m. the next day.

SECOND DAY'S PROCEEDINGS.

Wednesday, March 31st, 1880.

The meeting was called to order by the President, R. B. Roosevelt, who introduced Professor W. O. Atwater, of Wesleyan University, Middletown. Conn., who read a long and very interesting paper on the nutritive qualities and values of various kinds of fish, comparing them with the composition and valuation of animal foods, such as beef, mutton, pork, venison, etc.

The subject to which your attention is invited this morning is the study of the food values of some of our different sorts of fish, as shown by chemical analysis. The field of investigation is comparatively new, and, as respects American fishes, hitherto almost untrodden. It is, nevertheless, important.

At the instance of Professor Baird, Secretary of the Smithsonian Institution and United States Fish Commissioner, through whose interest in the matter an appropriation for the purpose has been secured, I have been engaged, with my assistants, for some time past in the analysis of samples of our more common food-fishes. From a preliminary report of this work, soon to appear, the following figures are taken. Before giving the results, however, permit me a few words by way of introduction.

Fish constitute one of our most valuable sources of nourishment. They live upon matter dissolved and suspended in the water, or found on the bottom of streams, lakes, and the ocean, and thus gather for us nutritive material, which without them would be inaccessible to man. And since cheap and wholesome food is fundamental to the material prosperity, culture, and even the morality of a people, it follows that fish-culture may be made an important factor of our national welfare.

I deem myself particularly fortunate in the opportunity of presenting this topic to an Association which has done, and is doing, so much to further the good cause of fish-culture.

THE TASTE FOR FISH,

I think, is a thing that advances with the advance of civilization. The taste of different civilizations vary, however. We read of Roman nobles who were in the way of paying twenty-five hundred sesterces (one hundred dollars) for a single lamprey, and twelve thousand and even twenty-five thousand sesterces for a six-pound mullet, and considered only the livers and gills of these fish fit to set before an emperor. We are told that they sent ships to foreign lands for fish ; that they built reservoirs for breeding them at home ; that they fed them with veal soaked in human blood, and even with the flesh of slaves sacrificed for the purpose. But this was part of an imperial shoddyism that would devote four hundred thousand sesterces to a single banquet, whose guests were content with gross cooking and grosser accompaniments if they could be regaled with peacocks' brains and singing birds' tongues.

The fish to please the taste of the members of this Association would be served with less splendor and more wholesome sauce. We of to-day ask for palatable and nutritious food, and, with the increasing culture of our palates and consequent call for variety, we demand more and more kinds, and larger and larger quantities of fish.

THE FLESH OF FISH.

The flesh of fish does not differ essentially from that of mam-

mals. To the epicure it is more dainty, while the poor man can purchase nutritive materials in dried and salt fish for only a fraction of their cost in ordinary meats.

In general, fish has somewhat more water and less solids than the beef, pork, mutton, and other common meats. Like the latter, the fatter it is the less water it contains. The amount of fat in the flesh of different species of fish, and in the same fish at different times, varies widely. Cod, bass, and bluefish, have usually but little fat, while the flesh of eels, shad, trout, and salmon, in their season, is very fat. With the leaner fish we use butter or oil to make up the deficiency of fat.

For the best apprehension of our subject, it will be well to devote a few minutes to

THE CHEMISTY OF FOODS.

We eat meat and fish, milk and bread, to build up our bodies, to repair their wastes, to supply heat to keep ourselves warm, and strength with which to work. This is the common way of putting it. Speaking as chemists and physiologists, we should say that our food supplies, besides mineral substances and water, albuminoids, carbohydrates and fats, whose functions are to be transformed into the tissues and fluids of the body, muscle and tendon, blood and bone, and by their consumption to produce heat and force. That we may fix more clearly in our minds the nature and functions of the food materials, allow me to call your attention to the table before you, in which I have tried to condense some of the more important facts respecting foods and nutrition:

NUTRIENTS OF FOODS.

ALBUMINOIDS, CARBOHYDRATES, AND FATS.

ALBUMINOIDS OR PROTEIN COMPOUNDS.

NITROGENOUS.

Contain *Carbon*, *Oxygen*, *Hydrogen*, and *Nitrogen*.

In Plants.—ALBUMEN; CASEIN; FIBRIN, e. g., in gluten of wheat.

In Animal Body.—ALBUMEN ; e. g., in blood serum and white of eggs.

FIBRIN ; e. g., in muscle (lean meat).

In Milk.—ALBUMEN ; CASEIN (curd).

CARBOHYDRATES.

NON-NITROGENOUS.

Consist of *Carbon*, *Oxygen*, and *Hydrogen*.

In Plants.—SUGAR ; STARCH ; CELLULOSE (in woody fiber).

In Animal Body.—INOSITE (sugar).

In Milk.—MILK SUGAR.

FATS.

NON-NITROGENOUS.

Consist of *Carbon*, *Oxygen*, and *Hydrogen*.

In Plants.—VEGETABLE FATS and OILS ; e. g., linseed oil, olive oil.

In Animal Body.—FATS ; e. g., fat meat, tallow, lard, etc.

In Milk.—FAT (butter).

FUNCTIONS OF FOOD INGREDIENTS IN NUTRITION.

NUTRIENTS OF FOODS.		OFFICES IN BODY.
ALBUMINOIDS.	are transformed into	ALBUMINOIDS, e. g., in muscle, gristle, and casein of milk. FATS, e. g., fat meat and fat (butter) of milk. CARBOHYDRATES, e. g., milk sugar.
	Serve for FUEL.	
CARBOHYDRATES.	Serve chiefly for FUEL.	
FATS.	are transformed into	FATS ; e. g., for meat and butter. CARBOHYDRATES, e. g., milk, sugar.
	Serve for FUEL.	

ALL contribute to the production of MUSCULAR FORCE (?).

This schedule seems somewhat complicated at first sight, as well it may when we consider the amount of painstaking and costly scientific investigation, some of whose main results it attempts to summarize.

If the time and place permitted I should be glad to tell you

something of the ways in which the facts, as far as we know them, have been found out; of the thousands of chemical analyses of vegetable and animal substances that constitute our foods and the tissues and fluids of our bodies; of the years and years of labor of many men that have been devoted to the experimental study of the ways in which the food is used, the body built up, and its tissues consumed again; of the wonderfully complicated and yet beautifully simple instruments and operations by whose aid the utmost ingenuity of science has sought to discover the subtle processes by which the transformations go on in the body and flesh and fat are stored and heat and force produced. Suffice it to say, that the research of the past fifteen years, especially, has taught us much of the fundamental principles of nutrition, though we are still in the dark as to many of the details, as the interrogation point after the last word in the schedule implies. So let us return to our subject—the nutrients of our foods and their functions in nutrition.

Leaving out of account the water and mineral substances which, though essential to nutrition, are not to our present purpose, we have three classes of nutrients in our foods—albuminoids, carbohydrates, and fats.

ALBUMINOIDS, PROTOPLASM.

A little short of a dozen years ago many earnest-minded people on both sides of the Atlantic were startled by an address from Professor Huxley, on "A Physical Basis of Life." This "formal basis of life," this soulless substance in which vital phenomena were centred, while vitality, as a force, was excluded, was protaplasm, a material containing "the four elements, carbon, hydrogen, oxygen, and nitrogen, in very complex union. . . . . To this complex combination the name protein has been applied, and if we use this term with such caution as may properly arise out of our comparative ignorance of the things for which it stands, it may be truly said that all protoplasm is protinaceous, or, as the white or albumen of an egg is one of the commonest examples of a nearly pure protein matter, we may say that all living matter is more or less albuminoid."

As the schedule indicates, we have albuminoids in plants, as in the gluten of wheat ; and in the animal body, as in the fibrinogen and fibrinoplastic substances of blood, in the fibrin of muscle, in egghalbumen (white of eggs), and in the casein (curd) of milk.

The albuminoids are the most important of the nutrients of foods. Not only do they share in the formation of the fatty tissues and in the supply of material for the production of animal heat and muscular power, thus performing all of the functions of the other food ingredients in the body, but they also have a work of their own in the building up of the nitrogenous tissues, muscles, tendons, cartilage, etc., in which none of the other ingredients can share.

THE CARBOHYDRATES,

of which we have familiar examples in sugar, starch, and cellulose, differ from the albuminoids in that they have no nitrogen. They have, according to the best experimental evidence, no share in the formation of nitrogenous tissues in the body. It is hardly probable that they are transferred into fats to any considerable extent ; their chief use seems to be to supply fuel for the production of animal heat, and very probably of muscular power. They are very important constituents of foods, but much less so than the albuminoids and fats. They occur in only minute proportion in meats, fish, and like animal foods. We are well acquainted with

THE FATS,

as they occur in vegetable fats and oils, like linseed and olive oils, in fat meat, tallow and lard, and in butter. The fats, like the carbohydrates, are destitute of nitrogen. The fats of the food we eat are stored in the body as fats, transformed into carbo-hydrates, and serve for fuel, but do not form nitrogenous tissue. They are more valuable than the carbo-hydrates, because they are richer in carbon and hydrogen, the elements which give value to fuel, and because they supply the body with fats.

The albuminoids are often spoken of as the "flesh formers," and the carbohydrates and fats as "respiratory" substances. It was formerly believed, too, that the albuminoids alone could be transformed into the nitrogenous tissues of the body, but later research has led to the views stated above. The functions supply any material for respiration and for production of muscular energy are in all probability shared by all the nutrients.

To resume briefly—asking your pardon for the repetition: the albuminoids, the nitrogenous constituents of foods (albumen, fibrin, etc.), which make the lean meat, the muscle, the connective tissues, skin, and so on, are the most important of the nutrients. Next in importance come the fats, and last, the carbohydrates—sugar, starch, and the like. One reason of the inferior position of the carbo-hydrates is the fact that they have no nitrogen. The albuminoids can do their own work and all the work of the carbo-hydrates and fats as well, while these latter can only do their own. With lean meat alone we might make a shift to get on for a good while, but with carbo-hydrates and fats alone we should speedily starve.

Now the flesh of fish, like other animal foods, consists mainly of albuminoids, but has more or less of fats, and contains very little of the carbohydrates. Vegetable foods, on the other hand, consist largely of carbohydrates, and contain less of the albuminoids and fats. Science and experience unite in testifying that a proper combination of all makes the most wholesome, as we know it gives the most agreeable, diet.

Let us, then, note some of the main facts concerning

THE CHEMICAL COMPOSITION OF FISH.

TABLE I.—Analysis of Fish. Ingredients of Flesh and of Whole or Dressed Fish as taken for Analysis.

KIND OF FISH AND PART TAKEN FOR ANALYSIS.	FLESH—EDIBLE PORTION.					WHOLE OR DRESSED FISH.					
	Water.	*Solids.*	*Ingredients of solids (Nutrients).*			*Waste, bones, skin, entrails, etc.*	*Edible Portion.*				*To'l edible solids. Actual nutritive subs.*
			Albuminoids (Protein)	*Fats.*	*Mineral matter.*		*Water.*	*Albuminoids.*	*Fats.*	*Mineral matter.*	
1. Flounders—Entrails removed	82.85	17.15	15.24	.62	1 29	58.51	4.37	6.33	.26	.53	7.12
2. Halibut—Posterior portion of body	79 36	20.64	17.33	2.15	1.10	21.13	30.22	13.14	1.63	.88	15.65
3. Halibut—Section of body	69 26	30.74	19.08	10.61	1.15	11.59	61.23	16.86	9.29	1.03	27.18
4. Cod—Head and entrails removed	83.12	16.18	15.44	.28	1.26	35.40	53.63	9.97	.18	.82	10.97
5. Cod—Head and entrails removed	82.45	17.55	15 90	.40	1.24	31.63	56 38	10.86	.27	.86	11.99
6. Eels—Skin, head and entrails removed	70.44	29.56	18.66	9.80	1.00	23.99	53.60	14.33	7.43	.68	22.41
7. Alewives—Whole	75 70	21.30	18.90	3.94	1.46	50.45	37.51	9.37	1.95	.72	12.04
8. Shad—Whole (Hudson River, first of season)	69.34	30.66	18.59	10.77	1.30	51.58	33 58	8.99	5.22	.63	14.84
9. Shad—Whole (Connecticut River, first of season)	64 53	35.47	19.80	14.25	1.42	47.37	33.95	10.42	7.48	.78	18.68
10 Striped bass—Whole (Connecticut River)	78.66	21.34	18.86	1.56	.92	57.75	33.23	7.97	.66	39	9.62
11. Striped bass—Entrails, head, skin, etc., removed	79 61	20.39	16.32	2.70	1.37	57.49	33.84	6.94	1.15	.58	8.67
12. Mackerel—Whole	77.82	22.18	19.05	2.18	.95	39.18	47.32	11 61	1.32	.57	13.50
13. Mackerel—Whole	74.23	25.77	17.51	7.02	1.24	54.28	33.98	8.01	3.21	.57	11.79
14. Bluefish—Entrails removed	78.15	21.85	19.33	1.25	1.27	49.66	39.34	9.37	.63	.64	11.00
15. Salmon—Entrails removed (Maine)	66.41	33.59	19.72	12.71	1.10	23.61	50.75	15.06	9.75	.83	25.64
16. Porgie—Whole	79.69	20.31	17.45	1.46	1.40	61.66	30.55	6.69	.56	.54	7.79
17. Haddock—Entrails removed	80.63	19.37	18.03	.18	1.16	52.73	37.32	8.34	.08	.53	8.95
18. Lake trout—Entrails, head, skin, etc., removed	68.69	31.31	17 70	12.26	1.35	56.69	29.75	7.67	5.30	.59	13.56
19. Brook trout—Entrails, head, skin, etc., removed	75.70	24.30	19.92	3.02	1.36	53.05	35.54	9.35	1.42	.64	11 41
20. Whitefish—Entrails, head, skin, etc., removed	69 59	30.41	21.66	7.14	1.61	54.23	31.85	9.92	3.26	.74	13.92
21. Red snapper—Entrails, head, skin, etc., removed	75.45	21.55	22.40	.67	1.48	60.40	29.88	8.87	.26	.59	9.72

Table I. herewith gives the results of a number of analyses as samples of fish, some supplied through the courtesy of Mr. E. G. Blackford, of your Association, and some purchased at the fish-markets in Middletown, Conn., where the analyses were made. Some of the samples were entire fish, others had been dressed. All were taken as they are ordinarily sold in the markets. Each sample on its receipt at the laboratory was weighed, then the flesh (the edible portion) was separated as carefully as practicable from the skin, bones, entrails, etc., weighed and prepared for analysis.

The figures in the table show, first, the composition of the flesh (the edible portion), freed from skin, bones, entrails, etc.; and second, the calculated composition of the whole fish, that is, of the whole sample as received, including, in some cases, the entire fish, and in others, the dressed fish.

Taking the flesh (the edible portion), one of the first points that strikes us in looking down the rather cumbrous columns of figures is the difference in the amounts of water in the different samples.

In one hundred pounds of flesh of cod we have eighty-three of water, and only seventeen of solids; while the flesh of the salmon contains only sixty-six and one-half per cent. of water, and thirty-three and one-half per cent. of solids. That is to say, about one-sixth of the flesh of cod and one-third of that of salmon consisted of solids, actual nutritive substances, the rest being water. The figures for some of the samples are:

IN FLESH OF—	WATER, PER CENT.	SOLIDS, PER CENT.
Flounder	82.8	17.2
Cod	83.1	16.9
Cod	82.4	17.8
Striped bass	78.7	21.3
Striped bass	79.6	20.4
Blue fish	78.1	21.8
Halibut (lean)	79.4	20.6
Halibut (fat)	69.3	30.7
Mackerel	77.8	22.2
Mackerel	74.2	23.8
Shad	69.3	30.7
Shad	64.5	35.5
Eels (salt-water)	70.4	29.6
Whitefish	69.6	30.4
Brook-trout	75.7	24.3
Lake-trout	68.7	37.3
Salmon	66.4	33.6

A good quality of beef, lean meat, free from bone, contains

about 75 per cent. water and 25 per cent. solids, while the fat beef may have as low as 55 per cent. of water. The fish are on the whole rather more watery than beef. Still the difference is not very great.

One of the samples, I confess, has disappointed me. With an enthusiastic sportman's appreciation of both the game qualities and the flavor of the speckled trout, I had looked for a higher per centage of solids in the flesh of that most respected fish. The sample stands well, to be sure, but not at the top of the list. But I take consolation in the fact that this is only a single analysis, and perhaps future results will show that it is below the average. The sample was a cultivated trout, and until we are assured to the contrary, we can assume that in his native streams he would have as solid flesh as his only superior in the sportsman's eyes, the salmon.

If now we consider not simply the flesh, the edible portion, but whole sample, as sold in the markets, and consisting of either the entire fish, or of that which is left after it is dressed, we have, of course, different figures, just as the per centage of edible solids in a roast of beef would be less than in the meat without the bone.

Looking down the last column of Table we find in the samples as received for analysis, after removal of bones, skin, and other work, including the water of the flesh, there would remain the following percentages of actually nutritive materials.

Flounders, 7.1.	Cod, 10.5.	Mackerel, 11.4.
Halibut (lean), 15.6.	Halibut (fatter), 27.2.	Shad, 14.8.
Shad, 18.7.	Lake-trout, 13.6.	Salmon, 25.6.

I ought to say that these figures are based upon our separations in the labaratory of the fresh, uncooked fish. It is not as easy to get the flesh off clean from the bones in this way, as it is after the fish has been cooked. So in the very bony fish more of the flesh went to waste than would be the case at the table in an economical household. Such fish, therefore, appear at somewhat of a disadvantage in the figures above. I should add that many of the details of the analyses, such as the per centage of so-called "extractive matters," albumen, gelatine, phosphorus,

sulphur, and other ingredients are omitted from the table. Some of them, however, are very important. We all know what a useful article of commerce is "Liebig's Meat Extract," which is prepared from the flesh of cattle slaughtered in South America and Texas. Fish can furnish an extract of equal value in every way. There is a fortune for somebody, I mistrust, in the extract from menhaden.

Leaving for the present the further examination of the table, allow me a few words concerning

THE NUTRITIVE VALUES OF FOODS.

This subject has of late begun to attract very general attention. The chemico-physiological research of the past two decades has brought us where we can judge with a considerable degree of accuracy, from the chemical composition of a food material, what is its value as compared with other foods for nourishment. The bulk of the best late investigation of this subject has been made in Germany, where chemists and physiologists have already got so far as to feel themselves warranted in computing the nutritive values of foods and arranging them in tables which are coming into popular use.

From one by Dr. König, who has given more attention to this especial subject than anybody else, I cite a number of analyses and valuations of meat, milk, etc., and add corresponding computations for some of the samples of fish reported above. The analyses of cured fish, however, are from Dr. König, our work having extended, as yet, only to fresh fish.

The valuations are based upon the amounts of albuminoids, carbohydrates, and fats in the several kinds of foods.

TABLE II.

COMPOSITION AND VALUATION OF ANIMAL FOODS. (Flesh free from bone.)	INGREDIENTS.					Nutritive valuation compared with medium beef=100.
	Water.	*Albuminoids (Protein.)*	*Fats.*	*Extractive matters.*	*Mineral ingredients.*	
MEAT.						
Beef, lean	76.71	20.61	1.50	.....	1.18	91.3
Beef, medium	72.25	21.39	5.19	.....	1.17	100.0
Beef, fat	54.76	16.93	27.23	.....	1.08	112.0
Veal, fat	72.31	18.88	7.41	.07	1.33	92.4
Mutton, medium	75.99	18.11	5.77	.....	1.33	86.6
Pork, fat	47.40	14.54	37.34	.....	.72	116.0
Smoked beef	47.68	27.10	15.35	.....	10.59	146.0
Smoked ham	27.98	23.97	36.48	1.50	10.07	157.0
GAME, FOWL, ETC.						
Venison	75.76	19.77	1.92	1.42	1.13	88.8
Hen	70.06	18.49	9.34	1.20	.91	93.9
Duck	70.82	22.65	3.11	2.33	1.09	104.0
MILK, EGGS, ETC.						
Cow's milk	87.41	3.41	3.66	4.82	.70	23.8
Cow's milk, skimmed	90.63	3.06	.79	4.77	.75	18.5
Cow's milk, cream	66.41	3.70	25.72	3.54	.63	56.1
Butter	14.14	.86	83.11	.70	1.09	124.0
Cheese, skimmed milk	48.02	32.65	8.41	6.80	4.12	159.0
Cheese, fat	46.82	27.62	20.54	1.97	3.05	151.0
Cheese, very fat	35.75	27.16	30.43	2.53	4.13	163.0
Hen's eggs	73.67	12.55	12.11	.55	1.12	72.2
FRESH FISH.						
Flounder	82.85	15.24	.62	.....	1.29	65.0
Halibut	74.31	18.20	6.38	.....	1.12	88.0
Cod	82.78	15.67	.34	.....	1.25	68.0
Eels	70.44	18.66	9.80	.....	1.00	95.0
Shad	66.93	19.19	12.51	.....	1.36	99.0
Striped bass	79.13	17.59	2.13	.....	1.14	79.0
Mackerel	76.02	18.28	4.60	.....	1.09	86.0
Bluefish	78.15	19.33	1.25	.....	1.27	85.0
Salmon	66.41	19.72	12.71	.....	1.10	104.0
Haddock	80.63	18.03	.18	.....	1.16	78.0
Lake trout	68.69	17.70	12.26	.....	1.35	94.0
Brook trout	75.70	19.92	3.02	.....	1.36	91.0
Whitefish	69.59	21.66	7.14	.....	1.61	103.0
Red snapper	75.45	22.40	.67	.....	1.48	97.0
CURED FISH.						
Salt mackerel	48.43	20.82	14.40	.38	16.27	111.0
Dried cod	16.16	78.91	.78	2.59	1.56	346.0
Smoked herring	69.49	21.12	8.51	.....	1.24	104.0

This table will help us to a very fair idea of the comparative composition of some of our more common animal foods. The percentages refer to the fresh substance, except when especially stated as "dried," "smoked," etc. In the meats and fish the bones are excluded, the calculations referring only to the edible portions. The "extractive matters" are essentially the carbohydrates, which in the fish are of little moment.

Looking down the first column we see that while medium beef contains 72 per cent. of water, milk contains 87½ per cent. Roughly speaking, beefsteak is about three-fourths, and milk seven-eights, water. A pound of beefsteak would thus contain four ounces of solids, and, if we assume a pint of milk to weigh a pound, a quart would contain four ounces of solids also; that is, a pound of steak and a quart of milk contain about the same weight of actual nutrients. But we know that for ordinary use the pound of beefsteak is worth more for food than the quart of milk. The reason is simple. The solids of the lean steak are nearly all albuminoid, while those of the milk consist largely of fats and of milk sugar, a carbohydrate.

The figures in the table are, I think, worth looking through with some care. Remembering that those for meat and fish apply to only the edible portion, let me call your attention first to the varying proportions of albuminoids and fats in the second and third columns. On the whole you will notice that the fish average about the same percentages of albuminoids as the meats, but have rather less fats.

RELATIVE NUTRITIVE VALUES OF THE ANIMAL FOODS.

The figures in the last column are intended to show how the foods compare in nutritive valve, "medium beef" being taken as the standard. They are computed by ascribing certain values to the albuminoids and fats, and taking the sum in each case for the value of that particular food. The ratio here adopted, which assumes one pound of albuminoids to be equal to three pounds of fats, is that assumed by prominent German chemists. Taking medium beef at 100, the same weight of milk comes to 23.8; butter, 124; mutton (medium), 86.6; fat pork, 116; smoked beef,

146, and so on. The different samples of fish run from flounders, 65 ; cod, 68 ; shad, 99 ; whitefish, 103, to salmon, 104, while dried cod leads the list at 346.

These figures differ widely from the market values. But we pay for our foods according, not to their value for nourishing our bodies, but to their agreeableness to our palates.

CHEAP VERSUS DEAR FOOD.

Taking the samples of fish at their retail prices in the Middletown markets, the total edible solids in striped bass came to about $2.30 per pound, while in the Connecticut river salmon, whose price—thanks to our Fish Commission—was very low, we bought nutritive material at forty-four cents per pound. The cost of the nutritive material in one sample of halibut was fifty-seven cents, and in the other $1.45 per pound, though both were bought in the same place at the same price, fifteen cents per pound, gross weight.

It makes very little difference to a man with five thousand dollars a year whether he pays twenty-five cents or five dollars a pound for the albuminoids of his food, but it does make a difference to the housewife whose family must live on five hundred dollars a year. And a little definite knowledge of this sort will be of material help to her in furnishing her table economically.

The cook-books and newspapers have occasionally something to say upon these points, but their statements are apt to be as vague and wild as in the lack of authoritative information they might be expected to be.

Of course the nutritive valuations above given are only approximate, since they are made with very imperfect knowledge of either the digestibility of the foods or the influence of palatibility and other factors upon their nutritive value, and also because they are based upon very few analyses. But it is certain that we need to know more about these things, and that such investigations as I have been telling you about may help us toward that knowledge.

Before closing I ought perhaps to refer briefly to the very

widespread but unfounded notion that fish is particularly valuable for brain-food because of its large contents of phosphorus. Suffice it to say that there is no evidence as yet (though we hope to have more data before long) to prove that the flesh of fish is especially richer in phosphorus than other meats, and even if it were so, there is no proof that it would be on that account more valuable for brain-food. The questions of the nourishment of the brain and the sources of intellectual energy are too abstruse for speedy solution in the present condition of our knowledge.

In conclusion I have to say that I should be very sorry to be understood as implying that the facts I have given you exhaust or even begin to cover the subject we have been considering. They are only the very feeble and imperfect beginnings of a kind of investigation which, if sufficiently encouraged and rightly carried on, may hereafter bring knowledge of the greatest value. And let me beg you not to forget that while scientific research does so much to promote our material welfare, its highest value is in what it does for the culture of our minds.

The committee on nominations (Dr. Hudson, chairman) reported that the committee thought the re-nomination of the present officers as good a one as they could make; who were thereupon duly elected. An alteration was made in the Executive Committee, Mr. James Benkard, of New York, being elected in place of Benjamin L. Hewitt; Mr. McGovern, of Brooklyn, in place of Dr. Theodore Gill.

The Secretary, Mr. B. Phillips, in behalf of the officers, returned thanks for the compliment, and said he hoped that they would be able to make arrangements for as interesting a meeting in 1881 as the present one had been.

A vote of thanks was passed by the Association to both Professor Atwater and Dr. Brooks for their very valuable and interesting contributions.

Mr. George S. Page then presented a paper entitled Black Bass Planting—results of their introduction into Maine waters.

Notwithstanding the diffusion of information concerning the results of restocking depleted rivers with salmon and shad; ponds, lakes, and streams, with bass, and brooks with trout, through the medium of the now widely circulated *Forest and Stream*, Chicago *Field*, and *Sea World*, and the Reports of the State and United States Fish Commissioners, the general public still profess great ignorance upon the subject. The press of the country, with few exceptions, fail to promulgate pertinent facts, and the legislatures of most of the states refuse to appropriate other than paltry sums in aid of this important interest.

The chief object of the American Fish Cultural Association is to educate public sentiment by the presentation, annually, of actual results experienced in stocking public waters with food-fish.

Of late the metropolitan press is well represented at our meetings. Liberal space in their thronged columns is given to our deliberations. The papers read are copiously quoted. Editorials are written commendatory of our labors. The Associated Press agents telegraph a synopsis of our proceedings to all parts of the land. The secular and religious press, east, west, north, and south, copy to a greater or less extent from the journals of the metropolis. Surely, in the near future the people will become informed of the really remarkable progress that is being made in the theory and practice of fish-culture, and their representatives in the state and national councils will make liberal appropriations to more rapidly advance the coming day when the most poverty-stricken citizen can procure an abundance of cheap, fresh, preserved, or salted fish-food.

It is a fact well-known to those who have been identified with this comparatively new science that many of the most successful efforts in restocking exhausted waters have been due to private enterprise.

Monuments are erected to military heroes and notable statesmen. Surely the praiseworthy act of the unknown engineer of the Baltimore and Ohio Railroad, who transported in the water-tank of his engine a score of black bass from the waters of the Ohio to the rapids of the Potomac, over twenty years ago, is equally deserving. Look at the results of that philanthropic

seed-sowing. The markets of Washington, Baltimore, Richmond, and other cities, are supplied with the numerous progeny of those few fishes. The members of several angling-clubs find health and recreation in the pursuit of these game-fish. The dealers in fishing-tackle secure greatly increased business from the demand for rods, lines, and flies, especially adapted for their capture.

But the good deed was repeated by some other unknown benefactor of his race. Bass from the Potomac were transported to the Susquehanna and Delaware. They have increased with great rapidity, and the markets of nearly every town and city of the great states of Pennsylvania and New Jersey are abundantly supplied.

It will be admitted by all who are familiar with the recent great popularity of Greenwood Lake as a summer resort, that the chief attraction is found in the black-bass fishing. Thousands of dollars are annually expended there, which but for these fish would flow in other directions.

But I desire to put on record the history of the introduction of black bass into the state of Maine. From the year 1860, in company with friends from other states, I had annually taken large numbers of the famous Rangeley trout, a goodly weight of which were transported out of the state of Maine, to become the witnesses of what Maine alone produced, and to serve as advertisements in drawing others to that region. In 1867 I brought to New York forty-three Rangeley trout, weighing from two to ten pounds, averaging five pounds each ; the two large t, male and female, respectively weighed ten and eight and a quarter pounds, were alive.

The ten-pound trout is now exposed in a glass case at Mr. Blackford's, in Fulton Market.

In 1868 I brought home in the same car thirty-three trout, from one and a half to two pounds each.

These experiences determined me to attempt to transport black bass to the Pine Tree State. Certainly some return in *fish kind* was due.

The following summer, accompanied by four friends, we took

the "Mary Powell," for Newburg, by invitation of Walter Brown, Esq., to fish his private pond for black bass. At daybreak we fairly surrounded the miniature lake, scarcely a quarter acre in extent; indeed we could readily cover the centre four feet of water with our flies. But the bass were there, and this was our first introduction to them. It is needless to say that we were highly gratified by their evident pleasure in making our acquaintance. So eager were they to meet us that some went whizzing by our ears and lodged in the long damp grass a hundred feet from their natural home. By six o'clock we had thirty-five sprightly bass, from a half pound to one pound each, in the car A team in waiting took them to the "Mary Powell" by seven A. M. At ten A. M. they were on the Fall River pier, with the Croton hose turned on. At five P. M. I took them in charge. One of the deck-hands gave them fresh air occasionally by the aid of an air-pump attached to the car. At seven A. M. the next day we reached Boston, and an express wagon conveyed them to the Eastern Railroad, the train leaving at eight A. M. They required much less attention than brook-trout. Aeration once an hour, and an occasional bucket of water, sufficed to keep them right-side up.

At three P. M. the train arrived at Monmouth, Maine, the station adjoining Crochnewaga Pond, four miles long, and sixteen bass were liberated here. At Winthrop, the next station, the car was taken to the famous Cobbossecontee Pond, one of a chain of ponds, or rather lakes, twenty miles in extent. The rest of the fish were deposited here, all in good condition. They did not move off at first, but seemed to be examining the immediate surroundings of their new home, five hundred miles from Newburg. One by one they slowly swam off into deep water, and I returned my fish-car to the steam-car, mentally congratulating myself that at least I had endeavored to make some return for the many trout I had captured, and the glorious sport I had experienced during ten years at Rangeley. The expenses were under $25.

Ten years have elapsed since the first black bass were deposited in Maine waters. Now mark the results.

I hold in my hand a letter from Mr. Henry O. Stanley, for

several years Commissioner of Fisheries of Maine, dated Dixfield, Maine, March 15th, 1880. In answer to my queries he writes:

The stocking of Maine waters with black bass, for the first time, by yourself, in 1869, has proved a great success. There are probably fifty ponds in the state that furnish good bass fishing, and many more where they are just beginning to be taken. I have found small bass quite abundant the third year from the time a dozen large ones were deposited.

With regard to their effect on pickerel: in every instance the latter have decreased, leaving the former masters of the situation, with a decided improvement upon the morals of the other denizens of the domain. We do not introduce them in waters frequented by trout, although I do not think they would be as disastrous as pickerel in destroying the trout.

The domestic qualities of the bass are admirable, and might well be taken as an example by some members of the human family. They always look after their little ones, and woe to any pickerel in a sucker's clothing that loiters around the family rocks.

Long may he live in Maine waters, that is, if he retains his present commendable characteristics, and he does not undertake to count out the salmon and the trout, as some human gar-fish and suckers in Maine have undertaken to—to—to—well—well—I'm hooked on to another line of thought. Please pardon me, and believe me,

Ever gratefully yours,

HENRY O. STANLEY.

GEO. SHEPARD PAGE,

Stanley, N. J., March 29th, 1880.

MR. ANNIN then exhibited the model of an outlet for a pond, and made the following remarks:

The great objection made by many persons desiring trout in their private pond or brook (when all other points are satisfactorily settled) is, that if they put in the small-fry they are afraid they will never see any good results; that the fry will all be

washed away or devoured by the larger fish, or unless fed they will starve.

Questions on this point, answered by fish-culturists in the majority of cases, seem to give but very little satisfaction to the inquirer, for by a word, after you supposed that matter all settled, you will see he is troubled about it yet.

For the benefit of all such I would say, if you have put fry into your brook, don't worry; go to bed and rest, feeling you have done your part. Rest assured that nature and their natural instincts will bring them through all right.

In ninety-nine cases out of a hundred the young fry turned loose in stream or pond, and allowed to take care of themselves, will bring forth at the end of the year a much larger per cent. and better fish in every respect than can be produced by confinement and artificial food.

I have found that the male trout, after three or four years of confinement, becomes almost barren; that is, the yearly supply of milt becomes very limited. One good wild-trout will impregnate more eggs than a half dozen domesticated ones.

In a liquid form, resembling milk (see male and female specimens).

Information is often asked as to which is the best kind of a screen for the outlet of a pond.

I have been troubled very seriously in the fall and early winter with leaves, etc., floating down against the screens and choking them up, causing an overflow of the pond.

The trouble is not so much in the day time, when we can watch the ponds, but during a windy night, after the ground is covered with leaves; in the morning you will often find your pond full and running over, and if it contains yearling fish, or smaller, you will find many have escaped or lay on the bank dead.

I had suffered in this way several times, when I thought some plan might be hit upon so that the difficulty would be remedied, and so made something like the model, which you will see will not allow the surface-water or leaves on the surface to clog the outlet during one night or more. After putting this in use the

trouble was done away with at once. I have seen the same principle in use before.

MR. GEO. CHAPPELL then brought forward the subject of the protection of lobsters.

A letter was read from MR. MIDDLETON, which was as follows:

NEW YORK, March 31st, 1880.

MR. GEO. CHAPPELL:

DEAR SIR—As a member of the Association now in session, I would request you to lay the enclosed copy of the Massachusetts lobster law before it for consideration.

It would seem only necessary to refer to the gradual destruction of lobsters to have the subject receive the earnest attention to which its importance entitles it. The law, if enacted, can work no hardship to the citizens of New York, and will only be in harmony with the laws of the states of Massachusetts and Maine, and prevent the selling in our markets a poor article, which is really contraband, having been caught in violation of law.

Hoping this will receive your attention, and meet the views of dealers generally,

I am yours, etc.,

GEO. W. MIDDLETON.

AN ACT,

PROVIDING FOR THE PRESERVATION OF LOBSTERS.

Be it enacted by the Senate aud Assembly, in Legislature assembled, and by the authority of the same, as follows:

§ 1. Whoever sells, or offers for sale, or has in his or her possession, with intent to sell, either directly or indirectly, any lobsters less than ten and one-half inches (10 1-2) in length, measuring from one extreme of the body to the other, exclusive of claws or feelers, shall for every such lobster be fined five dollars (should be $10).

§ 2. All forfeitures accruing under this act shall be paid, one-half to the person making the complaint, and one-half to the city or town where the offence is committed.

§ 3. This act shall take effect on the first day of May, 1880.

The views of Mr. J. M. Johnson, of Boston, who has paid attention to this subject for a number of years, was then cited.

By a vote of the Association the Executive Committee were called upon to see that a law be passed in New York to limit the size of the lobsters sent into the market to ten and a half inches.

Mr. Page made a motion that the Committee present the bill to the Legislature at once, which was carried.

A vote of thanks was then offered to the Fulton Market Fishmongers Association for the use of their room.

The meeting then adjourned to next year, the date to be fixed at some future period by the Executive Committee.

CONSTITUTION.

ARTICLE I.—Name and Objects.

The name of this Society shall be "The American Fish Cultural Association." Its objects shall be to promote the cause of fish culture; to gather and diffuse information bearing upon its practical success; the interchange of friendly feeling and intercourse among the members of the Association; the uniting and encouraging of the individual interests of Fish Culturists, and the treating of all questions regrading fish, of a scientific and economic character.

ARTICLE II.—Members.

Any person shall upon a two-thirds vote of the Society, and a payment of three dollars, be considered a member of the Association, after signing the Constitution. The annual dues shall be $3.00.

ARTICLE III.—Officers.

The officers of the Association shall be a President, a Vice-President, a Corresponding Secretary, a Recording Secretary, a Treasurer, and an Executive Committee of seven members, and shall be elected annually by a majority of votes; vacancies occurring during the year may be filled by the President.

ARTICLE IV.—Meetings.

The regular meetings of the Association shall be held once a year, the time and place being decided upon at the previous meeting.

ARTICLE V.—Changing the Constitution.

The Constitution of the Society may be amended, altered, or repealed, by a two-thirds vote of the members present at any regular meeting.

TREASURER'S REPORT.

DR. *American Fish Cultural Association in account with Eugene G. Blackford.* CR.

1879.				
	To balance as per last report,	$232 25	By membership dues collected, - -	$198 00
Feb. 28th,	To stationery at meeting, -	65	Balance due Treasurer, - - -	131 70
March 5th,	To messenger, - -	1 00		
" 7th,	To printing invitation circular,	4 50		
	To printing report of meeting,	90 45		
	To wrappers, - - -	85		
		$329 70		$329 70

New York, March 30th, 1880.

MEMBERS

OF THE

American Fish Cultural Association.

Ambler, Andrew S., Danbury, Conn.
Andariese, C. H., Bedford Avenue, Brooklyn, N. Y.
Andersen, E. J., Trenton, N. J.
Anderson, A. A., Bloomsbury, N. J.
Annin, James, Jr., Caledonia, N. Y.
Baird, Spencer F., U. S. Commissioner of Fish and Fisheries, Washington, D. C.
Benjamin, Pulaski, Fulton Market, New York.
Benkard, James, Union Club, New York.
Betteman, C. G., Bergen Opzoon, Holland.
Blackford, E. G., Fulton Market, New York City.
Boardman, H. G.
Boyer, B. Frank, Reading, Pa.
Bradley, Richards, Brattleboro, Vt.
Belmont, Perry, 19 Nassau Street, New York.
Bogert, Harris, Central Market, New York.
Breese, W. L., Union Club, New York.
Brewer, J. D., Muncey, Pa.
Bridgman, J. D., Bellows Falls, Vt.
Brush, G. H., Norwalk, Conn.
Burges, Arnold, West Meriden, Conn.
Bush, John T., Niagara Falls, Canada.
Campbell, Anthony, Brooklyn, N. Y.
Carey, H. T., 29 New Street, New York.
Carman, G., Fulton Market, New York.
Chandler, F. J., Alstead, N. H.
Chappel, George, Fulton Market, New York.
Chase, Oren M., Detroit, Michigan.

Chrysler, Gifford W., Kinderhook, N. Y.
Clapham, Thomas, Roslyn, L. I.
Clapp, A. T., Sunbury, Pa.
Clift, William, Mystic Bridge, Conn.
Colburn, Charles S., Pittsfield, Vt.
Collins, A. S., Caledonia, N. Y.
Comstock, Oscar, Fulton Market, New York.
Conklin, William A., Central Park, New York.
Conselyea, Andrew, Springfield, Long Island, N. Y.
Coup, W. C., New York City.
Crocker, A. B., Norway, Maine.
Crosby, Henry F., 18 Cliff Street, New York.
Cox, Townsend, 50 Exchange Place, New York.
Develin, John E., 155 Broadway, New York.
Dieckerman, George H., New Hampton, N. H.
Dwight, H. P., Toronto, Ontario.
Edmunds, M. C., Weston, Vt.
Evarts, Charles B., Windsor, Vt.
Farnham, C. H., Milton, N. Y.
Farrar, Benjamin, St. Louis, Mo.
Fearing, C. I., 30 Broad Street, New York.
Ferguson, T. B., Baltimore, Md.
Feuardent, G. L., 30 Lafayette Place, New York.
Foord, John, *New York Times*, New York.
Fliess, W. M., 47 Broadway, New York.
French, Asa B., South Braintree, Mass.
Gilbert, E., 273 Pearl Street, New York.
Gill, Theodore, Washington, D. C.
Goode, G. Browne, Washington, D. C.
Gray, H. W., Union Club, New York.
Green, Seth, Rochester, N. Y.
Hall, G. W., 16 West 24th Street, New York.
Hallock, Charles, New York City.
Haley, Albert, Fulton Market, New York.
Haley, Caleb, Fulton Market, New York.
Habershaw, William M., 159 Front Street, New York.
Habershaw, Frederick, 6 West 48th Street, New York.
Harris, J. N., Fulton Market, New York.
Harris, W. C., 50 North 7th Street, Philadelphia.
Hessel, Rudolph, Washington, D. C.
Hewitt, C. L., Holidaysburg, Pa.
Heywood, Levi, Gardner, Mass.

Hilmers, H. C., 63 Wall Street, New York.
Holberton, W., 65 Fulton Street, New York.
Holley, W. P., Katonah, N. Y.
Hopson, W. B., *Sea World*, New Haven, Conn.
Hollins, H. B., Union Club, New York.
Hooper, H. H., Charleston, N. H.
Hudson, William M., Hartford, Conn.
Hunt, J. Daggett, Summit, N. J.
Hunt, N. W., 70 Lee Avenue, Williamsburgh, L. I.
Hunt, Luther B.
Huntington, Dr., Watertown, N. Y.
Hutchinson, Charles, Utica, N. Y.
Janney, J. L., Newton, Bucks County, Pa.
Jerome, George H., Niles, Michigan.
Jewett, George, Fitchburg, Mass.
Johnson, S. M., Warren Bridge, N. Y.
Jones, Gilbert E., *New York Times* office, New York.
Kelley, P., 346 Sixth Avenue, New York,
Kent, Alexander, Baltimore, Md.
Kingsbury, Dr. C. A., 1119 Walnut Street, Philadelphia.
Kimball, Robert J., 4 Exchange Court, New York.
King, O, K., Union Club, New York.
Laird, James H., 252 Sixth Avenue, New York.
Lamberton, Alexander B., Rochester, N. Y.
Lamphear, George, Fulton Market, New York,
Lawrence, G. N., 45 East 21st Street, N. Y.
Lawrence, F. C., Union Club, New York.
Lawrence, Alfred N., 172 Pearl Street, New York,
Lawrence, A. G., Union Club, New York,
Ledyard, L. W., Cazenovia, N. Y.
Lees, Edward M., Westport, Conn,
Leeds, Theodore E., 102 Broadway, New York,
Lewis, C. A., Washington Market, New York.
Lowrey, G. P., Tarrytown, N. Y.
Lowrey, J. A., Union Club, New York.
Lyman, Theodore, Brookline, Mass.
Maginnis, Arthur, Stanhope, Pa.
Malcomson, A. Bell, Jr., New York City.
Mann, J. F., Lewiston, Pa.
Mather, Frederick, Newark, N. J.
Mathews, W. C., Toronto, Ontario.

Mallory, Charles, foot Burling Slip, New York.
McGovern, H. D., Brooklyn, N. Y.
Middleton, W., Fulton Market, New York.
Miller, S. B., Fulton Market, New York.
Miller, Ernest, Fulton Market, New York.
Milner, James W., Washington, D. C.
Morford, Theodore, Newton, N. J.
Morgan, John B., 85 Broadway, Brooklyn, N. Y.
Mull, B. E., Fulton Market, New York.
Mullaly, John, 114 White Street, New York.
Munn, H. N., Union Club, New York.
Neidlinger, Phil., 27 Beekman St., New York City.
Newell, W. H., San Francisco, Cal.
Nicholas, N. J., Union Club, New York.
Page, George S., 10 Warren St., New York City.
Parker, Wilbur F., Meriden, Conn.
Paxton, E. B., Detroit, Mich.
Phillips, B., 41 Troy Ave., Brooklyn, N. Y.
Porter, B. B., Colorado.
Post, W., Knickerbocker Club, New York.
Price, Rodman M., Ramsey, New Jersey.
Raynor, William P., 115 William Street, New York.
Redding, B. B., San Francisco, Cal.
Redding, George H., Stamford, Conn.
Redmond, R., 113 Franklin Street, New York.
Reeder, H. J., Easton, Pa.
Reinecke, Theodore, Box 1651, New York.
Reynal, J., 84 White Street, New York.
Reynolds, J. B,, *Forest and Stream*, New York.
Richmond, W. H., Scranton, Pa.
Ricardo, George, 195 Water Street, New York.
Roach, John C., Brooklyn, New York,
Robinson, R. E.
Rockford, A. P., Salt Lake City, Utah.
Rogers, A. L., Fulton Market, New York.
Rogers, H. M., Fulton Market, New York.
Roosevelt, Hon. Robert B., 76 Chambers Street, N.Y.
Rupe, A. C., New York.
Saltus, Nicholas, New York City.
Sherman, R. U., New Hartford, Oneida Co., N. Y.
Shultz, Theodore, New York City.
Simonton, J. W., 195 Broadway, New York.

Smith, Greene, Peterboro, Va.
Sprout, A. B., Muncey, Pa.
Steers, Henry, 10 East 38th Street, New York.
Sterling, Dr. E., Cleveland, Ohio.
Stetson, J. A., Cleveland, Ohio.
Stewart, T. B., 23rd Street and Sixth Avenue, N.Y.
Stillwell, E. M., Bangor, Maine.
Stone, Livingston, Charlestown, N. H.
Stone, Summer R., 46 Exchange Place, New York.
Stoughton, E. W., Windsor, Vt.
Stuart, Robert L., 154 5th Avenue, New York.
Swartz, William H., Point Pleasant, Bucks Co., Pa.
Tagg, Henry, Philadelphia, Pa.
Townsend, Isaac, Union Club, New York.
Townsend, Thomas D., Toronto, Ontario.
Thomas, H. H., Randolph, N. Y.
Thompson, H. H., 12 East 46th Street, New York.
Thompson, John H., New Bedford, Mass.
Thompson, J. S. W., 31 Pearl Street, New York.
Trimble, Dr. J. P., 221 East 12th Street, New York,
Van Brunt, C., 121 Chambers Street, New York.
Van Cleve, Joseph, Newark, N. J.
Van Siclen, G. W., 99 Nassau Street, New York.
Van Wyck, J. T., New York City.
Ward, George E., 43 South St., New York City.
Weber, Samuel, Manchester, N. H.
Weeks, Seth, Corry, Erie Co.. Pa.
West, Benjamin, New York City.
Whitcher, W. F., Ottawa, Ontario, Canada.
Whitcomb, T., Springfield, Vt.
Whitehead, C. E., 61 Wall Street, New York.
Whitin, Edward, Whitinsville, Mass.
Wilbur, E. R., 40 Fulton St., New York.
Wilmot, Samuel, Newcastle, Ontario, Canada.
Willets, J. C., Skeaneatles, N. Y.
Woods, Israel, Fulton Market, New York.
Worrall, James, Harrisburg, Pa.
Wiman, Erastus, 312 Broadway, New York.
Whipple, John, Union Club, New York.
Wharton, W. F., Union Club, New York.
Worthington, H. R., 239 Broadway, New York.
Yarrow, Dr. H. C., U. S. A., Washington D. C.

(*While this report was going through the press, the Executive Committee, as instructed by the Association, lost no time in presenting an act limiting the size of the Lobsters, the same as printed in this report, to the attention of the Legislature at Albany. The Executive Committee take great pleasure in announcing that this act limiting the size of the Lobster, has since June 1st, become a law of the State of New York.*)

May 31st, 1880.

SIÈGE DE LA SOC

HÔTEL LAURAGUA

RUE DE LILLE,

PARIS

LA SALLE DE LECT

ET LE BUREAU DE L'

SONT OUVERTS DE 10 A

Les lettres et paquets doivent êtr

EXTRAITS

DES STATUTS ET RÈGI

Le but de la Société est d
1° A l'introduction, à l'acc
à la domestication des e
maux utiles et d'ornemen
2° Au perfectionnement et à
cation des races nonvel
duites ou domestiquées.
3° A l'introduction et la pr
végétaux utiles.

Le nombre des membres
est illimité.

Les Français et les étran
en faire partie.

Pour faire partie de la S
vra être présenté par un m
taire, qui signera la proposit
tation.

Chaque membre paye :

1° Un droit d'entrée de 1

2° Une cotisation annue
ou 250 fr. une fois payés

La cotisation est due et
partir du 1er janvier.

Chaque membre ayant pay
recevra à son choix :

OU une carte qui lui perm
au Jardin d'Acclimatation et
avec lui une autre personne

OU une carte personnelle
d'entrée au Jardin d'Acclim
pourra disposer à son gré.

Les membres qui ne voud
de ces entrées peuvent les

Les sociétaires auront le
au Jardin d'Acclimatation le
leur famille directe (mères,
non mariées, et fils mineu
5 francs par personne et p

Il est accordé aux mem
de 10 °/. sur le prix des v
vement personnelles) qui le
au Jardin d'Acclimatation.

Le Recueil périodique d
la Société est gratuitem
chaque membre, à partir d
l'année où il a été admis.

La Société confie des
plantes en cheptel. Pour ob
tels il faut :

1° Être membre de la S

2° Justifier qu'on est en
ger et de soigner convenal
maux et de cultiver les pl
cernement ;

3° S'engager à rendre
année, avant le premier
cembre, des résultats bo
obtenus, et des observatio

4° S'engager à partager
les produits obtenus.

M. Fred

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dear
assu
thans

SIÈGE DE LA SOCIÉTÉ
HÔTEL LAURAGUAIS
RUE DE LILLE, N° 19
PARIS

LA SALLE DE LECTURE
ET LE BUREAU DE L'AGENCE
SONT OUVERTS DE 10 A 4 H.

Les lettres et paquets doivent être affranchis

EXTRAITS
DES STATUTS ET RÈGLEMENTS

Le but de la Société est de concourir :
1° A l'introduction, à l'acclimatation et à la domestication des espèces d'animaux utiles et d'ornement ;
2° Au perfectionnement et à la multiplication des races nouvellement introduites ou domestiquées.
3° A l'introduction et la propagation des végétaux utiles.

Le nombre des membres de la Société est illimité.

Les Français et les étrangers peuvent en faire partie.

Pour faire partie de la Société, on devra être présenté par un membre Sociétaire, qui signera la proposition de présentation.

Chaque membre paye :
1° Un droit d'entrée de 10 fr.;
2° Une cotisation annuelle de 25 fr., ou 250 fr. une fois payés

La cotisation est due et se perçoit à partir du 1er janvier.

Chaque membre ayant payé sa cotisation recevra à son choix :

OU une carte qui lui permettra d'entrer au Jardin d'Acclimatation et de faire entrer avec lui une autre personne ;

OU une carte personnelle et douze billets d'entrée au Jardin d'Acclimatation dont il pourra disposer à son gré.

Les membres qui ne voudraient pas user de ces entrées peuvent les déléguer.

Les sociétaires auront le droit d'abonner au Jardin d'Acclimatation les membres de leur famille directe (mères, sœurs et filles non mariées, et fils mineurs) à raison de 5 francs par personne et par an.

Il est accordé aux membres un rabais de 10 °/o sur le prix des ventes (exclusivement personnelles) qui leur seront faites au Jardin d'Acclimatation.

Le Recueil périodique des travaux de la Société est gratuitement délivré à chaque membre, à partir du 1er janvier de l'année où il a été admis.

La Société confie des animaux et des plantes en cheptel. Pour obtenir ces cheptels il faut :

1° Être membre de la Société ;

2° Justifier qu'on est en mesure de loger et de soigner convenablement les animaux et de cultiver les plantes avec discernement ;

3° S'engager à rendre compte, chaque année, avant le premier du mois de décembre, des résultats **bons ou mauvais** obtenus, et des observations recueillies ;

4° S'engager à partager avec la Société les produits obtenus.

SOCIÉTÉ D'ACCLIMATATION

FONDÉE LE 10 FÉVRIER 1854

RECONNUE ÉTABLISSEMENT D'UTILITÉ PUBLIQUE
PAR DÉCRET DU 26 FÉVRIER 1855

Paris le 14 9bre 1878

Dear Sir!

I have the pleasure to inform you that we have received the Salmon eggs in most splendid condition.

This excellent result is evidently owed to your skilful care, of whom we are very much obliged.

Almost all these eggs are now hatched, the fry is very lively, and it seems to me

M. Fred Mather.

certain they will thrive in the best way.

In good time, they will be turned loose in various streams, especially in Rhône, Hérault and Yonne, by the care of our society and of "Ingénieurs des Ponts et Chaussées,"

Again praying you, dear Sir, to receive the assurance of all our thankfulness,

I remain
Very truly yours
Raveret Wattel
Secretary

in they will thrive
the best may.

In good time, they
be turned loose in
es streams, especially
Rhône, Hérault and
ne, by the care of
Society and of "Ingénieurs
Ponts et Chaussées"

Again praying you
Sir, to receive the
ance of all our
Gratitudes,

I remain
Very truly yours

Raverat Wattel

Secretary

LA SALLE DE LECTURE

ET LE BUREAU DE L'AGENCE

SONT OUVERTS DE 10 à 4 HEURES

Les lettres et paquets doivent être affranchis

EXTRAITS

courant de l'année suivant la séance où elles auraient dû être remises à leurs titulaires seront refrappées. Toutefois il pourra en être remis un nouvel exemplaire au lauréat, mais à ses frais.

Les personnes qui croient avoir droit aux récompenses ou encouragements de la Société devront envoyer *franco*, avant le 1er *décembre*, un rapport circonstancié sur les résultats qu'elles auront obtenus. Elles devront mettre la Société en mesure de constater ces résultats, soit par elle-même, soit par l'intermédiaire des Sociétés affiliées ou agrégées ou des Délégués ; en cas d'impossibilité, l'envoi de procès-verbaux, *certificats légalisés* ou autres documents authentiques, propres à tenir lieu d'un examen direct, sera toujours exigible.

Lorsque les prix devront être obtenus à la suite de résultats annuels, les faits devront être *légalement constatés chaque année.*

SOCIÉTÉ D'ACCLIMATATION

FONDÉE LE 10 FÉVRIER 1854

RECONNUE ÉTABLISSEMENT D'UTILITÉ PUBLIQUE

par décret du 26 février 1855

Siége de la Société : RUE DE LILLE, 19, A PARIS (HÔTEL LAURAGUAIS)

A Geoffroy Saint-Hilaire

MONSIEUR Frédéric Mathet.

Des places particulières sont réservées aux lauréats.

Cette lettre servira de carte d'entrée, aussi bien que les cartes spéciales qui sont distribuées au siége de la Société, rue de Lille, 19, de 10 à 4 heures.

LA SALLE DE LECTURE

ET LE BUREAU DE L'AGENCE

SONT OUVERTS DE 10 À 4 HEURES

Les lettres et paquets doivent être affranchis

EXTRAITS

DES STATUTS ET RÈGLEMENTS

Les Français et les Étrangers, les membres de la Société et les personnes qui n'en font pas partie peuvent également obtenir ces récompenses et encouragements.

Les résultats que la Société prend en considération et qu'elle récompense, s'il y a lieu, sont de trois ordres :

1° Introduction d'espèces, races ou variétés utiles, soit d'animaux, soit de végétaux.

2° Acclimatation, domestication, propagation, amélioration d'espèces, races ou variétés animales ou végétales, soit susceptibles d'emplois utiles, soit même simplement accessoires ou d'agrément.

3° Emploi agricole, industriel, médicinal ou autre, d'animaux ou de végétaux récemment introduits, acclimatés ou propagés, ou de leurs produits.

Les récompenses et encouragements que décerne la Société sont, chaque année :

1° S'il y a lieu, le titre de membre honoraire. La Société, réunie en séance, sur la proposition du Bureau, pourra conférer ce titre aux personnes qui, par leurs voyages ou par leur séjour à l'étranger, auront rendu d'importants services.

Les membres honoraires, pendant leur séjour à Paris, jouiront de tous les droits des membres titulaires. Leur nombre ne pourra pas dépasser le quart des membres titulaires.

Un membre honoraire qui serait resté pendant cinq ans sans avoir entretenu aucune relation avec la Société pourrait être déclaré démissionnaire.

2° Une ou plusieurs médailles d'or, grand module, d'une valeur intrinsèque de 400 fr. (Médaille hors classe.)

3° Une ou plusieurs grandes médailles d'argent à l'effigie d'Isidore Geoffroy Saint-Hilaire. (Médaille hors classe.)

4° Des médailles de première classe, d'argent.

5° Des médailles de seconde classe, de bronze.

Chaque médaille portera gravés le nom du lauréat ainsi que la date et l'objet de la récompense accordée par la Société.

6° Des mentions honorables.

7° Des récompenses pécuniaires. Ces encouragements sont particulièrement destinés à être donnés aux gens à gages qui auront concouru, par leurs soins, au but que poursuit la Société.

La Société a en outre proposé, sur des sujets spécialement désignés, des prix extraordinaires, consistant en des médailles ou prix en argent.

D'autres prix ont été également fondés à diverses reprises par différentes personnes.

Les prix peuvent être convertis, au choix du lauréat, en médaille d'or de même valeur.

Deux prix différents ne peuvent être décernés à un lauréat pour le même objet.

Les médailles non réclamées dans le courant de l'année suivant la séance où elles auraient dû être remises à leurs titulaires seront refrappées. Toutefois il pourra en être remis un nouvel exemplaire au lauréat, mais à ses frais.

— Les personnes qui croient avoir droit aux récompenses ou encouragements de la Société devront envoyer *franco*, avant le 1er *décembre*, un rapport circonstancié sur les résultats qu'elles auront obtenus. Elles devront mettre la Société en mesure de constater ces résultats, soit par elle-même, soit par l'intermédiaire des Sociétés affiliées ou agrégées ou des Délégués ; en cas d'impossibilité, l'envoi de procès-verbaux, *certificats légalisés* ou autres documents authentiques, propres à tenir lieu d'un examen direct, sera toujours exigible.

Lorsque les prix devront être obtenus à la suite de résultats annuels, les faits devront être *légalement constatés chaque année.*

SOCIÉTÉ D'ACCLIMATATION

FONDÉE LE 10 FÉVRIER 1854

RECONNUE ÉTABLISSEMENT D'UTILITÉ PUBLIQUE

par décret du 26 février 1855

SIÉGE DE LA SOCIÉTÉ : RUE DE LILLE, 19, A PARIS (HÔTEL LAURAGUAIS)

Paris, 20 Mai 1879.

MONSIEUR,

J'ai l'honneur de vous informer que la Société d'Acclimatation, sur la proposition de sa Commission des Récompenses, vous a décerné une Médaille de 1re classe (Soins donnés aux envois de poissons faits à la Société)

Cette Médaille vous sera remise dans la séance publique annuelle qui aura lieu le Vendredi 30 Mai 1879, à 2 heures précises au Vaudeville

Vous êtes instamment prié, Monsieur, de vouloir bien me faire connaître, par retour du courrier, s'il vous sera possible de venir retirer cette récompense ou si vous vous ferez représenter ; dans ce dernier cas, veuillez me donner le nom et l'adresse de la personne chargée de retirer votre diplôme, afin que je lui fasse parvenir une lettre d'invitation.

Veuillez agréer, Monsieur, l'assurance de ma considération la plus distinguée.

Le Secrétaire Général,

Geoffroy Saint-Hilaire

MONSIEUR Frédéric Mathet

Des places particulières sont réservées aux lauréats.

Cette lettre servira de carte d'entrée, aussi bien que les cartes spéciales qui sont distribuées au siége de la Société, rue de Lille, 19, de 10 à 4 heures.

Woods Holl,

Jan. 31st 1887

My Dear Mr. Matter.

I read with much pleasure, an account of my delightful visit to Cold Spring Harbor, which has appeared in the recent issue of your "Forest & Stream", & in so doing I found a slight mistake in regard to the occurence of <u>red-snapper</u> in our water. I meant by that name a Japanese equivalent, & not the identical fish to your <u>Lutjanus</u> blackfordii. For correctly speaking, the fish

I referred to, is *Pagurus turnip*
Tem & Schleg., called "Tai" by the
natives

I changed my plan a
little & came here first. I
will go from here to Boston
& after staying there a week, I
will go to Gloucester.

Please give my best
regards to Mrs. Mather & to Mr
Blackford.

Truly yours
L. Stejneger

at once without stop
in New York as the season
is almost coming to end.

I shall have the pleasure
of seeing you however, in
Washington at the time of
your association meeting

Give my best regards
to Mrs. Mather & Mr. Blackford.

Yours truly
R. E. Peary

N. Webster, Proprietor.
H. A. Tarr, Manager.

ESTABLISHED 1835.

Stable connected with the House.

WEBSTER HOUSE,

NO. 9 PLEASANT STREET,

NEXT BUILDING TO CUSTOM HOUSE AND POST OFFICE.

Gloucester, Mass., Apr. 23rd 1887

Dear Sir.

I have been studying here, during the past two months, every thing connected with cod fisheries. I once took a trip on board the sch. Ly, ancient, & went out in a dory to see the trawling. My notebooks, & portfolio are quite well filled, & got a many practical points which can be applied to the fisheries of my country with great benefit.

I intended to go from here to New York, & remain there until the tournament gave

spoke of, but now it became necessary for me to sacrifice that pleasure. I learnt lately that the only chance of seeing the method of hauling seine, which I am very anxious to do, is to visit a Shad fishing station in North Carolina, & consequently I concluded to go there at once without stopping in New York as the season is almost coming to end.

I shall have the pleasure of seeing you, however, in Washington at the time of your association meeting.

Give my best regards to Mrs. Mather & Mr. Blackford.

Yours truly,

S. F. B.

spoke of, but now it became necessary for me to sacrifice that pleasure. I learnt lately that the only chance of seeing the method of hauling seine, which I am very anxious to do, is to visit a Shad fishing station in North Carolina, & consequently I concluded to go there.

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The question of giving some one else a chance

N-ch. 26.

HOKUSUI KYŌKWAI,

(Northern Fisheries Society.)

SAPPORO, JAPAN.

K. Ito,
President.

Sapporo 25th 1888

My Dear Mr. Shatter

Your favor of Feb 8th I have received & I am very glad to learn that you have now a new hatchery & are carrying on hatchery works in a larger scale.

I have just finished my report, & I am now making preparation for different field works for the coming season.

I recollect with much pleasure my visit at your pleasant home, & I hope in some future years to be able to visit it again; and at the same time I hope that some day in future you may visit our country & meet you here in my own home.

I am regularly receiving your Forest & Stream. I find it very interesting paper & have taken liberty of publishing translated extract from it in our society's report.

I think you have noticed that the portrait of Prof. Goode in the Report is what was copied by a native artist from the very excellent one appeared in the Forest & Stream.

I am sorry to [illegible] that [illegible] I will [illegible] able to work something about our fish culture for the Forest & Stream. I would like very much that you will contribute some articles upon the importance of fish culture for our society, as I am well aware that it will be read with much pleasure by all members, & will have great influence in [illegible] public into for fish culture.

Please give my best regards to Mrs. Mather. My wife also send her compliments to you &c.

Yours truly

N. Ito.

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N. Ito.

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K. Ito,
President.

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HOKUSUI KYŌKWAI,

(Northern Fisheries Society.)

SAPPORO, JAPAN.

K. Ito,
President.

Tomakomai
May 19th 1888

Dear Sir:

I have been travelling along the coast since the last month, & your letter enquiring the name of corresponding member of our society found me at last in this place & I have answered it by today's mail. I am here superintending the hanging of a Purse seine which I am going to make trial of some times during the coming month. I must stay here about a week more, & then I will go to Hakodate

to order some American Dories, & after
that I will return to Sapporo to obtain
an appropriation to start a Salmon
hatchery. I will come to this
place in the latter part of the next
month & expect to make a big haul
of "Iwashi" (Small herring) Fishe
of this place is very much excited
about the purse seine, & if the trial
will be successful, they will all u
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a trial.

Yours truly

K. Ito.

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K. Ito.

STATE OF CONNECTICUT.

FISH COMMISSION.

COMMISSIONERS.
WM. M. HUDSON, *Hartford.*
ROBERT G. PIKE, *Middletown.*
JAS. A. BILL *Lyme.*

[illegible] Dec 26th 1888

real fun and enjoyment out of this fish business than you and I?

Seriously speaking, next year will complete my twentieth (20th) consecutive year as Fish Commissioner, and I am considering the question of giving some one else a chance

W. H. H.

STATE OF CONNECTICUT.

FISH COMMISSION.

COMMISSIONERS.
WM. M. HUDSON, *Hartford.*
ROBERT G. PIKE, *Middletown.*
JAS. A. BILL *Lyme.*

Hartford, Conn., Aug 26th 1888

My dear Mather

Your letter of the 20th lies before me. I am something in the spirit of it myself. Now that Seth Green is dead, and Bob Roosevelt has become minister to the Hague, and married Mrs Fortescue, there is nothing left for you and me to do but go to Philadelphia, have a farewell spree, resign and quit.

Yours Fraternally
Wm M. Hudson

P. S. Are there any two of them, all things considered, that have had more real fun and enjoyment out of this fish business than you and I?
Seriously speaking, next year will complete my twentieth (20th) consecutive year as fish commissioner, and I am considering the question of giving some one else a chance
W. M. H.

TRANSACTIONS

—OF THE—

AMERICAN FISH CULTURAL ASSOCIATION.

Tenth Annual Meeting,

Held at the Directors' Rooms of the Fulton Market Fish-Mongers' Association, in the City of New York.

March 30th and 31st, 1881.

New York.

1881.

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New York City.

GEO. SHEPARD PAGE, - - - VICE-PRESIDENT.
New York City.

EUGENE G. BLACKFORD, - - TREASURER.
New York City.

BARNET PHILLIPS, - CORRESPONDING SECRETARY.
Brooklyn, N. Y.

JAMES ANNIN, JR., - - RECORDING SECRETARY.
Caledonia, N. Y.

EXECUTIVE COMMITTEE.

FRED. MATHER, - - - *Forest and Stream.*

G. BROWNE GOODE, - - *Washington, D. C.*

SAMUEL WILMOT, - - - *Ottawa, Ont.*

BENJAMIN WEST, - - - *New York City.*

THOMAS B. FERGUSON, - - - *Baltimore Md.*

JAMES BENKARD, - - - *New York City.*

JOHN B. MORGAN, - - - *Brooklyn, N. Y.*

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TENTH ANNUAL MEETING

—OF—

THE FISH CULTURAL ASSOCIATION.

WEDNESDAY, March 30th, 1881.

THE meeting was called to order in the Director's Room of the Fulton Market Fish-Mongers' Association, in the City of New York, by the President, Hon. ROBERT B. ROOSEVELT.

The Secretary read the minutes of the last meeting, which were approved.

Mr. MATHER then proposed an amendment to the Constitution to permit honorary members to be elected by a two-thirds vote, the same to be added to the Constitution as part of Article II, relative to members, and to read as follows: "Any person shall, upon a two-thirds vote of the Society, be considered as an honorary member of the Association."

MR. MATHER'S proposition was approved of.

MR. MATHER then proposed for honorary membership Dr. Theodatus Garlick, of Bedford, Ohio, the first American fish culturist, which was unanimously carried.

MR. E. G. BLACKFORD then announced the forced absence of the Vice-President of the Association, Mr. George Shepard Page, who was then in England.

THE Treasurer, Mr. E. G. BLACKFORD, then read the following letter from Mr. Page, dated at London, England, March 14th:

"As you are aware, there is to be a fishing exhibition at Norwich, England, Easter week, and Mr. Huxley will read a paper

there on the herring family. In all his magnificent collection of fishes he has no shad. I have urged him to introduce shad into the English, Scotch and Irish rivers. Indeed, knowing that none existed there, was the principal object of my visit to Mr. Huxley. It seems that Mr. Huxley had thought something of this kind would be well to do, but was not familiar with their habits or the food of the shad. Of course, on my part, I was only too happy to present details in regard to our shad. I may, perhaps, have rehearsed a great deal of that information we all get at our meetings. Anyhow, I told him that you would undoubtedly be glad to send over immediately by steamer a half dozen specimens on ice, a part of which he could preserve in alcohol at South Kensington, and the balance to be exhibited at the Norwich Fish Show. Mr. Huxley will, of course, give you credit for the same, both at the exhibition and at the museum. Mr. Huxley is also very desirous of knowing by what means he can secure millions of shad eggs the ensuing season, and I shall use my best exertions to aid in that matter, providing I can secure your valuable assistance. Just think that perhaps by our efforts we might succeed in giving some of these 35,000,000 English people as food, such a fish as the shad, and that there is a possibility that in eight or ten years these fish would be so abundant as to be had at a low price. Mr. Huxley will endeavor to convince landlords and those owning rivers that the modest shad will not eat up the aristocratic salmon. I want to add that I spent yesterday evening with Professor Huxley, and met there a great many people, and they were informed of the proposed plan for the introduction of shad into English waters, and that fresh shad and eggs were to be sent to Norwich in the future. Mr. Chamberlain, M. P., for Birmingham, was very much interested; since the fish business may come under his supervision he has promised to do all in his power to advance it. Professor Huxley would like you to send a few fresh herrings with the shad, so that he may compare them with the English fish."

Mr. Roosevelt.—I believe that Mr. Mather has eaten the shad of Germany, and perhaps he will tell us how they compare with ours?

MR. MATHER.—The fish which is called shad in Europe is inferior to ours in flavor. In 1874, at the request of Professor Baird, I attempted to take young shad to Germany, but the attempt was a failure. At that time the question arose as to the comparative value of the two shads, some of the Germans holding that their maifish was as good as the American. This, of course, could not be decided by argument, and so it rested until last summer, when at the Berlin Fishery Exhibition it occurred to Mr. Von Behr, the well-known President of the German Fishery Association, to have some of their fish brought down for the American Commission to bring to the test of the knife and fork. Unfortunately, Prof. Goode and Mr. True were absent. That day and I was alone. We had a gridiron improvised from wire, for this household implement is unknown in Germany, and some shad were broiled and some boiled and served with sauce after the German fashion. The broiled fish was pronounced best by all—five Germans and Prof. Ward, of Rochester, N. Y., and myself—but we did not think it equal to American shad by any means.

MR. ROOSEVELT.—Will Prof. Goode tell us the ichthyological differences between the American and the European fish?

PROF. GOODE.—There is a difference observable in the scales, which in the fish of Europe are thicker and do not lie as closely as in the American. There are other differences in the opercular bone which show them to be a different species.

The following paper was then read by the PRESIDENT, on Hybridizing Fishes, by Mr. Seth Green :

MR. PRESIDENT AND GENTLEMEN OF THE AMERICAN FISH CULTURAL ASSOCIATION :—You have again met for the purpose of mutual benefit and an interchange of knowledge, such as has come under our observation during the past year.

The subject of hybridizing is one which has been demanding the attention of fishculturists, more or less, for the past few years, and whether any of the varieties of our fishes can be im-

proved upon by crossing the different breeds, is still a question. Of one thing we are certain, and that is, we would never know unless we tried. We know that many varieties of stock have been greatly improved by putting together different strains, and also that fruits and vegetables have been rendered more palatable by grafting and other methods of infusing the sap of the different varieties into each other. These questions are of comparatively old standing, and it has been definitely decided in many cases just which kinds will be improved upon by the process of hybridization. The field for experiment is large, and, as we live in a world of progression, there will doubtless be constant advances in these branches, as well as in other things. Hybridization with fish for the purpose of bettering them, as food, and also producing fish suited to the nature of our different waters is the problem we are trying to solve. We cannot change the natural characteristics of our different bodies of water, and hence we find it necessary to produce varieties of fish which will thrive and multiply in them or learn from experiment and observation which species will do the most good when deposited in certain waters. With plants and animals it has been learned which varieties can be crossed advantageously, and which are productive of the best results, but with fish this has not been ascertained, but there is no question but what it will in time.

There are very many difficulties attending the hybrydization of fish—much more so than in anything else. One of the troubles lies in keeping the experiment constantly under the eye, thus enabling you to watch the different stages of development accurately, and the habits of water animals cannot be as closely observed as those on the land. At different periods during my career as a fishculturist I have made several experiments with fish in hybridizing. The most successful one that I have been enabled to watch clear through has been brought out this winter. Three years ago, in the fall of 1877, at the New York State Hatchery, we crossed the female native brook trout with the male Lake Ontario salmon trout. A good per centage of the eggs taken and impregnated hatched. The offspring were healthy and they continued to thrive. The fish are a fine, trim-built fish, resembling both parents; they will weigh at the present time

from three-fourths to one pound each. Last November they commenced to spawn for the first time. They commenced the first and continued until the 12th of November, during which time we succeeded in taking 19,400 spawn, the males and females both being fertile. The eggs hatched in about ninety days, the season being prolonged by the unusual cold winter. The yolk sack has now disappeared and the young fry are feeding and doing well. The question now arises, Will they be capable of reproducing their own kind? My opinion is they will, but time will tell. I shall endeavor to put a few thousand into some of our lakes and streams and thus determine to what waters they are best adapted.

My next most successful experiment was with the cross between the California salmon and brook trout. They are now four years old and, like the salmon trout and brook trout hybrids, resemble both parents. The cross was made with female brook trout and male California salmon. Nearly all the fish have a deformed appearance; a few of them are perfect fish. Last season they exhibited signs of spawning. There were either no males among them, or, if there were, they were not fertile. On attempting to take the spawn from them the vent was found to be too small to pass the eggs. The aperture was enlarged and spawn taken and impregnated with brook trout milt. None of them hatched. The eggs were nearly the size of salmon eggs. The parent fish have done well and some of them will weigh nearly, if not quite, two pounds. I do not think this cross will ever amount to anything. The salmon used were those kept in confinement and not as large or in as good condition as in their natural state. I am of the opinion that if the perfect salmon and brook trout could be brought together a perfect cross might be made, or at least the experiment would be worth trying.

I have made several other experiments in hybridizing, such as crossing the hybrids with brook trout and also crossing them with salmon trout. I have also crossed the brook trout with the California mountain trout, all of which have been attended with more or less success. I have this season been trying a series of experiments in impregnating the eggs of brook trout, the results of which will undoubtedly be interesting to the society. My

first experiment was as follows: By using a small glass syringe I injected the milt of the male brook trout into the vent of the ripe female brook trout and left it there thirty minutes before taking the eggs. The result of this experiment was an impregnation of 75 per cent. In my second experiment I took the spawn from brook trout directly in a vial, and corked tightly, taking care that no water was allowed to get in. I then placed the vial under water and left it forty minutes, after which brook trout milt was put on them and remained in vial thirty minutes, the result of which was an impregnation of 75 per cent.

Third Experiment.—I injected milt of brook trout into ripe female, and allowed it to remain fourteen hours before taking. 15 per cent. of them proved to be good.

Fourth Experiment.—I injected milt of brook trout into ripe female, and allowed it to remain in fish twenty-four hours before taking. In this experiment none of the eggs were fertilized.

Fifth Experiment.—I injected milt of brook trout into ripe female, and left it in fish one minute before taking. 40 per cent. was impregnated.

Sixth Experiment.—Took brook trout spawn in vial corked tightly, and placed under water for nine hours, after which milt was put on them. 15 per cent. of the eggs were impregnated.

Seventh Experiment.—Spawn was taken from female brook trout three hours after she had died, and milt from live male brook trout put on them. In this experiment 15 per cent. were found to be good.

As all fishculturists know the spawn of brook trout taken in the usual way adheres to the pan for from twenty minutes to half an hour directly after taking, we tried the experiment of putting them directly on the hatching trays within one minute after they were taken, and kept the pan in motion so they could not stick. The result of this experiment shows that the impregnation takes place almost instantaneously, as fully 95 per cent. were impregnated

During last summer I spent considerable time on several of our inland lakes investigating them, and teaching the local inhabitants how to catch the fish with hook and line with which

their waters have been stocked by the New York State Fish Commission. My efforts were attended with great success; I made several large catches, and taught many others how to do so. The effect will be to stop illegal modes of taking fish to a great extent in our inland waters. When the people learn that they have a fish barrel at their door, and can take a fish dinner in a short time, when they feel so disposed, they will see to it that the laws are enforced.

I learned during my investigations that the alewives breed in our inland lakes. This I consider a very valuable discovery. As fish food their value is inestimable, and all our lakes can be stocked with them. They are much more valuable than the fresh water herring, for the reason that they spawn in the spring and the eggs hatch in a few days. Whereas, the herring cast their spawn in the fall and are all winter in hatching, and consequently a much larger percentage of them is destroyed. The alewife hatches at a low estimate one hundred and fifty young fry for every one of the herring. It would be an impossibility to overstock any waters containing the alewives for food, and the fish found in the waters containing them are in the best possible condition. I hope to be able to stock several of our lakes with the alewife during the coming summer. This winter has been unusually severe and the ice has formed to a great thickness, and snow has fallen upon it to a considerable depth. In all small bodies of water, unless air holes are cut, there is always great mortality among the fish, caused by stagnation and lack of oxygen. Many of our larger inland lakes that do not usually freeze entirely over have this season been covered in some instances with ice two feet in thickness. While this would not materially affect the fish in ordinary winters where this is of short duration, I am of the opinion that where it has extended over a period of several months a great many fish will be destroyed by suffocation.

Waters can easily be depleted in this way to a great extent and no one ever be the wiser, for, contrary to the general opinion that all fish float when dead, my experience is that not one in ten ever comes to the top of the water.

MR. BLACKFORD.—I would call attention to one remark made by Mr. Green on the death of fish below the ice. If this is the case generally we should take measures to prevent it, and perhaps it would be well to invite discussion of this subject.

MR. ANNIN.—I saw a pond on the Genessee Flats, this winter, which was frozen over, and contained perch, catfish, etc. The ice was three feet thick, but near the head was a small spring, and it was packed full of small fish, all alive.

MR. MATHER.—The case mentioned by Mr. Annin is different. In the winter of 1855 I was trapping about the Grant River, Wisconsin, and near it along the Mississippi. There were along the latter river numerous sloughs where in the overflows the fish were left. One of these I knew to be full of fish in the fall, and in the winter cut through the ice to spear them. They were all dead and the stench was fearful.

MR. ROOSEVELT.—Mr. Annin tends to confirm Mr. Green. The fish were distressed, and crowded to the spring holes for relief. If there had been no springs to make an opening the fish would have died.

PROF. GOODE.—I do not care to argue this question, but having given some attention to the hibernation of fishes in cases where they assume a torpid condition and vitality seems suspended, it may be well to state that in Africa there are fishes which live in a state of æstivation or a suspension of life in summer. They live in the mud when the ponds dry up, and wait for the rainy season to release them. We also know that in high Northern latitudes the fish go into a state of hibernation as the temperature falls to a certain point. Mr. Mather has published some experiments with mud-minnows. I should think that in some cases the instinct of hibernation might be hereditary, and often death might ensue while the fishes were torpid.

DR. HUDSON.—The question arises if a pond of large size freezes entirely over. Most large bodies of water have air holes.

MR. MATHER.—The one to which I referred on the Mississippi bottoms had no air hole. It was about three acres in extent, and perhaps five feet deep, with two feet of that solid ice from shore to shore.

THE SECRETARY then read a communication by Mr. H. D. McGovern, on the Habits and Food of the German Carp :

It is with pleasure that I place before you some of my experience with fishes, more particularly the carp, during the past year. In the carp I have taken great interest, and have been, I am glad to say, successful in developing their growth in our New York State waters. My first mention will be of a lot of eighteen-months-old carps, thirty-five in number, placed by me in a pond prepared for them. The pond was three feet in depth, there being a bottom of mud or fine loam of six inches. Some of my carp would turn the scales at two and a half pounds previous to placing them in the pond, which was constructed for observation and fed from springs. In the early part of January I kept an air hole open in the ice which had accumulated on the pond, and fed the fish by means of a wooden spout, one foot square and four feet long, inclosed in a large sheaf of cat-heads and closed at the opening with a wad of salt grass to keep the frosty air from entering the tube or shaft. When I wanted to feed my carp I would remove the grass wad and drop my food down the aperture, after which I would obscure the light from the opening by throwing a coat over my head, and would then be rewarded by seeing all fish within range of the opening at the bottom. By this means I could ascertain the fish most relished by the carp. And here it is well to say that they disposed of oat meal dough and a dough of rye meal mixed with chopped cabbage more quickly than any other kind of food given them. My shaft worked well until the temperature fell to zero, for then, notwithstanding the covering of reeds or cat-heads, it closed up, and I was compelled to cut holes in the ice and remove all the particles remaining.

After the opening was cleared I would drop in food, and as the fish were not shy they would come to the opening and hover

around after eating. Then suddenly you would see a fine carp turn over on its side and, as if attracted by magnetism, come to the under part of the ice and there stick fast. I extricated some few, which you will see on exhibition in the market, with my other fish on Mr. Blackford's stand. I could have saved more of them, but, to use an old fisherman's phrase, I could not see the point of wasting a mackerel to catch a sprat. Now, gentlemen, I am inclined to think that a carp pond should be at least four feet deep, with a foot of soft bottom, making in all five feet. I say this only for our Northern waters, and would not recommend feeding in the months of December, January and February, as I think the fish I have mentioned would have gone in the mud and be safe now had I not given them the habit of being fed in frosty weather. They are a fish that I can assure you will withstand any amount of handling in moderate weather, and live longer out of water than any other fish I have ever handled. Some time ago I took an eighteen-months-old carp from my pond—its weight was about two pounds—folded it in a piece of wet bagging, brought it to my home, No. 288 Fulton street, a distance of four miles, and laid it on a slab while I partook of dinner. I then started with it for New York, and arrived at Mr. Blackford's stand two hours and thirty minutes from the time the fish was taken from the pond. I placed the fish in one of the tanks, and in presence of many of the market men the carp swam off as if it had only been changed from one tank to another. There was no swooning nor cause for resuscitating. I would still further inform those who may have carp in their ponds, not to be astonished if, after placing them in one pond, at the lapse of a month or two they find them in an adjacent one having no seeming connection with the first. The fact is, the carp will jump three feet, and then like an eel wriggle its way over damp grass, and make its way to other waters. This has been my experience, and having had, previous to its introduction from Germany by Prof. S. F. Baird, but very little knowledge of the fish. I suppose some of my associates in this body are still in the same position of uncertainty in regard to the carp as I was in previous to my personal investigation.

Mr. Annin.—My experience with carp has been that I received seventeen from Mr. Blackford and have only one left.

A Member.—I would like to ask if we have not had the carp in the Hudson River for years? I have heard of their being caught there quite often, but do not know if they are the same as the so-called German carp.

Mr. Roosevelt.—I have seen many hundreds of the carp in the Hudson. They seldom grow above a pound in weight, but in Ohio they have a carp which weighs several pounds; as much as seven, I think.

Prof. Goode.—The fishes spoken of are not the German carp which has lately been introduced. The latter are best for warm waters, especially in the Southern States. In the national carp ponds at Washington there are now two hundred of the original carp brought from Germany some four years ago; many of them are so large that they cannot be put in an ordinary wash-tub. The smallest of them will weigh over fifteen pounds. So great has been their growth in America that the Germans have applied for some of the stock to improve their own. A carp sent to Texas when only a few inches long, grew to eight pounds in one year.

Mr. Mather.—I collected all the accounts of the growth of carp in America, and read them before the Central Fishcultural Society at its last meeting at Chicago. It was published in *Forest and Stream* of January 27th, of this year, and will soon appear in the report of the society referred to, of which I have the honor of being corresponding secretary, and I will be pleased to mail that report to any members of this association who may apply for it.

Mr. Roosevelt.—I forget what that large carp in Ohio is called. I gave some account of it in a book of mine, published many years ago.

Prof. Goode.—The President probably refers to some of the

"carp-suckers," which from their superficial likeness to the carp, are so called. They are common in the Ohio Valley and occur in the great lakes. They were called *Carpiodes* by Rafinesque and belong in the family *Catostomidæ* or suckers, and not in the family *Cyprinidæ*, where the carps are. There are half a dozen or more species, which are locally known as spear fish, moon carp, etc.

MR. MILLER.—We have quantities of Ohio carp here at times in Fulton Market. They are slightly red.

MR. BLACKFORD.—The fish referred to is the Lake Sheepshead, *Haploidonotus grunniens*, and not the one referred to by Mr. Roosevelt and Prof. Goode.

MR. MILLER.—I once had a Hudson River carp which lived two days out of water in the bottom of a barrel, and when put in an aquarium he swam off none the worse for it.

MR. PHILLIPS.—The fish which is called carp in the Hudson is simply an uncolored gold fish.

MR. MATHER.—Mr. Phillips is correct. The mark which distinguishes the true carp from the gold fish is the fact that the former has a barbel or beard attached to each side of the upper jaw, near the angle of the mouth, while the gold fish has none. The Hudson carp has no barbels.

MR. PHILLIPS.—I once went up the Hudson to collect these carp for the Smithsonian at a time when it was claimed by some that there were good carp in the Hudson. A gentleman of color professed to be able to get them in quantity and I employed him. He brought in a very poor specimen which, as he promised more, I threw away ; but no more were forthcoming, and I was forced to return without the specimens.

MR. MATHER.—You will find the Ohio carp figured in the first annual report of the fish commissioners of that State for 1875

and 1876. It has the rays of the front part of the dorsal fin exceedingly elongated.

Dr. Hudson.—Among the carp distributed by Prof. Baird are three varieties of one species. There is the scale carp, which is covered with scales; the mirror carp, which has a few large scales in different parts, or perhaps a row of them along the back, and the leather carp, which is naked. Mr. Hessel thinks the latter are best, and Prof. Baird thinks that all the carp in America are tending to the nude variety and will eventually become so.

Mr. Roosevelt.—In Europe they have worthless varieties of carp as well as good ones.

Mr. Blackford.—If you will take a walk through Fulton Market some morning you will hear the cry, "Here is your German carp!" but so far there have been no true carp in the market. There have been several different fishes sold as the German carp here, among them the fish called "Buffalo" in the West. I have not eaten them, and do not know how they would compare with the carp.

Mr. Mather.—I have eaten both fishes, and while they are neither of them what we would call first-class fishes, the carp are the better of the two. I have eaten carp that were very good and carp that did not seem so good. The Germans often cook carp in beer or with a beer sauce, which is no doubt excellent to those who are accustomed to it, but did not strike me as being a delicate combination. The carp has a more solid texture than the Buffalo fish. The excellence of the carp lies in the fact that it grows in waters which produce nothing edible, and in the inland portions of the South and other parts where there are no good fish.

Mr. Annin.—To what class does the Buffalo belong?

Prof. Goode.—It is also one of the *Catstomidæ* or suckers. There are two genera now, according to the latest authorities, the *Ichthyobus* of Rafinesque and the *Bubalicthys* of Agassiz.

MR. MORGAN.—Will the carp take the hook ?

MR. ROOSEVELT.—We read of its doing so in Walton and the older angling books ; modern books do not say much about it.

THE SECRETARY then read a paper by Dr. Tarleton H. Bean, entitled, A Contribution to the Biography of the Commercial Cod of Alaska :

" The codfishery of Alaska has nearly ended its second decade, yet we did not know positively until the summer of 1880 what species is the object of that fishery. Most writers have referred to it under the name of *Gadus macrocephalus*, which was created by Tilesius for the Kamtchatkan cod, the figure of which suggests that it was based upon a deformed individual. Cope, in 1873, described the young of the common Alaska cod as *Gadus auratus*, from specimens collected by Prof. George Davidson, at Unalashka. Steindachner, in the Proceedings (*Sitzungsberichte*) of the Vienna Academy, lxi., 1, 1870, adopts the name *G. macrocephalus* for a large cod taken in Decastris Bay ; in this example the length to the head is contained exactly three times in the length of the extreme end of the pointed caudal peduncle. The same proportion may, however, be found in any place where large numbers of *Gadus morrhua* are taken, and it is only a matter of individual variation. The Commissioner of Fish and Fisheries, Prof. S. F. Baird, with a view to investigating the fisheries and the fish of Alaska, sent the writer to that territory to collect specimens and statistics during the summer of 1880. Thus an opportunity was gained for comparing the Alaskan cod directly with that of New England and of Europe, and for determining that the commercial cod of both oceans is the *Gadus morrhua* of Linnæus. I have not seen the species from Kamtchatka, but there is no probability that it is different from the Alaskan. It is a matter of daily experience to find long-headed and short-headed cod in the same school off the New England coast, the length of the head being one of the most variable characters. A series of cod showing just such variation, has lately been received from Alaska by the National Museum.

Golden cod, red cod and other algæ forms are as well-known at the Shumagin Islands as they are around Cape Cod and Cape Ann. Even the beautiful lemon-yellow fish, which occasionally are found in the Ipswich Bay schools, are duplicated in Alaskan waters. Nor does the similarity between the commercial cod of the two oceans end with external characters which are taken into account in determining specific relationship, for we find a wonderful resemblance in habits and in their food. Thus the shore fish about Kodiak make their appearance in schools similar to ours—first, the "herring school;" next, the "lant school;" then the "capelin school;" followed by the "squid school" and the "winter school." Besides these there is an abundance of bank fish, which are always larger than those previously named. All of the food-fish of the cod here mentioned are exceedingly abundant. The herring is not identical with the common sea herring of the Atlantic, but it is wonderfully like it. The lant is closely related to one of our New England species; the capelin is the same as ours. The squid is a species of *Octopus* (*O. punctatus* Gabb).

The cod come on the rocks in twenty-five to thirty fathoms about Kodiak to spawn in November and December, just as they do in the East, and these spawning fish will sometimes lie perfectly still on the bottom and refuse to take the hook. Young cod swarm near the shores, just as they were observed to do in Gloucester Harbor after the experiments of the U. S. Fish Commission with artificial propagation. On the 13th of July, 1880, our seine took young cod at St. Paul, Kodiak Island. We dredged numbers of them near our anchorage at Belkofssky, on the peninsula of Aliaska, July 23rd, 1880, averaging one and one-half inches in length. On the following day young cod of the same size were found in the stomach of a large one of the same species caught near Oleny Island in seven fathoms of water. On the first of October, in the harbor of Chernofssky, Unalashka Island, the cod fry were very abundant and had reached a length of four inches. At Iliuliuk, on the north end of the same island, young cod of the same length were seined at various times from October 6th to October 18th; they fairly swarmed around the wharves, eagerly biting at anything in the form of bait and

readily fastening themselves on hooks intended for much larger fish.

The resemblance between the Atlantic and Pacific cod-fishing grounds is strengthened by the presence in Pacific waters of a genuine pollock—not the fierce, cod-devouring tyrant of the East, but a prettier, weaker relative, greatly loved and grievously persecuted by the cod. We have not yet heard of a haddock. (*Melanogrammus*), hake (*Phycis*), or of a cusk (*Brosmius*) in Alaskan waters. The only members of the cod family definitely known are the true cod (*Gadus morrhua*), the tom-cod (*Microgradus proximus*), the polar-cod (*Boreogadus saida*), the "wachna" (*Gadus wachna*, Tilesius) and the pollock (*Pollachius chalcogrammus*). Wherever the true cod is found occurs also the halibut (*Hippoglossus vulgaris*), the same as the Atlantic species. These two prime fish are associated; they come almost to the doors of the fishermen, and are present now around the shores of Alaska in the profusion which attended the infancy of the Cape Cod fishery.

DISTRIBUTION.

The cod seems to be entirely unknown as far south as San Diego, California. A circular sent by the Chief of the Bureau of Statistics to Mr. W. W. Bowers, Collector of Customs at San Diego, elicited the following response: "I referred the circular to Dr. G. W. Barnes, the president of a society of natural history, and to various fishermen, but cannot ascertain that the codfish is known to exist in any of the waters adjacent to this port." On the Heceta bank, north north-west from Cape Oxford, Oregon, cod are found. The Indians residing on that coast report this fish as quite abundant in the summer months, and they are said to be large, solid and delicious.

J. L. McDonald, in a book entitled "Hidden Treasures, or Fisheries Around the Northwest Coast," states that "cod are taken in very limited numbers off the Farralones; they are lean and very poor, and resemble the jaundiced cod on the Grand Bank." James G. Swan, in a report on the food fishes of Cape Flattery, Washington Territory, writes that "the cod of the North Pacific is not found in abundance at Cape Flattery; occasionally it is brought in, but it is by no means common. It seems

to inhabit the deep water of Fuca Strait, and for that reason is seldom fished for, except occasionally some of the older fishermen will try during very fine weather to take fish in eighty fathoms. Further up the Sound and in Hood's Canal, and a few other localities, the *Gadus* is taken, but it is small—evidently a young fish. Although its existence is well-known to residents on Puget's Sound, it is not taken in sufficient quantities to be relied on as a food fish." Mr. H. A. Webster, Collector of Customs at Port Townsend, Washington Territory, writes thus to the Chief of the Bureau of Statistics: "The cod, I believe, is always present in the waters of Fuca Strait and Puget Sound, but in such limited quantities that catching has not been pursued as a business, and the knowledge of their habits is very limited. Young cod, about the size of shad, have been somewhat abundant in Puget Sound during the winter months. Cod weighing from four to six pounds have been taken during the summer months by Indians at Nee-ah Bay. The presence of small cod in the winter months in Puget Sound and at the mouth of the Strait of Fuca, is an indication that large quantities may be found in the neighborhood of Cape Flattery—say west of Tahosh Light and south from Vancouver Island. No efficient search has been made off the coast of Washington Territory for this valuable fish."

At Sitka, Indians brought a few cod to our vessel in June, 1880. The cod were reported abundant and readily caught, but the halibut, the many fine "bass" (*Sebastichthys*, several species) and "rockfish" (*Hexagrammus*) seemed to have greater popularity. Mr. A. T. Whitford told me that the cod spawn in the vicinity of Sitka in spring, and that they have a remarkable number of eggs. We bought a fine cod twenty-six inches long for ten cents here. At Port Mulgrave, Yakutat Bay, we took but one cod in the harbor during the day spent there; this one was large but sick. Good fish are to be had in the deeper water outside. Nothing but handlines were used from the vessel. Capt. J. Haley reports cod very abundant on the Hoochenoo bank in Chatham Strait. The bank extends from Hoochenoo Point to Point Samuel. He also states that there is a bank off Point Gardiner, and that there are banks on the east shore of Baranoff Island, near Poghibshi Strait; also

that small cod are abundant in Prince Frederick's Sound. While on a visit to the Aleut village near Graham Harbor, Cook's Inlet, we were told by Mr. Cohen that cod are present there throughout the year. On the 6th of July, in Refuge Cove, Port Chatham, Cook's Inlet, a great many fine young cod were seined. It was in Port Chatham that we first saw capelin schooling. Plenty of excellent cod were caught with lines from the vessel. Around the island of Kodiak cod are very numerous. On the 9th of July, while the "Yukon" was lying at anchor in the harbor of St. Paul, schools of these fish were seen swimming about her. These were fine, lively fish, evidently the first of the summer run, which Mr. B. G. McIntyre informed me had not yet begun. Young cod were seined on Wooded Island, July 13th. Between Kodiak and Unalashka are the extensive and well-known banks Portlock, Seminoffsky and the Shumagins, which have furnished the great bulk of the cod so far taken in Alaska.

There are cod banks in the vicinity of Unalashka. We had no difficulty in catching all we wanted with a small trawl line, or with hand-lines late in July. Native fishermen at Iliuliuk were bringing in bidarka loads of beautiful fish, most of which were very large, to dry them for use in winter. The wonderful abundance of young cod three to four inches long was a feature here in October. Cod have been reported as far west as the island of Atka of the Aleutian chain. Cod have been reported abundant in Bristol Bay; they appear to be uncommon in Norton Sound, though occurring again more abundantly further north as far as the ice line. The eastern portion of Behring Sea may yet furnish important supplies of cod in suitable depths, since there is an abundance of its favorite food—notably sand launce, capelin, smelt, herring and pollock, which last is probably the "whiting" spoken of by Seeman as occurring abundantly in Hotham Inlet, Kotzebue Sound. At the island of St. Paul cod are taken rarely, the fur seal having a monopoly of the catch. At St. Lawrence Island Messrs. Maynard and Elliott caught cod on the 22nd of August, 1874. The great fishing grounds of Kamtchatka are in the Okhotsk Sea and the Sea of Kamtchatka.

We were informed by one of the whaling captains in Plover Bay last September, that he has caught cod off the heads off Mar-

cus Bay, East Siberia. Off Indian Point (Cape Tchaplin), East Siberia, a little further north than Marcus Bay, we were told by Eskimo, who came aboard the vessel, that they sometimes take cod at that point.

In the Arctic Ocean we saw no traces of the *Gadus morrhua*, its place being supplied to some extent by myriads of small polar cod (*Boreogadus saida*), which, like the pollock, has the lower jaw longer than the upper. On the 19th of August, 1880, in latitude 60 deg. 45 min. north, longitude 166 deg. 35 min. west, we saw great numbers of young *Boreogadus ;* from an inch to an inch and a half long, swimming under the tentacles of a *Cyanea*-like jelly-fish.

COMMON NAMES.

J. G. Swan writes that the cod is called "Kadatl" by the Makah Indians. The Sitkas call it "Sacht." A Kodiak Eskimo, to whom I showed one of the fresh fish, told me that they knew it as "Ah-mo-doc'." The Russian name for the species is "Treska" —a name pretty widely known in the territory. It is worthy of remark here that natives generally distinguish closely the "Wachna" from the "Treska." To the fishermen generally the fish is known as "the cod." Men who have come to the Alaskan grounds from New England have brought with them the terms "rock cod" and "kelp bangers" for certain individual varieties. "Rock cod" are the variously colored algæ fish, exactly similar to those known by the same name at Gloucester. "Kelp bangers" are shore fish that frequent the kelp, as their name suggests. "Wachna" is a term applied to the tom-cod and also to a species very different structurally from this.

SIZE.

J. G. Swan reports that none but small cod occur in Puget Sound and Hood's Canal. I measured several fresh ones at Sitka which were bought from Indians ; one taken May 30th was 662 millimeters long, two others secured June 12th, were 435 millimeters and 542 millimeters respectively. Capt. J. Haley informed me that he purchased 10,000 fish in two weeks from Indians on

the Hoochenoo cod bank, which averaged three pounds each when dried. The largest he saw weighed thirty pounds. He saw a few young fish. A cod caught by us in the Harbor of Port Mulgrave, Yakutat Bay, June 24th, measured 870 millimeters. It was stout and heavy, but sick. In Port Chatham, Cook's Inlet, two healthy fish among a lot taken July 5th, measured 722 millimeters and 750 millimeters ; one of these was a spent female. Off Marmot Island (Portlock Bank) on the 8th of July, we caught with hand-lines in a very short time preceding dark, twenty-six cod, fine, plump and healthy, averaging not less than twelve pounds. Capt. D. C. Bowen, who passed twenty-five years on the eastern fishing banks, gave me the following information about the shore fish around Kodiak :

First comes the "herring school," consisting of medium size fish, continuing from May 1st to June or July ; then the "lant school," short, thick, well-meated, but not so large as the herring school, June to July, After this the "capelin school" of good-sized fish, about equal to Newfoundland cod, July to September. Last, the "squid school," averaging twelve pounds each. All of these are shore fish ; the bank fish are always larger. Capt. J. C. Caton, who is well acquainted with the Shumagin fishery, says that in 1867 the "Sanborn" took 60,000 fish, averaging 2¼ lbs., ready for market. Now vessels will average eighty tons (60,000 fish) of 2½ lbs. each. Capt. C. told me that none of the fish are so large as the George's cod. Capt. Andrew Anderson informed me that when he was mate in the "Wild Gazelle," in 1873, she took on Seminoffsky Bank 93,000 fish in three months, averaging 2½ lbs. dressed. In 1874 she caught 97,000, averaging 3 lbs. Capt. H. R. Bowen, of St. Paul, Kodiak, gives the average of the shore fish there as six pounds round, and says that the largest weigh fourteen pounds. Thomas Devine, in charge of McCollum & Co.'s fishing station at Pirate Cove, Shumagins, gives me as an average of the fish there something between eight and twelve pounds, the largest weighing fifty pounds round. On the 19th of July I saw many fish brought to this station by dorymen. One of the men had 157 for his day's catch, none of them being less than twenty-six inches in length, and many of them weighing not less than thirty pounds ; the smallest weighed about eight according to my

estimate. Prof. George Davidson, assistant to the United States Coast Survey, in his report on Alaska, states, that in north latitude 53 deg. 39 min., west lon. 164 deg. 10 min., in fifty to sixty fathoms of water, many cod were caught from his vessel, the largest being thirty-seven inches long; several reached thirty-six inches; the finest was thirty-six inches long, twenty-three inches girth, and weighed twenty-seven pounds, was very fat, etc., etc. In the New York *Times*, of July 15th, 1879, is found the following extract from the report of Capt. White, of the United States Revenue Marine Service, who was on duty in the Alaska waters in 1878: "One day when sounding south of Kodiak, wishing to lay in a stock of codfish, I ordered the sails set back, and prepared twenty lines with four or five hooks to each line. Puget Sound clams were used as bait, and in two hours we caught two hundred and fifty fish weighing thirty to forty pounds each."

From Dr. A. Kellogg, of San Francisco, surgeon and botanist of one of the Coast Survey's expeditions, I have the following memorandum: "I copy from my diary *verbatim* the very brief note made on the spot relative to the cod caught on board the 'Lincoln,' lat. 58 deg. 30 min. north, lon. 164 deg. 30 min. west: cod eighteen inches girth, thirty and one-half inches length, fourteen and one-half pounds; twenty and one-fourth girth and thirty-four inches long, weight twenty to twenty-two pounds; three feet long and twenty-three inches girth, twenty-seven pounds." We were in the harbor of Iliuliuk, Unalashka, from the 27th of July to August 3rd, and from October 6th to 18th, 1880. Between the first two dates we saw native fishermen daily bringing in cod for winter use. The fish were caught near the village, and were uniformly good-sized, many of them of fifteen to twenty pounds in weight at least. Men were sent out from the vessel also to supply us with fresh fish. They generally fished on the ridge at the entrance to Port Levasheff, and never failed to secure a good supply of cod averaging fully twelve pounds. In October there was no falling off in the supply, and the size was about the same. In deeper water further from the village we took larger cod. I find in the notes of Prof. D. S. Jordan the following comparison between the Okhostk cod and that of

the Shumagin Islands: "Okhotsk cod are larger and more numerous than Shumagin cod, but they are thinner, less fat and more pot-bellied, and weigh rather less when dressed—80,000 Shumagin fish, dressed, weigh 260,000 pounds; 80,000 Okhotsk fish, dressed, weigh 220,800 pounds. The latter are poorer perhaps because they are caught so early in spring. They are fatter in July; fishing, however, begins in June." For the dressed Shumagin fish this gives an average of three and one-quarter pounds each, and for the Okhostk two and three-quarter pounds. The average for the Shumagin fish agrees substantially with that given by most persons who have furnished information about the Alaska cod. Prof. Jordan's information was obtained from the foremost fish merchants in San Francisco, and mine from captains of fishing vessels.

SHAPE AND COLOR.

With reference to the Shumagin cod, Capt. J. C. Caton informed me that most of them have black napes, but there are some white napes. Some of the fish we caught on Portlock Bank, July 8th, 1880, had black napes, and others white napes. Thomas Devine, who has charge of McCollum & Co.'s fishing-station at Pirate Cove, Shumagins, reports mostly black napes, some white or gray. Capt. H. R. Bowen, of St. Paul, Kodiak, Id., says they "very seldom find fish with white napes—generally black." Capt. D. C. Bowen, of the same place, told me that white nape and black nape fish both are caught; black napes being most plenty. He says that white napes are generally young fish; the big ones are almost always black napes. Capt. J. Haley informed me that the Hoochenoo cod have black napes. These statements coincide with my own observations at various points along the coast of Alaska, and it seems to be true that black napes predominate among the Alaskan cod. Two large ones, measuring 722 and 750 millimeters, caught in Port Chatham, Cook's Inlet, July 5th, 1880, had black napes. The same variations in the external colors of the fish exist as are known in the Atlantic; the shore fish are generally darker than the bank fish, and a reddish tinge is very

common. Rock cod are as well-known as with us. Mr. Devine states that very pretty yellow cod are sometimes taken. Capt. H. R. Bowen says that the deep water fish are generally light in color. Mr. Devine informed me that the winter fish are whiter than those of any other season. The same gentleman mentions peculiarities of shape among the cod, as, for example, "bull-eyed" fish with prominent eyes, and "seal-head" fish with short snout and wide forehead. The shore fish which were brought to us by Indians from Old Sitka were always dark-colored, with long heads and eyes far apart, and with conspicuous blotches, in general appearance often resembling the small cod taken in shallow water off South Greenland—the *ogac* form of the common cod. There are no differences, so far as general appearances go, between Alaskan and New England cod ; it would be impossible to tell one from the other if they were mixed in a tank without tags or some other means of identification.

DISTRIBUTION.

In general terms, we may say that cod are found around the whole southern shore of Alaska, and westward along the Aleutian chain as far as Atka, extending on the western shore not much beyond Bristol Bay, though they have been observed as far north as St. Lawrence Island. They are said not to penetrate far into Cook's Inlet. We caught several large ones in Chugachik Bay, but they were sick. In Port Chatham, which is near the entrance to the inlet, we found them common and good. Mr. Cohen told me that cod are present all the year near Fort Alexander. In Refuge Cove, a small arm of Port Chatham, we took many young cod in brackish water. At Chernoffsky, also, on the island of Unalashka, we again found them abundant in brackish water associated with young *Oncorhynchus*, *Salvelinus malma*, *Ammodytes*, *Lumpenus* and *Cottus*. Several small streams flow into Chernoffsky Bay at this point, and the young fish were taken in water varying from three feet to one fathom in depth close to the shore. Fish of considerable size (weighing several pounds) were taken from the wharves at Iliuliuk during our stay. Cod are quite abundant close to the shores of the Kodiak group, the Shumagins and Unalashka Island. I have seen them taken in about

nine feet of water at Iliuliuk, and at a depth of at least fifty fathoms off Cape Cheerful. Mr. Devine, of Pirate Cove, says they are caught as far as thirty miles off Seminoffsky Island as deep as forty-five fathoms, and that on the middle ridge, in sixty to seventy fathoms, the best fish are taken with hand-lines.

Capt. H. R. Bowen states that they are caught in three feet of water sometimes at the village of St. Paul, but these are always sick fish. Wherever there are soundings good fish may be caught. The cod of the Shumagins are generally taken at such short distances from the shores as can be readily reached in dories. The fishermen go out in dories from their vessels, or from the fishing station, in the morning, and return in time to dress the fish aboard or on shore in the evening.

MOVEMENTS, ETC.

MIGRATIONS.

Mr. J. B. McIntyre, Mr. D. C. Bowen and Capt. H. R. Bowen, all agree in stating that cod remain throughout the year around the island of Kodiak. They were scarce last winter on account of the extreme cold, and up to the time of our arrival at St. Paul (July 9th, 1880) the customary summer sun had not yet begun. Between that date and July 14th, however, we saw schools of them around the vessel where she lay at anchor. According to Mr. Bowen they made their first appearance at St. Paul, May 7th, 1880. Capt. Bowen states that they are always found in the same places. Mr. McIntyre said that they were so scarce about St. Paul last winter that the natives could not catch enough of them for their own use.

According to Capt. J. C. Caton, cod are present around the Shumagin Islands all the time, but at some seasons they are very scarce. The best fishing is in February, commencing about the 10th and lasting to March 10th. Most of the vessels coming up get their best fish and best fare in July. Sometimes they do well in May. The fleet come up late in April or early in May, and stay until the 10th or 15th of August.

Mr. Thomas Devine, who manages the permanent fishing station on Popoff Island, Shumagins, also informed me that cod

are to be found all the year, but that they go into deep water in cold snaps and toward evening. He stated that the schoolfish leave in August or September, and return in January and February. They seem to move off to the southward and to return from the southward and westward.

With reference to the bank, twenty miles east northeast of Seminoffsky, Capt. Andrew Anderson told me that the fishing is best in August and September. The "yellow fish," *Pleurogrammus monopterygius*, school there abundantly about the middle of August and will follow the bait up to the top of the water. Cod will bite at the yellow fish in preference to anything else.

Mr. Marcus Baker has translated for me a note by Ivan Veniaminoff, on the marine fishes of the Unalashka region, in which occurs the following sentence: "Some of these, and especially the cod, in the winter go off shore into deep water, but in summer time they are found along the shores of certain bays and in shoal water."

SCHOOLING.

Mr. D. C. Bowen, of St. Paul, distinguishes various schools of cod about the Island of Kodiak, which vary in size and other particulars, and take their names from their favorite food during the time of their stay. He gives them in the following order: First, the "herring school," consisting of medium sized fish, which come about May 1st and stay until June or July; next, the "lant school," feeding on sand-launce (species of *Ammodytes*), made up of short, thick, well-meated fish, not so large ae those of the herring school, which are present in June and July. Then follows the "capelin school" (the capelin is our *Mallotus villosus*), July to September; these are good-sized fish, about the same as Newfoundland cod. The "squid school" comes in August or September, and remains until October. The fish of this school average twelve pounds in weight. The schools so far enumerated are all shore fish, and they are always smaller than bank fish. From October there are winter schools in some places; these are generally short, thick fish.

Capt. J. C. Caton says that they catch males and females together in the spawning season, and that they do not school when spawning.

Mr. Wm. J. Fisher has furnished the following information concerning the schooling of cod around Kodiak, which he obtained from Capt. H. R. Bowen : Cod associate in schools generally from May to the middle of September, and they live independently the rest of the year, the severity of the winter having much influence. At different seasons and in different places there are different schools. Males, females and young are found in the same schools. The movements of the schools are affected by the presence of food and by the state of the tide, the fish taking the hook more readily at slack water.

Mr. Devine speaking about the Shumagin cod told me on the 19th of July, 1880, that they found the fish both in schools and independent. There were "picking fish" at the time, and there had been "no great flush" of school fish this year. Different schools are found at different seasons and in different places. Mr. Devine says that males, females and young are not found associated. The males go together at certain times and the females. At the spawning season there are more females than males. The movements of the schools are very much affected by sharks especially, and dogfish to some extent. Dogfish are not abundant; sharks are quite so. The dogfish is identical with our Atlantic spined dogfish. We did not get a specimen of the shark, but the National Museum has a couple of small ones from Sitka, which are very close if not identical with *Galeorhinus galeus.* As for the influence of the tides, Mr. Devine says that fishing is best during the spring tides, and poorest in slack tides. Sometimes the cod have such a superabundance of food that they refuse to take the hook. My own observations at various points along the Alaskan coast, seemed to indicate that young cod, from two to four inches in length, prefer to school near the shores in sheltered coves where the water is shallow, and often where it receives a large admixture of fresh water. At Iliuliuk I found myriads of such young fish playing about the wharves, eagerly seizing the hooks baited for larger prey. Occasionally a larger cod, say of sixteen or eighteen inches in length, would be caught in the same vicinity, but almost invariably we found the small fry unmixed with older fish. The supply of food forms a very important motive for the presence of cod in particular places at certain

times. When we were in Port Chatham, for example, capelin were schooling there abundantly, and we caught fine cod freely. On Portlock Bank, again, capelin were plentiful, and nearly every cod examined had its stomach filled with them.

At the Shumagins "England hake," or more properly pollock (*Pollachius chalcogrammus*) were abundant in July, and the cod were feasting on them. The "yellow fish" (*Pleurogrammus monopterygius*) is one of the finest of all baits for cod, and will play an important part in the future of the fishery. This "yellow fish" is said by Capt. Andrew Anderson, to be very abundant, about the middle of August, on the off-shore bank, twenty miles east northeast of Seminoffsky, where they are found schooling, and will follow the bait up to the surface of the water. It is to be noted that August and September are the best months for cod on this bank. The herring (*Clupea mirabilis*) also has a great deal to do with a prosperous cod fishery. Capt. J. Haley told me that herring are wonderfully plenty on the Hoochenoo bank at the fishing season, and that there are enormous quantities of fine herring in Prince Frederick's Sound, where also small cod are abundant.

ABUNDANCE.

Before entering into an examination of the influence of modes of fishing and practices of the fishermen upon the abundance of fish, it will be well to review the actual numbers taken at different times and places. Captain Haley secured 10,000 fish in two weeks from Indians on the Hoochenoo Bank, and could have got many more. The Indians caught these cod with bark lines, on barbless bent iron hooks, two of them going off in a canoe and bringing in from twenty-five to fifty fish, which were quite enough to satisfy their laziness.

Mr. D. C. Bowen states that as many as five hundred have been taken in a day by one hand-liner, on Portlock Bank, and that the average catch of the whole season, per man, is seventy-five a day. Here may be repeated the statement of Capt. White, of the United States Revenue Marine Service, who reported the capture, south of Kodiak, of 250 fish, weighing thirty to forty pounds each, with twenty lines, having four or five hooks each.

This number was taken in two hours. From the New York *Times* of July 15th, 1879, I extract a sentence by William S. Dodge, formerly Mayor of Sitka, to the effect that: "At Kodiak, Henry Richard and Thomas Bache, fishermen, caught alone, with hook and line, within the last six months, 22,000 cod."

Captain Andrew Anderson told me at St. Paul, that with a crew of ten men, on Seminoffsky Bank, he has caught as many as 4,000 in a day, and that his average catch there was from 1,600 to 1,800 daily. Mr. D. C. Bowen stated that John McCathrine and a man named Smith, caught 1,700 cod in a day on one trawl (a 12-line trawl of 600 or 700 hooks) in Unga Straits. Their average catch was 1,200 fish. A correspondent of the San Francisco *Post*, writing of the season of 1876, says: "One man on board the schooner Selma, which arrived the other day, had 13,000 fish to his credit," etc. These were caught during a season of four months. Captain J. C. Caton, who has been familiar with the Shumagin fishery ever since the second year of its existence, affirms that fish are plenty enough to supply a large market when that is found. The evidence of all the fishermen goes to prove that the great want is not fish, but demand for fish. One such customer as Gloucester would whiten the Gulf of Alaska with hundreds of sails where now there are less than a dozen, and there is every indication that full fare will repay the venture.

As to the influence of fishing and its accompanying practices, we have information from only two points—St. Paul, Kodiak and Pirate Cove, Shumagin. Capt. H. R. Bowen, of the former place, says that cod are as abundant there now as they were when white man began fishing; that their haunts and habits have not been changed by the influence of man, and their numbers have not been diminished by over-fishing. Trawls have never been used in that vicinity. He regards the practice of throwing gurry overboard as injurious to the fishery; the cod, he says, will leave and their place be taken by sculpins. Mr. Thomas Devine, of Pirate Cove, said that cod are scarcer there now than they were five years ago. He accounts for their decrease by the increased fishing, the injurious effects of trawling and of throwing overboard gurry from the vessels, and to some

extent by the capture of the mother fish, which will sometimes take the hook freely. The lost gear attendant upon trawling has a bad effect upon the fishery.

FOOD.

The food of the cod in the Pacific is as plentiful and as varied as in the Atlantic. Most other fishes of suitable size are liable to suffer from its voracity, while certain species for which it has an especial liking are slaughtered in great numbers. There is a wonderful abundance of invertebrated animals, such as quid, shrimp, holothurians, crabs, marine worms, sea-fleas; and, in short, just such forms as are well known to every fisherman on the eastern grounds. The waters of the Alaskan fishing grounds fairly swarm with this kind of life suitable to the wants of the cod. The fish which constitute in large measure the food of the cod are herring (*Clupea mirabilis*), capelin (*Mallotus villosus*), lant (*Ammodytes*), halibut (*Hippoglossus vulgaris*), whiting or England hake (*Pollachius chalcogrammus*), sculpins (*Hemilepidotus Jordani* and *trachurus*, also *Cottus polycanthocephalus*), and yellow fish or striped fish (*Pleurogrammus monopterygius*). Sometimes young cod are swallowed by older ones. I have seen a species of *Liparis* from a cod stomach on Portlock Bank. The yellow fish is the best bait for cod, according to Capt. Anderson and Capt Caton. Another food fish of the cod is worthy of mention here, because of the interest which attaches to its common name of "Cusk"(*Bathymaster signatus*)—a species very different indeed from the cusk that is so much eaten for cod in the Eastern States.

Mr. Devine says that sick cod are sometimes seen feeding at the surface, and sometimes healthy fish will chase bait up. In this way yellow fish will attract cod to the surface, and capelin will also. I have counted forty capelin in one cod taken on Portlock Bank, July 8th, 1880.

REPRODUCTION.

According to Mr. D. C. Bowen, cod about Kodiak come on the rocks in twenty-five to thirty fathoms, spawning in November and December. Capt. H. R. Bowen, of the same island, states that cod, full of eggs, are caught in February ; the eggs

are very light straw color and about as large as number 12 shot. He says that eggs and milt sometimes run from the fish after they are caught. Capt. J. C. Caton informed me that cod spawn around the Shumagins in February on sandy bottom in shore, and that they will bite freely when spawning. Mr. D. C. Bowen says that at certain times spawning cod will lie perfectly still at the bottom and not take the hook. Mr. Thomas Devine tells me that the Shumagin cod spawn in rom ten to fifteen fathoms of water in January and February; the size and color of the eggs are the same as in the Eastern cod. The wharf at the Pirate Cove fishing-station is sometimes covered with spawn which has run from the fish after they were landed. He says that during the breeding season the males are long and slim and the females are short and deep. The smallest codfish he has recognized as such, were about six inches long, and they appeared in May or June. The smallest ones seen by Capt. Bowen were, also, six inches long; they made their appearance about July, and were in company with old fish On the 6th of July, 1880, we seined many young cod in Refuge Cove, Port Chatham, Cook's Inlet, where the water was less than a fathom in depth, and was largely diluted by fresh streams. At Belkoffsky, on the Peninsula of Aliaska, young cod about one and one-half inches long were dredged on the 23rd of July. On the following day, while laying on the west side Oleny Island, a cod one and one-half inches long was found in the stomach of a large one.

On the 1st and 2nd of October we seined many young cod at the head of Chernoffsky Bay, Unalashka; from the 6th to the 18th of the same month we saw them in great numbers swimming around the wharves at Iliuliuk, Unalashka, very active, and wonderfully greedy. We may, therefore, say that from May to October, at least, young cod are found in shallow water near the shore, and that about the middle of the latter month they have reached an average length of four or five inches. At Iliuliuk, when a jig or a baited hook was let down into the water it would be at once surrounded by a throng of nibbling fry, not at all frightened by the presence and antics of numerous small boys. These small fish frequently succeeded in fastening themselves on the hooks, and

were pulled out on the wharf, either to be eaten or used as bait, or thrown away.

ENEMIES, FATALITIES, ETC.

DISEASES.

As a rule, all large cod caught in harbors in shoal water are sick. On the 24th of June, 1880, one was taken in Port Mulgrave, Yakutat Bay, that measured 34¼ inches in length, and was stout and heavy, but sick and unfit for food. The gills were not bright red as in a healthy fish, but dull and faded; the colors of the body were also dull. Numerous parasites were present externally, and the abdominal viscera were infested with worms. A very unpleasant odor came from the belly when it was opened. On the 2nd of July, in Chugachik Bay, Cook's Inlet, three large cod were caught from the vessel, all of which were sick, their abdominal viscera being lined with worms and giving off a bad odor, yet the fish were quite heavy. On the 5th of July a healthy cod 28 2-5 inches long, and blind in both eyes, was caught on a hook in Port Chatham near the entrance to Cook's Inlet. The fish was entirely free from parasites. Its stomach contained only the herring with which the hook was baited. Instead of the transparent aqueous humor in the anterior chamber of the eye there was an opaque white substance, the result, doubtless, of an old injury. A second fish taken here (about an inch longer than the blind one) seemed to be perfectly healthy, but there were numerous small worms on the intestines. In its stomach were an *Ammodytes*, a little wad of kelp, and a pebble.

In examining a fresh fish caught near Sitka I found the inside of its mouth containing many lernæan parasites.

Capt. H. R. Bowen has never seen deformed cod in the vicinity of Kodiak, but diseased ones are common. He has frequently noticed ulcerated sores along the body, and especially on the head. Dead cod have never been seen to his knowledge. Mr. Devine, of the Shumagins, has seen cod sometimes with their backbone broken, causing a deformity known as "rose bones;" but he has never seen dead fish in any quantity at or near Pirate Cove. In earlier years, he says, you could heave up hundreds

of sick cod at the wharf; sometimes you would take the cod long, thin and gaunt, and after taking out the bone you might 'read the Bulletin through them."

PARASITES.

Mr. Devine mentions, as external parasites found on Shumagin cod, "cuttle-fish, welks, worms and fish-lice." The commonest external parasites observed by me were small lernæans.

ENEMIES.

Around Kodiak seals and sea-lions prey upon cod, frequently taking them from the line, according to Capt. Bowen.

Mr. Devine tells me that sharks are very abundant about the Shumagins and very destructive to cod; dogfish (*Squalus acanthias*) also prey upon cod, but they are not abundant. We caught comparatively few dogfish during the summer—one at Port Althorp, one on Portlock Bank and many at Sitka.

EPOCHS IN THE HISTORY OF FISH CULTURE.

BY PROF. G. BROWN GOODE.

(Prof. Goode remarked that the paper was tentative, and that he had no intention of treading on the toes of any one, but merely of arranging each important triumph of fish-culture in its order of sequence, and that he would be glad of corrections.)

It has been my aim in the following paper to recount, in chronological order, the principal steps in the progress of fish culture in Europe and America. No originality of matter or of method is claimed. The work has been done for my own convenience, and that of others who may have felt the need, often felt by me, of a concise summary of the facts in the history of the artificial propagation of fish. This paper has been hastily prepared, and, perhaps, contains misstatements or omissions. Criticisms or corrections will be received gladly, especially if they relate to statements concerning priority of invention. Without further introduction, I will proceed to the consideration of the first and greatest epoch.

I. 1741—*The Discovery of the Art of Fish Culture.*—In the year 1741 the art of fish culture was discovered by Stephan Ludwig Jacobi, a wealthy landed proprietor living at Hohenhausen, a small village in the duchy of Lippe, in Northwestern Germany. This discovery was not made public until 1763, thirty-eight years after the time when Jacobi, a youth of seventeen years, first conceived the idea of artificially fertilizing the eggs of fish for the purpose of restocking ponds and streams, and began a series of painstaking experiments.

There is so much of interest in these early efforts at fish-breeding, that I shall not hesitate to speak of them somewhat at length, quoting pfreely from a paper recently published by my friend, Dr. Ludwig Hapke of Bremen, who has taken the pains to visit the home ef Jacobi, and to correct many errors concerning the worker and his work, which may be found in all the writings hitherto published on the subject of fish culture.

Stephan Ludwig Jacobi was born April 28th, 1709, upon his ancestral estate of Hohenhausen, in the province of Varenholz. After a few years of study, under a private tutor, he was sent to the Gymnasia of Lemgo, Detmold and Hamburg. In 1734 he entered the University of Marburg, where he spent four years in the study of jurisprudence, philosophy and mathematics. In 1738 he turned his attention to agriculture, and, in 1741, after his marriage, he assumed the management of the estate which he had inherited from his father. In 1745 he was appointed "Landlieutenant," or Lieutenant of Militia. He was not, however, a military man, though he is spoken of as an army officer in all works on fish culture. Like many of the leading landed proprietors of Germany, he engaged in various enterprises not strictly agricultural, though properly pertaining to his functions as landlord. The village of Hohenhausen, which was located upon his estate, was a prosperous settlement of about one thousand inhabitants.

Among the industries in which he was engaged was the management of a flour-mill, a vinegar factory and a factory for the fabrication of starch from potatoes. He was also employed in public service, having been chosen superintendent of the work of building a canal from Schottmar to Uffeln, an enterprise by which numerous meadows and swamps were reclaimed from the water, and which was also of importance in the years of destitution (1771 and 1772) in providing work and food for many hundreds of suffering peasants. He was, however, particularly devoted to the culture of fruit and of fish, and is said to have employed successfully for many years a system of rotation of crops. Certain extensive tracts upon his estate he was accustomed to devote for a certain period to fruit-growing, then, by overflowing, to give

them up with equally satisfactory results to the rearing of fish. As late as 1805 the twelve little troughs which he used in hatching fish eggs, as well as the other apparatus devised by him, were still to be seen by those who were sufficiently interested to enquire for them.

Jacobi was a man of commanding stature and fine personal appearance. He died, aged seventy-five years, on the 22nd of April, 1784, his widow surviving until 1805. He left twelve children, the eldest of whom, Gerlach Ferdinand Jacobi, inherited the estate, and, up to his death, in 1825, continued the fish-breeding industries which had been established by his father,

The "Father of Fish Culture" was, in the opinion of Dr. Hapke, one of the most important scientific investigators of the age in which he lived. A pupil of the renowned Christian Wolf, the disciple of Leibnitz, the predecessor of Kant, he was trained in the best methods of the mathematicians and natural philosophers of his day and nation, He was unfortunate in being ahead of his time. He was a citizen of one of the smallest of the, at that time, infinitessimally small German provinces, and was in the prime of life when the Seven Years' War occurred [1756–1763], and when the social and scientific development of Germany was retarded by internal dissensions. He appreciated the full scientific and practical import of his discovery and lost no opportunity to make it public and to introduce it into general usefulness. He himself published papers in various periodicals, and was in constant correspondence with the chief naturalists of Germany and France, like Buffon, Lacepede, Fourcroy and Gleditsch, while also encouraging others to give publicity through the press to the methods and results of his labors. A contemporary biographer wrote: "By reason of his discovery of the method of artificially fertilizing the eggs of fish, as well as many useful discoveries in physics and mechanics, he was well known to the academies of Berlin and St. Petersburgh, as well as within the narrower limits of his own fatherland." [Lippische Intelligenzblatter, 1768, p. 585.] He was so well known throughout the country that a letter sent to him from the American Colonies sometime between 1760 and 1770, and addressed to *The Trout Culturist Jacobi, Germany*, passed safely to his address. [HAPKE, Dr. L. Zur Entdeckungsgeschichte des Konstlichen Fishzucht. Abhandlungen des Naturwissenschaftlichen Vereins, Bremen, VI., 1876, pp. 157–164.]

It is claimed by many French writers that the process of artificial fecundation was discovered as early as 1420, by Dom Pinchon, a monk in the Abbey of Reome. This claim was not advanced until 1854, when the Baron de Montgaudry called attention to certain manuscript records at that time in his possession, found among the archives of the

abbey. The claim is a somewhat feeble one, and it is believed by many authorities that the practice of the French monk was simply to collect and transplant the eggs which he had found already naturally fertilized, thus discovering artificial breeding, but not artificial propagation. However interesting to the antiquarian, the proceedings of Dom Pinchon had no influence upon the progress of fish culture. [MONTGAUDRY: Bulletin de la Societe Zoologique d'Acclimatation, Paris, I., 1854, p. 80. HAIME: Revue des Deux Mondes, June, 1854, and Report U. S. F. C., Part II., 1873 (pp. 465–492), p. 472 (translation.) MILNER: Report U. S. F. C., Part II., 1873, p. 531. MILLET: La Culture de l'Eau, p. 128. HAPKE: op. cit., p. 151. MOLIN: Rationelle Zucht der Susswasserfische, etc. Wien, 1864, p. 4.]

To Germany, beyond question, belongs the honor of discovering and carrying into practical usefulness the art of fish culture. Upon the estate of Jacobi as has been seen, it was carried on as a branch of agriculture for nearly eighty years—from 1741 to 1825—though it was nearly one hundred years before public opinion was ripe for a general acceptance of its usefulness. Recognition of fish culture was finally brought about by the zealous advocacy of men of science in France, Scotland, Bohemia and Switzerland. During the interim it appears to be certain that at no time was the practice of fish culture from a practical standpoint entirely abandoned by citizens of Germany.

II. 1763—*Announcement of the Discovery of Fish Culture.*—In 1763 some anonymous contributor to the Hanoverian Magazine published a description of the methods employed by Jacobi in the artificial culture of trout and salmon. [Hannoversche Magazin, 1763, Erster jahrgang, p. 363.] On the 5th of August, 1765, Jacobi himself, in the same periodical, recounted the story of his experiments and their results. [HAPKE: op. cit., p. 160. HAIME: op. cit., p. 474. MILNER: op. cit. p. 531. MILLER: op. cit., p. 127. BLOCH: Hannoverschen Magazin, 1782, pp. 337–360. KRUNITZ: Encyklopadie, 1778, p. 456. MEZLER: Landwirthschaft's Kalender, Stuttgart, 1771, p. 72.]

III. 1764—*Indorsement of Fish Culture by the Savans of Germany.*—In 1764, in the year after the announcement by Jacobi of the results of his experiments, Dr. J. G. Gleditsch, a renowned botanist, presented to the Berlin Academy of Sciences a communication, in which he pointed out the importance of the new discovery. [GLEDITSCH: Denkschriften. der Koniglichen Akademie zu Berlin, xx. (1764), 1766, p. 47.]

IV. 1770—*First French Publication of a Treatise on Fish Culture.*—In 1770 the memoir of Jacobi was published in Paris in an abridgment of the Memoirs of the Academy of Berlin. [Memoires de l'Academie Royale de Prusse, etc.] In Duhamel Dumonceau's "General Treatise

upon the Fisheries," published in 1773, was published a translation of Jacobi's memoir on artificial propagation. [DUHAMEL DU MONCEAU: Traite General des Peches, publie par ordre de l'Academie des Sciences. Paris, 1773, part ii., p. 209.]

V. 1771—*First Recognition by Governments of the Importance of Fish Culture.*—George III., of England, recognizing the importance of the discovery of Jacobi, granted to him a life pension. [PEZAY: "Soirees Helvetiennes," Amsterdam, 1771, p. 169. MILLET: op. cit., 1870, p. 128.]

VI. 1772—*First Public Demonstration of the Principles of Fish Culture.*—In 1772, Prof. Adanson, in his lectures in the Royal Garden of Paris, now the Garden of Plants, demonstrated to his hearers by practical illustration the processes of fish culture. [MILLET: op. cit., p. 128.]

VII. 1788—*First Publication in English of a Treatise on Fish Culture.*—A translation of Jacobi's memoirs was published in London, in 1788, under the title, "S. L. Jacobi's Method of Breeding Fish to Advantage."

VIII. 1791—*Beginnings of Fish Culture in Italy.*—As early as 1791, Joseph Bufalini, of Cesena, in Northern Italy, had succeeded in artificially fecundating the eggs of many species of fish. [*Opuscoli Scelti di Milano*, XV., 1791. *Vis Litteraire de Spallanzani*, by Tourdes, p. 63.] Little has, however, since been done in Italy, particularly in the way of public fish culture.

IX. 1800–1840—*The Work of Early Disciples of Jacobi in Germany.*—As we have already seen, the son of Jacobi carried on fish culture at Hohenhausen from 1784 to 1825. According to Hartig and Von Kaas, the forester Franks, and perhaps others, practiced successfully the methods of Jacobi at Steinburg, in Lippe Schaumburg, soon after their promulgation. Head-forester Martens made some successful trials at Schieder in 1827, which were continued for many years. In 1837, Court-hunter Schnitger, a pupil of Martens, established in Lippe Detmold, Jacobi's own province, a trout-breeding establishment, which, in 1844, was still in successful operation. Here were made some interesting observations upon the influence of temperature on the development of eggs. In 1840, Knoche published an account of successful experiments at Oelbergen. [HARTIG (Ernst Friedrick): Lehrbuch der Teichwirthschaft, 1831, p. 411. KNOCHE: Zeitschrift fur den landwirthschaftlichen verein des Grossherzogthums Hessen, No, 37, 1840, p. 407. WAGENER: Vaterlandische Blatter, Detmold, 1844. HAPKE: op. cit., p. 161. HAIME: op. cit., p. 476. BLANCHARD: op. cit., p. 589.]

X. 1820—*Initial Efforts at Fish Cultare in France.*—About the year 1820, MM. Hivert and Pilachon fertilized the eggs of the trout, and attempted to restock the waters of the provinces of Haute Marne. in

Eastern France. [MILLET: op. cit., p. 128, BLANCHARD: op. cil., p. 374.]

XI. 1824—*Beginning of Fish Cultvre in Bohemia.*—In 1824, in the duchy of Horazdovic, in Bohemia, successful experiments in salmon culture were carried on by Director Studeny, the young fish dying when fingerlings. [FRITSCH: Die Flussfischerei in Bohmen, Prague, 1871, p. . HAPKE: op. cit., p. 162.] In 1853, a new interest was awakened in Bohemia by the experiments of Prof. Purkynje in trout culture.

XII. 1837—*Beginnings of Fish Culture in Great Britain.*—In 1837, Mr. John Shaw, after studying for several years the habits of the spawning salmon, succeeded in fecundating their eggs and raising the young fish to the age of two years. His experiments, though undertaken chiefly to demonstrate the identity of the fishes known as the *parr* and the *smolt* with the young of the salmon, were of great importance in the development of fishcultural science in Great Btitain. [SHAW, JOHN: An account of some experiments and observations on the pan and on the ova of the salmon, proving the pan to be the young of the salmon. Edinburgh New Philosophical Journal, XXI., 1836, pp. 99–110, Experiments on the growth of the salmon, Proc-Royal Society, Edinburg, I., 1838, pp. 178–9, pp. 275–9, Edinburgh: New Philosophical Journal, XXIV., 1838, pp. 165–179. Observarions on the growth of the salmon. London, Smyman, 1840, p. 11.]

Gottlieb Boccins claims to have successfully raised young trout at Chalsworth and Uxbridge, England, as early as 1841. [BOCCIUS, GOTTLIEB: A treatise on the management of fresh-water fish, with a view to making them a source of profit to landed proprietors. London, 1841, 8vo. A treatise on the production and management of fish in fresh waters, by artificial spawning, breeding and rearing. XXX., London, 1848.]

In 1854, the Brothers Ashworth hatched 260,000 young salmon at Lough Corrib, in Ireland, and soon after similar enterprises were undertaken for the River Tay, by Mr. Ramsbottom, and for the Dee, by Mr. Ayrton.

XIV. 1842–1844—*Experiments of Remy and Gehin.*—In the year 1842, according to various French authorities, an illiterate fisherman, named Joseph Remy, living in the mountains of Vosges, after studying for some years the spawning habits of the trout in the brooks about his home, succeeded in fecundating and hatching their eggs, and in feeding the young fish until they were old enough to shift for themselves. In the latter part of his undertaking he had an associate named Antoine Gehin. These fishermen were actuated solely by professional zeal,

and before their labors became generally known, had succeeded in rearing to a marketable size several thousands of trout. In 1843, Remy, in a letter to the Prefect of the Vosges, narrated the results of his experiments, and in the following year he and his colleague received a premium from a local society—the Society of Emulation of the Voges.

An immense stress has been laid upon the importance of these men to fish culture, particularly by French writers, Quatrefages, Haxo, Milne Edwards, Haim and others, an importance which I am, however, unable to appreciate to the same extent as they. In the first place, it seems somewhat improbable that the art of fertilizing fish eggs was, as is usually claimed, an original discovery of these men. Jacobi's experiments had been published nearly eighty years, and in the French language, in various popular treatises on fish and fishery, for fully seventy years. Remy was not so thoroughly illiterate as is usually represented, or he could not have communicated his observations in writing to the provincial authorities, nor have become a candidate for an award from a scientific society. It seems quite unlikely that the names of Jacoby and Goldstein were to him entirely unfamiliar. Consider, too, that the reputed discovery of Dom Pinchon, in the fifteenth century, was made in the neighboring province of *Cote d' Or*, while in *Haute Marne*, the remotest portions of which are not thirty miles distant from Vosges, local experimenters, as early as 1820, "had succeeded in hatching the eggs of the trout and obtaining their young to replenish the brooks and creeks of that district." [MILLET: op. cit., p. 128.]

Even the claim that the labors of the Vosges men were of immense importance to fish culture in France is not so clearly tenable. When the important essay of Quatrefages was published in 1848, their work was unknown to its author, and to this essay all Frenchmen agree in ascribing great influence in stimulating their national efforts in fish culture.

I hope it is not uncharitable to suggest that the chief significance to fish culture of the work of Remy and Gehin lies in the opportunity it afforded to France to throw its energies into the field without acknowledgment of indebtedness to Germany. At the same time I am not disposed to deprive their experts of the commendation which they deserve for their practical successes in fish breeding. The French Government, when in 1850, after resolving to make a grand experiment in stocking the waters of France with fish, seriously considered the question of giving to Remy and Gehin the direction of a portion of the enterprise as a recompense for the merit of having created a

new branch of industry in France—an encomium which they thoroughly deserved, [HAXO: ——— Reflexions sur l'Ichthyogenie, ou des œufs des poissons l'eclosion Epinal: Impremerie de Cabane, 1851. 12mo. German edition, Leipzig, Spamer, 1855. MILNE EDWARDS, A.: Annales des Sciences, Naturelles, Paris. 3d series. XIV., 1850, p. 53. MILLET: op. cit., p. 129. HAIME: op. cit. Annales de la Societe d'Emulation des Vosges. V., 1844, p. 301.]

XV. 1842—*Beginnings of Fish Culture in Switzerland.*—A decree of the Swiss Government, issued in 1842, gave complete instructions to fishermen upon the method of artificially propagating fish. [VOGT: —, HAIME: Revue des Deux Mondes, 1854.] As early as 1784 Spallanzani, Prevost of Geneva, who had been one of the first to recognize the value of the discovery of Jacobi, published a treatise "On the Artificial Propagation of Animals and the Nature of Hermaphrodites," in which he detailed the results of experiments made by himself. [BOSGREN, 186.] In 1857 was founded the establishment at Zurich, soon followed by many others. [BOUCHON BRANDELEY, Rep. U. S. F. C., Part II., p. 575.]

XVI. 1848—*Revival of Interest in Fish Culture Among the French.*—In 1848 was published the celebrated memoir of Quatrefages upon "Artificial Fertilization in Fish Culture," to the influence of which Haime and other French writers attribute the new interest in fish culture, which was for several years quite absorbing, which resulted in many improvements in the art, and to which, indeed, may be directly attributed the general revival of interest on the subject, which soon spread to America and elsewhere, and which has not since abated. [QUATREFAGES, A. DE: Des fecondations artificielles appliques a l'eleve de poissons. Comptes Rendus of the Academy of Sciences of Paris. XXVII., 1848, pp. 413-416. Revue des Deux Mondes, Jan. 1, 1849.]

XVII. 1850—*Encouragement of Fish Culture by the French Government.*—In 1850, Prof. Alphonse Milne Edwards, Dean of the Faculty of Sciences of Paris, was instructed by the French Minister of Agriculture to ascertain the value of the facts recently published concerning fish culture. He visited England, and also the establishment of Remy and his associate in the Vosges, and published a report, in which he recounted that the Government takes measures to stock the streams of France with fish.

In 1850 was established at Huningen, in Alsace, the first fish breeding station, or "piscifactory," as it was named by Prof. Coste. The year 1850 should be memorable in the annals of fish culture, since it marks the initiation of public fish culture. To the establishment at

Huningen the world is indebted for some important practical hints, but most of all for its influence upon the policy of governments. The fortunes of war and conquest have now thrown Huningen into the hands of the German government. [COSTE (J. J. M.): Notice Historique sui l'etablissment de pisculture de Huningen. Paris, 1850. Instruction practiques sur la pisciculture, survies de memoirs et de rapputs sur le meme sujet. Avec figures, Paris, Massen, 1853, 12mo. DETZEM et BERTOL: Fecondation Artificielle des Poissons. Mem. de la Soc. d'Emulation des Doubs, 1851.]

XVIII. 1850—*Beginning of Public Fish Culture in Norway.*—In 1850 the Storthing or Parliament of Norway voted 3,000 specie thalers for the prosecution of fish culture. Norway is thus entitled to share with France the honor of pioneership in fish culture, though by reason of her remoteness, her influence has not been so extended. [HAPHE, op. cit., p. 160.] It is worthy of mention that about 1850 the art of fish culture was again independently discovered by one Jacob Sandungen, a Norwegian peasant. [MOLIN: op. cit.]

XIX. *Beginnings of Fish Culture in Finland..*—For a third or fourth time the art of fish culture was independently discovered by a Finnish peasant named Matts Thomasson Wallila about the year 1852.] MOLIN: op. cit., p. 7.]

In 1857 H. J. Holmberg was sent by the Russian Government to Sweden and Norway to see how far the methods of fish culture then employed were applicable to Finland. [MOLIN: p. 10.]

In 1862, through the labors of Holmberg, who in that year became inspector of pisciculture in that country, the first breeding station was established. In 1873 there were already ten large establishments in this province. [SOUDAKEVICZ: Rep. U. S. F. C., Part II., p. 512.]

XX. 1853—*Beginnings of Fish Culture in the United States.*—In 1853, Dr. Theodatus Garlick and Prof. H. A. Ackley, of Cleveland, O., succeeded in artificially propagating the brook trout (*Salvelinus fontinalis*), This may be considered as the beginning of fish culture in America, though allusion must be made to the claim of Rev. Dr. Bachman, of Charleston, S. C., who has published an account of experiments successfully carried out, in 1804, upon the corporal (*Semotilus corporalis*) and the trout. Bachman's experiments, even if successful, a point not yet demonstrated, bear much the same relation to the history of American fish culture that those of Dom Pinchon bear to those of France. Dr. Garlick's paper "On the Artificial Reproduction of Fishes," was read before the Cleveland Academy of Natural Sciences, Feb. 14, 1854, though not printed until 1857. Dr. Bachman's claim was not pub-

lished until 1855. [MILNER: Rep. U. S. F. C., Part II., p. 533. GARLICK, Ohio Farmer, 1857.]

In Mr. Milner's excellent paper on "The Progress of Fish Culture in the United States" may be found accounts of the experiments of other pioneers, Kellog and Chapman in 1855, Muller and Brown in 1857, Ainsworth in 1859 and Seth Green in 1864. The experiments of Captain N. E. Atwood in 1856 are also deserving of prominent mention [Report Mass. Commissioners, 1856.]

In 1854 was published, in New York, by the Appletons, a treatise on Artificial Fish Breeding. This, in connection with the publication of the results of Garlick and Ackley's work in 1857, and the report of the Massachusetts Commission in the same year, to which was appended a translation of the essay of Jules Haime, had a most important influence on the development of public interest in fish culture. The writings of Coste, too, were in the hands of many Americans.

XXI. 1854—*Beginnings of Fish Culture in Belgium.*—In February, 1854, a fish-breeding establishment was organized by the Belgian Government, De Clerg, an engineer, having been sent, in November, 1853, to France to investigate the subject of fish culture therein. [MOILN: op. cit., p. 8.]

XXII. 1854—*Beginnings of Fish Culture in Holland.*—In 1854 the King of Holland established a fishery commission, and set up a hatching apparatus in his palaces at Bois and Wiss. [MOLIN: op. cit., p. 8.]

In 1860, a fishcultural establishment was founded in the Zoological Gardens at Amsterdam, which was successful in the culture of salmon. [DE BONT: La Culture du saumon et des ses congeneres et la Pisiculture au Jardin Zoologique d'Amsterdam—Amsterdam, 1872. BOUCHON-BRANDELET: op. cit., p. 215.]

XXIII. 1854—*Beginnings of Fish Culture in Russia.*—In 1854 V. P. Vrasski, after studying the French literature of fish culture, made experiments on the eggs of the eel, pout and the trout, and after independently discovering the process or dry impregnation, in 1860, established an extensive breeding station at Nickolsky, in the province of Novgorod, which was afterward extensively subsidized by the Russian Government. [SOUDAKEVICZ: Report of U. S, Fish Commission, Part II., 1853, p. 504.]

A large government establishment was founded in the province of Suwalki, in 1860, breeding trout, salmon and several species of whitefish. [IBID, p 512.]

XXIV. 1856—*Beginnings of Public Fish Culture in the United States. Massachusetts Fish Commission.*—May 16, 1856, the General Court of Massachusetts appointed three commissioners "to ascertain and report

to the next General Court such facts respecting the artificial propagation of fish as may tend to show the practicability and expediency of introducing the same into the Commonwealth, under the protection of law." Capt. N. E. Atwood, one of the commissioners, experimented with the trout and succeeded in fecundating, though not in hatching, their eggs. He also made observations upon the breeding of mackerel, having in contemplation their artificial propagation. The committee published a report giving a resume of past progress in fish culture, and a translation of Jules Haime's famous essay in the *Revue des Deux Mondes.* Public opinion was not, at this time, quite ripe for the substantial encouragement of fish culture, and it was not until 1865 that Massachusetts established its fish commission upon the present basis. [MASSACHUSETTS: Report of Commissioners appointed under resolve of 1856, etc., 1857, p, 54.]

XXV. 1856—*Discovery of the Russian Method of Dry Impregnation.*—Mr. V. P. Vrasski, a Russian fish culturist, discovered, in 1856, the dry method of impregnation, not publishing his results, however, until 1871. The same or a similar method was described by Carl Vogt as early as 1857. [MILNER: op. cit., p. 540.]

XXVI. 1857—*Early Action of the States of Vermont and New Hampshire.*—In October, 1857, a report on the artificial propagation of fish was made to the General Assembly of Vermont by Mr. George P. Marsh. At almost the same time a similar report was made to the Legislature of New Hampshire by Mr. A. H. Robinson. These had an undoubted effect on public opinion, and led to the efforts at restoring the salmon streams which shortly followed. [VERMONT: Report made under authority of the Legislature of Vermont on the artificial propagation of fish, by George P. Marsh, Burlington, 1857, 8vo. p. 52, appendix.]

XXVII. 1857—*First Attempt at Propagation of Whitefish.*—In November, 1857, Mr. Carl Muller, of New York, and Henry Brown, of New Haven, obtained whitefish eggs, in Lake Ontario, impregnated them, and transported 1,000,000 to Lake Saltonstall, near New Haven. In 1858 the experiment was repeated. No results are reported. [Report U. S. F. C., II., pp. 534-545. Report of Commissioner of Patents for 1859, 1860, p. 227.]

XXVIII. 1857—*First Attempt at Propagation of Lake Trout.*—In the same manner, in 1857 and 1858, Messrs. Muller and Brown transported several millions of lake trout eggs. No results are reported. [Report U. S. F. C., l. c.]

XXIX. 1857—*First Attempt at Propagation of Pike-Perch.*—In May, 1857, Messrs. Muller and Brown obtained fertilized eggs of pike-perch,

and planted them in Lake Saltonstall. They are supposed to have been destroyed by the fall freshets. [Report U. S. F. C., l. c.]

XXX. 1862—*First Attempt to Introduce Salmon into Australasia.*—This attempt was made by Mr. H. R. Francis, from England to Tasmania, and was a failure. In 1864, and in subsequent years, successful efforts were made, From 1869 to 1876 many hundreds of these planted salmon were found. [Report N. Y. F. C., II., pp. 7–24; VI., pp. 819–23.]

XXXI. 1864—*First Breeding of Salmon in America.*—In 1864 Mr. James B. Johnston, of New York City, hatched out in the studio building in New York city the eggs of salmon procured by him in Europe. None of the fry were liberated. [NORRIS: American Fish Culture.]

In 1865, it is said, Seth Green applied to the French Establishment at Huningue for some salmon eggs, and received 5,000, which died, however, in the New York Custom House.

XXXII. 1864—*The Establishment of the Green Hatching House.*—Mr. Seth Green was the first American fish culturist who carried on fish culture upon a basis pecuniarily profitable. [NORRIS: op. cit., p. 99. MILNER: op. cit. p. 535.]

XXXIII. 1865—*Establishment of the New Hampshire Fish Commission*—In 1865 Henry A. Bellows and W. A. Sanborn were appointed Fishery Commissioners and Dr. W. W. Fletcher, of Concord, N. H., was sent by the State Legislature to Canada to obtain salmon eggs. This was the first practical move in public fish culture in America, though Massachusetts, as has been seen, made a preliminary step ten years before [MILNER: l. c., p. 543. Report of the Select Committee on Fisheries 1865. Reports of the Commissioners on Fisheries made to the Legislature of New Hampshire. I., 1866; II., 1867; III., 1868; IV., 1869; V., 1870; VI., 1871; VII., 1872; VIII., 1873; IX,, 1874. X., 1875; XI., 1876; XII., 1877; XIII., 1878; XIV., 1879; XV., 1880; XVI., 1881.]

From 1866 to 1879 the State of New Hampshire appropriated $22.-663 for purposes of public fish culture*.

XXXIV. 1865—*Establishment of the Fish Commission of Vermont.*—In 1865 the Fish Commission of Vermont was established, Albert D. Hagar and Charles Barrett being appointed commissioners.

From 1871 to 1879 $7,800 was appropriated for purposes of public fish culture. [Reports of the Fish Commissioners of the State of Vermont. I., 1866; II., 1867; III., 1869; IV., for 1871-2 (1872); V., 1873-4 (1874); VI., 1876; VII., 1877-8 (1878); VIII., 1879-80 (1880).]

*For this and other statements as to amount of money appropriated for fish culture by the various States, I am indebted to Mr. C. W. Smiley.

XXXV. 1865—*First Effort at Propagation of Codfish.*—In March 1865, Prof. G. O. Sars, then engaged in investigating the codfisheries of the Lofoten Islands, Norway, succeeding in fertilizing and hatching the eggs of the cod. This appears to have been the first attempt to propagate sea fish artificially. [Rep. U. S. F. C. V. p., 583.]

XXXVI. 1865—*Beginning of Fish Culture in Austria.*—In 1865 the Government establishment at Salzburg was founded, and in 1873 every province in the Empire was provided with its own breeding establishment. [BOUCHON-BRANDELET: Report U. S. F. C., Part II., p. 518.]

XXXVII. 1866—*Establishment of the Fish Commission in Connecticut.*—In 1866 the Fish Commission of Connecticut was established, F. W. Russell and Henry C. Robinson being appointed Commissioners. From 1868 to 1880 $43,300 was appropriated by the State for purposes of public fish culture. [Reports of the Commissioners, I., 1867; II., 1868; III., 1869; IV., 1870; V., 1871; VI., 1872; VII., 1873; VIII., 1874; IX., 1875; X., 1876; XI., 1877; XII., 1878; XIII., 1879; XIV., 1880.]

XXXVIII. *Establishment of the Pennsylvania Fish Commission.*—In 1866 the Pennsylvania Commission was organized, but no regular commissioners were appointed until 1870, when James Worrall was elected by the Legislature to that office. From 1873 to 1880 the State has appropriated $99,030 for purposes of public fish culture. [Reports of the Commissioners for the Restoration of the Inland Fisheries, I., 1870 (1871); II., 1871; (1872); [see Report U. S. Fish Culture, II., p. 782]; III., 1873 (1874); IV., 1874 (1875); V., 1876 (1877); VI., 1877 (1878); VII., 1878 (1879).]

XXXIX. 1866—*The Establishment of the Canadian Commission of Fisheries.*—The Dominion of Canada this year established its Fishery Commission, which has since, under the direction of Commissioner W. F. Whitiker, performed such efficient service.

XL. 1867—*The Establishment of the First Hatching Establishment in the United States for Public Fish Culture.*—Although New Hampshire, as has just been stated, was first to take active measures toward restocking its streams, Massachusetts in 1867 again took the lead, establishing a hatchery for shad at South Hadley Falls on the Connecticut River. [MILNER: op. cit., p. 542, Massachusetts Reports.]

XLI. 1867—*The Invention of the Seth Green Shad Box.*—While operating on the Connecticut River in 1867, Mr. Seth Green devised that form of floating hatching box, with wire bottom, tilted at an inclination toward the current, which bears his name and which has been so extensively used in shad hatching in all parts of the United States. [MILNER: op, cit., p. 543. Rep. Mass. Comm. Fisheries, 1868, p. 35, pl. 11.]

XLII. 1867—*Successful Propagation of the Shad.*—The shad was this year successfully propagated at South Hadley, Mass., by Mr. Seth Green, working in behalf of the New England Commissioners, and at his own expense, though the apparatus was provided. This was the first attempt to propagate any member of the herring family. [MILNER: l. c., Mass. Reports, ll. c.]

XLIII. 1867—*Establishment of the Maine Fish Commission.*—The Maine Fish Commission was organized by the appointment, as commissioners, of Nathan W. Foster and Charles G. Atkins. From 1867 to 1880 appropriations were made to the amount of $36,975. [Reports of the Commissioners (later Commissioners) of Fisheries for the State of Maine, I., II., 1877, 1868 (1869); III., 1869 (1870); IV., 1870; V., 1871 (1872); VI., 1872 (1873); VII., 1873 (1874); VIII., 1875; IX., 1876; X., 1877; XI., 1878; XII., 1879; XIII., 1880.]

XLIV. 1868—*Establishment of the New York Fish Commission.*—The New York Commission was organized in 1868, the Hon. Horatio Seymour, Hon. Robert B. Roosevelt and Seth Green being chosen Commissioners. From 1868 to 1879 $165,000 was appropriated for fish culture. [Reports of the Commissioners of Fisheries of the State of New York, I., 1869; II., 1870; III., 1871; IV., 1872. V., 1873; VI., 1874; VII., 1875; VIII., 1876; IX., 1877; X., 1878; XI., 1879; XII., 1880.]

XLV. 1868—*The Successful Propagation of the Lake Whitefish.*—The successful propagation of the Lake whitefish was first accomplished in 1868 by Mr. Seth Green, at the New York State Hatching House at Caledonia, and by Mr. Samuel Wilmot of the Canadian Fish Commission. In 1869 Mr. N. W. Clark, of Clarkston, Mich,, was successful in several efforts. [MILNER: Report U. S. F. C., II., pp. 545-552.]

XLVI, 1869—*Beginning of Shad Culture in the Hudson River.*—In 1869 Mr. Seth Green, acting for the New York Fish Commission, began the culture of shad in the Hudson River. [MILNER: Report U. S. F. C., II., p. 544. Reports, New York Commission.]

XLVII. 1870—*Establishment of the Deutscher Fischerei Verein.*—In 1870 was established a German Fishery Society, which has had so powerful an influence upon the progress of fish culture in Europe. Prominent among its originators were Messrs. Von Behr, Von Bunsen, Peters, Wiltmacly and Virchow. [Circulars of the German Fishery Society, 1870 to 1880.]

XLVIII. 1871—*Establishment of the California Fish Commission.*—In 1870, by the election of B. B. Redding, S. R. Throckmorton and J. D. Farwell as commissioners, the California Commission was established. From 1870 to 1879 $37,000 was appropriated for purposes of fish cul-

ture. [Reports of the Commissioners of Fisheries of the State of California, I., 1870-1871 (1872); II., 1872-3 (1874); * * *.]

XLIX. 1870—*Establishment of the New Jersey Fish Commission.*—In 1870 the New Jersey Commission was organized, B. P. Howell and J. H. Slack, Commissioners. From 1871 to 1880 the appropriations were $29,500. [Reports of the Commission of Fisheries of the State of New Jersey, I., 1871 (1870?); II., 1872 (1871?); III., 1872; IV., 1873; V. 1874; VI., 1875; VII., 1876; VIII., 1877; IX., 1878; X., 1879; XI., 1880.]

L. 1870—*Establishment of the Rhode Island Fish Commission.*—In 1868 Rhode Island appointed commissioners to investigate the practicability of restocking the waters of the State with salmon and other migratory fish. In 1871 regular Commissioners of Fisheries appear to have been first chosen, these being John H. Barden, Newton Dexter and Alfred A. Reed, Jr, Between 1870 and 1879 the State appropriated $10,500 for purposes connected with fish culture and the fisheries. [Reports of the Commissioners on Inland Fisheries, I., (?), 1869; II., 1872; III., 1873; IV,, 1874; V., 1875; VI., 1876; VII., 1877; VIII., 1878; IX., 1879; X., 1880.]

LI. 1870—*Atkins' Device of Penning Migratory Fish.*—This device, which was provided for in 1870, but not carried into effect till the following year, consisted in obtaining seed fishes by purchase through the whole period of immigration into the rivers prior to spawning, and preserving them in ponds for from four to six months. "This," says Milner, "is an original method, never, I believe, before adopted in any country." [MILNER: l. c., p, 543.]

LII. 1870—*Successful Propagation of Lake Trout.*—Although experiments with this species were made in Connecticut as early as 1857, and also by Mr. Wilmot in 1868, and by Mr. N. W. Clark in 1870, the first considerable success was that by Mr. Seth Green in the same year. [Reports New York Commission. MILNER: Rep. U. S, F. C., Part II., p. 553.]

LIII. 1871—*Establishment of the American Fish Culturist Association.*—In 1871 the American Fish Culturist Association was organized. Its original members were William Clift, A. S. Collins, Fred. Mather, Dr. J. H. Slack and Livingston Stone. Its influence upon public opinion, and the aid it has rendered to fish culture, have been important beyond the possibility of statement. Its meetings have all been held in New York city, with the exception of the special meeting in Philadelphia in October, 1876. At the seventh annual meeting, 1878, the name of the society was changed to "The American Fish Cultural Association." [Transactions American Fish Culturists Association, I., 1872, II.,

1873; III., 1874; IV., 1875; V., 1876; VI., 1877; VII., 1878; VIII., 1879; IX., 1880.]

LIV. 1871—*Establishment of the Alabama Fish Commission.*—The Alabama Commission was organized in 1871 by the appointment as Commissioners of Charles S. G. Doster, Robert Tyler and D. R. Hundley. [Report of the Commissioners to encourage fish culture, I., 1872; II., * * *.]

LV. 1871—*Discovery of the American Method of Dry Impregnation.*—The American method of dry impregnation was discovered and practiced by Mr. C. G. Atkins in 1871. [MILNER: l. c., p. 541.]

LVI. 1871—*Transportation of Fish Across the American Continent.*—In 1871 young shad were successfully transported from the Hudson River to the Sacramento River, California. [MILNER: Rep. U. S. F. C., II,, p. 544.]

LVII. 1871—*Introduction of Shad into California.*—See LVII. above.

LVIII. 1871—*Establishment of the United States Fish Commission.*—On the 9th of February, 1871, Congress passed a joint resolution which authorized the appointment of a Commission of Fish and Fisheries. The duties of the Commissioner were thus defined: "To prosecute investigations on the subject (of the diminution of valuable fishes) with the view of ascertaining whether any and what diminution in the number of the food-fishes of the coast and the lakes of the United States has taken place; and if so, to what causes the same is due; and also whether any and what protective, prohibitory or precautionary measures should be adopted in the premises, and to report upon the same to Congress."

The resolution establishing the office of Commissioner of Fisheries required that the person to be appointed should be a civil officer of the Government, of proved scientific and practical acquaintance with the fishes of the coast, to serve without additional salary. The choice was thus practically limited to a single man for whom, in fact, the office had been created. Prof. Spencer F. Baird, at that time Assistant Secretary of the Smithsonian Institution, was appointed and entered at once upon his duties. Up to 1880, $476,200 had been appropriated for the use of the Commission. [See G. BROWN GOODE. The first Decade of the U. S. Fish Commission; its plan of work and accomplished results, scientific and technical. *Proceedings of the American Association for the Advancement of Science*, XXIX, 1880, pp. 563-574. *Forest and Stream*, XV, pp. 85-7. *Chicago Field*, XIV, p. 58. *Nature*, (London), XXII, pp. 597-9. *Circular Deutscher Fischerei Verein*, 1880, pp. 190-7. Report Smithsonian Institution, 1880, pp. 140-9.]

LIX. 1871—*Introduction of Shad into the Great Lakes.*—The introduction of shad into the Great Lakes was accomplished in 1871 by the New York Fish Commission, a quantity being placed in the Genesee River, a tributary to Lake Ontario. [Report U. S. F. C., II., p. xvii.]

LX. 1871—*Introduction of Shad into the Mississippi.*—In 1871 shad were introduced into tributaries of the Ohio and Mississippi Rivers by the U. S. Fish Commission, by the hands of Mr. Seth Green and Mr. William Clift. [Report U. S. F. C., II., p. xvii.]

LXI. 1871—*Establishment of the Salmon Breeding Establishment at Orland, Me.*—This was erected at the joint expense of the Fish Commissions of Maine, Massachusetts and Connecticut. [Report U. S. F. C., II., p. lxvi.]

LXII. 1872—*Importation of Rhine Salmon.*—A gift from the German Government, of 250,000 eggs, and 500,000 obtained by purchase, brought to this country under the charge of Dr. Hessel, arriving late in the fall. The 4,000 or 5,000 which were sound were planted in a tributary of the Delaware. [Report U. S. F. C., part II., xxii.]

LXIII. 1872—*Beginning of the Propagation of California Salmon.*—This work, begun at the suggestion of Mr. R. B. Roosevelt, was accomplished in October, 1872, for the U. S. Fish Commission by Mr. Livingston Stone. [Report U. S. F. C., II., xxiii.]

LXIV. 1872—*Invention of the Green Trough.*—This device, which was an improvement upon the former used by Coste and Atkins, was perfected in 1872, in the progress of experiments on whitefish. [MILNER: Report U. S. F. C., II., p. 546-556.]

LXV. 1872—*The Invention of the Holton Fish-Spawn Hatcher.*—The Holton Fish-Spawn Hatcher, devised in 1872 by Marcellus G. Holton patented March 18th, 1873, is of much importance in the hatching of whitefish eggs. [MILLET: Report, U. S. F. C., II., p. 546, plate liv.]

LXVI. 1872—*The Work of Propagating Fish Undertaken by the U. S. Fish Commission.*—At the suggestion and through the influence of the American Fish Culturist's Association. The recently established United States Fish Commission was charged with the task of restoring fish to the depleted waters of the United States. [Report U. S. F. C., II,, xvi.]

LXVII. 1878—*Invention of N. W. Clark's Fish-Hatching Trough.*—This important piece of apparatus was devised in 1873 and patented March 3rd, 1874. [MILNER: Report U. S. F. C., II., p. 546 pl. xv.]

LXVIII. 1872—*Invention of the Clark Transporting Case.*—This device was successfully used in transporting whitefish eggs to California. [MILNER: Report U. S. F. C., II., pp. 547-9.]

LXIX. 1872—*Invention of the Williamson or California Hatching Trough.*—This apparatus, similar to the Clark trough except that the water flows from below instead of from the top, was invented about 1872. [MILNER: Report U. S. F. C., II., p. 547.]

LXX. 1872—*Introduction of Whitefish into California.*—In February, 1872, the U. S. Fish Commission shipped 216,000 whitefish eggs from Clarkston, Mich., to San Francisco. [Report U. S. F. C., II., p. 550.]

LXXI. 1872—*Establishment at the Salmon Breeding Establishment at Bucksport, Me.*– In 1872 the extensive salmon breeding establishment at Bucksport, Me., was erected under the direction of Mr. C. G. Atkins and at the joint expense of the Fish Commission of Maine, Massachusetts and Connecticut, and of the United States Commission, which contributed funds to the amount of half the expense. This establishment has since passed entirely under the control of the United States Commission. [Report U. S. F. C., II., p. xviii.]

LXXII. 1873—*First Propagation of the Striped Bass.*—In May, 1873, Mr. M. G. Holton succeeded in propagating this species artificially at Weldon, N. C. [Report U. S. F. C., Part II., pp. 553-554.]

LXXIII. 1873—*The California Aquarium Car.*—In 1873 Mr. Livingston Stone, under the auspices of the U. S. Fish Commission and that of California, fitted up an aquarium car in which it was proposed to carry many species of fish to California. The car was capsized June 8th, in the Elkhorn River, Nebraska. In 1874 the experiment was repeated in behalf of the California Commission, [Report U. S. F. C., II., xxxvii.]

LXXIV. 1873—*Establishment of the Ohio Fish Commission.*—The Ohio Fish Commission was established in June, 1873, by the appointment as commissioners of John H. Klippart, John Hussey and Dr. E. Stirling. By act of April 26th, 1876, the commission in its present form was organized. Up to 1880 $29,000 had been voted for fish culture. [Reports of Ohio State Fish Commission (I.), 1874; I., (1875-6). 1877; II., (1877) 1878; III., (1878) 1879; IV., (1879) 1880; V., (1880) 1881.]

LXXV. 1873—*Establishment of the Wisconsin Fish Commission.*—In 1873 an appropriation was made by the Legislature to be expended under the direction of the U. S. Commissioner of Fisheries. In 1874 William Welsh, A. Palmer and P. R. Hoy were elected commissioners. Up to 1880 $38,860 had been voted for fish culture. [Reports I., 1874; II., 1875; III., 1876; IV., 1877; V., 1879; VI., 1880.

LXXVI. 1873-4—*Culture of the Land-Locked Salmon.*

Establishment of the Hatching Station of Grand Lake Stream.—Expe-

riments were begun at Sebec Lake, in 1873, under the auspices of the Massachusetts, Connecticut and United States Fish Commissions, and a station erected under the direction of Mr. H. L. Leonard. In 1874 this was transferred under the same auspices to Grand Lake Stream, and placed in charge of Mr. C. G. Atkins. [Report U. S. F. C., IV., p. *25.]

LXXVII. 1874—*Attempts to Transport Living Shad Across the Atlantic.*—The first trip was made with young fish by Messrs. Fred Mather and A. Anderson, in August, 1874, who lost the fish ten days after going to sea; the second by Messrs. H. W. Welcher and Monroe A. Green, who attempted to carry the eggs, which were destoyed before they reached the steamer· [Report U. S. F. C., III., pp. 328, 330. 338-9.]

LXXVIII. 1874—*Successful Propagation of the Oquassa Trout.*—In October, 1874, the Maine Fish Commission obtained 30,000 eggs, 5,000 of which were sent to New York. [Maine Reports. ROOSEVELT AND GREEN. Fish Hatching and Fish Catching, p. 136.]

LXXIX. 1874—*First Attempts to Propagate Grayling.*—In April, 1874, Mr. Fred Mather visited the Au Sable River, Mich., to experiment on the propagation of the grayling. From the 1st to the 3rd no ripe fish were found. He took 180 adult fish alive to his ponds at Honeoye Falls, N. Y. [*Forest and Stream*, vol. II,, p. 164.] On the 30th of April, 1874, Mr. Seth Green visited the river for the same purpose. Finding that the fish had finished spawning, he dug some fertilized eggs from the bottom of the river, which he subsequently hatched. [ROOSEVELT AND GREEN. Fish Hatching and Fish Catching, pp. 133-135.]

LXXX. 1874—*Propagation of the Sea Bass.*—In September, 1874, the eggs of the Sea Bass, *Centropristes atrarius*, were successfully fertilized at the U. S. Fish Commission Station at Noank, Conn. They did not however, hatch.

LXXXI. 1874—*Establishment of the Iowa Fish Commission.*—The Iowa Fish Commission was established by act of the Legislature, March 19th, 1874. S. B. Evans, B. F. Shaw and C. A. Harris were appointed commissioners. Up to 1880 $22,750 had been appropriated for fish culture. [Reports (biennial), I., (1874-5) 1876; II., (1875-6 and 1876-7) 1877; III., (1877-8 and 1878-9) 1880.]

LXXXII. 1875.—*First Artificial Impregnation of Grayling Eggs*—In April, 1875, Mr. Fred Mather made a second attempt to take grayling spawn on the Au Sable River, Mich. He found them ripe from the 6th to the 10th, and 10,000 were impregnated and afterward hatched,

by F. N. Clark at Northville, Mich., and himself at Honeoye Falls, N. Y. [*Forest and Stream*, Vol. IV, p. 214.]

LXXXIII. 1875—*Invention of the Mather Hatching Cone.*—The principle of suspending eggs in water by a stream, admitted at the bottom of a cone, and thereby hatching them in a bulk instead of in layers, was discovered in 1875 by Mr. Fred Mather and his assistant, Charles Bell. [*Forest and Stream*, Vol. VI., p. 19; Report U. S. F. C., III., p. 372-376, IV., p. 1,012.]

LXXXIV. 1875—*Hatching of Sturgeon.*—In 1874 efforts were made by Seth Green in behalf of the New York Commission to hatch sturgeon. In 1875 their efforts were successful. [ROOSEVELT AND GREEN. Fish Hatching and Fish Catching, p. 164.]

LXXXV. 1875—*Invention of Chase's Self-Picking Apparatus.*—This ingenious device for the removol of dead eggs from hatching jars was invented by Oren M. Chase, of Detroit, Mich. [Report U. S. F. C., IV., p. 1,012; VI., p. 616.]

LXXXVI. 1875—*Establishment of the Minnesota Fish Commission.*—This Commission was created in 1875, David Day, M. D., Horace Austin and A. W. Lathan being appointed commissioners. Up to 1880 $22,500 had been appropriated for fish culture. [Reports: I., 1875; II., 1876; III., 1877; IV., 1878; V., 1879; VI., and VII., 1880.]

LXXXVII. 1875—*Establishment of the Virginia Fish Commission.*—The Virginia Commission was organized in 1875, Hon. Alex. Mosely, Dr. W. B. Robertson and Dr. M. G. Ellzey being appointed Commissioners. Reports: I., 1875; II., 1876; III., 1877; IV., 1878; V.. 1879; VI., 1880.]

LXXXVIII. 1876-77-78—*Restoration of Salmon to the Connecticut River.*—In 1876 a single salmon was taken in the Connecticut; in 1877 several; in 1878 more than 600 individuals. These were the first seen in the river since the exclusion of the species from the river by the building of the Millers' River Dam in 1798. [Report U. S. F. C., V., p. 36*; VI., p. 31.]

LXXXIX. 1876—*Introduction of Whitefish into New Zealand.*—At the request of the Government of New Zealand the U. S. Fish Commission sent a lot of whitefish eggs to that country, a portion of which arrived in good condition. [Rep. U. S. F. C., IV., p. *27.] 1877.—Through the mediation of the U. S. Fish Commission arrangements were made between the Government of New Zealand and Mr. Frank N. Clark for the sending of whitefish eggs to New Zealand. The experiment was successful. [Rep. U. S. F. C., V., p. 39.]

XC. 1876—*Establishment of the Arkansas Fish Commission.*—The Ar-

kansas Commission was organized in 1876, N. H. Fish, J. R. Steelman and M. B. Pearce being appointed commissioners.

XCI. 1876—*Establishment of the Kentucky Fish Commission.*—By fish law of Kentucky, approved March 20th 1876, the Kentucky Commission was organized by the appointment of ten commissioners, one from each congressional district. Mr. Pack Thomas was the active worker and was elected President of the Board. Up to 1880 $11,000 had been appropriated for fish culture. [Reports: I., 1876; I., 1878; II. (second biennial), 1879.]

XCII. 1877—*Establishment of the Kansas Fish Commission.*—In 1877 Mr. D. B. Long was appointed Commissioner of Fisheries for Kansas. Up to 1880 $2,000 had been appropriated for fish culture. [Reports: (biennial), I., 1878; II., 1880.]

XCIII. 1877—*Introduction of the Madue Maraena into the United States.*—By the courtesy of Mr. R. Eckhardt, of Lubinchen, Germany, who presented 1,000 eggs of the Madue Maraena (*Coregonus maraena*) to the U. S. Fish Commission, this species was introduced into Gardner's Lake, Michigan. [Rep. U. S. F. C., IV., p. 16*; V., p. 40*.]

XCIV. 1877—*Artificial Hatching of the Herring and Discovery of a Method of Retarding their Development.*—Experiments were successfully carried out by Dr. H. A. Meyer, of Kiel, Germany, in hatching and retarding the development of the eggs by cold, and in hatching them by Vinal N. Edwards, of the U. S. Fish Commission. [Rep. U. S. F. C., V., p. 45*"; VI., p. 629.] These experiments in hatching were repeated at the U. S. F. C. station in Gloucester in 1878, by Mr. Frank N. Clark. [Rep. U. S. F. C., VI., p. 39.]

XCV. 1877—*Establishment of the Clackamas Hatchery.*—A hatching station established by the salmon canners of the Columbia River, and carried on under the supervision of Mr. Livingston Stone. [Rep. U. S. F. C., V., pp. 22*, 31*.] This was continued, by the aid of the U. S. F. C., in 1878. [Rep. U. S. F. C., VI., p. 27.]

XCVI. 1877—*Introduction of Carp into the United States.*—On the 26th of May, 1877, Mr. Rudolph Hessel, acting for the U. S. Fish Commission, deposited 227 leather and mirror carp and 118 scale carp in the ponds of the Maryland State Hatching House at Baltimore. A few carp had some years previously been introduced by Mr. Poppe, of Sonoma, Cal., which were utilized for his own private purposes. [Rep. U. S. F. C., V., p. 42.*]

XCVII. 1877—*Establishment of the Government Carp Ponds.*—The Government carp pond on the Monument Lot, Washington, were established in 1877 by the passage of an appropriation by Congress.

From this pond several hundred thousand carp have already emanated to all parts of the United States. [Rep. U. S. F. C., V., p. 43*.]

XCVIII. 1877—*Introduction of California Salmon into Europe.*—On the 18th of October Mr. Fred Mather sailed for Europe with 300,000 eggs of the California salmon from the U. S. Fish Commission, consigned to England, France, Germany and Holland, all of which, except 25,000, which were packed in a refrigerating box of his own construction, perished. [Rep. U. S. F. C., V., p. 34*.]

On the 23d of October, 1878, Mr. Mather again arrived in Bremenhaven with 250,000 eggs for Germany, 100,000 for France, 15,000 for Great Britain, and 100,000 for the Netherlands. This venture was entirely successful.

XCIX. 1877—*Discovery of Planted Salmon in the Delaware River and in the Susquehanna.*—In November, 1877, a mature female salmon was taken in the Delaware, at Trenton, supposed to have been planted in 1872 or 1873. In 1878 several hundred were taken. [Rep. U. S. F. C., V., p. 36*; VI., p. xxxi.]

May 11th, 1878, a salmon 40½ inches large was captured in the Susquehanna at Havre de Grace. [Rep. U. S. F. C., VI., p. xxxi., 941.]

C. 1877—*Invention of the Ferguson Plunging Buckets for Hatching Fish.*—In 1877, the system of plunging buckets, worked by steam, for hatching shad in tidal waters, then newly devised by Major T. B. Ferguson, was first tested at Havre de Grace by the joint efforts of the United States and the Maryland Fish Commissions. In 1878, 10,000,000 shad were hatched out with this apparatus by the U. S. Fish Commission. [Rep. U. S. F. C., V., p. 847, VI., p. lvi., 611.]

CI. 1877—*Establishment of the Colorado Fish Commission.*—In 1877 Mr. Wilson E. Sisty was chosen commissioner for Colorado. Up to 1880 $2,400 had been appropriated for fish culture. [Reports I. and II., 1879 (?); III and IV., 1881.]

CII. 1877—*Establishment of the Nevada Fish Commission.*—A fish commission for Nevada was created in 1877, and Hon. H. G. Parker appointed commissioner. Up to 1880 $5,000 had been appropriated for the use of the commissioner. [Reports (biennial), I., 1879.]

CIII. 1877—*Establishment of the West Virginia Fish Commission.*—In 1877, the West Virginia Commission was established by the appointment of John W. Harris, Henry B. Miller and C. S. White as commissioners. Up to 1880 $3,900 had been appropriated for the purposes of fish culture.

CIV. 1878—*Invention of the Wroten Bucket.*—This ingenious contrivance, a modification of the Chase jar, was invented in 1878 by W. T. Wroten. [Rep. U. S. F. C., VI., p. 616.]

CV. 1878—*Introduction of Soles into the United States.*—On the 6th of January, 1878, Mr. Mather, who had been sent to England by the U. S. Fish Commission for the purpose of procuring a supply of soles, deposited two soles on Stelwagen Bank in Cape Cod Bay. [Rep. U. S. F. C., V., p. 47, 866.]

CVI. 1878—*Captures of Planted Shad in California Rivers.*—In the year 1878 over a thousand shad were caught in the Sacramento River, being fish planted in 1871 by Seth Green for the California Fish Commission, or of others sent in subsequent years by the U. S. Fish Commission. [Report U. S. F. C., VI., p. xxxvii.]

CVII. 1878—*Capture of Planted Shad in the Ohio and Mississippi Rivers and the Rivers of Alabama.*—In the spring of 1878 several hundred shad, doubtless from those planted in 1872, were taken in Ohio River at Lowville. These were derived from a deposit of 30,000 made by Seth Green in the Allegheny River, and by Wm. Clift at Salamanca, N. Y., in 1872, in behalf of and at the expense of the U. S. Fish Com. Others taken at Madison, Ind.; Mt. Carmel, Ill.; Steubenville, Ohio; Nashville, Tenn. Shad were taken also in the Coosa River, Ala. [Report U. S. F. C., VI., p. xxxvii-ix.]

CVIII. 1878—*The Successful Propagation of Cod.*—In the fall of 1878 an experiment of propagating codfish was carried on by the U. S. Fish Com. at Gloucester, under the supervision of Mr. J. W. Milner and Capt. H. C. Chester. About 9,250,000 eggs were obtained, and about 1,500,000 were hatched out and turned into the narbor, where in the subsequent years young cod have been unusually numerous. [Rep. U. S. F. C., VI., p. xviii., p. 725.]

CIX. 1878—*Establishment of the Tennessee Fish Commission.*—In February, 1878, Gov. Porter appointed three fish commissioners for the State. They were: W. W. McDowell, of Memphis; Geo. F. Akers, of Nashville, and W. T. Turley, of Knoxville. No money had been appropriated, and the Commissioners have done some work at their own personal expense.

CX. 1878—*Establishment of the Utah Fish Commission.*—The Utah Fish Commission was created by Act of the Legislature, February 22, 1878. Albert P. Rockwood was appointed commissioner. No money had been appropriated up to 1880.

CXI. 1879—*Artificial Propagation of the Haddock*—In May, 1879, the eggs of the haddock were successfully fertilized and large numbers of young were hatched by Mr. R. E. Earll at the U. S. Fish Com. station in Gloucester. [Rep. U. S. F. C., VI., p. 730.]

CXII. 1879—*Invention of the McDonald Fishway.*—In August, 1878, Col. M. McDonald, Fish Commissioner of Virginia, devised a form of

fishway different in principle from all previous, by means of which the water from the dam is delivered down a straight incline sluiceway at an angle of 30 deg. without practical acceleration of velocity. [Report Va. Fish Com., 1879.]

CXIII. 1879—*Establishment of the South Carolina Fish Commission.*—A Fish Commission for South Carolina was created by Act of the Legislature, approved Dec. 23rd, 1879, it was continued under the direction of the Department of Agriculture, A. P. Butler, Commissioner. In 1879 $800 was appropriated and $661.60 was expended. No special appropriation has since been made, the expenses being met by the Department of Agriculture.

CXIV. 1879—*Establishment of the Nebraska Fish Commission.*

CXV. 1879—*Establishment of the Texas Fish Commission.*

CXVI. 1879—*Establishment of the Wyoming Fish Commission.*—The Wyoming Fish Commission was established by an act, passed in December, 1879, which provided for the appointment of a Commissioner, with such deputies throughout the Territory as he might choose to appoint, and appropriated $1,600 for the purpose for the two years ending December, 1881. Henry B. Rumsey was appointed Commissioner, and he appointed Dr. M. C. Barckwell and Otto Gramm as deputies.

CXVII. 1879—*Organization of the Central Fishcultural Society.*—This society held its first meeting at the Palmer House, Chicago, Oct. 1st, 1879, in pursuance to a call by B. F. Shaw and F. Mather.

CXVIII. 1880—*The Building of the Fish Hatching Steamer, Fish Hawk.*—In 1880, the steamer Fish Hawk, built by the United States Government for the service of hatching fish on a very extensive scale, was launched at Wilmington, Del.

CXIX. 1880—*The Successful Propagation of the Spanish Mackerel.*—In June and July, 1880, the Spanish Mackerel was successfully propagated by Mr. R. E. Earll, at Crisfield, Md., at the same time the King Cero, (*cybium regale.*)

1880—*The Propagation of the Moonfish* (*Parephippus faber.*)—At the same time and the same place the moonfish was hatched.

CXX. 1880—*The International Fishery Exhibition at Berlin.*—From March 20th to June 20th, 1880, the International Fishery Exhibition was held in Berlin, Germany. The Exhibition, though general in its scope, was intrinsically a fishcultural exhibition, the chief interest being concentrated in those matters which relate to the culture and preservation of fish.

The prizes in fish culture were distributed as follows:

	Gold Medal.	Silver Medal.	Bronze Medal.	Hon. Mention.
United States..	6	1	1	2
Germany.....	3	1	3	11
Russia.....	1	1	1	1
Norway.,.....	—	1	—	1
Sweden.....	—	1	—	—
Austria.....	—	—	1	—
Switzerland....	—	—	1	—

Mr. Annin moved a vote of thanks to Prof. Goode for his valuable paper. Carried.

Mr. Blackford thought it a long needed work which had now been done, and would serve as a record

Dr. Hudson asked why the "McDonald fishway" alone was mentioned when there are many others.

Prof. Goode: All others are merely modifications of existing plans which have been in use in other countries, and the record of whose invention is lost. The McDonald fishway is a new and an original principle.

Mr. Mather: If the McDonald fishway works as well as it appears to in model, it is bound to be the fishway of the future. It looks to be perfect when water is run through a working model.

Mr. Blackford: I would refer to the letter of Mr. Page on the introduction of shad into England, and ask if it can be done?

Prof. Goode: Mr. Mather has had some experience with their ocean transportation, and I would call on him.

Mr. Mather: The shad which we took over in 1874 died at Southampton from starvation. The full account can be found in the reports of the United States Fish Commission. I believe that if the eggs could be retarded in their hatching until the steamer is five or six days out they might be taken over safely. The trouble is that there is no food in the water taken out to sea as there is in river water, when we cross our continent.

Mr. Phillips: How low a temperature would it require to keep them for that length of time, and how low a degree can the eggs of this summer spawning fish bear?

MR. MATHER: Perhaps a steady temperature of 65° Fahr. would retard them for five days, but it would require careful experiment. I doubt if they would hatch at 50 degrees, or if they did burst the shell, if they would live to take food.

PROF. GOODE: The eggs of the sea herring have been kept for a long time and hatched, and it has been argued from this that it can be as readily done with the shad, but the case is very different. Dr. Meyer, of Kiel, kept herring eggs for months by the use of ice.

MR. MATHER: Whitefish eggs can also be kept. I saw them in December in Clark's hatchery, which were kept in an ice chest, and Mr. Clark thought he could keep them until June.

PROF. GOODE: It is easy enough to keep the eggs of fishes in a refrigerator if they are of a species which, like the herring, spawn on a falling temperature; but the shad spawn on a rising temperature. They will wait about rivers until the water gets warm enough to suit them, before they deposit their spawn.

MR. BLACKFORD: The Professor's explanation is conclusive that the eggs of shad will not bear the same treatment as the fall spawners. Mr. Phillips has some facts on the sturgeon fisheries which are important, and we would like to hear from him.

MR. PHILLIPS: I have been surprised at the amount of sturgeon which comes to New York—2,000,000 pounds. It is now scarce. The men who smoke sturgeon have asked me to lay the fact of their growing scarcity before this Association. I think it would be desirable to propagate this fish.

PROF. GOODE: The sturgeon fishery ranks in value among the first fifteen valuable fisheries of the country, leaving out the Mollusks. Its annual value is $350,000.

THE PRESIDENT then said that if there was nothing else of importance before the meeting to-day he would call for the Treasurer's report.

Report of the Treasurer accepted.

Election of officers being next in order, a Nominating Committee was appointed.

The meeting then adjourned until 12 o'clock the following day.

SECOND DAY.

The meeting was called to order, and the Nominating Committee reported in favor of the following officers, who were elected:

Robert B. Roosevelt, President.
Geo. Shepard Page, Vice-President.
Eugene G. Blackford, Treasurer.
Barnet Phillips, Corresponding Secretary.
James Annin, Jr., Recording Secretary.

EXECUTIVE COMMITTEE.

Fred. Mather, G. Browne Goode, Samuel Wilmot, Benjamin West, Thomas B. Ferguson, James Benkard, John B. Morgan.

The following members were present: R. B. Roosevelt, E. G. Blackford, James Annin, B. Phillips, F. Mather, C. M. Evarts, G. Browne Goode, J. B. Morgan, J. S. W. Thompson, E. R. Wilbur, W. A. Conklin, H. D. McGovern, Dr. Hudson, S. B. Miller, Al. Haley, Geo. Lamphear, Dr. J. B. Trimble, Asa French, Geo. Ricardo, Geo. Chappel.

NEW MEMBERS.

Robert T. Morris, 10 Morton street, New York; David T. White, New York; Wm. A. Wilcox, Boston; Chas. Barrett, Grafton, Vt.; Chas. Hawlett, Woodsburg, L. I.; Prof. Atwater, Middletown, Conn.; G. N. Woodruff, Sherman, Conn.; John D. Hicks, Roslyn, L. I.; Samuel Whitney, Katonah, N. Y.; Frank Endicott, 57 Beekman street, New York; Geo. H. Shafer, Fulton Market; Abel Crook, 99 Nassau street, N. Y.

GENERAL STATISTICS.

BY BARNET PHILLIPS.

Last year one of our most useful and practical members, Mr. G. S. Lamphear, presented to the notice of this meeting carefully prepared statistics, relating to the total pounds of each kind of fish received in the wholesale markets of this city. These tables, the result of a great deal of careful investigation, were perhaps the first of the kind ever brought to your notice. I need not suggest to you all the deductions which arose from these figures. I may cite, however, the following. It is only by such exact figures that we can arrive at positive determinations in regard to the abundance or a scarcity of any particular fish. Now, this abundance or scarcity may be general or local. New York city, with capacious maw, devours an incalculable quantity. I use the word incalculable perhaps in a poetic sense, for it is more or less impossible to count the fish. To be less vague, let us say that our markets draw to themselves an enormous quantity of fish. If fish, then, be scarce in one locality, this want of fish is supplied necessarily from another quarter. This area of productive water is then, by means of easy transportation, always yielding a certain quantity of fish. Say that cod are scarce off Sandy Hook—the demand for cod brings in fish from Gloucester, from Maine. Take striped bass. It may not be found at one season in the North River, but the supply may come from the Delaware or from the Chesapeake. It is, then, the gross quantity of fish received in New York which tells us absolutely whether a fish is generally scarce or plenty. Now, with such tables as have been made by Mr. Lamphear, to be supplemented later by other compilations which the United States Fish Census will shortly have ready, I believe we will get to the great bottom facts in regard to fish, whether caught on our coast or in our inland waters or lakes. If we do get these figures as accurately as human investigations can make them, we shall then better determine what kind of fish, being scarcer, may present themselves to our special care as worthy of culture.

It would be very presumptuous on my part, not having the

whole series of figures, to advance any judgment on this subject. I may, however, be very certain that in some special localities sea fish are scarcer than they were in former years. Professor Baird informs us on the best authority—and I may say that no one is more careful and accurate than our most distinguished fellow-member, the United States Fish Commissioner—that hallibut, once plenty, are becoming scarcer every day. Formerly it was caught near shore in large quantities ; to-day long and expensive trips have to be made to secure it. Spanish mackerel is also another most prominent case of the absence of a fish, most particularly in the waters adjacent to this city. Although it does not come within the province of this brief paper to enter into details accounting for the absence of the Spanish mackerel in New York waters, I can only state that it is believed to arise mainly from the dumping of the city refuse in our bay.

Now, as to that great staple fish which forms the bulk of our fish food, cod, perhaps its absence in certain localities will be found to be quite positive, though such want of fiish in one area may be made up by catches in other quarters. The object, then, of such specific investigations derivable fron the examination and comparison of this vast series of fish tables, which will be submitted to the United States Fish Commissioner, will he to eliminate these facts : Whether fish of a certain kind have been plenty or scarce. There is every reason to suppose, in looking at this vast subject in a general way, that constancy being a rule of nature, the quantity of the sea fish will not vary a great deal when an average of years is taken. It is unsafe to corner nature. The year 1880 may have been a bad year for fish, which we will call A and a good one for another fish, which we will call B. But had we been able to study the decade from 1870 to 1880, we might have found in certain years A was plenty and B scarce, and so the general average of A and B were about the same. But now, though we might arrive at this deduction, that is no reason why we should not, if we could, try and make A and B plenty all the year raund. A is scarce off New York Bay and continues getting scarcer, and fairly plenty off Cape Cod. To get the fish A from Cape Cod may be easy enough, but still A will cost a fraction more to bring it to New York market. These

are then some of the great problems which the Fish Ceusus will solve; it will give us exact determinations, and, having some fixed basis to work upon, we will no longer be in the dark.

Might I be allowed to state that public opinion, even special opinion in regard to such matters, is worth very little? We are all inclined to take too narrow views of such objects as surronud us. Our own horizon is necessarily limited. A fisherman, a single dealer, may form his own personal experience declare that fish are scarce, and so they may be. The fisheaman may have had bad luck or the dealer few consignments. These individual experidnces are perfectly correct, but their general deductions may be absolutely incorrect. Then again, popular opinion in regard to fish is prone to error. Providing fish remain in the same quantity, are there not incalcalably more mouths to eat them? It is not possible to imagine that while fifty years ago there was one fish and more for every New Yorker (say in 1831), in 1881 there is not one-half of a fish for each person, and that the extra person must be satisfied with the bones? All this means that the fish being the same in the sea, even with increased fishing, there are more fish wanted. The fish is then a fixed quantity, the methods and men necessary to get more fish augment, but the number of people who want to eat fish, must eat fish, increases faster than the other two. There might be then a time arrived at—we do not pretend to fix the date—when the one fish would have to go round among three, five, ten people. If the example of the wants of a single large centre of population may be precised, does not the same rule of supply and demand hold good for the whole country?

Now comes in that which this Association are doing their utmost to advance, and that is fish culture. We have then, say, that fixed quantity, the normal number of fish, and that constantly increasing hunger of many more mouths to eat this normal number. Is the first to remain a rigid quantity? The American Fish Cultural Association believe that this need not be fixed, but that there are possibilities of increasing the number of fish. Now, not so many years ago, all the ends of this association were limited to trout culture. We have expanded somewhat since then, and with us the science and detail of fish culture

has wonderfully broadened. We are not now bound within the comparative narrow limits of a stream to grow our fishes. Our pond has widened out until it has become almost an ocean, or if not an ocean, any long expanse of sea coast on which the sea breaks. What has been the great progress in these last two or three years has been made in the direction of the propagation of sea fish, and it is in this direction that the United States Fish Commission is advancing, and it is to this that the attention of the members of this association is called. We began with the ornamental, we have come down, or come up to the absolutely practical, unornate but useful. From what so many of our good and intelligent newspaper friends will insist on calling "speckled beauties," we must now come to the descriptive of the commonplace cod. We want the handsomest flowers in the fish bouquet—to use a doubtful metaphor—but we mu t not forget those other vegetables, the potatoes and the turnips. From the horticulturists we may derive both pleasure to the eye and sometimes to the taste, and even the humble kitchen gardener may learn a lesson from him. It is these trout, a handsome show of which Mr. Blackford will present to-morrow, which has made us proficient, as I have been endeavoring to explain, in other larger and better ways.

If then I were to tell you that I believe, from something like an actual count, errors excepted, that last year 49,442,900 pounds of fresh fish of all kinds were received in New York, worth $3,339,827, and that these represented 55,373,862 individual fish—halibut of 150 pounds, or smelt, eight going to a pound, being all counted. Let us hope that by fish culture our children may see these numbers very greatly increased, not only by the introduction of new fishes, which stupid prejudice now turns away from, but by the actual propagation of more fish.

Mr. Blackford called attention to a few viviparous perch from California, sent by Mr. B. B. Redding. They were examined and two were opened but the insides were too decomposed to trace the presence of young.

FISHES WHICH CAN LIVE IN BOTH SALT AND FRESH WATER.

BY FRED. MATHER.

In respect to the medium which they inhabit fishes may be divided into three classes, viz.: salt water fishes, fresh water fishes, and a third class which can live in either fresh or salt water indifferently. There is no name for this class, that I can learn, and, if there is no objection, I will propose to call them *Amphiæcious* fishes, from the Greek *Amphi*, both or everywhere, and *Oikeo* to inhabit. This class includes many fishes besides the anadromous fishes which leave the sea and seek the rivers to spawn, and the catadromous fishes which leave the fresh to spawn in salt or brackish waters, as the eel does. It contains fishes which seem to be indifferent to the medium which they breathe so far as its saltness or freshness is concerned, provided the change is not made too suddenly, and it is an open question if the chemical properties of salt water are of as much importance to the fishes living in it as its destiny is, but it is one that I have no inclination at present to discuss.

Foremost among the fishes which seem at home, as far as breathing and procuring food are concerned, in either salt or fresh water, are most members of the salmon family. I say *most* members because there are some which do not seem to have been observed in salt water, but as I think it highly probable that all members of this family, which as at present constituted includes the salmons, trouts, smelts and the *coregoni* or "whitefishes," "lake-herrings," graylings, ciscoes, etc., are descended from a common ancestor and have been differentiated by physical causes, there would seem reason to suppose that the graylings and other untried members might live in salt water also. These fishes may not be able to increase their species without access to fresh waters, as the density of salt water is probably too great for the gills of the embryo, even if it did not destroy the embryo before its gills were formed. In some experiments which I made a few years ago with young quinnat salmon of six months old, it was found that when placed in sea water they showed signs of uneasi-

ness at first, then of a desire to keep their noses out into the air and to jump out of the tank, after which they became exhausted and began to die in half an hour after immersion in it. This trial did not prove that salmon of six months old could not have lived in sea-water provided the change had not been sudden. In a state of nature there are no such sudden changes, and young fish making their first voyage from the upper waters of a river to the ocean may consume several months in the journey, dropping down gradually and hardly noticing the increasing density from day to day to which they have become accustomed.

The list of fishes which live in either salt or fresh water as given by the late Prof. Milner is as follows :

Salmon	*Salmo salar*
Sea-trout	*S. immaculatus*
Brook-trout	*S. fontinalis*
Whitefish	*Coregonus sp.*
Smelt	*Osmerus mordax*
Four-spined stickleback	*Apeltes quadracus*
American sole, or hog choker	*Achirus lineatus*
Tom cod	*Microgadus tomcodus*
Striped bass, or rockfish	*Roccus lineatus*
White perch	*Morone americana*
Silver gar, or bill fish	*Belone longirostris*
Shad	*Alosa sapidissima*
Alewife	*Pomolobus pseudoharengus*
Tailor (shad)	*P. mediocris*
Hickory shad, or toothed herring	*Dorosoma cepedianum*
Eel	*Anguilla bostoniensis*
Sharp-nosed sturgeon	*Acipenser oxyrhynchus*
Short-nosed sturgeon	*A. brevirostris*
Lamprey	*Petromyzon americanus*

Of these nineteen fishes Prof. Milner says : "Eight of the fishes named are believed to enter the rivers solely for the purpose of spawning." The genus *Pomolobus* has been divided by Prof. Goode, since Mr. Milner wrote, into two species, it would therefore add another.

To this list I can add :

Ten-spined stickleback	*Pygosteus occidentalis*
Flounder	*Pseudopleuronectes americanus*
Killy fishes or mummies	*Cyrrinodontidæ sp. sp.*
Anchovy or spearing	*Engraulis vittatus*
Sawfish	*Pristis antiquorum*

The flounder I have taken in Currituck Sound, which is fresh water now, but was salt twenty years ago. It was in winter and not in the spawning season. A species of ray was found in the interior of Eastern Africa and the sawfish is said to exist in Lake Nicaragua and in Laguna de Bay, near Manila. The others I have taken in fresh water or experimented with in aquaria. I also hear that pike (*Esox*) are taken in the brackish and even salt waters of Maryland, but diligent inquiry among fishermen on the south side of Long Island, where the little "mud pike" (*E. americanus* or *E. fasciatus*) is found in great numbers, failed to learn of its going into salt water, although found in the salt bays where fresh water pours in. Animals with soft skins are easily affected when changed from fresh to salt water. Frogs die soon, and, as they breathe by means of lungs, it follows that it is entirely from osmosis, or absorption by the skin, and probably our catfishes (*Siluridæ*) would not stand the change well, although there are two marine species (*Ælurichthys marinus* and *Ariopsis milberti*) on our coast.

I am informed by Professer G. Brown Goode that sting rays (*Trygon centrura*) are found in Lake Harney on the headwaters of the St. John's River, in Florida, while the following species are often found in the river in pure fresh water above Jacksonville :

Sheepshead	*Archosargus probatocephalus*
Sailor's choice	*Lagodon rhomboides*
The flounder, or New York fluke	*Paralicthys dentatus*
Triple tail	*Lobotes surinamensis*
Whiting	*Menticirrus alburnus*
Yellow tail	*Bairdiella punctata*
Menhaden	*Brevoortia tyrannus*
Cutlass fish	*Trichiurus lepturus*
Silver moon-fish	*Vomer setipinnis*

and perhaps twenty others, but the above are the principal fishes in point of value.

It is interesting to note that none of these fishes enter fresh waters in the Northern States, and it immediately raises the question why they do so in Florida? Possibly it is only in the winter time, as the large striped bass (rockfish) run up the Hudson at the same season; probably an instinct connected with hibernation, as it is certainly not for food or the purpose of spawning. It would be interesting to know out of all this class of fishes, for which I have proposed the name *Amphiœcious*, how many would breed in their new home; for while a salmon or a shad might exist for years in salt water, I would be surprised to learn that their eggs would hatch in the water of the ocean. According to Eckstrome, species of the pike-perch, *Stizostethium*; the miller's thumb, *Cottus gobio*; the ling or eel pout, *Lota vulgaris*, and a species of *Acerina*, a perch-like fish, were found in the brackish waters of the Baltic Archipelago. In the Caspian sea Eichwald found a species of Cyprinus; the pike, *Esox lucius;* the common river perch, *Perca fluviatilis;* the loach, *Cobitus fossilus*, and a *Stizostethium*. Of mammals, birds, reptiles, crustaceans, mollusks and worms I have taken no account, for although not foreign to the subject, they would tend to swell this paper beyond its limits.

It does not appear that it is due to any toxic action that some fresh water fishes die in salt water, but rather a difference in the density of the fluids, just as we would die in a short time under the great pressure to which sub-marine divers are subjected. The reverse would occur in salt water fishes when introduced into fresh water. They would then resemble ourselves on mountain tops where the blood is forced by internal pressure from the nose and ears, and the "baloon sickness" is felt. A French investigator, M. Paul Bert, has examined the causes of death in fishes and reptiles when changed from fresh to salt water, and is of the opinion that the cause does not reside in any poisonous quality of sea water, but is simply a phenomenon of osmosis, or transmission of fluids through the membranes; or, in other words, absorption of a heavier fluid in a membrane already filled with a lighter one. An example is cited of a frog which, when plunged into sea-water, it is claimed, loses one-

third of its weight, and if only one foot of the frog be immersed in it, the blood globules can be seen to leave the vessels and distribute themselves under the skin. If an animal be taken whose skin is not so absorbed, the same results appear in its bronchial system. When salt water fishes die from sudden introduction into fresh water endosmosis takes place, which is about the same thing under a reversed condition—the body of the fish containing a denser fluid than its new medium. If the slime be removed from a fish its death will be accelerated when the change of water is made. This is illustrated by the eel, which can bear these sudden changes if uninjured, but if a portion of its protecting mucous coating be removed, its skin becomes absorbent of the surrounding medium and it dies. The eel, which seems at home everywhere, puzzled M. Bert in a curious manner, but in the end confirmed his theory He had already experimented with them in changing fresh water ones into salt water, and found that they were indifferent to the change, and, wishing to continue his experiments, he directed his assistant to introduce the fish and report the results. To his great surprise the eels died after being three or four hours in salt water, and a long search failed to show why it was that they lived when he placed them there, and died when his assistant did so. Finally he found that on account of the eels being so slippery his assistant had used a cloth in handling them and rubbed off their slime, while M. Bert used his wet hands to which very little adhered. Osmosis had occured in the denuded portions and the eels died. Observations on introducing sea fish into fresh water producad analogous results. The gills were the seat of alterations, the same as those noted in the fresh water fish ; and he observed that the life of sea fish could be prolonged after the change by adding salt, which also tended to coufirm his views.

The shad, which passes so much of its life in the sea, cannot live there when first hatched. The experiments conducted by Prof. Milner and others, by direction of Prof. Baird, at Noank, Conn., in 1874, while I was on the way to Germany with young shad, showed that the newly hatched fish soon died under a gradual addition of sea water. My shad starved to death on the tenth day, as we reached England, and as it was impossible, and is

yet in our ignorance, to feed the fry, it was hoped that they could be trained to endure sea water and find food in it as they do in river water when we transport them inland.

Concerning the alewife in fresh water, the Watertown, N. Y., *Times* said, in June, 1878: "In the bay at Dexter they are having a great run of small fish at the present time. The species is new down there, and they are called shad and 'herring.' They are only caught in nets, and in such great quantities that they are almost valueless. They are sold at twenty-five cents per barrel, and farmers are buying them for manure." The fish proved to be one of the species of alewife and not young shad, as some of the fishermen supposed, as proved by the following letter from Dr. Bean written to me shortly after in reply to one in which I sent the account:

SMITHSONIAN INSTITUTE, Washington.

MR. FRED. MATHER.—Your letter and article on a supposed shad in Lake Ontario particularly attracted my attention. The Institution has received specimens of the so-called shad, and also from Cayuga and Seneca lakes, New York. These fishes were not shad, but alewives, *Pomolobus pseudoharengus*. The individuals from Lake Ontario were spent females and could not be distinguished from the average alewife of the coast, even by their size. The Cayuga and Seneca Lake specimens were *young* females and males. The ova of the females was quite immature. These alewives differ from the coast alewife *only in size*. I have compared the last specimens with a large series from the coast, and find no other difference.

Yours very truly,
TARLETON H. BEAN.

It is evident that the alewife is not appreciated at its full value among the people residing near its new home. It is a fish of great value, coming in enormous schools, and when they learn to eat it in its fresh state and salt it for winter, they would grieve to lose it. It is not a fine fish in the epicurean sense, but like the farmer's pork barrel, it is a good reserve to draw upon when the butcher fails to get through the snow drifts.

There are many good fishes which can safely be transplanted from salt water to fresh, and one object of this paper has been to show that it can be done with certain species if done gradu-

ally. Among the most valuable of these are the smelt, the striped bass, the tom-cod and the alewife. The smelt is already established in fresh water in Vermont, New Hampshire and New York. The Vermont Fish Commissioners say that smelt have been fully established in every lake into which they have been placed and heard from, and it is a curious fact that the people have not found out what a truly excellent fish this is for the table, its insignificant size seeming to fully protect it, save from an occasional fisherman who has taken them for *bait.* This use of smelts would cause smelt-fishers to raise their eyebrows and examine the man who did such a thing in their presence ; but the rural angler will get over that in time, which will educate him that the little smelt has other uses and a higher value. The report truly says of the smelt : " When they come to be established wherever there is a fit lodgment for them, that event alone will fully pay for all the expenses incurred since the formation of the Commission."

In New York it has been established so long that the memory of man runneth not to the contrary, and in the Adirondacks the guides call it " frostfish " and salt it down. It is found in some of the Fulton chain of lakes and not in others, a very interesting account of which will be found in *Forest and Stream* some time during the coming month (April), from the pen of Mr. E. R. Wilson. They are locally known as frostfish in that region. Mr. Wilson says : " Some time ago I observed in your columns an inquiry relative to the finding of smelts or " frostfish " in fresh water. The so-called frostfish is found in several lakes of the Fulton chain, in the 'John Brown's Tract.' Most visitors to that region have annually wondered at the sight of the old wooden weirs or 'picket lines' set up in the inlets. These fish run up the shoal inlets between those lakes in October, or about the period of the advent of frost—whence the peculiar title—at which time they are taken and salted down in considerable numbers by the guides for home use, and occasionally sent to the adjoining settlements. The fish is a regular habitant of Second, Fourth and Eighth lakes of the Fulton chain, and also Racquette Lake —all deep waters. They seem to stick to the deeper lakes, except in the spawning season, and are a favorite dainty for the salmon

trout, as I have frequently caught the latter all through the summer, both by trolling and deep fishing, which, on opening, almost invariably contained the remnants of frostfish. Early in 1862 a party of us camped at the head of Fourth Lake and set buoys for salmon trout. The suckers had not commenced to run, and we had no bait, so sent back to Arnold's for a net, which we set out well in the lake, off the mouth of the inlet. On hauling it the next morning we found the 'net proceeds' comprised suckers and (tell it not, for we let them go), speckled trout, with some twenty frostfish. After baiting the buoys we found that the 'lakers' bit best at the latter. The guides claim to prefer the fresh frostfish as an article of diet to any trout that swims. They run remarkably uniform in weight, say about one pound, and are somewhat slim in proportion to length, with bright white scales, and flesh of firm texture and light color. They have a long nose, and are evidently a bottom fish. The guides say that the young, when hatched, immediately head for deep water, and reappear only to spawn when fully grown.

"There is a physical oddity in the topographical distribution of this fish. Eighth Lake is entirely disconnected from Fourth Lake, or any others on the chain, and Racquette has a long land barrier from any waters known to contain this finny denizen. A veteran visitant to the Nothern Wilds, Mr. L. H. Redfield, of Syracuse, advances the theory that fish spawn are transported over long distances by being entangled in the feet of wild fowl, and also that mature fish are carried over intervening land through the agency of water spouts. Without the aid of some similar hypothesis, it would seem difficult to account for the presence of finny population in certain localities. I once stumbled upon a little bowl of a lake in that section, away up close to the crest of a mountain, swarming with trout and the course of its only outlet, a mile or two long, would have broken the neck of an Alpine goat to descend, and his very heart to look at the cataract descent. There are two lakes near the mouth of the Moose River, severally known as "Indian" and "Squaw" lakes, separated by high falls impassable for fish, while the lower pond literally teems with trout, yet my companion trappers and guides

asserted roundly that not a fish had been taken in the upper waters. From sheer contradictory "cussedness" I fished it for the best portion of three days with fly-bait—from shore and dug out—and with every possible device and captivation, without raising a fin. The water was clear, the season right and every surrounding apparently favorable, yet I couldn't circumvent the first sight of a scale from its crystalline depths. To discount my disgust I caught a dozen or so *Salmo fontinalis* from the lower lake, and transported them safely into a camp-pail through the woods to the upper sheet, where I trust they have since followed the scriptual injunction in their new Eden. Eheu! that I might revisit those shores next summer and see.—E. R. WILSON."

Mr. N. K. Fairbank, of Chicago, one of the Fish Commissioners of Illinois, owns a part of Geneva Lake, just over the line in Wisconsin, and has ordered a million of smelt fry from Mr. Ricardo this spring. Mr. Fairbank has succeeded in completely land-locking the quinnat salmon, an account of which can be found in *Forest and Stream* of February 10th, of this year; they have not only lived but have spawned.

The introduction of a new fish requires that the people should be educated to appreciate it. The small size of the smelt in the case of the people living near the Vermont lakes led them to neglect it for any purpose but bait, and there are people who are accustomed to seeing them eaten who think it necessary to remove the head and the bones. This may be necessary in the case of the large Eastern smelts, which sometimes weigh half a pound but in the delicate little New Jersey smelts, they are simply cooked without opening and taken in the fingers by the tail and eaten, there being no waste whatever.

The striped bass is another fish which, although we do not know of its being perfectly acclimated in fresh water, I believe would readily become so; and in this connection permit me to quote from *Forest and Stream* of to-day (March 31) as follows:

STRIPED BASS IN LAKE ONTARIO.

We saw the following in the Watertown *Times* of March 15th: 'Clark & Robbins, the fish merchants of Sacket's Harbor, had

brought to their office the other day a sea bass, probably the only one ever caught in the lake or river. It was caught in Chaumont Bay and weighed six pounds. They are a very fine fish, and it is thought by some that this is a forerunner and that there will be others caught."

We immediately wrote the firm named, inclosing drawings of two fishes which might be meant by the term "sea bass," and received the following reply:

SACKET'S HARBOR, N. Y., March 24th.

"Your favor of the 21st inst. at hand with inclosure of slip from the Watertown *Times*, also drawings. The fish taken here was the lower one in drawing—*Roccus lineatus*—or striped bass of New York.

It is the first one ever seen by us taken from these waters, and we have an idea that it found its way up here by following the alewife, The specimen was very handsome, and there is no doubt as to its identity, The great question here is, "What will be the ultimate result of the appearance here of the alewife?" Have they caused the extermination of the native ciscoe? Will the alewife remain with us, or are they to disappear as mysteriously as they came, or will some of the food fishes of the salt water become *habitues* of our lake?

These are questions we hardly dare venture an opinion on, as we really can see no good that is to be enduring by the appearance of the alewife in our waters.

We should be glad to read your opinion on these questions, and would be pleased if the Department at Washington would appoint a commission to investigate. The subject needs to be dealt with in a masterly manner. CLARK & ROBBINS."

The Ogdensburg *Journal* has an article on the alewife as follows, for we think we are correct in assuming that they refer to this fish when they speak of menhaden, which do not go into fresh waters in this latitude. It says:

"Considerable interest will hang upon the question, 'What effect did the singular mortality noticed last year have upon the alewives or menhaden of the St. Lawrence?' The total absence from the fish market of the old-fashioned ciscoes of Lake Ontario, reminds us that this species of fish have been supplanted by the newcomers as certainly as the aborigines have disappeared before the whites on the land. If it shall turn out that the men-

haden are as numerous as ever the present season, the fish commissioner should take some steps to investigate them and teach the people how to utilize their presence. If the presence of the sea bass recently caught near Sacket's Harbor comes from the following of the menhaden to our waters, and other species are liable to do the same thing, fishermen and fish eaters may be benefited by the facts. We suggest the superintendent of the Fishery Department send a duly qualified deputation to the St. Lawrence in June of the present year, to investigate the menhaden visitation which takes place at that time."

The people are alarmed at the new visitation ; but, in my opinion, when they learn that the alewife can be eaten and salted for winter they will find that its greatly increased numbers will make it a more valuable fish than the lamented "cisco," as it breeds faster, being a spring spawner and therefore hatching quicker, as well as having smaller eggs and many more of them.

There may be no fresh water fishes which would be of practical value if introduced into salt water, but it is interesting from a zoological point of view to know that some of them will live there. The brook trout of Long Island run down into the salt bays and the sea and feed on shrimp, and some species of white fish are recorded by Pallas as living in the sea and sending off legions into the streams flowing from Lake Baikal, from whence some of the young return and some remain in fresh water forever ; while shad have been taken in the Genesee River, in western New York, and in Lake Erie, at Toledo, as well as in Lake Champlain. It is also reported that two valuable salt water fishes of Europe, the basse (*Labrax*), and the gray mullet (*Mugil*), are artificially bred in pure fresh water in the Lake of Acqua, near Padua, at the head of the Adriatic.

POACHERS.

BY JAMES ANNIN, JR.

I shall endeavor to give a list of some of the most destructive frequenters of the trout pond and stream which have come under my observation, and also some of the remedies used.

First, I have the kingfisher. His notes are heard from early spring until cold weather in late fall, and sometimes he will appear during the winter, like some sportsmen I have seen who could not stand it until the season opened in the spring, but they must just go and take a look at the stream where, during the summer past, they had had such fine sport.

This bird is never satisfied. From daylight to dusk he is on the lookout, and ever ready to plunge in after any fish which may be exposed.

I honestly think that a kingfisher, undisturbed during his stay on or near the stream, will take as many trout as the average sportsman. Some say, Why don't you shoot them? Well, cold lead is very good when you get the time and chance to send it after them, but you can't be on the look-out all the time, and I think the best way to get the fellow out of harm's way is to trap him. For that purpose I have used small, round steel traps, the kind without the shank or tail-piece, fastening them on the end of a pole, say ten or fifteen feet long, and then putting them up along the stream near enough to a good fishing spot, so that the bird may think it a splendid point to make observations from. When the trap is set and in position the little plate or drop is a little the highest part of the trap, and as he flies up and drops on the trap you have him every time, and by both legs. I have taken as many as three of the birds in one trap during a day. It is always ready; it costs nothing to keep it running besides the first cost of the trap. Occasionally you will have a visit from some other variety of birds. I have taken large fish-hawks, owls, etc.; never but one robin.

Next come the ducks, wild and domestic. The latter are very destructive, not only to the fish but to the fish food of the stream. They are almost always at work feeding during the day, and are not easily driven away.

The best plan is to have no ducks yourself, and if your neighbors have them and they come on your premises, offer to buy them, and with the understanding if they have more and they trouble you that you will shoot. I have seen a tame duck catch and swallow a trout six inches long.

But few species of wild duck trouble fish much, but during the past winter I was annoyed by a flock of what I called sawbills or sheldrakes. Most of the streams throughout the country were frozen, and they came to our Caledonia Spring Creek as that never freezes. I had a hard time with them for about two weeks in trying to keep them off. If occasionally I could get a shot they would only fly to the other end of the stream, and would soon be back. (The stream is only about one mile long.) They would go over the large spawning beds where you could see from one hundred to a thousand fish, and after they had been over it you would not see a fish, and could not find one near for all that day, and once or twice it was the third day before they began to show up again.

I found that shooting did not work, so I made some scarecrows out of old clothes and set them up on the bank of the stream. That did very well for a day or two, but they soon saw through the fraud and were as bad as ever. I then thought I would try something that would move, as I saw that a boat on the stream, or a person in motion would start them the moment they saw it, even if a long way off. So I made some small red flannel flags and put them by the side of the scarecrows, and that did the business, and I had no more trouble with the sheldrakes.

Next I have the common hoot or screech owl. I have but little to say about them, as they have given me but little trouble or damage that I know of. What first made me suspect that they were up to some mischief was that I found them in my steel traps that were set for muskrat, mink, etc. In setting traps for these we generally place them under the surface of the water from one to four inches, and when I found the owls in them I

could not make out what they were after in the water, but I soon found that it was for the fish-food in the stream, such as the fresh water lobster, caddis worm, shrimp, etc. So that if not a direct enemy to the fish they indirectly do much harm, as I said under the head of Poachers No. I. I have taken them during the night in the traps placed for kingfishers.

Then comes the heron, the "blue heron," and what a wicked fellow, dealing death to everything in the fish line that he once strikes with that long, heavy and sharp bill of his. Most of his poaching is carried on after dark and early mornings. During the day you find him in the more secluded parts of the stream or marshes, but after dark he will come into any of your shallow ponds, coming to within a rod or two of your house, and as the fish move around (he standing in the water perfectly motionless), and come within his reach, he strikes, and good-bye to the fish if he hits him. From what I have seen myself and heard from others, I think the bird capable of getting outside of from one to two dozen, three dozen trout in one night.

During the summer, when I have been out night-fishing, I have often heard within a short distance of me a great flopping and disturbance in the water. The next morning I have often gone to the spot as near as possible, and found the mark of the heron's feet, and very often near by the stream a large trout, say from one-half to one pound in weight, dead, with a hole in his back or side into which you could put your finger, and sometimes going through the fish. I suppose the fish found in this shape were a little too large and strong for the heron, and got away from him, but only to die from the effects of the wound.

If you see their marks, or think herons are visiting your ponds or stream, at once get out your steel traps, and at the spot frequented most set one, two or three, the more the better. Set them in the shallow water or soft mud without baiting. Secure the trap well, for when they find themselves caught they start to fly, and will carry it off unless proper precaution is used. I have taken several in this way, and sometimes in winter. When you find one in your trap be very careful about going very near until you have quieted him with a long club or a charge of shot, for

they are savage, and can and will inflict a bad wound, as I know from experience.

The bittern, a bird something after the nature of the heron, only very much smaller, must do some damage. I always shoot him when I can.

Then I have the muskrat. In his poaching he is after much the same food as the owls, only I think not quite as much of a variety. The only thing I have observed him taking was the caddis worm, which he has a great liking for. I have seen at least a peck of the empty caddis worm cases in one pile on the bank at the water's edge, which he had taken from the stream. He is also troublesome, and sometimes causes much damage by undermining the banks of your ponds, and by eating off the slats to your screens. I also make way with these by trapping in the winter and spring. At this season their fur is in prime order, and will sell for enough to pay for the time and trouble. I sell every spring from ten to fifteen dollars' worth of their fur. I have never seen any evidence of their catching or eating fish.

Then comes the mink, which is one of the greatest enemies the fishculturist has to contend with. If a trout is in the stream or pond, and they want it they will have it. If they get the notion of coming to one of your ponds they will follow it up until the fish are gone. If you don't keep good watch they will have half of them before you are aware of it. As soon as you think a mink is taking your fish lay for him. See how and where he goes into the pond. You will soon see that he enters at about the same place each time ; then set your trap just under the water, so that when he slides down (as he thinks) into the pond he will slide into the trap instead. In this way I took the mother and brood of four almost full-grown minks in two nights. One mink may destroy a hundred dollars' worth of fish in a short time. They often appear to catch them for the sport of the thing. I have seen them slide down the bank of a stream into the water, coming up with a fish, and repeating it time and again, hardly ever failing to get one.

Snakes.— I will not say all the snakes found along a stream will catch fish, but I have seen what I called a water-adder, thirty inches long, catch a trout of five ounces in weight, and I have

seen one of the same variety killed and opened that had three trout in his stomach. A gentleman told me this spring, that last summer he was passing near a pond which contained brook trout, and he saw a snake glide down the bank into the water, and as the water was clear he watched him. He went into some moss that was on the bottom of the pond. Entering the moss from below, soon he saw his head appear in the top of the bunch of moss, and then, for the first time, he noticed a small trout, about four inches long, that was almost over the snake's head. After slowly drawing his head out a little he made a dart for the fish and caught him; then came out on the bank. The only method I have found for their destruction is to kill them whenever they come in your path. In the months of May and June they may be found along the banks of streams or ponds sunning themselves, when a charge of No. 6 or 8 shot will put them on the retired list.

Last, but not least, I have the one coming more directly under the title of my paper, man. He knows better, but I am sorry to say that he steps over the mark very often, and in many cases proves the most troublesome of all, often deserving a charge of fine shot. If you commence an action against him, many (I am very sorry to say it) of our justices only wink at the offender, and he goes free. We know of the justice himself going on a private and posted stream, knowing it to be so, and afterwards telling of the good luck he had. A certain class of our people regard it as a smart thing to take trout from your pond or stream without being caught. But if any one should steal a chicken from them they say, "Oh that's a different thing." I have caught boys and men on my stream and a sign prohibiting fishing within ten feet of it. I have spoken to the boys' fathers and had each one make good promises that they would see to it that their boy never was there again, but when your back was turned laugh at you, and make brags to their neighbors of what a good mess of trout his boy caught. I think it will be a long time before all of our people get educated up to the point that they see the stealing of a few trout a sin.

I think some good would be accomplished if every sportsman and member of sporting clubs throughout the country would see

that at conventions or caucuses for nomination of local or town officers, the nominee for justice is one that will stand firm and give the offender the full extent of the law.

THE EEL QUESTION.

BY PROF. G. BROWN GOODE.*

NUMBER OF SPECIES OF EELS IN AMERICA.

It is the disposition of American ichthyologists to accept, for the present, the views of Dareste, and to consider all the eels of the northern hemisphere as members of one polemorphic species. Gunther is inclined to recognize three species in North America: one the commcn eel of Europe, *Anguilla vulgaris;* one the common American eel, *Anguilla bostoniensis*, which he finds also in Japan and China; and the third, *Anguilla texana*, described and illustrated by Girard, in the Report of the United States and Mexican Boundary Survey, under the name of *A. texana*, which, he remarks, is scarcely specifically distinct from *A. bostoniensis*, from which it differs only in the greater development of the lips. The distinction between *A. bostoniensis* and *A. vulgaris*, as stated by him, consists chiefly in the fact that the dorsal fin is situated a little farther back upon the body. so that in the former the distance between the commencement of the dorsal and anal fin is shorter than the head, while in the latter it is equal to or somewhat longer than it. This character does not appear to be at all constant.

GEOGRAPHICAL DISTRIBUTION OF THE EEL.

We may therefore provisionally assume the identity of the eels of the old and the new world, and define their distribution somewhat as follows: In the rivers and along the ocean shores of Eastern North America, south to Texas and Mexico, and north at least to the Gulf of St. Lawrence, but absent in the waters tributary to Hudson Bay, the Arctic Sea and the Pacific; present

*This paper, in a more extended form and with illustrations from anatomical designs, is published in the Bulletin of the United States Fish Commission, Vol. I., 1881, pp. — to 124.

in Southern Greenland (?) and Iceland, latitude 65 deg. north; on the entire coast of Norway, from the North Cape, latitude 71 deg., southward; abundant in the Baltic and in the rivers of Russia and Germany, which are its tributaries, and along the entire western and Mediterranean coasts of Europe, though not present in the Black Sea, in the Danube, or any other of its tributaries, or in the Caspian; occurring also off Japan and China and Formosa; also in various islands of the Atlantic, Granada, Dominica, the Bermudas, Madeira and the Azores.

GENERAL NOTE ON HABITS. [Professor BAIRD.]

The habits of the eel are very different from those of any other fish, and are as yet but little understood.

"This, so far as we know," writes Professor Baird, "is the only fish the young of which ascend from the sea to attain maturity, instead of descending from the fresh to the salt water. Its natural history has been a matter of considerable inquiry within a few years, although even now we are far from having that information concerning it that would be desirable, in view of its enormous abundance and its great value as a food fish.

"The eggs of the eel are for the most part laid in the sea, and in the early spring, the period varying with the latitude, the young fish may be seen ascending the river in vast numbers, and when arrested by an apparently impassable barrier, natural or artificial, they will leave the water and make their way above the obstruction, in endeavoring to reach the point at which they aim. Here they bury themselves in the mud and feed on any kind of animal substance, the spawn of fish, the roes of shad, small fish, etc. At the end of their sojourn in the ponds or streams they return to the sea, and are then captured in immense numbers in many rivers in what are called fish-baskets. A V-shaped fence is made, with the opening down stream into the basket, into which the eels fall, and from which they cannot easily escape. This same device, it may be incidentally stated, captures also great numbers of other fish, such as shad, salmon, and other anadromous fish, to their grievous destruction.

"As might be expected, however, the Falls of Niagara consti-

tute an impassable barrier to their ascent. The fish is very abundant in Lake Ontario, and until artificially introduced was unknown in Lake Erie. At the present time, in the spring and summer, the visitor who enters under the sheet of water at the foot of the falls will be astonished at the enormous number of young eels crawling over the slippery rocks and squirming in the seething whirlpools. An estimate of hundreds of wagon-loads, as seen in the course of the perilous journey referred to, would hardly be considered excessive by those who have visited the spot at a suitable season of the year."*

INTRODUCTION OF EELS INTO NEW WATERS IN THE UNITED STATES.

In describing the geographical distribution of the eel it was stated that it occurs in the rivers and along the ocean shores of North America. This being the case, as might be supposed, there are many inland lakes and streams of the United States in which this fish does not occur; for instance, in the chain of great lakes above Niagara Falls and in the upper waters of other streams in which there are considerable obstruc.ions. The cutting of canals in various parts of the country has, however, produced a great change in their distribution; for instance, it is stated by Mitchell† that eels were unknown in the Passaic above the Great Falls until a canal was cut at Paterson, since which time they have become plentiful in the upper branches of that river. They have also been placed in many new localities by the agency of man. Concerning this Mr. Milner remarks:

"The eel (*Anguilla bostoniensis*), appreciated in some localities and much vilified in others, is another species that has been frequently transplanted. It is pretty evident that it never existed naturally in the chain of great lakes any higher up than Niagara Falls, although specimens have been taken in Lakes Erie and Michigan. Their existence there is with little doubt traceable to artificial transportation.

"A captain of a lake vessel informed me that it was quite a common thing some years ago to carry a quantity of live eels in

*MS. note by Professor Baird.

†Transactions Lit. and Phil. Soc. New York, I., p. 48.

a tub on the deck of a vessel while on Lake Ontario, and they were often taken in this manner through the Welland Canal. He said that it was a frequent occurrence on his vessel, when they had become tired of them, or had procured better fishes, to turn the remainder alive into the waters of Lake Erie.

"In 1871 Mr. A. Booth, a large dealer of Chicago, had an eel of four pounds weight sent him from the south end of Lake Michigan, and a few weeks afterward a fisherman of Ahneepee, Wis., nearly 200 miles to the northward, wrote him that he had taken a few eels at that point. It was a matter of interest to account for their presence, and a long time afterward we learned that some parties at Eaton Rapids, Mich., on a tributary of the lake, had imported a number of eels and put them in the stream at that place, from which they had doubtless made their way to the points where they were taken. The unfortunate aquarium-car, in June, 1873, by means of the accident that occurred at Elkhorn River, released a number of eels into that stream, and about four thousand were placed by the United States Commission in the Calumet River at South Chicago, Ill.. two hundred in Dead River, Waukegan, Ill., and three thousand eight hundred in Fox River, Wisconsin."*

They have since been successfully introduced into California.

GUNTHER ON THE LIFE-HABITS OF THE EEL.

Concerning the life-history of the eel much has been written, and there have been many disputes even so late as 1880. In the article upon Ichthyology, contributed to the Encyclopedia Britannica, Gunther writes:

"There is no group of fishes concerning the classification and history of which there is so much doubt as the eel family; an infinite number have been described, but most are so badly characterized, or founded on individual or so trivial characters, that the majority of the ichthyologists will reject them."‡

In his Catalogue of the Fishes in the British Museum, Dr. Gunther has claimed to retain those as species which are distin-

*Report U. S. Fish Commission, p. 2, 1874, 526.

‡Gunther, Catalogue of Fishes British Museum, VIII., p. 24.

guished by such characters that they may be recognized, though he remarks that he is by no means certain whether really specific value should be attached to them, remarking that the snout, the form of the eyes, the width of the bands of teeth, etc., are evidently subject to much variation. In his more recent work he remarks, "Some twenty-five species of eels are known from the coast waters of the temperate and tropical zones."

DARESTE'S VIEWS.

Other recent writers have cut the knot by combining all of the eels into three or four, or even into one species, and it seems as if no other course were really practicable, since the different forms merge into one another with almost imperceptible gradations. In his monograph of the family of Anguilla-formed fishes† M. C. M. Dareste remarks:

"Dr. Gunther has recently published a monograph of the apodal fishes, in which he begins the work of reducing the number of specific types. The study of the ichthyological collection of the Paris Museum, which contains nearly all of Kaup's types, has given me the opportunity of completing the work begun by Dr. Gunther, and of striking from the catalogue a large number of nominal species which are founded solely upon individual peculiarities.

"How are we to distinguish individual peculiarities from the true specific characters? In this matter I have followed the suggestions made with such great force by M. Siebold in his History of the Fresh Water Fishes of Central Europe. This accomplished naturalist has shown that the relative proportions of the different parts of the body and the head vary considerably in fishes of the same species, in accordance with certain physiological conditions, and that consequently they are far from having the importance which has usually been attributed to them in the determination of specific characters.

"The study of a very large number of individuals of the genera *Conger* and *Anguilla* has fully convinced me of the justice of this observation of Siebold; for the extreme variability

†Comptes Rendus of the Academy of Sciences. Paris.

of proportions forbids us to consider them as furnishing true specific characters.

"I also think, with Siebold, that albinism and melanism, that is to say, the diminution or augmentation of the number of chromatophores, are only individual anomalies and cannot be ranked as specific characters. Risso long since separated the black congers under the name *Muræna nigra*. Kaup described as distinct species many black Anguillas. These species should be suppressed. I have elsewhere proved the frequent occurrence of melanism and albinism more or less complete in nearly all the types of fishes belonging to this family, a fact especially interesting, since albinism has hitherto been regarded as a very exceptional phenomenon in the group of fishes. This also occurs in the *Symbranchidæ*. I have recently shown it in a specimen of *Monopterus* from Cochin China, presented to the museum by M. Geoffroy St. Hilaire.

"I must also signalize a new cause of multiplication of species; it is partial or total absence of ossification in certain individuals. This phenomenon, which may be explained as a kind of *rachitis* (rickets), has not to my knowledge been noticed, yet I have found it in a large number of specimens. I had prepared the skeleton of a *Conger* of medium size, the bones of which are flexible and have remained in an entirely cartilaginous state. Still it is not necessary to prepare the skeleton to determine the absence of ossification, for we can establish this easily in unskinned specimens by the flexibility of the jaws. It is very remarkable that this modification of the skeleton is not incompatible with healthy existence, and that it does not prevent the fish in which it is found from attaining a very large size.

"Those fishes in which ossification is absent are remarkable by reason of the great reduction of the number of teeth, which, although the only parts which become hard by the deposit of calcareous salts, remain, however, much smaller than in individuals whose skeletons are completely ossified.

"We can thus understand how such specimens could present characters apparently specific, and that they should have been considered by Kaup as types of new species. These considera-

tions have led me to reduce, on an extensive scale, the number of species in the family.

So, in the genus *Anguilla*, I find but four species: *Anguilla vulgaris*, occurring throughout the northern hemisphere, in the new world as well as the old. *Angutlla marmorata* and *A. mowa* of the Indian Ocean, and *Anguilla megalostoma* of Oceanica.

"There are at least four distinct types, resulting from the combination of a certain number of characters; but the study of a very large number of specimens belonging to these four specific types has convinced me that each of these characters may vary indepenedntly, and that consequently certain individuals exhibit a combination of characters belonging to two distinct types. It is therefore impossible to establish clearly defined barriers sepa rating these four types.

"The genus *Anguilla* exhibits, then, a phenomenon which is also found in many other genera, and even in the genus *Homo* itself, and which can be explained in only two ways: Either these four forms have had a common origin, and are merely races, not species, or else they are distinct in origin, and are true species, but have been more or less intermingled, and have produced by their mingling intermediate forms which coexist with those which were primitive. Science is not in the position to decide positively between these alternatives."

ANCIENT BELIEFS CONCERNING THE REPRODUCTION OF THE EEL.

The reproduction of the eel, continues Benecke, has been an unsolved riddle since the time of Aristotle, and has given rise to the most wonderful conjectures and assertions. Leaving out of question the old theories that the eels are generated from slime, from dew, from horsehair, from the skins of the old eels, or from those of snakes, and the question as to whether they are produced by the female of the eel or by that of some other species of fish, it has for centuries been a question of dispute whether the eel is an egg-laying animal or whether it produces its young alive; although the fishermen believe that they can tell the male and female eels by the form of the snout. A hundred years ago no man had ever found the sexual organs in the eel.

Jacoby has remarked that the eel was from the earliest times a riddle to the Greeks; while ages ago it was known by them at what periods all other kinds of fishes laid their eggs, such discoveries were never made with reference to the eel, though thousands upon thousands were yearly applied to culinary uses. The Greek poets, following the usage of their day, which was to attribute to Jupiter all children whose paternity was doubtful, were accustomed to say that Jupiter was also progenitor of the eel.

"When we bear in mind," writes Jacoby, "the veneration in which Aristotle was held in ancient times, and still more throughout the Middle Ages—a period of nearly two thousand years—it could not be otherwise than that this wonderful statement should be believed and that it should be embellished by numerous additional legends and amplifications, many of which have held their own in the popular mind until the present day. There is no animal concerning whose origin and existence there is such a number of false beliefs and ridiculous fables. Some of these may be put aside as fabrications; others were, probably, more or less true, but all the opinions concerning the propagation of the eel may be grouped together as errors into three classes:

"(I) The beliefs which, in accordance with the description of Aristotle, account for the origin of the eel not by their development from the mud of the earth, but from slimy masses which are found where the eels rub their bodies against each other. This opinion was advanced by Pliny, by Athenæus, and by Oppian, and in the sixteenth century was again advocated by Rondelét and reiterated by Conrad Gessner.

"(II.) Other authorities base their claims upon the occasional discovery of worm-like animals in the intestines of the eels, which they described, with more or less zealous belief, as the young eels, claiming that the eel should be considered as an animal which brought forth its young alive, although Aristotle in his day had pronounced this belief erroneous, and very rightly had stated that these objects were probably intestinal worms. Those who discovered them anew had no hesitation in pronouncing them young eels which were to be born alive. This opinion was first brought up in the Middle Ages in the writings

of Albertus Magnus, and in the following centuries by the zoölogists Leuwenhoek, Elsner, Redi, and Fahlberg; even Linnæus assented to this belief and stated that the eel was viviparous. It is but natural that unskilled observers, when they open an eel and find inside of it a greater or smaller number of living creatures with elongated bodies, should be satisfied, without further observation, that these are the young of the eel; it may be distinctly stated, however, that in all cases where eels of this sort have been scientifically investigated, they have been found to be intestinal worms.*

"(III.) The last group of errors includes the various suppositions that eels are born not from eels, but from other fishes, and even from animals which do not belong at all to the class of fishes. Absurd as this supposition, which, in fact, was contradicted by Aristotle, may seem, it is found at the present day among the eel-catchers in many parts of the world.

"On the coast of Germany a fish related to the cod, *Zoarces viviparus*, which brings its young living into the world, owes to this circumstance its name *Allmuter*, or eel mother, and similar names are found on the coast of Scandinavia."

"In the lagoon of Comacchio," continues Jacoby, "I have again convinced myself of the ineradicable belief among the fishermen that the eel is born of other fishes; they point to special differences in color, and especially in the common mullet, *Mugil cephalus*, as the causes of variations in color and form among eels. It is a very ancient belief, widely prevalent to the present day, that eels pair with water snakes. In Sardinia the fishermen cling to the belief that a certain beetle, the so-called water-beetle, *Dytiscus Roeselii*, is the progenitor of eels, and they therefore call 'this mother of eels.'"

SEARCH FOR AND DISCOVERY OF THE FEMALE EEL.

A scientific investigation into the generation of eels could only

*It is very strange that an observer, so careful as Dr. Jacoby, should denounce in this connection the well-known error of Dr. Eberhard, of Rostock, who mistook a species of zoarces for an eel, and described the young, which he found alive within the body of its mother, as the embryo of the eel. In Jacoby's essay, p. 24, he states that the animal described by Eberhard was simply an intestinal worm, an error which will be manifest to all who will take the pains to examine the figure.

begin when at the end of the Middle Ages, the prohibition which the veneration for Aristotle had thrown over the investigations of learned men was thrown aside. With the revival of the natural sciences in the sixteenth century we find that investigators turned themselves with great zeal to this special question. There are treatises upon the generation of the eel written by the most renowned investigators of that period, such as Rondelet, Salviani, and Aldrovandi. Nevertheless, this, like the following century, was burdened with the memory of the numerous past opinions upon the eel question, and with the supposed finding of young inside the body of the eel.

The principle supporters of the theory that the eel was viviparous, were Albertus Magnus, Leuwenhoek, Elsner, Redi, and Fahlberg. The naturalists, Franz Redi and Christian Franz Paullini, who lived in the seventeenth century, must be mentioned as the first who were of the opinion, founded, however, upon no special observations, that the generation of the eel was in no respect different from that of other fishes.

In the eighteenth century it was for the first time maintained that the female organs of the eel could certainly be recognized. It is interesting that the lake of Comacchio was the starting point for this conclusion as well as for many of the errors which had preceded it. The learned surgeon, Sancassini, of Comacchio, visiting an eel fishery at that place in 1707, found an eel with its belly conspicuously enlarged; he opened it and found an organ resembling an ovary, and, as it appeared to him, ripe eggs. Thereupon he sent his find, properly preserved, to his friend, the celebrated naturalist, Valisneri, professor in the university of Padua, who examined it carefully and finally, to his own great delight, became satisfied that he had found the ovaries of the eel. He prepared an elaborate communication upon the subject, which he sent to the Academy at Bologna.*

At the very beginning there were grave questions raised as to the correctness of this discovery. The principal anatomical authority at Bologna, Professor Valsalva, appears to have shared

* I fail to find any record of the publication of this paper, except that given by Jacoby, who states that it was printed at Venice, in 1710 with a plate, and subsequently, in 1712, under the title "Di ovario Anguillarum," in the proceedings of the Leopold Academy.

these doubts, especially since shortly after that a second specimen of eel, which presented the same appearance as that which was described by Vallisneri, was sent from Comacchio to Bologna. The discussion continued, and it soon came to be regarded by the scientific men of Bologna as a matter of extreme importance to find the true ovaries of the eel. Pietro Molinelli offered to the fishermen of Comacchio a valuable reward if they would bring him a gravid eel. In 1752 he received from a fisherman a living eel with its belly much extended, which, when opened in the presence of a friend, he found to be filled with eggs. Unfortunately the joyful hopes which had been excited by this fortunate discovery were bitterly disappointed when it was shown that the eel had been cunningly opened by the fisherman and filled with the eggs of another fish. The eel question came up again with somewhat more satisfactory results when, in the year 1777, another eel was taken at Comacchio which showed the same appearance as the two which had preceded it. This eel was received by Prof. Cajetan Monti, who, being indisposed and unable to carry on the investigation alone, sent a number of his favorite pupils to a council at his house, among whom was the celebrated Camillo Galvani, the discoverer of galvanism. This eel was examined by them all and pronounced to be precisely similar to the one which had been described by Vallisneri seventy years before. It was unanimously decided that this precious specimen should be sent for exhaustive examination to the naturalist Mondini, who applied himself with great zeal to the task, the results of which were published in May, 1777. The paper is entitled "De Anguillæ ovariis," and was published six years later in the transactions of the Bologna Academy.* Mondini was satisfied that the supposed fish which Vallisneri described was nothing but the swimming bladder of the eel in a diseased state, and that the bodies supposed to be eggs were simply postules in this diseased tissue. In connection with this opinion, however, Mondini gave, and illustrated by magnificent plates, a good description and demonstration of the true ovaries of the eel, as found by himself. This work, which in its beautiful plates illustrates also the eggs in a magnified fold of the ovary, must be regarded as classical work, and it is an

act of historic justice to state that neither O. F. Müller nor Rathke, but really Carlo Mondini was the first discoverer, describer, and demonstrator of the female organs of the eel, which had been sought for so many centuries.*

Three years later, entirely independent of Mondini, the celebrated zoölogist, Otto Friedrich Müller, published his discovery of the ovary of the eel in the "Proceedings of the Society of Naturalists," at Berlin.

The discovery of Mondini was next specially brought into prominence through Lazzaro Spallanzani. This renowned investigator, in October, 1792, went from Pavia to the lagoons of the Po, near Comacchio, for the sole purpose of there studying the eel question. He remained at Comacchio through the autumn; he was, however, unable to find anything that was new regarding the question, but in the report upon his journey of investigation he entirely threw aside the discovery of Mondini, and announced that the ovaries discovered by this authority were simply fatty folds of the lining of the stomach.†

It was without doubt this absolute negative statement of such a skilled investigator as Spallanzani which for a long time discouraged further investigations on the eel question, and allowed what had already been discovered to be regarded as doubtful, as finally to be forgotten. So when Professor Rathke, of Königsberg, in his assiduous labors upon the reproductive organs of fishes, in the year 1824, described the ovaries of the eel as two cuff and collar shaped organs on both sides of the backbone, and in the year 1838 described them as new, he was everywhere in Germany (and to a large extent to the present day) regarded as

*O. F. Müller, Bemühungen, bei den Intestinal Wurmern.

†Prof. G. B. Ercolani, of Bologna, and also Crivelli and Maggi, in their essays published in 1872, have rightly stated that Mondini's priority of discovery has been overlooked in Germany. Neither Rathke nor Hohnbaum-Hornschech nor Schlüser have mentioned his work. S. Nillson, in his Skandinavisk Fauna, 1855, says nothing of Mondini. He mentioned as the first discoverer of the ovaries O. F. Müller, while Cuvier, in his Historie Maurelle de Poissons," assigning the honor rather to Rathke. Th. von Siebold is the first to announce in his work, published in 1863, Die Süsswasserfische Von Mitteluropa, page 349, that Mondini, almost contemporaneously with O. F. Müller, and independently from him, discovered the ovaries of the eel. The error, as was discovered by Italian zoölogists later than by those of Germany, arofe from the fact that the announcement of Müller's discovery was printed in 1780, while that of Mondini, which was made in 1777, was first printed in 1783.

the discoverer. The first picture of the ovary after that of Mondini, and the first microscopical plate of the egg of the eel Hohnbaum-Hornschuch presented in a dissertion published in 1842—a paper which should be rightly considered as of great importance in the literateure of this question. The questions concerning the ovaries of the eel may be regarded as having been brought to a distinct conclusion by Rathke, who in the year 1850, published an article describing a gravid female eel, the first and only gravid specimen which had, up to that time, come into the hands of an investigator.*

HUNT FOR THE MALE EEL AND ITS DISCOVERY BY SYRSKI.

The history of the search for the female of the eel having been given, for the most part, in a translation of the work of Dr. Jacoby, it seems appropriate to quote the same author concerning the search for the male eel, which, though much shorter, is none the less interesting.

In the dissertation of Hohnbaum-Hornschuch, published in 1842, the opinion was expressed that certain cells found by the author in the ovaries which differed from the egg cells by their form and contents, should be regarded as the spermary cells of the eel, and that the eel should be regarded as hermaphrodite. Six years latter Schluser presented an interesting dissertation upon the sexes of lampreys and eels, in which he pronounced these opinions of Hohnbaum-Hornschuch to be erroneous, and expressed the opinion that the male eel must be extremely rare, or that it was different, perhaps, from the female. From this

*_Rathke_, who first, since Mondini, has in detail described (1824, 1838, and 1850) the ovaries of the eel, is considered by some to have recognized them ; but this, however, is not true, the additions made by him to Mondini's description being to a great extent erroneous. It is not true that the transverse leaflets are wanting in the ovaries of the eel, as he asserts in his last work, contrary to his former description, which was probaly based on the law of analogy, and that thereby they are distinguished from of the salmon and sturgeon. It is not true, what Rathke likewise asserts, that the genital opening of the eel consists of two small canals, for I have invariably only found one, which opens in the urethra. Rathke has certainly described the eggs quite exactly, distinguishing the larger whitish ones, having a diameter of about one-fifteenth of a line, and the smaller transparent ones, with the germinal vesicle inside ; but Mondini likewise says : "*innumeras sphærulas minimas, æquales, pellucidas, divisas tamen, quæ in centro maculam ostendebant, ecc. vedi*," thus showing the true nature of the ovaries and the eggs, and contrasting them with the fatty formation and with the ovaries and eggs of osseous fish." (Syrski).

time up to the beginning of 1870 a male eel was never seen, nor do we find any opinions expressed concerniug the form of the male of the eel or its reproductive organs.*

According to Robins in 1846, George Louis Duvemoy (Cuvier, Anatomie Comparée, ed. 2, 1848, tome viii, p. 117) described the ruffle-tube type of the testis of the lampreys and eels, with the free margin festomed in lobules, shorter to the right than to the left, like the ovaries, etc. He added: "At the breeding season, we perceive in it an innumerable quantity of granulations, or small spermatic capsules, the rounded form of which has often led to their being confounded with the ovaler, at least as the eels, in which, in reality, these capsules are nearly of the same size as the ovules, but the latter are distinguished by their oval form." The ovular are spherical, and not oval; but the other facts are fundamentally correct. It is also in error that Duvemoy adds (p. 133): "The eels and the lampreys have no deferent, canal, any more than an oviduct. Like the ova the semen ruptures the capsuler in which it has collected and diffuses itself in the abdominal cavity, whence it is expelled in the same way as in the ova." But he correctly describes the place of opening of the penbucal canal, the waters, etc. Robin, Comptes Renders, 1881, p. 383,

By some droll coincidence the university of Bologna and, soon after, that of Pavia, were again prominent participants in the eel tournament. At the meeting of the Bologna Academy, December 28th 1871, Prof .G. B. Ercolani read a paper upon the perfect hermaphroditism in the eel.*

Fourteen days later Prof. Balsamo Crivelli and L. Maggi read a detailed and elaborate paper upon the "true organs of generation in eels." These investigators, without concerted action, had all at once brought up the celebrated issue of the previous century ; this time, however, having specially in view the male organs of the eel, while all were convinced that they had reached a final result by their investigations. The results were certainly very peculiar. In the paper of Ercolani it was claimed that the

*Jacoby states that in a paper by Rathke, pvblished in the *Archiv fur naturgeschichte* in 1838, he remarked, "I expect soon to be able to say something concerning the male organs of the eel."

It would be very interesting to know whether in the papers left by this skillful investigator there may not have been recorded some valuable observations concerning the male eel.

snake-like folds of fat, which had formerly been noticed near the ovarium, were nothing else than the spermaries of the eel, and that upon the left side of the animal this organ developed into a true testicle, while the one upon the right side shrank up and became functionless. In the work of Crivelli and Maggi, on the other hand, the folds of fat next to the ovary were also considered to be the male organs of the eel, while the one on the right-hand side of the animal was considered without any doubt to be the male reproductive organ. The last-named authorities described the spermatozoa which they had seen in this stripe of fat upon the right side. Since these stripes of fat were universally found in all eels, and always in connection with the former, the investigators could come to no other conclusion than that the eels were complete hermaphrodites.

The male organ of the eel, as described by Ercolani, as also by Crivelli and Maggi, shows how carefully investigations may be expended upon things which are not in the least equivocal, since there was not the slightest trace of structure like that of a spermary. The cells of this body in the lining of the stomach next to the ovary are simply fat cells, with all the characteristic peculiarities, just as they are given in all the manuals of histiology. Professor Rauber, of Leipsic has examined these fat cells carefully, and they have also been investigated in many eels by the writer, Dr. Jacoby. Never has anything but fat cells and blood vessels been found in them. The so-called spermatozoa, described in the work of Maggi and Crivelli, proved to be miscroscopic fat particles or crystalline bodies, such as are commonly found in fat cells.†

In the meantime, at Trieste, the question concerning the male organs of the eel was making a very important advance. Darwin had already expressed the opinion that among nearly all fishes the female was larger than the male. He states that Dr. Günther had assured him that there was not a single instance among fishes in which the male was naturally larger than the female.

†In a microscopic investigation of fatty tissues it is very easy for the so-called Brownian molecular movements to be mistaken for moving spermatozoa, especially in fishes whose spermatozoa, if not very much magnified, shows only the head and appear like little bodies globular in form.

This opinion may, perhaps, have induced Dr. Syrski, director of the Museum of National History at Trieste, now professor in the university of Lemberg, when he undertook, at the request of the marine officials of Trieste, the determination of the spawning time of the fish which were caught in that region, and was obliged to take up the eel question, to devote his attention especially to the smaller eels. Dr. Hermes, in behalf of Dr. Syrski, protests against this idea, stating, on the authority of the latter, that the published opinions of Günther and Darwin were unknown to him prior to the publication of Jacoby's paper. Up to that time every investigator had chosen for investigation the largest and fattest of eels, thinking that the largest and oldest specimens must have the most highly developed organs of generation. On Nov. 29th, 1873, Syrski found in the second specimen which he investigated—an individual 15 inches long, which is now preserved in the museum at Trieste—a completely new organ, which had never before been seen within the eel by any former investigator, although tens of thousands of eels had been zealously studied.* Syrski published his discovery in the April number of the proceedings of the Imperial Academy of Sciences, Vienna, in 1874. The most important point of the discovery was stated to be that in all the specimens of eels in which the Syrskian organ was found, the well known collar-and-cuff shaped ovary, the female organ of generation, was entirely wanting. It was evident from this that eels were not hermaphrodites. The question now arose, is the newly discovered organ in the eel, in its external form, as well as inner structure, so different from the ovary that it could be considered as a partially developed or peculiarly shrunken ovary? According to all researches which have up to this time been made, there is the highest kind of probability that this newly discov-

* "I commenced my investigations," writes Syrski, "on the 29th November last year (1873), and already in the second eel which I dissected on that day I found the testicles, and therefore a male individual of the eel. I sent in March of the following year (1874) to the Academy of Sciences in Vienna a preliminary communication, which was read at the public session held the 15th April, and printed in the reports of the academy."

In 1875 Professor Von Siebold found male eels in the Baltic at Wismar, although this discovery was not at that time made known to the public. They have since been found in the German Ocean, in the Atlantic, and in the Mediterranean.

ered structure is actually the long sought male organ of generation. The investigator cannot, however, answer this question with complete certainty, since the thing which, is most necessary to the solution of this question, namely, the finding and the recognition of the spermatozoa, has not yet been accomplished.

In February, 1879, Professor Packard announced the discovery of spermatozoa in eels from Wood's Holl, Mass., but soon after declared that this was a mistake, and that he had been deceived by molecular movements among the yolk nuclei in the female organs. The discovery of spermatozoa in the spermaries of the conger-eel, recently announced by Dr. Hermes, of Berlin, is, however, sufficient to demonstrate fully the correctness of Syrski's theory. The confirmation in the case of the common eel is solely a matter of time.

HOW TO DISTINGUISH MALE AND FEMALE EELS.

INTERNAL CHARACTERISTICS.—BENECKE AND SYRSKI.

The differences between the organs of sex in the eel are well described by Benecke. The ovaries of the eel are two yellowish or reddish-white elongate organs as broad as one's finger, situated alongside of the backbone, arranged in numerous transverse folds, extending through the entire length of the abdominal cavity. They have no special opening to the outside of the body, and their contents must be discharged into the abdominal cavity and must find exit through the very small opening situated behind the anus. These two bodies, on account of their great size, are of course not easily overlooked, but they contain such a great quantity of fatty cells and the eggs imbedded in them are so small and delicate that one might easily believe, even after a superficial microscopic examination, that the whole organ consists only of fat. While the eggs of other fishes measure from one to three millemeters in diameter—and sometimes are much larger—still the eggs in the ovary of the eel have, on an average, a diameter of about one millemeter, and are so closely surrounded by fatty cells with outlines much more strongly marked that it requires great skill to prepare a microscopic slide in which they shall be as plainly visible as they are in the

accompanying illustration, in which they are magnified 150 diameters. When a person has a microscope which magnifies only 100 diameters, it is best to put a portion of the ovary in water when dissecting it, in order that the eggs may be easily found. It is much easier to find the eggs in young eels, 7 or 8 inches in length, than in the adult fish, since in the former, although the ovaries and the eggs are smaller, the fat cells have not made their appearance, and the eggs are, therefore, plainly visible at the first glance through the microscope. The number of eggs is extraordinarily large, amounting to many millions. The eggs of larger size, which sometimes are found in great quantities in eels that have been cut up and have been considered to be eel eggs, have always proved to be the eggs of other fish which they have swallowed, and in the course of cutting them up have been found in the eel's belly.

The male eels, which are found only in the sea and in the brackish water, are much smaller than the females, rarely exceeding 15 or 16 inches in length; in them, in the place of the ovaries in the female, are found spermaries, which differ in appearance in the manner heretofore referred to. These consist of two tubes which stretch the whole length of the body cavity, situated close to each other, and provided with numerous sacculations. Ripe spermatozoa are as rarely found in these organs as eggs ready to be laid have been found in the ovaries of the female. According to many accounts the male eels, which later were found also by Von Siebold in the Baltic Sea at Wismar, differ from the females in the possession of a proportionally sharper snout, less conspicuous dorsal fins, darker colonation of the back, a more prominent and metallic luster upon the sides, the clean white coloration of the belly, and the larger size of the eyes. I propose to reproduce here the original descriptions and figures of Syrski, the discoverer of the male eel.

EXTERNAL CHARACTERISTICS.—JACOBY.

The external differences presented by living eels (remarks Jacoby), corresponding to the presence of an ovary and the supposed male organ, are very interesting.

The most important, writes Jacoby, is (1) the difference in the size and length of the animal. Syrski states that the largest eels found by him with the supposed male organ measured about 17 inches, 430^{mm}. I have, however, found specimens with this organ at Trieste and in Comacchio which measured 17 to 19 inches, 450 to 480^{mm}. All the eels which exceeded this size, for instance those which were over 3 feet in length, 1^{m}, many of them growing to the thickness of the arm of a strong man, have been hitherto found to be females. The other recognizable external character in the female are (2) a much broader tip of the snout in comparison with the small, either attenuated or short and sharply pointed, snout of the eel with the supposed male organ; also (3) a clearer coloration in the female, usually of a greenish hue on the back, and yellowish or yellow upon the belly, while the others have a deep darkish green, or often a very deep black upon the back and always a more perceptible metallic luster upon the sides (I, once in a while, found eels covered all over with a brownish tint, always possessing the organ of Syrski), usually exhibiting also a white color upon the belly. In addition (4) there is an important external character in the height of the dorsal fin; all females have these fins much higher and broader than the eels of the same size which possess the supposed male organ. Finally (5) there is a character, which is not always a safe one, in the greater diameter of the eye in the eels with the supposed male organ. Eels with quite small eyes are almost always found to be females; eels with the organs of Syrski usually have comparatively large eyes, yet female eels with quite large eyes are not unusual.

The following proportional measurements, the average results of the study of a great number of eels measured by me, will be of general interest; column *a* gives the total length of the eel; *b* the breadth of the snout between the nostrils; *c* the breadth of the snout between the eyes; *d* the length of the snout from the center of the eye to its tip; *e* the average measurement of the eyes; *f* the length of the head to the gill-opening; *g* the height of the dorsal fins, all the measurements being given in millemeters.

	A. Eels with supposed male organs.							B. Female eels.						
	a.	*b.*	*c.*	*d.*	*e.*	*f.*	*g.*	*a.*	*b.*	*c.*	*d.*	*e.*	*f.*	*g.*
I	480	6	13.5	15	8	52	5	480	8.5	12	17	5	62	9
II	470	6	10.5	12	7	54	6	475	7.5	14.5	16	8	59	9.5
III	445	5	11	12	6	47	6	440	8	12	14	5	56	7.5
IV	411	4	9	12	5.5	47	6	410	8	12.5	13	7.5	51	7
V	386	4.5	9	12	5.5	46	4	378	7.5	11	12	5	49	7.5
VI	370	3.5	7	10.5	5	40	6	369	7.5	11	13	6.5	51.5	7
VII	344	4	7.5	10	4.5	40	5	342	6	8	11	4.5	44	6.5
VIII	319	4	7	10	5	40	4.5	313	5.5	8	10 5	3 5	41	6

According to the distinguishing marks which have been given, special reference having been paid to the height and narrowness of the dorsal fin, much success has been met with in picking out, in the fish-market of Trieste, the eels which possessed the organ of Syrski; absolute certainty in recognizing them cannot, however, be guaranteed. If one is searching among living eels with no characters in mind with the exception of the first—that of length—he will find in every ten eels, on an average, eight females, and two with the supposed male organ; but, if the selection is made with a careful reference to all these marks of difference, the proportion changes, and out of every ten examples about eight will be found with the supposed male organ.

For another excellent discussion with figures of the characters of male and female eels, the reader is referred to a translation of an article by S. Th. Cattie, in the Proceedings of the U. S. National Museum, vol. iii, pp. 280–4.

QUESTION AS TO THE VIVIPAROUS NATURE OF EELS.—BENECKE.

The discovery of the two sexes has not, however, writes Benecke, settled the question whether the eel lays eggs or brings its young alive into the world. There has always been a strong disposition to adopt the latter hypothesis, and there are many people at the present day who claim to have been present at the birth of young eels, or to have found a quantity of young eels in adult eels which have been cut open. Frequently ichthyologists hear accounts of occurrences of this kind, and receive specimens of supposed little eels from one to two inches in length, which have been kept alive for several days in a glass of water. These are usually thread worms, *Ascaris libeata*, which live by

the hundred in the intestinal cavity of the eel, and which may be easily distinguished from the eels of the same size by the sharp ends of the body, the absence of fins, of eyes and mouth, and by the sluggishness of their motions. The smallest eels, less than an inch in length, have already the complete form of the adult, and are also transparent, so that with a magnifying glass one may perceive the pulsations of the heart, and see behind it the brownish-red liver; the mouth, the pectoral, dorsal, anal, and caudal fins are easily seen, and the black eyes cannot be overlooked. In addition to the intestinal worms, the young of a fish of another family, *Zoarces viviparus*, have given opportunity to the ignorant for many discoveries; for instance, Dr. Aberhard, in No. 4 of the *Garten-laube* for 1874, described and illustrated an "embryo of the eel," which, in company with about a thousand similar embryos, had been cut out of the belly of an eel. This tolerably good drawing at first sight is seen to represent the embryo of zoarces which is almost ready for birth, since it still possesses a very minute umbilical sac. It is very evident that the minute egg of the eel could hardly produce a great embryo with an umbilical sac which exceeds by more than a hundred times in size the whole egg. It is also evident that the imagination of the writer had exaggerated the 200 or 300 young in the zoarces to a thousand.

HUNT FOR YOUNG EELS.—JACOBY.

As might have been foreseen (continues Jacoby), Syrski's discovery drew attention anew to the solution of the eel problem. In the spring and summer of 1877, the German and Austrian papers and journals were full of articles and paragraphs upon this subject. Among others the following announcement made the rounds of the press: "Hitherto, in spite of all efforts, science has not succeeded in discovering the secret of the reproduction of the eel. The German Fischerei-Verein in Berlin offers a premium of 50 marks to the person who shall first find a gravid eel which shall be sufficiently developed to enable Professor Virchow in Berlin to dissipate the doubts concerning the propagation of the eel. Herr Dallmer, of Schleswig, inspector of fish-

eries in that province, offered to transmit communications to Berlin, and in 1878, in the January number of the German Fishery Gazette, he published a detailed and very interesting report of his proceedings. He wrote, among other things, that it was quite beyond his expectation that this announcement would have found its way into nearly all the German journals between the Rhine and the Weichsel, and from the Alps to the sea. The number of letters which he received first rejoiced him, then surprised him, finally terrified him, so that at last he was obliged to refuse to attend to the communications. He had learned at Berlin that an equal number of communications from all parts of Germany had been received, sent directly to the address of Professor Virchow. Objects which professed to be young eels cut out of the parents, but which were really thread worms, were sent to him by dozens; the most incredible stories, usually from women, about great thick eggs which they had found in eels, were received by him. A witty Berliner communicated to him in a packet sent by express the information that the eel problem was now happily solved since a lady eel in Berlin had given birth to twins. Finally Herr Dallmer found himself compelled to insert the following notice in the Schleswiger Nachrichten: 'Since the German Fischerei-Verein has offered a premium for the first gravid eel, the desire to obtain the prize, curiosity, or the desire for knowledge has created so lively an interest upon this point that it might almost be called a revolution. I at one time offered, when necessary, to serve as an agent for communication, but since business has compelled me to be absent from home a great part of the time, I would urgently request that hereafter packages should be sent direct to Professor Virchow in Berlin. I feel myself obliged to inform the public upon certain special points. The premium is offered for a gravid eel, not for the contents of such an eel, since if only these were sent it would be uncertain whether they were actually taken from an eel. The eel must always be sent alone; the majority of senders have hitherto sent me only the intestines or the supposed young of the eel, which were generally intestinal worms; the eel itself they have eaten; nevertheless the prize of 50 marks has been expected by nearly all senders, etc. By this

transfer of the responsibilities, the inspector of fisheries has rendered a very unthankful service to Professor Virchow; he was obliged to publish a notice in the papers in which he urgently stated that he wished to be excused from receiving any more packages, for he would hardly know what to do with them. The comic papers of Berlin now circulated the suggestion that hereafter the eel should be sent to the investigators only in a smoked state. This amusing episode is interesting in showing how remarkable an interest the whole world was beginning to take in the eel problem."*

UNDOUBTED NORMAL REPRODUCTIVE HABITS OF THE EEL.—BENECKE.

It may be assumed with the greatest safety (writes Benecke) that the eel lays its eggs like most other fish, and that, like the lamprey, it only spawns once and then dies. All the eggs of a female eel show the same degree of maturity, while in the fish which spawn every year, besides the large eggs which are ready to be deposited at the next spawning period, there exist very many of much smaller size, which are destined to mature hereafter, and to be deposited in other years. It is very hard to understand how young eels could find room in the body of their mother if they were retained until they had gained any considerable size. The eel embryo can live and grow for a very long time supported by the little yolk, but when this is gone it can only obtain food outside of the body of its mother. The following circumstances lead us to believe that the spawning of the eel takes place only in the sea: (1) that the male eel is found only in the sea or brackish water, while female eels yearly undertake a pilgrimage from the inland waters to the sea, a circumstance which has been known since the time of Aristotle, and upon the knowledge of which the principal capture of eels by the use of fixed apparatus is dependent; (2) that the young eels with the greatest regularity ascend from the sea into the rivers and lakes.

All statements in opposition to this theory are untenable, since the young eels never find their way into land-locked ponds in

* Zoologischer Anseiger No. 26, p. 193; American Naturalist, vol. 13, p. 125, and Jacoby, p. 44.

the course of their wanderings, while eels planted in such isolated bodies of water thrive and grow rapidly but never increase in numbers. Another still more convincing argument is the fact that in lakes which formerly contained many eels, but which, by the erection of impassable weirs, have been cut off from the sea, the supply of eels has diminished, and after a time only scattering individuals, old and of great size are taken in them. An instance of this sort occurred in Lake Müskendorf, in West Prussia. If an instance of the reproduction of the eel in fresh water could be found, such occurrences as these would be quite inexplicable.

In the upper stretches of long rivers, the migration of the eels begins in April or May, in their lower stretches and shorter streams, later in the season. In all running waters the eel fishery depends upon the downward migrations; the eels press up the streams with occasional halts, remaining here and there for short periods, but always make their way above. They appear to make the most progress during dark nights when the water is troubled and stormy, for at this time they are captured in the greatest numbers. It is probable that after the eels have once returned to the sea, and there deposit their spawn, they never can return into fresh water but remain there to die. A great migration of grown eels in spring or summer has never been reported, and it appears certain that all the female eels which have once found their way to the sea are lost to the fisherman. In No. 8 of the German *Fischerei Zeitung* for 1878, Dr. Schock published certain statements sent to him by Dr. Jacoby. It is remarked in this paper, among other things, that after the deposition of the spawn, the female eel dies a physiological death, and that occasionally the sea in the neighborhood of the mouths of rivers has been found covered with dead eels whose ovaries were empty. When, where, and by whom this observation was made, and who pronounced upon the empty ovaries in these dead fish is unfortunately not mentioned.

A great number of the eels remain in inland waters while others proceed to the sea, either because their eggs are at this time not sufficiently ripe, or perhaps because they are sterile. It would seem probable that the increase in the size of the eggs in

the wandering eels begins to be very rapid after August and September, while in the earlier months of the year, in all eels of moderate size, the eggs were at the utmost but about 0.09 in diameter. In September of the same year, I found (as an average of numerous measurements) a diameter of 0.10; in October, 0.16; in November, 0.18 to 0.23, while the eggs showed other characters connected with approaching maturity which earlier in the season were not to be seen. All the eels which were captured later—in December and in January—part of which came from rivers and harbors, part from the harbor of Putzig (Putziger Wiek) had eggs measuring from 0.09 to 0.09^{mm}, while, very exceptionally, some measured 0.16^{mm}, although among the fish examined were some which measured 3 feet in length.

DO MALE EELS LEAVE THE SEA AND ENTER FRESH WATER.

This problem is one of great interest, both to the biologist, and the fish culturist—it is in fact this one disputed point still remaining to be solved. Upon its solution appear to depend the final decision of the question still so warmly debated both in Europe and America. "Do eels breed in fresh water only, in salt water only, or in both fresh and salt water." As has already been stated, the theory for a long time generally accepted, is that the eels are "catadromous" descending to the sea to spawn. This theory is, however, sharply contested by many observers, chief among whom on this side of the Atlantic is the Hon. Robert B. Roosevelt, President of the American Fish Cultural Association. It appears probable to the writer that the truth lies somewhere between these two extremes, and that it will be hereafter ascertained that the eel, like a majority of other animals, has flexible habits, sometimes deviating from its ordinary custom, which appears to be to spawn in salt or brachial water.

Male eels have been found in the following localities:

(1.) In 1874 by Syrski, in the fish markets of Trieste; these markets being supplied with eels from Chroggia on the Adriatic, and to a lesser extent from the lagoons of Commacchio.

(2.) In 1875, on the coasts of France, by Dareste.

(3.) In 1875, among specimens of *Anguilla marmarata* from India.

(4.) In 1875, in the Baltic, at Wismar, on the Danish coast, by Prof. Von Siebold.

(5.) In 1877, in the lagoons of Commacchio, by Jacoby. Among 1,200 specimens, five per cent. were males; while among these, less than 15 inches in length, 20 per cent were males. This was in brachial water. (See paragraph XIX).

(6.) In 1879, at Trieste, by Dr. Hermes, who found 15 males among 20 eels selected by Dr. Syrski.

(7.) In 1880, on the Baltic coasts of Denmark, by Dr. Hermes. Out of one lot of 39 from Wismar, he obtained 8 males, thus repeating Von Siebold's observation.

(8.) In 1880, from the Baltic between Zealand and Saland, Denmark. Out of one lot of 36, Dr. Hermes obtained 8 males.

(9.) In 1880, in France, by Robin.

(10.) In 1880, by Catter.

(11.) In 1880, by Dr. Hermes, at Cumlosen, on the Elbe, about 120 miles from the German Ocean.

(12.) In 1880, at Rugers on the Baltic, by Dr. Hermes, who found 44½ per cent. males in one lot of 137.

(13.) By Dr. Pauly, among eels planted at Hünnigen, in Elsass.-Sothringen. See below.

It has been shown by Dr. Pauly that among the very young eels [monté], taken near the mouths of rivers, is a considerable percentage of males, which, when transplanted to fresh water, will then retain their masculine characters and develop into perfect adult males. This discovery is, of course, of the utmost importance to fish culturists, making the attempt to introduce eels into new waters. Its importance has already been pointed out by Director Huack.

The practical lesson to be learned is simply this—that young eels, for introduction into strange waters, must be taken from very near the mouths of rivers, in order that both males and females may be secured. The interest to zoologists lies in the fact that Pauly's discovery renders the theory of Von Siebold less plausible, indicating that the sexes of the young eels are

differentiated before they begin to mount the rivers, and that the males do not ascend beyond the limits of brackish water.

Dr. Pauly's discovery is so interesting that I propose to translate his own account of it. The investigation was made, I believe, in Munich, and the report from which I quote was published in the Austro-Hungarian *Fishery Gazette*, at Vienna, December 23d, 1880. Dr. Pauly writes: "During the past year I have received from Court-Fisherman Kuffar a large number of eels, which I have used in my investigations. The large individuals, all of which came from the lakes of northern Italy, were females. I received, however, from the same individual, another lot of eels, consisting of much smaller individuals, weighing from 20 to 90 grains (2-3 of an ounce to 3 ounces), also taken in fresh water. At the request of Professor Von Siebold, I had paid particular attention to the sexes of the eels which I was engaged in investigating, and to my great astonishment I found that a large majority of these small eels [19 out of 27] were males, possessing instead of the familiar ovaries, the "lappenagan" described by Dr. Syrski. A histological examination of these organs convinced me that the structure of these tissues agreed with that described by Freud."

* * * * * * * *

My next inquiry was very naturally concerning the locality whence these eels had been obtained. I learned that Kuffer had received them two years before from Director Huack at Hunningen, and upon questioning Director Huack learned that they had been brought from a French river, the *Sevre niortaise*, where they were caught as young fry [montrée] at a distance of ten or twelve miles from its mouth, and furthermore were at the time of examination about four years old. The small size of these fish, their age being taken into consideration, satisfied us that they had been reared in captivity since uncultivated eels would have been much heavier. The females in this lot of eels exceeded the males in length and weight and exhibited those external characters described by Jacoby as indicating sex.

The locality in the *Sevre niortaise* where these fish were taken may easily, especially at flood tide, have been within the limits

of brackish water; my observations do not prove. therefore, that male eggs enter fresh water.

Dr. Jacoby found male eels in the lagoons of Commacchio, where the water is brackish. These males must have ascended in the "mountry" as fry, and probably at the approach of sexual maturity descend with the females to the sea. My investigations and those of Jacoby prove only this: that the young female eels do not necessarily break away from their parents and from their birth-places at sea, and entirely alone proceed upon their migrations, while the males scatter through the sea, but that their brothers seem to accompany them part of the way upon their journey. But how far? Do the males know where pure fresh water begins, and are the fry of different sexes found mingled together only at the river mouths? If we bear in mind the fact that the male organs had so long escaped discovery, that, on account of their crystal-like transparency, their detection in a fresh eel is so difficult, etc., may we not admit that past conclusions are probably erroneous, and that although thousands of fresh water eels have been studied by different investigators, male eels may yet be found in our streams, especially when more of the smaller individuals have been examined.

* * * * * * *

Dr. Pauly then discusses the observations of Dr. Hermes who found 11 per cent. of males among eels taken at Willenberg, on the Elbe about 120 miles from the German Ocean, and no males whatever at Havelberg, 20 or 30 miles higher up the stream, and closes his essay with the following conclusion: "*Male eels undoubtedly ascend the rivers, but the numerical percentage of males to females appear to diminish as one proceeds up the streams.*" This fact is opposed to the theory proposed by some one that young eels are at first of undifferentiated sex and have the tendency under the influence of fresh water to become females, under that of salt water to develop male characters."

STRANGE MISSTATEMENTS IN ICHTHYOLOGICAL LITERATURE.

One may conclude from these observations that the eels preparing to spawn leave the inner waters early in December and

seek out the deeper places of the sea, where they cannot be caught with our ordinary implements of capture. The eel eggs can only be found by a systematic investigation of certain parts of the sea bottom with the dredge and the microscope. This investigation might also include the sinking of the migrating eels in special cases to the bottem of the sea, in order to determine whether, under these circumstances, the eggs would ripen more rapidly. By using the largest fish for this purpose one could arrange, by means of small openings in the cages, to permit the entrance of the small male eels. At any rate, there is no doubt from these observations that the spawning period of the eel takes place in winter.

In an article by Guido Lindenhain, entitled "The Natural History of the Eel" (*Zur Naturgesehicte der Aale*), which has recently been published in the Austro-Hungarian *Fishery Gazette*, extending through six numbers, a fanciful contributor of that paper, among other wonderful things, claims to have discovered the spawning of the eel in rivers and ponds. I will allow the very sagacious gentleman to recount his summer-night's dream in his own words, in order to show with what certainty and precision the most baseless fables concerning the natural history of the eel are even yet narrated:

"The methods of spawning by the eel," writes this keen observer, are very interesting, but to observe them is very difficult and tiresome, and, indeed, only possible when the spawning places have already been determined by experience. One must remain for many nights upon the shore, hidden behind the bushes, with unflagging attention, until these nocturnal adventurers have come into the shallow water and made their presence known by their snake-like motions at the surface. As soon as they have gathered together upon their chosen haunts there is a great commotion in the water, and powerful blows are heard, so that the water splashes up a considerable distance, and the surface is covered with little waves, as if some great object was moving about, after which one gets glimpses of parts of the bodies of the contending rivals of the happy spawning fishes themselves. After the duration of an hour or so it is again quiet, and one sees that the water is moved in different directions in serpent-

like waves, which become less and less apparent to the eye of the observer, while the eels are leaving the spawning-places and are betaking themselves to hunt for food or are seeking their customary quiet dwelling-places. If the observer, moved by overwhelming curiosity, comes on the following day to the same place, he sees nothing, but if he looks with a strong magnifying-glass carefully over the water-plants, he discovers little greenish-white eggs resting upon the bottom, out of which the young eel will escape in about six weeks."

It is only to be regretted that the enterprising observer has not illustrated the whole development of the egg by photographic views of his fancies.

Another wonderful story was narrated by Dallmer.*

A Flensburg eel-smoker told him that once, in April, one of the sacks in which eels had been sent to him, after it had been emptied, was put into the water with the others; after having been tied up he found, after eight to fourteen days, millions of living young eels from one to two inches long. He thought that fertilized spawn had been left in the bag which, in eight to fourteen days, had developed into fishes of one to two inches in length. A million of young eels of 1½ inches in length would take a space of 9,761 cubic inches, which would be much more than a sack could contain. Such a quantity of little fishes would scarcely be able to find in a sack tied together at its mouth food enough to enable them to grow from a very minute size (the eggs in the ovary have been found only 0.23^{mm} large, and may, perhaps, when laid, measure 0.5^{mm}) in eight days to a length of from one to two inches; let us, however, suppose that the eel-smoker had confounded a hundred little eels with as many millions, it could hardly, even then, happen that these little animals in from eight to fourteen days could have grown to 160 times their original dimensions. The story would be much more probable if it were supposed that the young eels in their wanderings toward the fresh waters had, perhaps, found their way into a bag which was not tied up at its mouth.

* Fische und Fischerei im Sussen Wasser, Segeberg, 1877.

In De La Blanchêre's "Nouveau Dictionaire general de peche, Paris, 1868," occurs the following paragraph, without any indication of its source: "Chenu and Desmarest do not hesitate to state that the eel spawns upon the mud after a kind of copulation; that the eggs remain, adhering together, joined by a glutinous substance analogous to that which connects the eggs of the fresh-water perch, and forms little pellets or rounded globules. Each female, as they have succeeded in observing, produces annually many of these masses. The little fish soon hatch out and remain, for the first few days after their birth, together in these masses, but when they have reached a length of 4 or 5^{mm} they shake off the bonds which hold them and soon ascend in great bodies the streams and brooklets near which they find themselves."

According to this, the eggs are deposited in masses of slime, inside of which the young hatch out in the course of a few days, and a few days later they shake themselves free and swim about at liberty.

When and where these investigators have made such observations is not to be found out from the "Dictionaire;" at any rate, it is very hard to understand how they have proved that the same female eel yearly lays several sets of eggs.

BENECKE ON THE MOVEMENTS OF YOUNG EELS.

Benecke gives the following thorough discussion of the movements of young eels:

The young eels, hatched out of the eggs at sea, doubtless live at the bottom until they grow, through consumption of rich food substances there to be found, to a size from 1 to 3 centimeters. When they have attained this size they begin their wanderings in immense schools, proceeding to ascend into the rivers and lakes. These wanderings of the young eels have been known for a very long time; for instance, in the lagoons of Comacchio, in which they may be found, for the most part, after they have gained the length of from 6 to 8 millimeters, and in France, later also in England, Denmark, Sweden, and, more recently, in Germany they have also been observed.

According to the French reports young eels are hatched out early in the winter, and in February, having attained the length of 4 or 5 centimeters, they appear in the brackish water at the mouth of the Loire in immense numbers, soon to begin their wanderings up the stream. They swim in crowded schools at the surface of the river right up to the banks, and little detachments of the army deploy at the mouth of each tributary and pursue their wanderings along its course. These swarms of young eels are called in France "Montèe," in Italy, "Montata." The number of the young fish is, as might be expected from the number of the eggs in the ovary of the eel, wonderfully large. Redi has recounted that from the end of January to the end of April the young fish continue wandering up the Arno, and that in 1867 over 3,000,000 pounds of them were taken in five hours. Into the lagoons of the Comacchio the eels pour from February to April. In March and April they have been noticed in many French rivers, in which the migration continues for from eight to fourteen days. The first account of these wanderings in Germany was that given by Von Ehlers. In 1863 he wrote to Von Siebold: "This took place about ten years ago, in the village of Dreenhausen, in the Province of Wesen, in the Kingdom of Hanover. As we were walking, towards the end of June or the beginning of July, on a dike, which at that place projects out into the Elbe, we noticed that along the entire shore there might be seen a moving band of a dark color. Since everything which takes place in the Elbe is of interest to the inhabitants of that region, this phenomenon immediately attracted attention, and it soon became apparent that this dark band was composed of an innumerable body of young eels, which were pressing against each other, as, at the surface of the stream, they were forcing their way upwards towards its source, while they kept themselves so close to the shore that they followed all its bendings and curves. The width of this band of fish at the place where it was observed (where the Elbe has a considerable depth) was perhaps a foot, but how deep it was could not be observed, so thickly crowded together were the young eels. As they swam a great number could be taken in a bucket, and it was very annoying to the people who lived along the Elbe that so long as

the procession of fish lasted no water could be taken out of the river which was not full of the little fish. The length of the young eels was, on an average, from 3 to 4 inches; the thickness of the body was about equal to that of a goose-quill. By themselves might here and there be seen swimming eels of greater size, but none of them were probably more than 8 inches in length. All of them, even the smallest, were dark colored. This wonderful procession of fishes continued unbroken and of the same density throughout the whole of the day on which it was first observed, and continued also upon the following day. On the morning of the third day, however, not one of the young eels was to be seen."

Similar observations have been made at Wittenberg, on the Elbe. Kuppfer observed great quantities of young eels, of about 3 centimeters in length, in the brackish water of the Eider, at Freiderickstadt; so also did Von Stemann.

"Every year," writes the latter, "from April to the end of June, there appear great masses of young eels, which are present in large schools toward the Upper Eider, seeking in every way to pass each other. In April the first eels show themselves generally singly; cold weather has evidently kept them back up to this time; since this year, until to-day, no ascent whatever has taken place, and now the approach of the great schools is begining. Where the current is feeble, the procession is broad; but where the eels encounter a strong current—near a mill—it becomes small, and presses close to the shore, in order to overcome the currents. The little animals swim eagerly and rapidly along near the banks until they find a place over which they decide to climb. Here they lie in great heaps, and appear to await the rising of the tide, which makes their ascent easier. The tide having risen, the whole mass begins to separate without delay; eel after eel climbs up on the steep wall of rock, determined to reach the little pools, at the height of 15 or 20 inches, into which some of the water from the Upper Eider has found its way. Into these holes the little animals creep, and have yet to travel a distance of 40 or 50 feet under the roadway before they can reach the Upper Eider. Another detachment betakes itself to the sluice-ways, and clings to the cracks in the wood;

also around the mills their ascent may be observed, especially about sunrise." *

Davy sends a similar account from Ireland. He was a witness of the ascent of young eels, or "elvas," at Ballyshannon, at the end of July, 1823; he speaks of the mouth of the river under the fall being "blackened by millions of little eels about as long as a finger, which were constantly urging their way up the moist rock beside of the fall." "Thousands," he adds, "died; but their bodies, remaining, served as a ladder by which the rest could make their way; and I saw some ascending even perpendicular stones, making their way through wet moss or adhering to some eels that had died in the attempt." †

Such is the energy of these little animals that they continued to find their way in immense numbers to Loch Erne.

In the little eels which ascend the rivers there are no traces of sexual organs, but in the fresh water they develop only into females. One of the most recent observations made by Dr. Pauly, in Munich, would appear to contradict this idea, since he discovered male eels among the fish which were brought with a lot of young eels to Heningen, were kept there for two years in ponds, and were finally released in the fish pond of Court-Fisherman Kauffer. We should bear in mind, however, that these young eels were captured at the mouths of fresh rivers in brackish water; and that among the numerous small eels which swim in the brackish water there must be many larger specimens, in which the male organs have already begun to develop. Such are doubtless those which were sent in the male condition to Heningen and Munich, and were there recognized as males.

* Professor Benecke had in his possession some of the young eels, which escaped from all the vessels in which they were confined, and even climbed to the ceiling of his room.

† Eel-fairs in Connecticut.—Fresh water eels may be caught in large numbers, in weirs along the lake streams, when descending at the fall equinox to deposit their spawn in some lower region, and in the following August their offspring, from three to six inches long, return in immense numbers. The basin of the Still River Falls, near Colebrooke line, is for several days alive with them. They may be seen laboriously crawling up every rock which is moistened by the spray of the fall, and endeavoring to reach their ancestral lake or dam. At the foot of the Niagara Falls this phenomenon may be witnessed on a large scale at the same season of the year or later, and probably in other places where the fall is too high and the current too swift for the young eels to stem it without contact with the rocks.—Annals of Winchester, Conn., Boyd, p. 26.

This presumption can be set aside only if male eels shall hereafter be found among the fish which are caught in the upper part of rivers in the condition of young fry.

Concerning another important fact which is connected with the movements of the young fry of the eel, I became acquainted last year (in the course of an exploration of the waters of the district of Konitzkunde) with the river Brahe, at Muhlhof, above Rittel, where a high dam was built in 1846 and 1847 for the purpose of watering a large system of meadows by the overflowing of the stream. Below the dam is an inclined plane (constructed of boards), about 300 feet long, built for the purpose of preventing the water, which rushes out when the sluice-gate is opened, from washing away the bottom of the stream and its banks. This plank floor consists of two layers, the lower one of 2-inch, the upper one of 3-inch boards. The grade of the dam at Muhlhof (33 feet 3 inches) has entirely cut off the ascent of the fry of the eel into the upper part of the Brahe and the lakes tributary to it, and the number of eels caught above the dam—which was formerly very considerable—has become reduced almost to nothing. In the year 1847 the construction of the dam and the inclined plane was completed; in 1852 the upper layer of the planks on the plane had warped and sprung up in many places, so that it had to be torn up for repairs. The cause of the warping was immediately discovered: thousands of eels—as thick as a man's finger—somewhat flattened in shape, and, on account of the absence of light, of a pure white color, filled the space between the two layers of planks, and their united pressure from beneath had caused the upper layer to yield; these eels had found their way between the boards as fry, where they had found sufficient food and had grown to such a size that the pressure of their united strength had pushed up the roof of their prison. These facts, observed by an old millwright, were communicated to me by Privy Counsellor Schmid, of Marienwerder, who supervised the construction of the Muhlhof dam, and he fully confirmed them.

Eels of 4 inches in length, which in May are plenty in fish-ponds, by the end of October reach a length of 10 inches and the thickness of a man's little finger; in the following fall they

measure from 20 to 24 inches, and in the third year are ready to be eaten. On account of their rapid growth and hardy nature, in consequence of which latter they live in mud-holes and unprofitable waters of all kinds, the breeding of eels is a very remunerative business. The young fish (of which, at the time of their first appearance at the mouths of rivers, it takes 1,500 to 1,700 to make a pound, while, when taken later and a little further from the sea, it takes only 350 or 400 for the same weight) may be obtained at low prices from France through Huningen, or in Germany from Randesberg, and, through the Berlin Aquarium, from Wittenberg, and, when the temperature of the air is not too high, may be carried in soft moss throughout all Germany.

According to the statement of the well-known Paris fish-merchant, Millet, two pounds of eels, planted in a muddy pond in 1840, in five years yielded 5,000 pounds of fine eels.

OBSERVATIONS OF DR. HERMES IN 1881 ON THE CONGER.

The observations of Dr. Otto Hermes, director of the Berlin Aquarium, who has recently discovered the true nature of the organ of Syrski in the conger, are extremely interesting.

"Since Syrski, in 1874 found the organs in *Anguilla vulgaris*—which are called by his name, and which, by him and most zoölogists, were taken for the male reproductive organs—it is only necessary that a ripe male eel should be found that in order to settle forever the question of the sexes of the eel. Up to this time all efforts have failed to reach the desired result. The histiological investigations of the Syrskian organs pursued by S. Freud render it more probable that these were young roes; yet there remained all the time a doubt, since the spermatozoa had not been actually observed, and this uncertainty is an insuperable obstacle to the acceptance of the Syrskian discovery. The supposed discovery of spermatozoa by A. S. Packard in the male eel proved to be another delusion. The contradiction of this imaginary discovery appeared in No. 26 of the second volume of the *Zoologische Anzeiger*, p. 193, in which it was stated that the motile bodies were not spermatozoa, but yolk particles. This

correction was also made by Von Siebold's assistant, Dr. Paul,* and by S. Th. Cattie.

It is well known, as Von Siebold remarks, that young eels, ascending the rivers, developed into females and that the males remain in the sea or at the mouths of rivers. This statement cannot be exactly demonstrated, since among 250 eels, from 11 to 15 inches in length, taken in the vicinity of Cumlosen, I found 13 males or 5 per cent. (Cumlosen is situated in the vicinity of Wittenberg, and is at least 120 miles from the mouth of the Elbe). How large the percentage of difference between the neighborhood of the mouth of Elbe and places situated farther up the stream, as regards the proportion of males and females, may be, I have hitherto, from want of material, been unable to decide. Forty from the Havel at Havelberg (about 20 miles above Cumlosen) were all females. Out of 137 eels taken in the bays at Rugen, in the Baltic, I found 61 or 44½ per cent. males, while at Wismar, on the Danish coast, the males only constituted 11 per cent. Whether these facts have any connection with the discovery of the hitherto unknown spawning places of the eels, it is hoped that further observations will determine.

When Cattie, in his already cited work, gives it as a determined fact that the eels wander into deep water here, in order to let their generative organs attain maturity, which happens in six or eight weeks, and that the old male and female eels, after the reproductive act, die, according to my knowledge, there are wanting observations which will give this a scientific foundation. What Von Siebold and Jacoby only state as probable appear to him (Cattie) to have become already established facts.

As far as the distinction between male and female eels by external characters is concerned, the eels sent to me, some time in November, from the coast of Schleswig showed so great difference in color that their sender, the fish-master Hinkleman, was able to decide without difficulty between males and females. The former were distinguished by a specially brown coloration, while the females, in addition to greater size, almost without exception exhibited a dull steel-gray color. Among the males

* Austrian *Fishery Gazette*, 1880, No. 12, p. 90.

were found many specimens of $17\frac{4}{5}$ inches in length, which I was careful to note because Syrski had only found the size of $16\frac{4}{5}$ inches. In Comacchio, according to Jacoby, a specimen of $18\frac{4}{5}$ inches had been found.

JACOBY'S TOUR TO COMACCHIO IN 1877, AND HIS CONCLUSIONS.

"In the fall of 1877," writes Jacoby, "I undertook a journey from Trieste, by way of Ravenna, to Comacchio; convinced of the difficulty of the questions to be solved by my own previous labors, I had not great hopes of finding sexually immature eels, either gravid females or mature males. My highest aim was at the beginning to determine the following points: (1) Whether evidences of preparation for breeding might not be found in the eels which were wandering in the fall toward the sea; (2) to what extent eels with the organ of Syrski could be found participating in this migration; (3) as far as possible to obtain eels from the sea at a distance from the coast in order to compare their organs of reproduction with those of the eels in the lagoons.

"In determining the answers to the first two questions I was able to make some new and interesting discoveries, but with regard to the latter, my most diligent efforts were absolutely fruitless.

"I found that the eels when migrating to the sea in the fall took no food. In many hundreds examined by me, caught during their movement, I found stomach and intestines entirely empty; that the eels during their migrations eat nothing is also known to all fishermen and watermen of Comacchio. At the same time, the eels which remained in the lagoons were more or less filled with food, not only those which were not sufficiently mature to migrate, but also a breed of eels which never goes to the sea, but remains throughout its entire life in the lagoons.

"There may be found in Comacchio, and doubtless everywhere where eels live in great numbers in brackish water along the coast, a peculiar group of eels which, as far as I could determine, consists entirely of sterile females. These female eels with ovaries present a very peculiar phenomenon; when they are opened one finds instead of the well-known yellowish-white,

very fatty, cuff-shaped organ, a thin, scummy, slightly folded membrane, not at all fatty, often as transparent as glass, and of about the same proportional size as the so-called cuff-shaped organ. When this membrane is examined under the microscope there may be seen in it eggs very transparent in appearance, with yolk-dots absent or with yolk-dots very small and few. This organ appears to be an abnormally-developed ovary incapable of fertilization. These sterile females, which I found of all sizes, even up to the length of 27 inches, present all of the acknowledged female characters in great prominence and in an exaggerated degree; the snout is broader, and often, especially at the tip of the under jaw, extraordinarily broad; the dorsal fins are, on the average, higher; the eyes are much smaller, especially in large specimens, and the coloring is clearer; the back of a clearer green and the belly yellower than in the normal female. The flesh of these sterile females has a very delicate flavor, and quite different from that of other eels. I was quite astonished at the fine flavor when I tasted them for the first time in Comacchio. The flesh, as the expression goes, melts upon the tongue. It is even possible to distinguish them while living, by feeling them with the hand, their soft bodies being very different from the hard, solid, muscular flesh of the others.

"In Comacchio these eels are called 'Pasciuti.' Coste called them 'Priscetti,' and defined them to be those eels which had not become ripe, but which were at least a pound in weight. The name 'Priscetti' is, however, very incorrect, as I have

A.—Sterile female or Pasciuti.			B. Normal Female.			C.—Eels with supposed male organs.		
	a.	*b.*		*a.*	*b.*		*a.*	*b.*
I	508	10	I	511	8	I	—	—
II	480	8.5	II	497	7	II	480	6
III	458	11	III	465	9	III	470	6
IV	443	9	IV	447	7	IV	445	5
V	426	8.5	V	425	6	V	428	5
VI	408	8	VI	407	6	VI	403	5
VII	395	11 †	VII	396	7	VII	396	5.5

become convinced by questioning the fish inspectors and by hearing the conversations of the fishermen. 'Pasciuto' means 'pastured,' and the fishermen understand by this, those eels

which do not migrate, but which remain through the whole year feeding in the lagoons. They include, however, under this name, eels of two kinds—the sterile females already described, and the eels which are not yet ripe, as well as the normal females and supposed males, whose period of migration is somewhat remote. This circumstance is a cause of much difficulty to the investigator.*

"The studies on the second point to be solved were of special interest, viz., the determination of the presence and the behavior of eels with organs of Syrski, at Comacchio. I can answer this question very briefly, since among 1,200 specimens examined by me at the fishing stations and at the so-called eel-factories (with the exception of the largest specimens, which are always females), I found on an average of five per cent. with the organ of Syrski; of the eels under 15 inches in length (45 centimeters) on an average there were 20 per cent., so that the conclusions as to their abundance were very similar to those at Trieste, where the fish market is supplied, for the greater part, with eels from Chioggia, and to a less extent with those from Comacchio.

"In Comacchio the largest eels with the organ of Syrski, which I have observed, were about 17 inches (48 centimeters) in length, the smallest about 9 inches (24 centimeters). All of these were found among the eels taken during their migration to the sea, and, like the females, were found with stomachs completely empty or slightly filled with a slimy substance. It was impossible to find in any specimen a more advanced development of the Syrskian organ than in those examined in summer at Trieste.

"With reference to the third question undertaken by me, which relates to the actual kernel of the eel question, that is, the possibility of obtaining the eels which have migrated out to sea,

* It has been noticed by many early writers that there are certain eels which never come to the sea—Risso. in his "Histoire Naturelle," tome 3, p. 198, and S. Nilsson, in his "Scandinavisk Fauna," tome 4, p. 663. The latter called this variety "Grasaal," or grass-eel, and spoke of its yellowish-green coloration and the soft, delicious flesh. Strange enough, both these writers spoke of the sharper snout of this eel, and Risso, who founded upon it another species, *Anguilla acutirostris*, described it as brackish above and silvery below. These descriptions apply in every particnlar to the non-migratory eel at Comacchio. Jacoby remarks that all the sterile females brought to him under the name "Pasciuti," were distinguished by their broad snouts. The following tables were prepared at Comacchio. *A* gives the total length of the body of the eel; *b*, the breadth of the snout between the nasal tubes, in millimeters.

in order to obtain in this manner the sexually mature milters and spawners, I have been unable to obtain any results. I have, so far as my opportunities permitted, left no stone unturned to gain its solution. I went out to sea from Magnavacea and from Codigoro, on Chioggian vessels, and many times have fished myself, and have stimulated the fishermen by offers of reward to endeavor to obtain eels at sea, but I am forced to the conclusion that with the ordinary means this cannot be done.

"Intelligent grey-headed fishermen of Chioggia, who by means of their fishing apparatus know this part of the Adriatic as well as they know their own pockets, have assured me that throughout their entire lives they have never caught a grown-up river eel in the sea at any distance from the coast. The eels which were brought to me at Mannbach as having been caught in the sea, and which I found to be the ordinary females, or eels with the Syrskian organ, were either from localities close to the shore where they are not rare, or were taken in the Palotta canal. There was no lack of attempts at deception. Fishermen took eels from the shore with them in order to be able, on their return, to claim that they had been caught at sea. In the immediate neighborhood of the coast they are, as it has been stated, in the spring-time not rare, and there are not the slightest differences between these and the eels of the lagoons. I found both females and eels with the organ of Syrski with their reproductive organs in the same immature condition as in Comacchio; evidently they had just come through the Palotta canal from the lagoon into the sea. A certain distance, perhaps one or two marine miles from the coast, every trace is lost of the adult eels which wander by the many thousand into the sea. Strange as this problem appears at first sight, it is easily understood when the character of the fishing apparatus is considered; the nets are those used in the capture of lobsters, and are worked over the bottom; they have meshes much too large to hold the eels, or, when they are small-meshed, they do not reach the bottom. The problem can only be solved by using apparatus constructed especially for the purpose."

The economical value of the eel as a food fish has been well established, and it is now greatly sought after for introduction

into the localities where, for some physical or other reason, it is unknown. The advantages as summed up by a German writer, are, first, that an eel will live and grow in any water, however warm, and whatever be the general character of the bottom, though it prefers the latter when muddy and boggy; second, the eel requires no special food, but devours any thing, living or dead; it is an excellent scavenger, feeding upon dead fish, crabs, etc., as well as upon any living prey it can secure; third, but few conditions can interfere with its development, and it grows with very great rapidity, being marketable at the age of three years; fourth, the young, on account of their hardiness, can be transported in a crowded condition, and to any distance, with very little risk of destruction. These considerations are, in the main, well established, and there is no question but that the eel can be introduced in many waters to advantage, supplementing the earlier inhabitants. It has been planted in the waters of the upper lakes and the Mississippi River; in the latter they have reached an advanced development. It is, however, a very undesirable inmate of rivers in which fish are taken by means of gill-nets, the destruction of shad and herring in the waters of the Susquehanna and others further South being enormous. It is not unfrequent that when a gill-net is hauled up, the greater part of the catch consists simply of heads and backbones, the remainder being devoured by myriads of eels in the short time the net is left out. The spawning shad are considered by them a special delicacy, and are found emptied at the vent and completely gutted of the ovaries. Sometimes a shad, apparently full, is found to contain several eels of considerable size. They do not seem to be very destructive of living fish of any magnitude, although the young fry are devoured with gusto.

Mr. Roosevelt: Views differ as to the movement of eels, which perhaps, are influenced by the localities where they live, and investigators have, in my opinion, searched for spawning eels in the wrong places—along the bottom of the salt water, instead of in fresh water ponds and streams. Long Island eels may differ from other eels, but at my pond, there, I think, it is conclusively proved that the young descend to the sea after

hatching, and do not ascend from the salt to fresh water while they are in the fry state. Fish generally go down stream tail first and head up stream, and inexperienced observers would conclude they were ascending, but they are only feeling their way cautiously along. The screens in the troughs at my place were so arranged, that they showed distinctly which way the body of eels was moving; individuals often returning on their course as salmon do when playing about the mouth of a river, and preparing to seek their spawning grounds in the upper waters, but the great mass descending regularly although gradually. The young not much longer or thicker than a big pin, semi-translucent, would collect in a solid body first above, not below the upper screen, then if undisturbed they would work their way through this and collect in the same way above the next, and so on, down past three screens and through two preserves. They were never seen in considerable numbers below any obstruction, although single ones would remount the trough once in a while. Large eels begin moving in our fresh water ponds in March, and as the young appear about April 1st, it is probable the parents spawn in early spring. The young then descend to the salt water where they grow. This is the habit with all other migratory fish. Why should eels be an exception? They are caught in the fall in the larger rivers, and are generally supposed to be then seeking the sea, but it may be that they are ascending the rivers then.

Mr. Hewlitt: On nights and rainy days they try to ascend, when coming from sea. Then they go in May. Where they go I don't know.

Recess.

Professor Goode: One or two points I beg to submit. I have no desire to contradict Mr. Roosevelt. Have not made any investigations myself, and only stand on the assertions made by friends in Germany. If we admit Mr. Roosevelt's theory what are we going to do with the observers who see them going up stream. Eels are seen on dry land—going up dams and in crawling up, have heads up. Many have been seen stopped on

lower side of dams, when they could go down. As to the descent of large eels in fall—if it is not so, why are all eel fisheries arranged to intercept downward migration?—Most fresh water eels are caught in that way.

Mr. Blackford called attention to a few viviparous perch from California, sent by Mr. B. B. Redding. They were examined and two were opened, but the insides were too decomposed to trace the presence of young.

Unfortunately the best specimen was left on Mr. Blackford's stand in the market, which Mr. Mather had dissected and found filled with young.

Salmo purpuratus, from Alaska, were shown in alcohol. They were from the National Museum and were collected by Captain Beardslee, U. S. N., and identified by Dr. Bean.

An express messenger here delivered a package from Professor Baird to Mr. Mather, which proved to be an elegant diploma, awarding him a gold medal from the International Fishery Exhibition at Berlin, 1880, for his invention of the conical hatcher for shad eggs.

THE CHEMICAL COMPOSITION AND NUTRITIVE VALUE OF FISH.

BY PROF. W. O. ATWATER, WESLEYAN UNIVERSITY, MIDDLETOWN, CONN.

[This paper gave an account of the progress during the past year and the results of the work upon the composition and economic values of our food fishes, of which an account was given in the last meeting of the association and reported in this journal. A full report of the investigation up to the present time is to appear in the next report of the United States Fish Commission. In view of these facts and expectation that the work will in the near future have progressed so far as to permit more sat-

isfactory generalization, the paper was confined to a very brief statement of some of the more simple and practical results.]

The research, a brief abstract of some of the more interesting practical results of which is given below, has been going on for two or three years at Wesleyan University, under the auspices of the Smithsonian Institution and the United States Fish Commission, and now includes chemical analysis of fifty-three samples of American food fishes. Some forty-one samples have been previously analyzed in Europe. An idea of the extent of the work may be had from the fact that in the manuscript of the report prepared for publication in the next report of the U. S. Fish Commission, the figures, by which the main results of the analysis are expressed in tabular form, fill some seven or eight large folio sheets.

The samples analyzed were procured in part from fish markets in Middletown, Conn., where the analysis were made, but mostly from New York through the courtesy of Mr. E. G. Blackford, Treasurer of the American Fish Cultural Association, to whose help, in numerous ways, especial thanks are due.

MATERIALS OF WHICH FISH ARE COMPOSED.

Considered from the standpoint of the food value, fish, as we buy them in the markets, consist of—

1. Flesh or edible portion.
2. Waste—bones, skins, entrails, etc.

The proportions of waste matter in different kinds of fish and in different samples of the same kind in different condition vary widely. Thus a sample of flounder contained 68 per cent., of waste matter and only 32 per cent. of flesh, while one of halibut steak had only 18 per cent. of waste and 82 per cent. of edible materials. Among those with the most waste and least edible flesh are the porgy, bass, perch, lobster and oyster. Among those with the least waste are fat shad, fat mackerel and dried and salt fish,

Coming to the edible portion, the flesh, we find this to consist of—

1. Water. 2. Solid—actual nutritive substances.

The proportions of water and solids in the flesh of various kinds of fish are much more variable than most people would suppose. Thus the flesh of flounder had 85 per cent. of water and only 15 per cent. of solids, while that of salmon 36½ per cent. of solids and 63½ per cent. of water, and the flesh of dried. smoked and salt fish have still less water. Among the more watery kinds of fish are the flounder, cod, striped bass and blue fish. Among those with less water and more solid sare mackerel, shad, salmon and salt and dried fish. In brief, as compared with ordinary meats, the flesh of fish generally, though not always, contains more water.

To get the actual nutritive substance in a sample of fish we must subtract first the waste—the entrails, bones, skins, etc.—which leaves the flesh. Then we must allow for the water in the flesh. What remains will be the total edible solid or actual nutritive substance in the sample.

The percentages of total edible solids in the different samples analyzed were more varied than those of waste and of water. Thus 100 lbs. of flounder, as found in the markets, contained only 5 lbs of solids; 100 lbs. of lobster, 8 lbs.; haddock, 9 lbs; blue fish, 11 lbs.; cod, 12 lbs.; salt cod, 20 lbs.; salt mackerel, 15 lbs.; shad, 16 lbs.; salmon, 27 lbs.; smoked herring, 28 lbs.

THE NUTRITIVE VALUE OF FISH.

The value of the flesh of fish as food, like that of other meats, is decided, not only by the total amount of nutritive materials, but also by the ingredients, of which the most important are the albuminoids and fats.

The albuminoids, such as wheat-gluten, white of eggs, lean meat, curd, etc., are the nitrogenous constituents of foods, which make the lean flesh of the human body, the muscle, the connective tissues, skin, etc., and are the most important of the nutrients. Next in importance are the fats, such as oil, lard, butter, etc.; and last in importance are the carbohydrates, such as sugar, starch and the like. With the albuminoids alone we might maintain life a good while; but with the fats and carbohydrates alone starvation would soon follow. Now the flesh of fish, like

other animal foods, consists mainly of albuminoids, with more or less fats and very little of the carbohydrates. With this preliminary statement the following table of analysss of some of our most common food-fishes will be easily understood.

As was explained in the article on this subject in the last report of the association, chemical and physiological investigation have carried us so far as to enable us, when we know the chemical composition of different kinds of food, to determine approximately their relative values for supplying the wants of the body. Thus in Germany, where the most accurate and thorough investigation of these subjects has been made, it has become customary to compute the relative nutritive values of foods of similar kinds. We may, for instance, take as a standard four different kinds of flesh. Some are ordinary kind, as beef of medium quality. If we attribute a certain value to each pound of albuminoids and fats in this, and the same value to the same ingredients in other kinds of animal food, we may get at a valuation of each which will enable us to compare them with each other.

In the table which follows the albuminoids are estimated as worth three times as much as the fats, weight for weight. That is, a pound of albuminoids is assumed to be equal in food value to three pounds of fats. A pound of carbohydrates (extractive matters in the table) is assumed to be equal to three-fifths of a pound of fats. The nutritive valuations of a number of different kinds of animal food, as computed in this way, are given in the table on the following page.

THE TABLE.

For the sake of comparison the compositions and valuations of several other sorts of animal food are given with those of the fish. The figures for meats, game, fowl, milk, eggs, etc., are from European sources, few or no analyses having been made in this country. As will be noticed the first column gives the percentages of edible solids in the fish as received for analysis, some being whole, others dressed, *i. e.*, with head, entrails, etc., removed. The remaining columns refer to the flesh, free from entrails, bone, skin, and other matters:

Composition and Valuation of Animal Food.	In Whole Sample. Total per cent. Edible Solids. (Actual Nutritive Materials in Samples).	In Flesh. Free from Bone and other Waste. Solids. Actual Nutritive Materials. Water.	Albuminoids. Protein.	Fats	Extractive Matters.	Mineral Ingredients.	Nutritive Vaiuation. Medium Beef = 100.
Meat.							
Beef, lean	.....	76.71	20.61	1.50	.....	1.18	91.3
" medium	.....	72.25	21.39	5.19	.....	1.17	100.0
" fat	.....	54.76	16.93	27.23	.....	1.08	112.0
Veal "	.....	72.31	18.88	7.41	0.07	1.33	92.4
Mutton, medium	.....	75.99	18.11	5.77	.....	1.33	86.6
Pork, fat	.....	47.40	14.54	37.34	.....	0.72	116.0
Smoked Beef	.....	47.68	27.10	15.35	.....	10.59	146.0
" Ham	.....	27.98	23.97	36.48	1.50	10.07	157.0
Game, Fowl, Etc.							
Venison	.....	75.76	19.77	1.92	1.42	1.13	88.8
Hen	.....	70.06	18.49	9.34	1.20	0.91	93.9
Duck	.....	70.82	22.65	3.11	2.33	1.09	104.0
Milk, Eggs, Etc.							
Cow's Milk	.....	87.41	3.41	3.66	4.82	0.70	23.8
" " skimmed	.....	90.63	3.06	0.79	4.77	0.75	18.5
" " cream	.....	66.41	3.70	25.72	3.54	0.63	56.1
Butter	.....	14.14	0.86	83.11	0.70	1.19	124.0
Cheese, skimmed milk	.....	48.02	32.65	8.41	6.80	4.12	159.0
" fat	.....	46.82	32.62	20.54	1.97	3.05	151.0
" very fat	.....	35.75	27.16	30.43	2.53	4.13	163.0
Hens' Eggs	.....	73.67	12.55	12.11	0.55	1.12	72.2
Fish (fresh).							
Halibut	21.45	74.31	18.20	6.35	.....	1.14	87.9
Flounder	5.97	83.85	14.20	0.70	.....	1.25	62.4
Cod	11.45	82.76	15.65	0.34	.....	1.25	68.2
Haddock	8.88	81.22	17.26	0.16	.....	1.36	74.0
Alewives	11.95	75.84	18.75	3.94	.....	1.43	86.8
Eels (salt water)	22.50	70.48	18.85	9.77	.....	0.90	95.6
Shad	16.29	68.17	18.81	11.66	.....	1.36	98.2
Striped Bass	8.94	78.85	17.86	2.15	.....	1.14	80.4
Yellow Pike Perch	8.45	79.62	18.54	0.47	.....	1.37	80.9
Black Bass	9.57	77.84	19.66	1.01	.....	1.44	86.5
Mackerel	15.48	72.32	18.30	8.15	.....	1.23	90.9
Bluefish	10.96	78.16	19.32	1.25	.....	1.27	85.4
Salmon	32.99	63.52	19.73	15.67	.....	1.08	107.9
" Trout	14.38	66.80	17.22	14.69	.....	1.29	95.7
Brook "	10.77	77.06	18.45	3.08	.....	1 14	84.2
Whitefish	13.69	70.08	22.10	6.20	.....	1.62	104.5
Porgy	9.76	75.84	18.15	4.65	.....	1.36	85.2
Blackfish	10.72	76.16	20.78	2.79	.....	1.27	93.9
Red Snapper	10 10	76.74	20.53	1.31	.....	1.42	90.7
Smelt	12.51	79.75	16.43	1.92	.....	1.90	73.8
Spanish Mackerel	20.65	67.78	21.35	9.40	.....	1.50	105.9
White Perch	9.41	75.53	19.28	4.00	.....	1.19	89.2
Maskallonge	12.52	75.32	20.26	2.87	.....	1.55	91.8
Herring	11.52	67.70	19.42	11.40	.....	1.48	100.4
Sheepshead	11.99	71.63	20.69	6.68	.....	1.10	96.9
Turbot	15.61	70.14	14.47	14.13	.....	1.26	84.3
Spent Fish (fresh)							
Salmon (male)	14.87	75.13	19.52	4.55	.....	0.80	91 0
" (female)	12.17	78.34	17.65	2.84	.....	1.17	80.4
" land-locked (male)	10.97	78.37	16.33	4.03	.....	1.27	86.0
" " (female)	10.74	79.53	17.32	1.95	.....	1.20	77.4
Prepared Fish.							
Boned Cod	30.91	52.60	24.58	0.39	.....	5.94	106.9
Salt "	20.45	53.67	23.50	0.58	.....	3.45	102.5
Smoked Halibut	31.63	50.83	18.44	15.58	.....	0.60	102.2
" Herring	28.66	35.75	31.52	18.60	.....	2.15	163.2
Canned Salmon	29.95	65.96	21.09	11.10	.....	1.85	107.2
Salt Mackerel	30.97	44.69	17.74	23.87	.....	1.25	111.1
Invertebrates.							
Lobster	7.98	84.79	11.69	1.83	.....	1.69	50.3
Scallops	17.47	82.53	15.90	0.03	.....	1.54	68.8
Oysters (European)	.....	89.70	4.90	0.40	2.60	2.40	21.0

Three things should be said with reference to the table: First —The figures represent general averages. Sometimes different samples of the same kind of flesh will show widely varying percentages of constituents. This is particularly true of the fats, and to a less degree of the water.

Second—The figures of some of the kinds of food are based upon few analyses. More are needed to show the actual range of variation and the averages.

Third—The nutritive valuations are of necessity crude, and to be relied upon rather as approximations than as accurate quantitative statements. Much more chemical and physiological investigation is needed to make our knowledge of these as complete and satisfactory as it should be.

Looking down the figures in the table we note that the actual nutritive value is decided not only by the total amount of nutritive material and by ingredients of the same, the most valuable being the albuminoids or protein substances, the fats having less value.

Taking medium beef (flesh free from bone) at 100, the flesh of the different samples of fish varied from 62 to 163. Among those that excelled medium beef are smoked herring, 163; salt mackerel, 111; salmon, 108; canned salmon, 107; boned cod, 107; Spanish mackerel, 106; whitefish, 105; salt cod and smoked halibut, 102; herring, 100; shad, mackerel and eels vary between 90 and 100; turbot, white perch, alewives, between 80 and 100; haddock stood at 75, cod at 68, and flounder at only 62. In general, the fatter fish are more valuable than the leaner.

Some very interesting results are found in comparing the foul of spent fish with the same in good condition. As it becomes lean the fish loses nutritive value in three ways: first, in decrease of weight; second, in relative increase of waste and decrease of flesh; and, third, in the deterioration of the quality of the flesh which, in the lean fish, is more watery and considerably less valuable pound for pound than the flesh of the same fish in good condition. Thus the flesh of spent salmon was rated at 85, while that of fat salmon came up to 108. There is in this a strong argument in favor of legislation against the capture of fish out of season.

The practical application of these facts is of the utmost value. The same nutritive substances in the different samples of fish were found to vary from 40 cents to $3 per pound. It makes little difference to the man with $5,000 a year whether he pays 40 cents or $4 a pound for the albuminoids of his food, provided it suits his palate, but to the housewife whose family must be supported on $500 a year it is a matter of great importance.

As regards the value of fish as brain food, continued investigations confirm the statements of a year ago, that fish are no richer in phosphorous than other animal foods and are worth no more in nourishing the brain.

NEED OF POPULAR INFORMATION CONCERNING THESE MATTERS.

In Germany, whither we have to look for the best of our definite knowledge of these matters, information like that given above is widely and generally diffused among the people. Tables like those above are published in pocket diaries [a sample of one of these diaries was shown to the audience] and used for constant reference by hundreds of thousands of people, in all ranks and conditions of life.

We want statements of this sort concerning our own foods, and in such form that the people can make use of them.

As has been said, the investigations in this department of science have hitherto been confined to Europe. It is time that they be taken up on this side of the Atlantic. We are recognized as the first fish culturists of the world. Why should we not have a thorough investigation into the economic values as well as the methods of propagation of our fish?

Mr. Phillips then offered the following:

Resolved, That the American Fish Cultural Association heartily appreciates the importance of the investigations upon the nutritive value of fish, now being carried on by Professor Atwater, the results of which have been in part communicated by him at its meetings in 1880 and 1881, and that in the opinion of the members of the Association, the importance of these researches to the fish industries of the United States can scarcely be over esti-

timated. We would, therefore, urge upon the United States Commissioners of Fisheries, the importance of encouraging these investigations to the fullest extent possible. Carried.

Mr. Crook, President New York State Association for Protection of Fish and Game, then requested the members to send communications on subjects of interest in time for their June meeting, papers to be ready by the middle of May. Resolutions thanking the Fish Monger's Association for the use of the room were passed, and the meeting adjourned.

(*The Executive Committee of the American Fish Cultural Association, regret the delay in the publication of the present report. One paper of great importance had to be verified as to dates; some of the data having been subject to corrections at a late period.*)

TREASURER'S REPORT.

American Fish Cultural Association in account with Eugene G. Blackford, Treasurer.

1881.			
March 25th.	By amount annual dues received, - - - - -		$213 00
1880.			
March 30th.	To balance due Treasurer, - - - -	$131 70	
June 24th.	" J. M. Davis, for printing reports, etc. - - -	98 50	
July 22d.	" Postage stamps, and stamped wrappers, - -	6 71	
April 6th.	" Stationery for meeting, - - - - -	82	
1881.			
March 30th.	" Stationery for meeting, - - - -	2 00	$239 73
	Balance due Treasurer, - - - -		$26 73

MEMBERS

—OF THE—

American Fish Cultural Association.

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Yarrow, Dr. H. C., U. S. A., Washington, D. C.

TRANSACTIONS

—OF THE—

AMERICAN FISH-CULTURAL ASSOCIATION.

ELEVENTH ANNUAL MEETING,

Held at the Directors' Rooms of the Fulton Market Fish-Mongers' Association, in the City of New York

April 3rd and 4th, 1882.

NEW YORK.

1882.

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ELEVENTH ANNUAL MEETING

OF THE

Fish-Cultural Association.

Owing to the absence of the President, the Vice-President, Mr. George Shepherd Page, called the meeting to order. Mr. Page made some remarks upon the regular attendance of the old members, whom he was pleased to see present. They were men who not only kept themselves informed upon all progress in fish-culture from year to year, but made it a point to know of its progress from week to week. He was glad to see that there were evidences of progress on every hand, and on inspecting the fishes in the market he had noticed that shad are beginning to be plenty from all the rivers; a result which he attributed some little to the efforts of this association, as it was largely through its efforts that an interest in fish-culture had been awakened, and a fishery commission for the United States created. The trout exhibition which the members had just seen illustrated the extent of fish-culture. Trout were being largely cultivated in all favorable localities, and might yet be supplied at a figure which would place them within the reach of people who cannot afford to buy them now. Within the memory of members present the first black bass was transported over the Baltimore and Ohio Railroad from Wheeling Creek to Cumberland, in the tank of a locomotive tender, and turned into the Potomac. They have gradually been introduced North and South, and are found in plentiful numbers on the fish stalls of the interior towns. He remembered that in 1869 thirty-one black bass were planted in a lake in Maine, and their progeny is to be

seen to-day in a hundred lakes and streams of the State. They are replacing the pike or pickerel, and are sold in the markets in some seasons as low as eight to ten cents per pound.

The Secretary was then called on for a report of the last meeting. He read the amendment allowing of the election of honorary members, and the action was approved.

Mr. Mather then offered the following:

Resolved, That in future the following order of business be adopted in the association:

FIRST DAY.

Opening remarks by the President.
Report of Secretary on last meeting.
Proposals of new members.
Reading of papers and discussions.
Election of new members by acclamation.
Recess.
Election of Officers for ensuing year by ballot.
Reading of papers and discussions.

SECOND DAY.

Proposals of new members.
Reading of papers and discussions.
Election of new members by acclamation.
Recess.
Report of Treasurer.
Reading of papers.
Adjournment.

Mr. Evarts proposed to amend the section relating to the election of officers by making those which are largely honorary, as the President and Vice-president, vacant after one year, and those holding them ineligible for the same office until after an interval of one year. This amendment was accepted, and the resolution was carried.

The following persons were then proposed: Professor Alfred A. Mayer, Stevens Institute of Technology, Hoboken; Lieuten-

ant H. B. Mansfield, United States Navy ; Colonel M. McDonald, United States Fish Commission.

The Secretary then read :—

THE HABITS, ENDURANCE, AND GROWTH OF CARP.

BY HUGH D. M'GOVERN.

Having, at our previous meeting, mentioned something as to the habits and growth of carp, which was looked on by some of our theoretical fish-culturists as a good fish story, I now wish to give them some more facts. Having lost so many carp last year by experimenting in ponds that were covered with ice, this year I confined myself to observation.

I placed seven two-year-old carp in a small pond, and was successful in getting six hundred young carp, when I drew off my pond in the month of November.

I was delighted at my success, and knowing that I had thirty-four of the same age and size in my large goldfish pond, I came to the conclusion that I would be able to "run opposition" to the United States Fish Commission in supplying the wants of the public But alas! when after three anxious days of expectation and hard labor my pond was drawn off, I found but thirty-one large carp in fine condition, and twenty-five young carp; three of my original thirty-four had disappeared in some mysterious manner. Thus ended my expected bonanza.

I can account for the poor results in but one way, viz : that the carp spawned after the goldfish, and the goldfish ate up the spawn. I am well satisfied that those in the large pond were as well mated as those in the small pond. As it was, however, I would have been more successful had not my pond been so newly constructed that there was a lack of vegetation.

I placed six carp of the same age and size in one of my trout ponds for the purpose of using them as scavengers, and, indeed, they did their work well. It is well known to all fish-culturists that if there is not a strong current of water passing through a pond in which you feed, some food will escape. The trout remain on the bottom; the food becomes fungus and fouls the

water. There it will remain, for trout would scorn to go to the bottom for food. My notice was attracted to the fact that just as soon as I commenced to feed, two companies of fish could be seen—the trout on the top with their backs out of water, and the carp on the bottom with their heads down, rooting like hogs for the fragments that might escape the princes of the pond.

In this way I discovered that carp will eat chopped fish with a relish, for my trout are never fed on anything but the young of the goldfish—discolored ones—commonly known as silver fish. My carp have no other food, and it is settled in my mind that they liked it, and that it agreed with them.

I never saw fish so fat, and there are gentlemen in Brooklyn who had the pleasure of dining on some of them, who will verify my testimony in this particular. None of the six carp showed at any time the slightest sign of spawning.

During the first week of November I took them from the pond, and they weighed from 5 to 7½ lbs. each. Three of them I killed for my epicurean friends, and the remaining three I rolled up in a wet bag. I started with them for Brooklyn at 3 P. M., and on my way met Mr. James Ridgway, counselor-at-law, and Messrs. Page and McLean, of the *Eagle*, who carefully examined them. I gave the dead ones to my friends, and placed the living ones on the roof of my house, with two wet bags over and beneath them. There they remained all night. Next day at 2 P. M. I took one of them to the *Eagle* office, and there showed him still alive and in good condition, but as the tender-hearted Kinsella thought some of Mr. Bergh's men ought to be sent for, I made my escape, and went to New York to Messrs. Middleton & Carman's fish establishment in Fulton Market. These gentlemen were more consistent, and instead of calling on Mr. Bergh they proposed to give the carp a drink after his long journey. That suited us all, and for the first time in twenty-four hours Mr. Carp was in his native element, and it is needless to say that he enjoyed it.

The New York *Sun* noted the fact that of the fish distributed by the United States Commission, this was the largest one yet found in our waters. It turned the scales at 7¾ lbs.

The other two still remained in the wet bags in Brooklyn, and

at 9:30 P. M. I poured a pail of water over them. Next morning I took them to Chief Engineer John Y. Cuyler's house on the borders of Prospect Park, showed them to him, and received his permission to place them in one of the lakes of the park. I transferred the fish to Mr. Spear, chief clerk, and he drove near to the water, and gave them to an attache, who in my presence deposited them alive and in good condition in the water of our beautiful Brooklyn Park. This occured at 9:30 A. M., so that for 43½ hours the fish were out of water. This is a considerably longer time for the carp to be out of water than that mentioned in my previous paper. If I remain in the fish-culture business, and am spared for another year, I will test the endurance of the carp, study its habits, and report to this body at its next annual meeting. In conclusion I would say that persons owning trout ponds could do nothing better than place a few large carp in them. For a time they will become shy and hide away in some nook, but soon they will become less shy than the trout, and will actually raise their heads out of the water to take a piece of bread out of your fingers. This season I fed my carp with stale bread, refuse of the table, potatoe peels, etc., and I find that they do not refuse soft or damaged apples. In fact, they eat almost any vegetable food, properly chopped, and if possible partially cooked. I give you this, gentlemen, in my crude way, and without embellishment in any form, using no long-tailed Latin words or names, but simply trusting in the efficacy of our English tongue to convey to you my meaning.

REMARKABLE DEVELOPMENT OF EMBRYO SALMON.

BY FRED MATHER.

Persons who are unfamiliar with the development of animals during their embryonic state often ask, when viewing young fish just from the egg, "When does the sac drop off?" This question has often been put to me, as no doubt it has to other fish-culturists, and an explanation of how it is absorbed usually fol-


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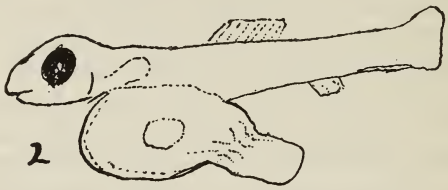
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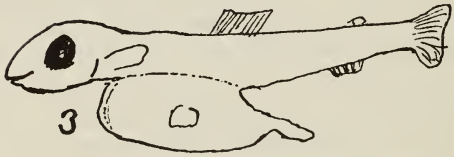
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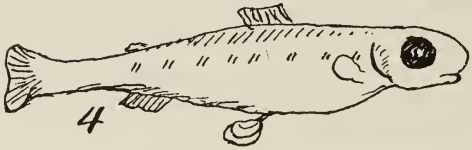
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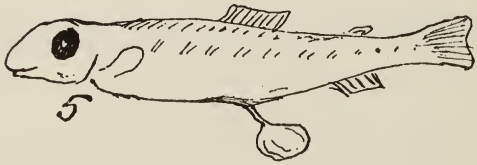
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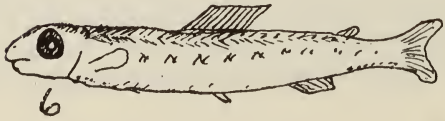
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lows. I have believed heretofore that every portion of the sac was necessary to the complete development of the fish; and have been rather amused at the innocent question given above. All fish-culturists have noted the fact that an embryo with a small coagulation in its sac, caused by an injury while in the egg, or after hatching, will die near the time that the injured portion is about to be taken up by the absorbent vessels; but, to my surprise, I have seen portions of the sac thrown off this winter, and the fish have lived and taken food afterward.

In the hatchery of Mr. Thomas Clapham, at Roslyn, L. I., which I fitted up the past winter to hatch salmon for Prof. Baird and Mr Blackford, the troughs were all new, and the haste with which they were made allowed but little time for coating with tar. One trough in particular had but a very light coating, and soon after the hatching of the eggs a singular spotted appearance was observable among the fry. This was caused by the turning white of their livers. Both Prof. Ryder and myself examined them under the microscope, and saw the clouded liver, through which the blood appeared to circulate feebly. Knowing no other cause than the exudations of unseasoned pine wood, I removed the fry at once, and placed them in a well tarred trough, and watched the result. Neither Prof. Ryder nor myself thought that the fish, some 15,000 in number, could live. He was of the opinion that the trouble originated in the sac, and that a deficient circulation in some portion had affected the liver. It was a new experience to both of us, and his extensive knowledge of embryology gave his opinion a weight which led me to accept his view, although I could not see any trouble in the sac at this time. I gave him some specimens afterwards which confirmed this theory, which I am now satisfied was a correct one.

The first indication of trouble in the sac was an elongation of the posterior portion of it, and a constriction about midway between its extremity and its connection with the body. This is shown in the specimens here before you in the vials Nos. 1 and 2. Sometimes the portion beyond the constriction contained the large oil globule, and sometimes it did not; and this globule seemed to be very irregular in its position. All the fish in the

trough were so affected, and in addition to the "liver complaint," the blue swelling, or "dropsy," appeared. The latter was fatal in every case, the microscope showing a deposit of watery fluid between the two membranes of the sac, in which great numbers of blood corpuscles could be seen drifting about.

No. 3 shows one form which followed. In this the part cut off from the circulation by the constriction seemed to wither away, and I suspect that in these specimens only a small portion was affected. No. 4 shows a small globe separated from the sac by a cord; and this globe is clear and has no sign of an opaque spot or injury. No. 5 shows a larger portion of the sac cut off by the cord and held suspended, giving somewhat the appearance of the sac and umbilical cord of the skate. Thus far I had but small hopes of the fish surviving, until one day while trying to capture a lively fellow which had a large ball hanging by a string, the fish made a sudden turn to escape the feather, which was under it, and I saw the cord break and that portion of the sac contained in the ball fall to the bottom. That particular fish was soon lost in the mass and could not be identified. In No. 6 are to be seen specimens which have lost the pendant ball and are about ready to take food. Of the original fifteen thousand in the infected trough, about three thousand died with blue swelling, and two thousand more from other causes, leaving ten thousand fry now taking food, of which a greater portion have lost some part of their sac. I firmly believe that had I not applied a remedy promptly the whole lot would have been past saving if left in that trough twenty-four hours more.

I do not know that any such experience is on record, and will frankly say that I should have considered this a very suspicious story if told by some fish-culturist whom I do not know, or at least, a story that required verification; and while I am aware that it actually happened, I cannot help feeling that some persons may suspect that a mistake has been made in some material point. To this I can only answer, "Here are my specimens, and I have seen the cast-off balls from the sac in the bottom of the trough where the fry which were affected as described are now swimming and feeding." When I say that I might have considered such a story a "suspicious one," I do not wish to be un-

derstood as meaning that I would reject an experience related by a brother fish-culturist which did not fully accord with my own, but wished merely to state that I clearly recognize the fact that a naturalist should believe nothing that he hears and only half of what he sees. He should be in that state of mind which is open to conviction, but neither believes nor disbelieves. To those to whom it seems incredible that part of the sac of a trout or a salmon should be thrown off by a mighty effort of nature when found to be poisoned, I would suggest following my experiment, if a blunder can be so called, and when the liver of the fry turns white, remove the fish into a clean, healthy trough and note the result.

In this connection it has occurred to me that the reason that trout do not flourish below sawmills is on account of the water being impregnated with either pine or oak. In 1875 I lost a lot of California salmon at Blacksburgh, Va., in an oaken trough which one of the then fish commissioners of Virginia, in whose employ I was, insisted upon my using. The impregnation of tannin was perceptible to the taste, and the fry died as fast as hatched. The theory of the fishermen near sawmills is that the sawdust gets into the gills of trout and kills them. This may be true to some extent, but I doubt it, for the reason that sand or other material does not appear to injure the gills, and I have taken adult trout below sawmills. I incline to think that the mills are destructive merely to the young, by covering the spawning beds to some extent with sawdust, but more by the absorption of turpentine from the pine, or tannin from the oak, the evil effects of which we know too well.

The President called on Col. McDonald to state what had been done in the way of retarding shad eggs with a view to transportation across the ocean.

Col. McDonald.—The results of the experiments have shown that retardation cannot be carried beyond six days, in the case of shad eggs. In connection with Prof. Ryder I undertook to retard them by keeping them at a constant temperature, but it was late in the season, and the water was up to 75 degrees.

We found that at 60 degrees we could secure a better development in from seven to eight days, but when the temperature was below that figure the development was abnormal, and the result was only a period of eight days, not enough to take them across. Eggs have been taken from the fish at a temperature of 75 degrees, and then kept in water at a temperature of 60 degrees for seven and eight days, and healthy fish hatched. When kept for a longer period, or at a lower temperature, the fish were invariably unhealthy. It had been proved by experiment that eggs kept in wet flannels in a damp atmosphere at a temperature of 60 degrees for forty-three hours could be successfully hatched. The problem of successfully hatching while the eggs were *en route* has now been solved by the use of closed hatching apparatus. This consists simply of a jar of about five quarts capacity, with two tubes leading into it. One of these, at the bottom, furnishes a constant supply of fresh water, and the other, at the top, carries off the impure water. As this water is forced into and carried out of the jar under pressure, and as the 75,000 eggs which the jar would contain lie in a solid mass at the bottom, the motion of a train or the rolling of a vessel would not affect the spawn. If we cannot retard the hatching until reaching the other side, we might at least delay it so far that the fish would reach there before requiring food. This closed apparatus has an advantage over the open ones for ocean travel, in the fact that the eggs are not displaced by motion as in the closed jars the rolling of a ship would not affect the eggs in the least ; they would lie as quietly as on a laboratory table. All that we would need is a water supply, or a means of securing purity to the water by circulation. With this apparatus shad spawn might be carried to Europe as safely and successfully as they are now transported to the rivers of California, Colorado, and Texas. The only question that a practical fish-culturist is now required to answer is as to the ability to keep a supply of pure water to feed these closed jars while a vessel was *en route*. It has been known to fish-culturists for years that the eggs of the *Salmonidæ* could be transported out of the water without injury ; but not until very recently that the same thing could be done with the eggs of the shad. This discovery was the result

of an accident. I had been thinking of transporting shad eggs for some time, and had constructed an apparatus for carrying 400,000 in a man's hand, when we were suddenly called upon to use it. The Fish Commission had a lot of eggs in water on board of a steam launch on the way from the spawning grounds on the Potomac to the hatchery in the Navy Yard. I filled my box, and took it in my hand to Washington, where they hatched after being fifteen hours out of water, and proved to be a very strong lot of fish. This accidental discovery has resulted in a great saving in the expense of artificial propagation, and has made possible the establishment of a central hatching station, at which the government will hereafter hatch all the impregnated spawn taken in the Potomac and Susquehanna rivers. Men will have buckets and take the eggs from the grounds to the hatchery in the armory at Washington.

The PRESIDENT.—Who invented this apparatus?

COL. MCDONALD.—It was not a new invention. It was the same system used in transporting salmon eggs on flannel trays, but it had not been tried with shad, and it has generally been believed that shad eggs are too delicate to transport in this way.

The PRESIDENT.—What has been done in the hatching of cod eggs?

COL. MCDONALD—The eggs of the cod, Spanish mackerel, sea mackerel, bonita, and other fish whose eggs float on the water, cannot be hatched in the closed apparatus used for propagating shad eggs. Just how to hatch them while being transported is a question that the Fish Commission is now trying to solve. The trouble is that the eggs are so buoyant that they will follow the current and pile up against the screens and clog them. A series of experiments is being made with a funnel-shaped apparatus, which is fed from the bottom with pure salt water. To carry off the impure water a syphon is used, the arm inserted in the upper portion of the apparatus, being long enough to reach below the mass of floating eggs. The experiments have proved

partially successful, and it is expected that they can be made wholly so. The transportation of the eggs of the cod from this city to the Washington hatching-houses is a problem which still awaits solution. An attempt was made last fall by the use of hermetically sealed jars. The eggs were taken at the Fulton Market slip and impregnated, and their development retarded by placing them in water at a temperature of 34 degrees. In attempting to hatch them artificial sea water was used, and the failure of the attempt, it is thought, was due to that fact.

Mr. Blackford.—The possibilities of cod hatching at Fulton Market are simply immense. I wrote to Prof. Baird, the United States Fish Commissioner, this winter, and offered, on behalf of the Fulton Market Fish Mongers' Association, the use of the ripe cod brought alive in the wells of the fishing-smacks, and offered to give all assistance possible. Prof. Baird sent two experts and Prof. Ryder. who wished to study their embryology. The first lot of eggs sent on trays and in kettles from the market to Washington was a failure. The second shipment went in glass fruit-jars, half full of eggs, and filled with salt water, and arrived safely, which proves that they can be sent that distance. Whatever failure occurred afterward was due to bad water. I have suggested to Prof. Baird that next fall the steamer Fish Hawk, with all its appliances for hatching, be sent here, and offered, if this was done, to furnish 100,000,000 per diem for hatching purposes. This could easily be done, as a large cod will strip 9,000,000 good eggs. This method will save the expense of sending out a special steamer to catch fish with ripe eggs, and will save a great waste of both fish and eggs.

The following gentlemen were elected members of the association: Charles W. Smiley, Smithsonian Institution, Washington, D. C.; Lieut. Henry B. Mansfield, United States Navy; Prof. Alfred Mayer, Stevens Institute of Technology, Hoboken, N. J.; Col. M. McDonald, Fish Commissioner of Virginia; W. L. Gilbert, Plymouth, Mass.; H. P Schuyler, Troy, N. Y.; Erastus Corning, Albany, N, Y.; John T. Agnew, Charles Banks, and Benjamin Wood, New York city. A recess was taken until two P. M.

Upon again assembling an election of officers for the following year was then declared in order, the first being that of President.

MR. MILLER nominated Mr. George Shepard Page for President. No other name was proposed, and he was balloted for and elected.

MR. BLACKFORD recounted the services of Mr. Page to fish-culture, and stated that it was from his suggestion that the United States Commission on Fish and Fisheries had sprung, and other facts which are matters of record.

MR. MATHER then named Mr. James Benkard for Vice-President, and his election followed.

MR. PAGE alluded to the fact that the South Side Sportmen's Club, of Long Island, of which Mr. Benkard is president, would market 4,000 pounds of brook trout this year, bringing the handsome sum of $3,000. He mentioned this because it has been asserted that this fish cannot be successfully raised for the market, an error that the club is slowly correcting.

MR. BLACKFORD named Mr. Charles B. Evarts for Treasurer. Mr. Annin named Mr. E. G. Blackford; upon ballot Mr. Blackford was elected, and Mr. Evarts moved that it be made unanimous; carried.

MR. EVARTS named Barnet Phillips for Corresponding Secretary; elected.

MR. BLACKFORD named James Annin, Jr., for Recording Secretary; elected.

An Executive Committee was then elected. The officers of the Association for 1882–3 now are:

GEORGE SHEPARD PAGE, New York, President.
JAMES BENKARD, South Side Club, Vice-President.
EUGENE G. BLACKFORD, New York, Treasurer.

BARNET PHILLIPS, Brooklyn, Corresponding Secretary.
JAMES ANNIN, JR., Caledonia, N. Y., Recording Secretary.

EXECUTIVE COMMITTEE.

FRED MATHER, *Forest and Stream*, (Chairman).
G. BROWNE GOODE, Smithsonian Institute, Washington, D. C.
SETH WEEKS, Corry, Pa.
BENJAMIN W. WEST, Fulton Market, N. Y.
T. B. FERGUSON, Washington, D. C.
CHARLES B. EVARTS, Windsor, Vt.
DR. W. M. HUDSON, Hartford, Conn.

MR. G. SHEPARD PAGE.—Permit me to express my heartfelt thanks for the highly appreciated honor bestowed upon me in the unanimous election to the position of presiding officer of this organization.

My own connection with the association goes back to its earliest history, and I have counted as of deepest interest the communion of effort with you, my fellow laborers, in behalf of this important subject.

Fish-culture is one of the latter day sciences; indeed its birth on this side the Atlantic was after that of every individual present here to-day. We have, as a new member of the association, meeting with us at this session, Charles Pease, Esq., of Cleveland, Ohio, an intimate friend and companion of the distinguished Dr. Theodotus Garlick, of Ohio, (who first successfully artificially propagated fish in 1853), bringing to us the "God speed" of the honored father of fish-culture in America.

Since our last session great activity has marked the progress of events. Many millions of shad have been hatched and deposited in the rivers of the Atlantic slope, and another consignment of them was successfully transported across the Continent, and the young fry planted in the waters of the Sacramento. Abundant catches of shad in Southern waters effectually confirm the good results of systematic annual reinforcement of the natural reproduction by artificial aid. A noticeable feature of the display of shad this season is their unusual large average weight. Many fish of six pounds and over are exhibited. It is a tenable theory that this is due to the vast accession to the species through the

efforts of fish-culturists, and therefore the greater number that escape the nets of fishermen and gain a longer lease of life and greater weight.

I think we can anticipate an increased catch of shad this spring, which will result in reducing the retail price to a figure which will enable the poorest man to place one daily on his table. For this we labor, our only reward being the consciousness that mankind is benefited.

England wants this delicious fish, truly termed by the famous Prof. Huxley "the king of the herring family."

It is known to many that Prof. Huxley succeeded the late Frank Buckland as Inspector of Fisheries. It was my good fortune to meet him a year ago at South Kensington, London. He was engaged in investigating the herring, and I found him at work sketching one of the family. When making myself known as the Vice-President of the American Fish-Cultural Association, he gave me a cordial welcome, and we discussed with natural enthusiasm the accomplished results and possibilities of the future of this science.

He acknowledged that we were far in advance of the mother country, and ascribed it not only to our greater enterprise, but also to the freedom from the vested rights of a nobility, in rivers, streams, and lakes. The riparian owners were suspicious of the slightest interference with their valued privileges. He acknowledged the indebtedness of the fish-culturists of Europe to the many ingenious inventions and valued experiences of our practical investigators—several of whom he referred to by name.

The paper upon the herring which he was preparing, was to be read at the National Fishery Exposition at Norwich, England. He regretted he had no specimen of the American shad to exhibit—a fish he had never seen. I at once promised to send him some, and suggested that our association would doubtless be glad to present to him for distribution in British waters a quantity of shad eggs. He expressed great gratification, and assured me that it would be of deep interest to the visitors at Norwich to examine the shad, and that he would confer with the River Conservators with respect to the introduction of the new

species—the power being vested in this body under certain restrictions applied by the riparian owners.

By the courtesy of Mr. E. G. Blackford several fine specimens of North River shad were placed in the center of the ice-box of the White Star steamer "Britannic." They reached Prof. Huxley in fine order and in season for the Norwich exhibition, and he made due acknowledgment.

Prof. Huxley invited me to his delightful home, when I had the honor to be introduced to many notable people, distinguished in scientific, literary and political circles—among them, Hon. J. Chamberlain, of Birmingham, the member of Gladstone's ministry who has specially to do with fisheries. He had already been advised by Prof. Huxley of my proposition, and desired to add his thanks also for the proposition concerning the introduction of shad eggs, stating that it was most generous on our part, and that it would be of great value to the nation. He promised to extend such aid as might be required.

SALMON.

The salmon hatching establishments at Belfast, Maine, and on the McCloud River, California, have yielded many millions of eggs, which are distributed in the States and Territories, the waters of which were adapted for their existence. Many salmon were taken in the Androscoggin, Merrimac, and Connecticut rivers, and several in the Hudson, Delaware and Susquehanna, and the question as to the ultimate success of their restoration to all depleted waters can be announced as settled.

BROOK TROUT.

The artificial culture of brook trout has reached a point when it is safe to assert that they can be raised and sold at a profit. The season of '82 opens with *tons* of this exquisite fish in market—every individual having been hatched from an egg expressed from the female, fertilized by the milt of the male, cared for in the hatching-house, the young fry tenderly nourished until becoming mature fish of two or three years, they are in eager demand at a dollar per pound.

The Southside Sportsmen's Club, the president of which is Mr.

James Benkard, also an efficient member of our executive committee, will market four thousand (4,000) pounds of artificially-bred brook trout. Scores of other associations and individuals will add their quota. Never before have so many thousands of people thronged the principal fish dealer's stalls to inspect the marvelous display of the salmon family, embracing specimens from fifteen States, Canada, and New Brunswick.

Magnificent marble and plate-glass aquariums permitted the noble fish to deposit in their native element. Lovely flowers, graceful shrubs, delicious green moss, exquisite porcelain and majolica added their attraction to the display. Truly the opening of the trout season of '82 was a most notable triumph for the American Fish-Cultural Association. We could say, as did Cornelia, the Roman matron, "These are our jewels."

BLACK BASS.

It hardly seems credible that any one can question the practicability of cultivating our waste water, in view of the absolutely demonstrated results of black bass planting.

Not three score years ago a few bass were transferred, via the Baltimore and Ohio R. R., from the Ohio to the Potomac—a few years later from the Potomac to the Susquehanna, less than fifteen years ago from the Susquehanna to the Delaware. In 1869 I took the first black bass to Maine. And now what are the facts? I refer you to the fish markets not only of all our principal cities, but the interior towns. This fish, admittedly as good on the table as it is game on the hook, is now more common than the pickerel and cheaper than white fish. So rapidly have the thirty-one deposited by me in Maine in '69 increased that a hundred lakes and ponds are fairly populated by their progeny. Summer hotels and cottages have been erected on some of the lakes, and thousands of visitors have been attracted to them almost entirely in consequence of the abundance of the black bass. Several of our prominent authorities pronounce this the "coming fish." One of the latest and best works on fish and fishing is exclusively devoted to the bass. Rod and fly makers find a constantly increasing demand for special black bass tackle. A large number of clubs have been organized

solely devoted to the capture of this eminently game fish. And most noteworthy it is, that with the introduction of black bass we shall speedily announce the exit of the pickerel, a commendable illustration of the "survival of the fittest."

Did time permit, I could refer to the latest development of fish-culture in the reproduction of the cod—soon to assume enormous proportions, even reaching hundreds of millions. In conclusion I must acknowledge the continued generosity of the National Legislature in annual appropriations for the interest. As I recall the fear and trembling with which I made the first appeal for a grant of $10,000, before the Ways and Means Committee in 1871, and the joy I experienced when the glad intelligence came over the wires that $15,000 had been voted, and contrast that with the $240,000 which the present Congress will doubtless appropriate, I cannot but feel just pride in being identified with a science that is thus protected and encouraged by the National Government, and which is acknowledged as under the control of a body of gentlemen whose sole desire is to effect "the greatest good to the greatest number."

THE RAINBOW TROUT.

BY JAMES ANNIN, JR.

In bringing this subject before you, gentlemen, I know how unable I am to handle it in a proper manner, and have a fear that I may be considered liable to reproach for my incompetency.

Every article upon the rainbow trout that I remember to have seen has been greatly in its favor and loudly in its praise. I think that something is to be said in the negative, but don't wish it understood that I take decided grounds against them, but think that there are a few facts and surmises worthy of your attention.

The advantages claimed for the mountain or rainbow trout are gameness, rapid growth, hardiness, adaptability to waters that will hardly support the brook trout, etc. Now as to their

game qualities, they certainly are one of our gamest fish known, and are quicker than our Eastern brook trout, requiring all your attention after they take fly ; but I have been told by a gentleman who has taken in our Eastern waters rainbow trout which weighed a pound each, that he thought after their first two or three rushes they tired out quicker than our native trout. As to their rapid growth it must be conceded that they grow faster than our native brook trout.

Are they a hardy fish ? Yes. Decidedly so. A person has no trouble in raising them ; they don't refuse food, pine away and die as many of the brook trout will do in confinement, but they will eat often and in great quanties, and will sometimes take a bite out of their neighbor, as a pond of them will show to be a fact, by many marks, scars, loss of part of a fin, etc. Adaptability to waters that will hardly support our brook trout is the best thing, I think, that can be said of them, for if such waters are stocked with them, we will have them in their proper place, and their mission will be fulfilled, and people in general will then consider them a great acquisition.

What I consider all wrong is that they are turned into good trout streams before the results can be told. We would not consider it any advantage if bass or pickerel were put into that good trout stream or pond. We have an endless number of streams, lakes and ponds in which they would doubtless thrive. I don't consider that it would be to the advantage of the brook trout if the mountain trout were introduced into the same stream ; certainly not if it is true that the hardier drive out the weaker.

Let me suppose a case. Mr. Blank has a splendid trout stream, say on Long Island ; there are plenty of brook trout in it, and it is no trouble on any favorable day for him to make a good catch. He takes it into his head that he will put into this stream the rainbow trout, and carries out his plans. After a year or two he begins catching the new comers, of good fair size, and he is astonished to see how they have grown. He has lots of fun with them, they are so very gamey ; but if the weather is at all warm, he will find on arrival home that the new fish are beginning to be quite soft, while the native fish are hard. What

I say about their becoming soft I have learned partly by experience and partly by what several fishermen have told me. One gentleman wrote that they were like dried herrings when he got home. Our gentleman don't think much of this, and a year or so more passes along, when he invites a friend out to his preserve on the opening day of brook trout fishing, and they have plenty of sport, fish are plenty and perfectly willing to bite, but, confound it, they are almost all rainbow trout, and must be returned to the stream, as the law on them is not off for a month or more yet! Our friend works hard and long for a string of brook trout such as he could formerly take in a short time before introducing the rainbows. Now, gentlemen, if this suppositious case proves true, is it advisable to put them into your fine trout streams? It is proving itself to be true as fast as possible in one of the best trout streams in the State of New York, that has been stocked some four years, I believe, with rainbow trout.

A word to fish-culturists. Will it pay to make any great outlay, until we know that the rainbow trout are a profitable fish? And another question is, are they a good market fish? They certainly are not if they become soft very soon after coming from the water. What will the market price be? Will the fly-fisherman show his basket of mountain trout with the same pride, as he did when filled with the native brook trout, are also questions to be answered.

I know one fisherman that will not put one of them into his basket, but throws all of them away, and it has seemed to me that it will do no harm to consider well the questions here raised before we stock our brooks with a fish which may exterminate our native species, and not prove to be so valuable in the end.

The President.—Mr. Annin has opened a question which it may be worth our while to consider. Perhaps it will be well to learn more of this fish before filling our streams with it. I would suggest that Mr. Mather give us his opinion on it.

Mr. Mather.—I have had no personal experience with the rainbow, or, as it is sometimes called, the California mountain

trout, and I am of the opinion of Mr. Page that it will be well to go slow until we know more. The fish came in with a hurrah and everybody seems to want it. It grows fast and may supplant our native trout entirely, and to my liking the latter is the best fish and the handsomest of the two. Imported species often thrive and drive out native ones ; witness the so-called Norway rat, which has supplanted the native until the latter is extinct on the seacoast, and even in parts of the West. An imported species often grows faster in its new home than it did in its original one, as witness the German carp in America. I am not prepared to say much of the rainbow trout ; I have watched it with interest in ponds, but do not know how it will agree in streams with the native. If it grows faster, it will get all the food and the native will suffer. In that case I am opposed to it. If it will live in streams where the native will not, then it may be a good thing. We now have the curse of sparrows upon us, brought about by enthusiastic introducers of foreign species, and with this example of mistaken benevolence before us, I think we should be cautious.

Mr. Blackford.—I do not yet know what value the rainbow trout will bear in the market. When it first comes in it will sell readily to those desiring to experiment. After that it will rest on its merits. I have no fear that it will supplant the *fontinalis* on the table of the epicure. Mr. B. B. Redding, Fish Commissioner of California, writes me that the Humboldt River trout, *Salmo clarkii*, is much superior to the *S. iridea*, or rainbow trout. The Californians are now introducing our Eastern brook trout into their streams, and are loud in their praises of it.

Mr. Phillips.—Might the rainbow trout not follow the rule that all the *Salmonidæ* of the Pacific coast are inferior to those of the Atlantic coast ? I believe that I have understood Mr. Blackford to assert that the Pacific salmon are inferior to ours.

Mr. Blackford.—They are. They may grow faster than our Eastern coast fishes, but California salmon are not so good. When they first began to send them here they sold car loads of

them at forty to fifty cents per pound. Now it is difficult to sell a small lot at thirty cents. I notice another market man here, one who has had experience with these fish, and would ask Mr. Middleton what his opinion is.

Mr. Middleton.—I agree with Mr. Blackford entirely. The salmon of the Pacific are inferior and do not sell well here, now.

Mrs. Lewis.—I think all fish should be judged by the color of its skin. The dark brook trout is coarser and of fuller fibre, and where this is the case it is the best. I think the rainbow trout brought East would be dark. California salmon have not gained the high reputation in the markets of Europe that the *Salmo salar* has. It is not considered a good salmon.

Mr. Annin.—I have eaten the rainbow trout. Lieutenant Mansfield, of the U. S. Navy, has caught them in the West, and in my stream, at Caledonia, N. Y. One of the party went on the lower end of the stream to take rainbow trout, and caught many. He saved the larger ones in the well of the boat, and had them cooked in the morning. We all ate of them, and it was the unanimous verdict that they were inferior. Lieut. Mansfield said that they tasted like black bass from warm and muddy waters. Last summer I cooked one which was good. It had red flesh, the only one of the species that I ever saw with red flesh. Some Rochester gentlemen own the lower preserve on our stream, and they have said that they would give a hundred dollars if there was not a rainbow trout in it.

Mr. Weeks.—We need all the trout we can get in Pennsylvania, but the proper thing to do is to get them into the right places. Rainbow trout should never be put into good streams where the native trout will thrive. Those who handle them should be certain that they are not making a mistake, and should have a correct knowledge of the habits and merits of the fish before distributing them too widely.

SECOND DAY.

On opening the meeting on the seoond day the president remarked that he was glad to see Mr. Wilmot present. Canada had not been represented in the association for some years, and he did not know but they had lost interest in the meetings.

Mr. Wilmot responded that it was not through a lack of interest that neither Mr. Whitcher nor himself had attended the meetings, but the fact was that it was always a busy time with them when the meetings were held. Parliament was then in session, and they had much important business on hand.

The following persons were then proposed for membership: Charles Pease, Cleveland, O.; W. H. Truslow, Cazenovia, N. Y.; T. J. Jessup, Virginia City, Nevada; W. E. Garrett, New York city.

The President.—There has been a suggestion made that the next meeting of this association be held in Boston, and perhaps this would be as good a time as any to agitate the question and get expressions of opinion concerning it.

Mr. Mather.—One of the first questions to be considered is, would it be to the advantage of the association to meet there? If it would, then it would be most desirable to do so. It will be recollected that we met one year in Philadelphia, and obtained many new members from that city. These members did not stick to us. One or two came to New York at the next meeting, but finally all dropped off. Our main object should be to increase our membership, as it broadens our usefulness.

Dr. Hudson.—If the meeting was held near the time of that of the New England Fish Commissioners, there is no doubt of our having a good attendance, and I would favor it unless it would prevent a large attendance from New York. I would like to hear from other members on this subject.

The President.—I would like to hear from Mr. Wilmot on the question of meeting in Boston.

Mr. Wilmot.—I do not care to express an opinion. Mr. Whitcher and myself can attend at either New York or Boston equally well. I feel like apologizing to the association for my long absence, and hope to meet with them oftener in future. Privately, I think New York the best place, on account of the opening of the trout season and the splendid display of the *Salmonidæ* which Mr. Blackford has at this time. As I said before, however, our Parliament is in session at that time, and it is difficult to leave.

Dr. Hudson.—The same objection exists in the New England States. Their Legislatures are in session at the time of our meeting, but as the trout opening is a great attraction it might be hard to say what is the best time. New York city is more attractive in May than in April, if we leave out the trout show.

Mr. Evarts.—It would be better to have the meeting earlier in the year than later. People like myself, who live in the country, find it easier to leave in February or March..

Mr. Blackford.—We formerly had a large attendance from New England, and we should strive to regain it. Being a continental association we should spread over more ground, and yet the question arises, would we be benefited by going to Boston? The trout exhibitions spoken of have grown from the association, and have in sort become part of it. As for myself, any other time would be more convenient for me, and I think for fish-culturists generally. They are now engaged in distributing fry and are very busy. I think the time should be changed, whether the place is or not, and for one, will favor Boston.

MR. MATHER.—If we can get an accession of members from the East, and hold them, then I would favor Boston also, but our Philadelphia friends deserted us.

The PRESIDENT.—No doubt we would have a large gathering in Boston, and our meeting would be a benefit to fish-culture.

DR. HUDSON.—It would be desirable to bring all Fish Commissioners together and have the meeting the day following the meeting of the association. We formerly had meetings of commissioners under Prof. Baird, but have had none since 1876. I do not know how far it would be practicable to bring the commissioners of the West in with us. It should be started by Prof. Baird in order to make it successful.

MR. SMILEY.—Only a year ago Prof. Baird had circulars printed, asking for a meeting of all Fish Commissioners, but they were never sent out, for fear that it might not be practicable to obtain such a meeting. Perhaps the Professor might consider that in connection with this association a meeting of the different Fish Commissions could be successfully held. In regard to the Boston meeting it appears possible to get the attendance of Prof. Baird and his assistants, as he is at Wood's Hall during the summer.

MR. BLACKFORD moved that the matter of the next meeting be referred to the Executive Committee, with power to arrange the time and place of meeting. Carried.

DR. HUDSON moved that Prof. Baird be requested to call a meeting of the Fish Commissioners of the different States, to take place about the time of our next meeting, either just before or after it. Carried.

The following paper was then read:

CHANGES IN THE FISHERIES OF THE GREAT LAKES DURING THE DECADE, 1870–1880.

BY CHARLES W. SMILEY.

A somewhat wide-spread impression exists in the lake regions that the fisheries of the Great Lakes are decreasing. That the number of pounds of fish annually caught is less than formerly is not true, and yet this instinctive impression is doubtless correct if formulated differently. That the resources are diminishing and liable to fail us is true.

From the statements of Mr. J. W. Milner, who visited the fisheries in 1871, and whose report was published by the United States Fish Commission, and by comparison with the investigation made in 1879 by Mr. Ludwig Kumlein, under the auspices of the Fish Commission and tenth census, the following facts appear:

I. The total number of pounds of fish obtained from the Great Lakes in 1879 was equal to or greater than the yield of any years in the first part of the decade.

II. The apparatus for capture has increased in effectiveness enormously, probably 500 per cent. The increased effectiveness was produced by the introduction of finer meshes in nets, the addition of steam tugs, the increase of pounds, and very great increase in the number of gill nets in use. The number of fishermen also increased.

III. The average size of the whitefish and trout taken greatly diminished during the decade.

IV. A considerable number of valuable fishing places became seriously or wholly exhausted. New places were sought out, and the supply thus kept up.

V. From these few facts the following conclusion is drawn: The perfection which the apparatus has attained, the diminution in the size of the fish taken, the exhaustion of numerous localities, and the fact that fishing is pressed under these circumstances enough to keep up the maximum supply, indicates that

in the natural order of events, remarkable diminution, if not complete collapse, is to be anticipated in the coming decade.

VI. The natural order of events may be averted by regulation of the size of meshes, preventing the pollution of the waters, and by artificial propagation.

In support of the foregoing statements the following details are submitted :

I. *The Supply Maintained.*—In his report for 1872, Mr. Milner gave a table of " the number of pounds of lake fish received by first handlers," but he stated that his figures for Sandusky, Milwaukee, Green Bay, and Mackinaw were incomplete. He then adds, "the sum total of this incomplete record is 32,250,000 pounds of fish." Mr. Kumlein's figures for 1879 foot up 68,742,000 pounds. That the total supply was not very much larger in 1879 than in 1872 is the universal opinion. It is also likely that the completion of the figures for 1872 would make a total of at least 50,000,000 pounds. In this period, the trade of Buffalo, Milwaukee, and some other places, fell off, but was compensated by the increase of trade in Chicago. This decline at Buffalo from 1872 to 1879 Mr. Kumlein places at from 6,374,100 pounds to 4,001,000 pounds. It is impossible to state the exact decline at Milwaukee, but one house reports a decrease from 14,000 half barrels to 2,058 half barrels. Another house sold 8,000 half barrels in 1871, 7,000 in 1872, and but 1,908 in 1879. A third firm handled 6,623 half barrels in 1872, and 10,397 in 1873, but only 2,003 half barrels in 1879. The only other wholesale dealer gave no comparative figures.

In 1872 Mr. Milner put the transactions in Chicago at 7,461,102 pounds ; in 1875 the total is given by a Chicago firm at 11,500,000 pounds; in 1876 the total is given by this same firm at 12,240,000 pounds; in 1877 the total is given by this same firm at 14,000,000 pounds; in 1879 Mr. Kumlein puts the Chicago trade at 17,247,570 pounds.

II. *Maximum Effectiveness of Fishing* —The summaries of apparatus used in Lake Michigan, as given by Mr. Milner in 1872 and by Mr. Kumlein in 1879, compare as follows :

	1871.	1879.
Pound nets	281	476
Gill "	450	24,599
Sail vessels and boats	689	612
Steam tugs	4	30

In their report the Wisconsin Commissioners say, "The number and variety of nets used for fishing are appalling, and their destructive character, supplemented by the spear, are rapidly exterminating the whitefish and salmon-trout in Lake Michigan, Green Bay, and in many of the larger inland lakes."

In 1860 Mr. Kalmbach, who is at present a dealer in Green Bay, began fishing with the pound net in Bay De Noquet: pound nets were at that time a new institution in these waters, and in fact his was one of the first trials. He employed two pound nets, one eighteen, the other twenty feet deep and twenty-eight by thirty feet square. From the 10th of October to the 25th of November, he took from these nets and salted 1,750 half barrels or 175,000 pounds of No. 1 whitefish, and could he have secured assistance, salt, packages, etc., he could more than double this amount. Very few fish were smaller than No. 1. Of late years the pound nets have contained smaller and smaller meshes. The Wisconsin Commissioners in their report for 1874 state, "At Racine there are four boats in constant use putting out and taking up not less than twenty-five miles of gill nets. We are told by Mr. Jacob Schenkenbarger, one of our oldest and most intelligent fishermen, that with an equal number of nets only one-fourth as many fish are caught as were taken four years ago." He further says, "Late in October, in 1870, I took with a set of thirty nets, at one time, 1,980 pounds of dressed trout. Four years ago, it was common to take from 1,000 to 1,500 pounds of fish at each trip. Now we never go over 500, and not unfrequently go less than 200 pounds. The lake is filled with nets, and the fish can hardly escape."

In the report of 1875, the Wisconsin Commissioners say, "At Milwaukee there are four steam smacks, and two sailing smacks, engaged in fishing. These six smacks have a total of sixty-five miles of nets. Each steam smack costs about $7,600. The capital invested at that place is not far from $75,000. Kenosha

employs four smacks, with about thirty miles of nets, and the catch is about equal to Racine. In these places, Kenosha, Racine and Milwaukee, there is a total of one hundred and twenty-five miles of gill nets used. There is a total of nets used in the waters of Lake Michigan to extend from one end of the lake to the other. During the year 1875 there have been great complaints of scarcity of fish, and there has been a falling off of at least one-fourth; so that it is evident to all that the waters of Lake Michigan are being gradually depleted of fish."

III. *Size of Fish Diminished.*—In their report for 1875, the Wisconsin Commissioners say, "In former days the fishermen used nets of a larger mesh, and took whitefish that weighed from eight to fourteen pounds each, the latter figures being the largest known to have been caught. Now they have to use smaller meshed nets and take smaller fish, the larger ones being almost unknown now."

From Green Bay, Mr. Kumlein reported: "Of late years, pound nets with small meshes have been largely employed, and thereby millions of young whitefish have been destroyed."

Writing from Port Clinton, Mr. Kumlein says: "In Mr. Nickel's opinion, the mesh is now rarely one-half the size it was ten years ago. The fishermen and dealers generally pronounce the decrease—especially of whitefish—very great indeed. However, Mr. Mathews, of Port Clinton, thinks there are just as many whitefish as ever, and as many caught; but, being distributed among more fishermen, they individually take less than formerly. Collectively the catch is pretty much the same as it was ten years ago, or ever was, in his opinion."

From Menominee, Wisconsin, Mr. Kumlein writes: "The number of whitefish to a half barrel is yearly growing greater. Sixty has been thought a good number; now, ninety is common. I am informed by Capt. Thos. Larsen, of Menominee, that he has seen a half barrel filled with twelve, no longer ago than 1874. It is the opinion of fishermen north of Menominee that the whitefish increased in number on their shore till 1876, when the yield rapidly fell off, till at the present date it is estimated to have fallen off two-thirds since 1875."

At Washington Island, in 1878, there were over five thousand barrels, equal to fully seven million, five hundred thousand young whitefish thrown away, being too small for market.

Writing from Green Bay, Wisconsin, Mr. Kumlein says: "During the autumn of 1878 and the spring of 1879, a prominent dealer at this point collected from fishermen along the shore of the bay, large quantities of whitefish, which he purchased already packed and salted in half barrels. They were bought for No. 1 fish, but in re-packing he found some of the packages to contain as many as six hundred fish, and, of course, none were large enough for No. 1. There were a very few No. 2, and the lot was even barely salable as No. 3. Many were found that did not measure three inches dressed."

IV. *Depletion and Search for New Fisheries.*—Of the eastern shore of Green Bay, Mr. Kumlein says: "The once famous fisheries of 'The Door,' around Washington and St. Martin's Islands, Little Sturgeon Bay and Chamber's Island are no more. On the ground where once stood forty staunch Mackinaws and five steam tugs, with about four thousand gill nets, brought to their owners in the neighborhood of $100,000 a year, the fishing is now carried on by a few superannuated Indians and the gulls. The same grounds that in 1873 yielded $4,000 in four months, from two pound nets (Chamber's Island), this year have yielded not quite $400 worth, and this with nets twice as large. The fishing grounds about the 'Door' were to the north and west of Washington Island, and south and west of St. Martin's, extending out in either direction for eight miles, and between the two islands the whole distance. These grounds were probably the greatest whitefish spawning grounds in existence prior to 1868. Now they are nearly abandoned both by fish and fishermen. From May 1st to August 15th, 1873, Mr. Blakefield, now of the firm of Blakefield & Minor, of Fish Creek, sold of fresh fish, from two small pound nets, set off Chamber's Island, $4,175.91 worth. This year on these grounds, with nets double the size, and in twice the length of time, the product has been a trifle less than $400. On the same grounds where one boat with two men sold from their gill nets $9,000 worth of fish in one year, there is no fishing at all now.

Mr. Windross, of Green Bay, estimates that at Oak Orchard and Pensaukee the catch of whitefish has fallen off ninety per cent. since 1869. He lays the decrease in a great measure to the sawdust polluting the spawning beds, and in corroboration of his statements cites the following, which he himself has witnessed. In 1845, the whitefish came up the Oconto River as far as the falls, twenty miles, to spawn. With a small seine he took 1,200 half barrels, and could have taken a great many more if he could have used them. This was only at one locality, and they entered all the weirs in the same manner. Now, the river bottoms are one mass of sawdust, and it also extends far out into the bay, so that the sheltered shoals are so covered that the fish desert them. Sawdust bottom extends out two miles from shore about the mouth of the rivers. Mr. Windross thinks the whitefish spawn more around the island and on the east shore. Very few spawning on the shore from Suamico to Peshtigo Point.

Of the tributaries of Green Bay near Menominee, Mr. Kumlein writes: "From fifteen to thirty years ago the most profitable fishing grounds were in the Menominee River near its mouth. Here racks were constructed which caught the fish as they came down from spawning. On such racks as high as six hundred barrels of whitefish have been taken in one autumn on a single rack.

Mr. Eveland says that not a whitefish has been caught in the river for the past twelve years. As soon as the sawdust began polluting the river the whitefish abandoned it. It was no unusual occurrence to take six hundred barrels of whitefish in a season, twenty years ago, on one of the Menominee River racks.

Duluth, Minn., does not seem to have been much of a fishing point until recently. Now the industry is assuming much greater proportions than in 1879. The town itself is only a few years old. (Statement of Ludwig Kumléin, June, 1880).

Of Bayfield, Wisconsin, Mr. Kumlein says: "The total number of men employed in 1879 was one hundred and thirty. In 1880 there were over two hundred. Pounds have been fished here for about twelve years. We could not learn that the de-

crease has been at all alarming. Ashland Bay (Chequamegan Bay) seems to have suffered the most, it is thought, because pound nets have been set there the longest. When a certain locality begins to show signs of giving out, a new one is found, and a rest of a few years is said in some cases to have restored the depleted waters. The present year (1880) the fishing is said to be better than ever before. But it must be remembered that the facilities for capture are better, the men more experienced, and the grounds better known. There is also more twine in use than ever before."

August 30th, 1880, Messrs. W. W. Paddock & Co., of Ashland, Wis., who own over 1,200 gill nets, twenty-three pound nets, and seven seines, wrote: "There seems to be only one-third of the whitefish caught near Ashland that there formerly was."

Of the fisheries of Lake Superior from Keewenaw Point to Huron Bay, where the catch in 1879 was 8,000 barrels, mostly whitefish and trout, Mr. Kumlein writes: "Whitefish are said to have decreased considerably in fifteen years, especially in Keewenaw Bay."

Mr. Kumlein, writing from Marquette, of the fisheries extending thirty miles east and west of that place, says: "Fifteen to twenty years ago the fishing was done almost entirely with hooks for trout, and only with gill nets for whitefish. Pounds were not used till 1869. There is supposed to have been a gradual decrease, especially among the whitefish and trout. This is stoutly denied by some, who say the fish have merely moved on to grounds inaccessible to the fishermen, or not yet discovered by them."

Mr. Kumlein says of White Fish Point: "This fishery was purchased in 1870 by Jones & Trevalle, of Buffalo, N. Y., who employ a steam tug, two Mackinaw boats, two pound nets, two seines, and thirty-six box gill nets. Of late the fishing has not been so profitable as it was five or six years ago. In 1879 there were but three hundred and fifty half barrels salted, while in 1874 there were 2,300. They take only whitefish and trout. In the last three years the catch has been too poor to pay expenses."

West Coast of Lake Michigan.—Mr. Kirtland, of Jacksonport,

Door county, says that in his neighborhood the amount of white-fish has fallen off fully one-third in seven years. No fresh fish at all is sold here now, as it was three years ago, but it is all salted and disposed of to coasters.

Mr. Marion, of Oostburgh, says that as many fish were caught the last three years as usual, but the number of nets has greatly increased, so that the decrease of each man's catch is thought by some to be fully one-half in ten years.

At Pentwater, once such a famous ground, there are at present but two boats; in 1874 there were five; ten years ago, seven and good fishing; now it is an almost abandoned locality.

Concerning the Mackinaw fisheries, the figures are quite reliable. In 1874, Judge G. C. Ketchum ascertained the product of that year to be equal to 3,542,840 pounds fresh, and in 1879 Mr. Kumlein shows the product to be equal to 3,259,896 pounds frèsh, or a decrease of 282,944 pounds, or eight per cent., in five years.

While visiting the Lake Huron fisheries, Mr. Kumlein wrote: "It is estimated by Mr. Case that ten years ago, with the same number of nets now used, three times the amount of fish would have been caught. He used to put up 1,200 barrels in a year; now he seldom gets over thirty tons."

Writing from Erie, Pa., Mr. Kumlein says; "Many years ago Barcelona was the most important fishing point on Lake Erie, but at the present time it amounts to but little. Dunkirk was also for a long time famous, but very little is done there now. Erie, on the other hand, is improving."

In 1872 Mr. Milner wrote of Sodus Point: "There are three boats here fishing pound nets." In 1879 Mr. Kumlein says: "Now there is none."

In 1872 Mr. Milner said: "Poultneyville, N. Y., has been a resort for Canadian fishermen for years. Fourteen or fifteen years ago they came over in numbers, and they came almost every year." In 1879 Mr. Kumlein said: "Now there are none at all."

From Sackett's Harbor, Mr. Kumlein writes: "Clark and Robbins. of Sackett's Harbor, say that in 1869 they salted 2,447 half barrels ciscoes, while in 1879 they got but one hundred.

They think such fish as pike, black bass, trout, etc., have increased since the alewives came, and that the whitefish and ciscoes have greatly decreased."

From Lorain county, Ohio, Mr. Kumlein writes: "The general impression seems to be that the decrease among the whitefish for ten years has been very great. Ten years ago there were not more than half as many nets as now, yet a much greater quantity of fish were taken."

Speaking of the vicinity of Green Bay, Mr. Kumlein says: "Five years ago Chamber's Island supported nine pound nets, doing a good business. Now there are but two, and these did not pay expenses the last year. In 1873 Mr. Minor alone sold to two firms, one in Chicago and one in Buffalo, $19,571.95 worth of salt fish, and $700 worth of fresh fish. At the same time a Cleveland firm on Washington Island did more than double this business. At the present time none at all are shipped from these same grounds which once yielded such a revenue. Prior to 1873 the average shipments per week, from May to July, was seven hundred half barrels, worth on an average four dollars. About 1874 the greatest decline was appreciable, and then the fishing suddenly dropped off entirely."

From 1870–1873 from sixty to one hundred tons were shipped from Fish Creek, and all taken within a radius of ten miles. These were worth four cents a pound to the fishermen on the ice.

V. *The Crisis.*—If the facts heretofore presented establish the allegation that (1) the number of pounds of fish caught has been maintained, but (2) by enormously increased and effective facilities, (3) that large fish are seldom caught, and that the small ones have not been allowed to survive, so that (4) already many fishing places have entirely failed us, it cannot be denied that a crisis has been reached such as seriously to alarm all who are interested in the lake fisheries.

VI. *The Remedy.*—The great efficiency of apparatus which has been reached will remain. We do not retrograde. Men will still use the powerful appliances which they have discovered; but it is possible for the neighboring States to regulate

by law the size of the mesh and some other minor details. This some of the States have attempted, and no doubt others will imitate them. It is also greatly in the interest of certain localities to prevent the pollution of their waters with sawdust, decayed lumber, offal, etc.

Artificial propagation has already been attempted on a limited scale, and the methods pretty well worked out. It is believed that if carried on extensively it may become a very powerful factor in the remedy desired.

The PRESIDENT.—The paper just read by Mr. Smiley is a most valuable one, and exhibits the power of statistics. Such information, covering such a wide extent of territory in so thorough a manner, could not well be gathered by private enterprise, nor by the Fish Commission of any State. The United States Fishery Commission is doing a grand work if it never does anything else than gather reliable statistics of our fisheries, and when this field is well worked, as is now being done, we will have what we never had before—a correct knowledge of our fishery resources.

The SECRETARY then read the following:

HATCHING STRIPED BASS, STURGEON AND TROUT.

BY SETH GREEN.

Mr. President and gentlemen of the American Fish-Cultural Association:—There have been but a few sturgeon and striped bass hatched artificially. The reason that there have not been more is that it is so difficult to get the mature fish when the spawn is ripe. In many of our waters there is no great difficulty experienced in getting both sturgeon and striped bass that are quite far advanced or well along toward the time when they are ready to cast their spawn, and if a suitable place could be prepared where the fish could be placed and kept securely for a few days until the ova had reached the proper stage of development, there could be millions of them hatched artificially without a doubt.

The New York State Fish Commission has stationed men at different points on the Hudson River where the most sturgeon were caught, principally at Hyde Park, New Hamburgh, Tivoli, and Catskill, during three seasons, and has succeeded in hatching one hundred and fifty-five thousand young fry. The mature fish are so scarce that it was with great difficulty that a ripe male and female could be obtained at the same time, although every exertion was made to obtain them, and every fish was inspected as it was brought in by the fishermen as long as the season lasted, which is during the months of May and June. If a pond or enclosure could be so constructed that eels could not gain access to it, it would be a long step toward the propagation of sturgeon. Eels are the great drawback to keeping sturgeon in pens for propagating purposes, for the reason that when the female is ripe, or ready to cast her spawn, the vent enlarges or loosens to such an extent that eels are enabled to enter therein and live upon the ova until it has all been destroyed. I have seen this frequently when I have had them in fish cars.

It would be very difficult to find a place on the Hudson or any other river that flows into the ocean, where a pond could be built and not be infested with eels, but I believe such an enclosure could be made, with a little experimenting and careful study. In case there was no pond, I think the experiment would be worth trying of putting the fish in ordinary cars and constructing a harness of some sort to fasten around the fish, and protect the vent from invasion by the eel; a simple cloth or leather bandage might answer, but I would suggest a small bag made in the shade of a jug or otherwise, being fastened to the bandage securely around the aperture. I think the difficulty could be overcome by pursuing some such course. I offer this as a suggestion, and perhaps it may put somebody on the right track to work it out and make a great success.

There is no question about its being very necessary to propagate sturgeon artificially. There is no other way to keep up the supply, and unless it is done sturgeon must soon become a luxury of the past.

I have never seen or known of an eel entering a striped bass,

but I should think some precaution would be necessary in case very large females were kept in confinement, either in careful construction of pen, or protecting the vent as suggested above, in case it was found necessary. The striped bass are caught at Weldon, N. C., in the Roanoke, and in some other of our Southern rivers, in large quantities. In some localities large numbers are caught on what are called by the fishermen racks or slides. These are built of wood on the inclined plan principle, the top being covered with slats raised a short distance apart, allowing the water to sift through. They are set in the most rapid part of the river, and leaders branch out from both sides near the water's edge, which guide the fish to the rack or slide. Thousands of striped bass are caught in this way. I am of the opinion that if experienced men were placed on these racks during the month of May, when the fish were running, and select the females which were nearly ripe, and place them in a car properly constructed, that a great success could be made in hatching them. There is no trouble in securing ripe males when the fish are running, but as a precaution it would be well to pen a few in case of an emergency. I have hatched both sturgeon and striped bass successfully in my shad hatching-box. If sturgeon or striped bass were to be kept in confinement for propagating purposes, at least two cars should be constructed, so that the fish could be overhauled daily, or as often as was thought necessary, and worked over from one car into the other. This would aid greatly in the prosecution of the work.

The New York Fish Commission has this season offered for distribution to any parties in the United States or Canada, applying before March 1st, and sending fifty cents to defray cost of packing, a package of three hundred to five hundred eggs of the California mountain trout for experiment. In response to the notice we have received two hundred and forty-eight applications from the following States, Territories and Provinces: Massachusetts, Pennsylvania, Connecticut, New Jersey, Rhode Island, Missouri, Indiana, Michigan, Minnesota, Vermont, New York, Iowa, Illinois, Ohio, Georgia, Virginia, Kentucky, Dakota, Wisconsin, Kansas, Texas, New Mexico, Mississippi, Louisiana, New Hampshire, Maine, Nebraska, North Carolina, Ontario,

California, Quebec, Oregon, Nova Scotia, Utah, Wyoming, and Newfoundland. Each one of the applicants will be given as large a supply as that with which the New York Fish Commission started, and from which we have succeeded in hatching 1,340,000 young fry. If one half of the two hundred and forty-eight applicants should succeed in raising and propagating this species, so that each one should succeed in hatching 1,000,000 during the next six years, we would have 124,000,000 more of this excellent game and food fish in existence than would otherwise have been the case. I am very anxious to see this fish in every lake and stream in the country suitable for them, and hope that the success of this wide distribution may be as great, if not greater, than I have mentioned above. I have also taken pains to put each applicant in the way of procuring practical information in the way to hatch and rear the fish successfully.

The President.—Mr. Green has been called "the father of fishes," but I notice here among us a gentleman who is a friend of him who may be called the "grandfather of fishes." I refer to the venerable Doctor Garlick, the father of American fish-culture, and would ask Mr Pease, of Cleveland, who is a friend of the Doctor's, how he is in health and spirits.

Mr. Pease.—Dr. Garlick's health, as most of you know, has not been good for many years. He is now in his seventy-sixth year and is a great sufferer, but his spirit is unbroken. He takes great interest in fish-culture yet, and reads all your reports and the *Forest and Stream* with great interest. I do not know that I can say more on this subject than to say that the Doctor is with you in spirit, although not able to be here in person.

Mr. Phillips.—We expected a paper from Mr. S. M. Johnson, of the firm of Johnson & Young, Warren Bridge, Boston, on the lobster question. Mr. Johnson has given us much valuable information at previous meetings, and is one of the best informed men on the lobster question in the country. In place of a paper he has written a letter to Mr. Blackford, which I will take the liberty of reading, although evidently not intended to be read

before the association. My apology for doing this is the information contained, which we cannot afford to miss. He says.

BOSTON, April 1st, 1882.

Mr. Blackford:

DEAR SIR—This everlasting lobster question appears so inevitably that I thought I would write just one word to you instead of attempting to bore the Association, and in a word say what I think about the matter now, as well as in the past. If my memory serves me, I made the statement before the Association at the first meeting which I attended, that we were doing more injury than we realized, and I think so still. And that each recurring year confirms and intensifies the truth of that assertion, and the seeming necessity for evading a wise law to keep up even a partial supply proves the wisdom of that law, and that we are making sacrifices of future good to gratify present demands. In using these small lobsters we are hypothecating our stock in trade and cutting off our future supply. The price that has been paid this year for those small lobsters shows to what straits we are already reduced, and using small ones this year to keep the price down only adds greatly to what the price will be next year, and so on. This of course is apparent to you, and I should not say anything about it except for the reason that I wish to keep the matter alive and try to avert an evil so sure to come unless we can manage to have our law enforced. If lobsters have been worth, or rather if they would bring, twelve cents a pound this year in New York, it is because we have destroyed so much of our supply, and using small ones is a sure way to increase the price year by year. We are constantly in receipt of letters saying we cannot ship to you because we can sell everything in New York regardless of size, which, if true, is wrong. Not because it affects me personally, but because it affects the whole business, and brings about a state of things which good men and the combined wisdom of such associations as the American Fish-Cultural Association are striving to prevent.

I wish to put myself on record as advocating a just and wise law for the preservation of lobsters. I do not write this to have it appear to the Association, but hope you will see fit to mention the matter.

S. M. JOHNSON.

MR. BLACKFORD.—Mr. Johnson is greatly interested in the ten-and-a-half-inch lobster law, as the only way to preserve the lobster fisheries. Last year lobsters sold as high as twenty-five cents per pound at retail, and even higher. Small lobsters are

sent here for sale, notwithstanding the law against it, and many go to New Jersey, where there is no law on the subject.

Mr. Mather.—It is not uncommon to see small lobsters, much below the legal size, offered for sale in New York city. It seems to be no person's duty to complain of it.

Mr. Blackford.—Some people think it the duty of the Fish Commissioners to enforce the laws. This is the case in some States, but not in the State of New York. The Fish Commissioners have nothing whatever to do with the enforcement of the laws. There are eight public officers whose duty it is to enforce the laws relating to fish and game in the State of New York. They are called "Game Protectors." Their appointment is for the State at large, and they have no particular districts. The nearest one to New York city resides in Hudson.

The President.—We should have one for New York city alone, and it might be well for this association to take some action looking to the appointment of one for the city.

Mr. Mather.—I would state that a short time ago I attended a meeting of delegates from the New York State Sportsmen's Association in Albany. The object of the meeting was to revise the game and fish laws and draft a bill for introduction into the Legislature. This has been done, and the bill provides for the appointment or four more "Game Protectors," making twelve in all. Two of these new ones are for western counties, one for Long Island, and one for New York city.

Mr. Blauvelt.—I have tried to enforce some laws, but there seems to be a difference of opinion as to the way the mesh of a net should be measured.

Mr. Mather.—These differences of opinion are not to be taken into account. There is but one way to measure a mesh, as you will find if you order a net of any net-maker, and this is to stretch the mesh the longest way and measure it. Those who measure from knot to knot do not measure the mesh, but only

a "leg." The mesh is twice as large as they make it. For instance, when it is one inch between knots it is a two-inch mesh. I am aware that some inland fishermen measure differently, but an enquiry at any house that sells nets will show that they are wrong.

The PRESIDENT.—I would recommend that the officers of this association send a communication to either the Legislature or the Governor, asking for the appointment of a game constable expressly for this city. I don't see that we can do more. I notice that Mrs. Amelia Lewis, the editor of that popular paper, *Food and Health*, is with us, and as she has promised to read a paper on the carp and its treatment from a culinary point of view, we will be pleased to listen to it.

The PRESIDENT.—Mrs. Lewis is the first lady who has honored us with a paper, and there are some things which she has said that I shall remember, especially that carp should never be boiled, never fried nor cooked in lard.

The SECRETARY then read the following :

THE WINTER HADDOCK FISHERY OF NEW ENGLAND.

BY G. BROWN GOODE AND CAPT. J. W. COLLINS.

The winter fishery for the capture of the haddock, *Melanogrammus aeglefinus*, is carried on chiefly from the ports of Gloucester and Portland, though participated in to some extent by vessels from Portsmouth, Swampscott, and Boston. Although haddock are caught in large quantities, from spring to fall, by numerous vessels and boats employed in the inshore fisheries between Portland and Philadelphia, the winter haddock fishery is peculiar in its methods. It is of comparatively recent origin, dating back about thirty years. We are told that in 1850 immense quantities of haddock were caught on the trawls in Massachusetts Bay, and that a petition was prepared by the Swampscott fishermen asking for a law which should prohibit

trawl-fishing, on the ground that this method would soon exterminate the haddock. It is impossible to trace with any degree of certainty the steps in the history of this fishery, since it is pursued for a few months in the year only, by vessels otherwise occupied a large portion of the time. Since the fish have always been disposed of in a fresh condition, they have been less carefully recorded.

FISHING GROUNDS.

The winter haddock fishery is prosecuted, from October to April, on all of the inshore ledges and the nearest of the offshore banks south of Sable Island bank and north of Cape Cod. The depth at which the fish are taken varies with the locality, but is within the limits of twenty-five and ninety fathoms; usually in water deeper than thirty fathoms.

In the fall, when fishing first begins, the vessels set their trawls along the coast from Nantucket Shoals to Grand Menan, in thirty to ninety fathoms of water. On the outside of Cape Cod the fishing is within five to fifteen miles of the shore; in Massachusetts Bay, principally on the outer slope of Middle Bank and the southern slope of the shoal ground that lies to the eastward of Cape Ann, usually called the "Southeast," the eastern part of the shoal-water of Jeffries Ledge, and along the coast of Maine within thirty miles of the shore, especially about Monhegan Fall, South-southwest and Western Ground. Fishing in this region continues until midwinter, and is kept up by a smaller class of vessels, such as those hailing from Portland, throughout the whole season. In the latter part of January and in February the larger vessels comprising the major portion of the Gloucester fleet, strike farther out to sea, fishing upon George's Bank, usually in twenty-five to forty fathoms, near the localities frequented by the winter cod-fishermen, and also on the western part of the bank. They also fish on Brown's Bank, in water about the same depth, and on Le Have and about Cape Sable. The fishing on Le Have Bank for haddock was first attempted in the winter of 1880–81.* This fishery has been attended

* Capt. S. J. Martin, of Gloucester, writes, under date of May 10th, 1881, as follows: "The first vessel that went to Le Have Bank for haddock was the schooner Martha C., of this port. She made her first trip there last winter."

with the greatest success. Fishing continues on these outer banks until the end of the season, when it is time for the vessels to engage in other branches of the fishery.

THE FISHERMEN.

The fishermen who take part in this fishery are usually picked men from the Gloucester fleet. A large portion of them are engaged in the mackerel fishery in the summer.

This fishery requires as much skill, pluck and endurance as the halibut fishery, and men are selected in both these fisheries on account of similar qualifications. Not unfrequently the same crew will remain with the vessel in the summer when she is in the mackerel fishery. There is so much competition among those who desire to ship with a good skipper that very often his entire crew list is made out five or six months in advance.

THE VESSELS.

The vessels composing the winter haddock fleet are chiefly stanchest and swiftest of those which in summer engage in the mackerel and cod fisheries. The Portland fleet is made up of a smaller class of vessels, averaging from thirty-five to forty tons; these in summer are engaged in the mackerel or shore fisheries. The few Swampscott and Boston vessels which take part in the winter haddock fishery are marketmen and mackerelmen in the summer.

The rigging of the haddock catchers is precisely similar to that of the halibut catchers, with the exception that very few of them carry gaff-topsails and riding sails. Their outfit of nautical instruments and charts is, as might be expect, less complete. The larger ones, however, have every thing which belongs to the outfit of the halibut schooner excepting the chronometer, the Epitome, and the Nautical Almanac.

Since the haddock vessels are rarely, if ever, anchored on the fishing grounds, their arrangement of cables and anchors is very different from that in the halibut and George's fleets. They usually have a chain cable on their starboard side, and upon the port side a cable similar to that used by the George's and hali-

but vessels, from one hundred and fifty to two hundred and twenty-five fathoms in length, which is stowed in the fore hold. One end of this cable is bent to the anchor, and the other passes down through a hole in the fore hatch and is coiled below in the fore hold. The anchors are like those used on "Georgesmen."

The deck is arranged in a manner different from any that has yet been described. There is usually a single gurry-pen forward of the house, and the space between the sides of the gurry-pen and the house, and the rail on either side, is so arranged that it can be divided into pens for the reception of the fish. Three or four pens may be placed on each side.

The remainder of the deck is clear, but there is a booby-hatch over the main hatch, through which access is gained to the bait-room.

The haddock catchers do not ordinarily carry davits, or a reefing plank. The mainsail is provided with an "out-hauler" or patent reef-gear, which answers the purpose of a reef-tackle and gearing, and facilitates the process of reefing from the deck. A few of the larger vessels, however, are provided with davits and reefing-planks.

The arrangement of the hold is also peculiar. The space which in a halibut catcher is occupied by the forward ice-house, is here taken up by the bait-room. The bait-room is sometimes, but not always, bulkheaded off from the fore hold. It is one large compartment, with rough board benches all around, on which the men sit while baiting their trawls. In the center stands a stove. In this room the fishing-gear is always stowed when not in use. The after hold is generally fitted up with pens resembling those in the after hold of a halibut schooner. In these pens ice is carried when the vessel is making long trips. When large fares are obtained, part of the fish are stowed in the bait-room, which, on the larger vessels, is so arranged that partitions can be built in it by sliding boards into grooves. The haddock schooners carry a larger amount of ballast than those of any other class, a vessel of fifty tons requiring thirty to thirty-five tons of ballast.

THE APPARATUS AND METHODS OF THE FISHERY.

Dories.—The larger haddock catchers carry six dories, the smaller, four or five.* Most of the dories used in this fishery are deeper and wider than those in any other fishery, and are built specially for the purpose. The ordinary dory is also frequently in use. These dories are fourteen feet in length. When on deck they are nested in the ordinary manner, two or three on a side, and are stowed nearly amidships on each side of the booby hatch, not nested close to the rail, as is the practice upon other vessels carrying dories.

A haddock dory ready to leave the vessel, in order to set its trawl, is provided with the following articles in addition to the trawl lines: Trawl-roller, two pairs woolen nippers, dory knife, gob stick, gaff, bailing-scoop, tholepins, two pairs 9-ft. ash oars, buoys, buoy lines, anchors, and black balls.

Trawls.—The haddock trawls have the ground line of tarred cotton, of fourteen to eighteen pounds weight to the dozen. Hemp is occasionally used, especially by the Maine vessels and by some of the Irish vessels from Boston. The gangings are of white or tarred cotton, in weight about four to six pounds to the dozen. They are about two feet in length, and are fastened to the ground line at intervals of three and a half feet. The manner of fastening the gangings to the ground line is very different from that employed upon the halibut trawls.† The hooks are No. 15 or 16, center draft, and eyed.‡ The hooks are fastened to the gangings in the same manner as on the cod trawls. The haddock trawls are coiled in tubs, these being similar to those employed in the George's fishery. A flour-barrel, sawed off above the lower quarter hoops, is used for a tub. Each tub of haddock trawl contains five hundred hooks, or about two hundred and ninety-two fathoms of ground line. Each dory

* The haddock catchers of Maine, and some of the ports in Massachusetts, fishing with "single dories," carry one for each man besides the skipper and cook. These boats are thirteen feet long, and managed by a single fisherman.

† They are fastened either by tucking and hitching, or by a simple hitch around the ground line.

‡ The Irish fishermen of Boston sometimes use a galvanized hook of the same size without an eye.

is provided with six or eight tubs of trawl, and two to eight of these tubs of line are set at once, as the case may require. Sometimes only two or three tubs are set at a time, and several sets are frequently made in a day when the weather is suitable.

One of the anchors is similar to those used upon the cod trawls, while the second anchor is often of the killick pattern. The buoy line is the same as in the cod or halibut trawl, and its length is fifteen to thirty fathoms more than the depth of water in which it is used. The buoys are similar to those used in cod-trawling. Each buoy at the end of the trawl has a black ball upon it, and a middle buoy, without a staff or black ball, is also used* when the whole length of the trawl is set.† Instead of the regulation keg buoy, a "kit" is sometimes used by the haddock trawlers.

Bait.—When it can be obtained, the principal bait used by the haddock-catchers is menhaden slivers, salted. This is considered the best bait, and it is said that haddock will often bite at this when nothing else will tempt them. The trawl-hooks, when this bait is used, may be baited days, or even weeks, in advance, while the vessel is waiting for a chance to set. When fresh bait is used, the trawls can be baited only a short time before—indeed, only a few hours before they are to be set.

Fresh herring is also used for bait, though to a comparatively limited extent, until within the past two or three years, when they have been the principal bait relied upon, as a sufficient quantity of menhaden could not be procured.

Capt. S. J. Martin, of Gloucester, writes: "Five or six years ago pogie slivers were exclusively used for bait by haddock fishermen, but for the past two winters none of these could be obtained, and mackerel and herring have been the principal bait. The first vessels that started in October (1880) took fresh mackerel for bait. When the herring came on the coast, or were brought to Gloucester frozen, they were the bait depended on by the haddock-catchers.

*This is to aid the fishermen in recovering their trawls in case they are parted at either end.

†When the trawls are set in shallow water, where there is a rock bottom, three or four middle buoys are sometimes used.

In cutting up menhaden slivers for haddock bait, sections are made trapezoidal or square in form, with a surface area of about a square inch. One of these pieces is placed on each hook, and as the hooks are baited the line is coiled in the tub, the hooks being placed around on the side, points up.* When the fisherman is ready to bait his trawl, he sits upon his bench with the empty tub between his legs and the trawl-line removed from the tub and turned right side up in front of him, his bait being in a bucket at his side. In his left hand he takes eight or ten pieces of bait, and with both hands he pulls the line towards him, coiling it in the tub after baiting the hooks; he places them in the tub in the manner just described.

As is always the case when a number of men are working together at the same employment, there is a sharp competition among the men as to who shall be the first to get his trawl baited. The average time consumed in baiting five hundred hooks is from forty-five to sixty minutes, though the most skillful men have been known to accomplish the task in half an hour. It will be seen that the labor of baiting three or four tubs, which falls daily to each man when the fishing is good, occupies a considerable portion of the day, or, rather of the night, since the baiting is usually done at night. In baiting at night, each man has a lamp of peculiar pattern which is fastened to the edge of his tub by a hook; sometimes the trawls are snarled, and the whole night is devoted to clearing and baiting them. A man will go into the hold to bait after the fish are dressed in the evening, and perhaps not finish his task until daybreak, when it is time to go out to set again.

Methods of Fishing.—As has been remarked, the haddock-catchers never anchor on the banks when fishing. The usage in this respect has greatly changed within the last few years. When the fishery was less extensive and was carried on entirely upon the inshore grounds, they were accustomed to anchor, set their trawls and under-run them, but now the trawls are all set while the vessel is lying to, waiting for the dories. This oper-

* The Irish fishermen of Boston place their trawls in baskets, coiling the line in one part and putting the baited hooks in another division of the basket.

ation is called "setting under sail," and its successful performance is one of the most complicated evolutions performed by vessels or boats, requiring a high degree of skill on the part of the men on the vessels and in the boats.

Let us imagine ourselves on the deck of a haddock schooner at daybreak, approaching Jefferies Ledge; the skipper, having first sounded and obtained the desired depth of water, decides to make a set, and gives the order, "Get the top dories ready," at the same time indicating how many tubs he thinks it desirable for each dory to set. The four men to whom the two top dories belong, adjust the anchors, buoy-lines and buoys which are already in the dories, and also place in them the other necessary fishing-gear. The dory-tackles are then hooked on, and the boats are swung over the side of the vessel. The middle dories are then equipped in a similar manner by their respective crews, and as soon as these are ready the top dories are dropped into the water and paid astern, and the middle ones are swung over the side, the bottom dories being then prepared for action in their turn. The middle dories are now dropped down and paid astern with the others, and the bottom dories are swung upon the sides and are ready to be lowered at the proper moment. Eight men take their places in the dories towing astern; perhaps, in fact, the four men belonging to the top dories are already there and ready to set.

The skipper now gives the order to one of the dories that was first put out, "Throw out your buoy." This being done, the dory tows astern of the vessel until the buoy-line runs entirely out; the men in the dory then sing out, "Let go the painter." The dory is cast off and they begin to get their trawl in the ordinary manner, their course usually being to leeward, and nearly at right angles with the direction of the vessel. This operation is repeated in succession with each dory, the last dories dropping astern after the others have been let go. Sometimes when the wind is moderate and it is practicable, all six dories are dropped down before the first begin to set. The boats having been let go in the manner described, are thus left scattered along in the wake of the schooner at intervals of one hundred to two hundred fathoms, the first and the last dory being

from three-quarters of a mile to a mile and a half apart. As soon as the dory has been dropped, the vessel keeps off and runs to leeward, and is ready to pick up the first one as soon as her trawl has been set, and the others in regular succession. The time occupied in setting the trawls under sail varies from half an hour to an hour.

When the dories are picked up, a part or all of them are taken on deck and the vessel immediately begins to work back toward the weather buoys ; as soon as the weather buoys are reached, the boats are usually dropped again in the manner already described, and the men begin hauling. This second evolution occupies from one hour to an hour and a half, according to the strength of the wind and other circumstances. As the dories are dropped a second time they find themselves at the very place where they threw overboard the first anchor, and a mile or two to the windward of the place where they dropped their last anchor. They are now able to haul to the leeward, which is easier than hauling to the windward, and is more advantageous to the fishing, since the tender-mouthed haddock are less liable to drop from the hooks of a trawl when it is slack than when it is taut.

For the dories to haul their trawls occupies from one to four hours, according to the length of the trawl, the number of fish on the hooks, and the state of the weather. While the dories are hauling, the vessel is lying-to with the jib to windward and drifting back and forth along the line of boats, waiting for the men to finish hauling their trawls or signalize, by raising one of the oars, that they have a load of fish and wish to be taken on board. After the lines have all been hauled the dories are again taken on deck, unless another set are to be made on the same ground. When the dories set the whole length of lines, it is very unusual for a vessel to make more than one set in a day; sometimes, however, a smaller number of lines is set, and the operation is twice performed. In exceptional instances, after the whole string of tubs has been once set, a smaller number, perhaps a tub to each man, is set in the latter part of the day.

The operation of shooting alongside the dories and picking them up is one of the most difficult feats of seamanship which can be accomplished by a fishing schooner.

The haddock trawls are often set in rough weather, and at times when there is what would be called a strong whole-sail breeze, and, occasionally, when it blows hard enough to make it necessary to reef the sails. After the trawls have been set and the vessel worked back to the weather buoys, if the weather looks at all threatening it is customary to take the bonnet out of the jib and put a reef in the mainsail, so that if the wind should increase while the trawls are being hauled, the vessel can be managed by the skipper and the cook—the only men left on board.

As might be expected, men are sometimes lost in this method of fishing, the losses being occasioned by sudden snow storms, which cut the dories off from the view of those on board of the vessel, or by heavy squalls, which render it impossible for the schooner with only two men on board to go through the necessary evolutions.

It should be stated that the evolution of setting under sail is varied at different times and by different skippers, but that the differences in the manner of performing the evolutions are not of much importance, and that the most common method is that which is here described.

When fishing on George's Bank the Gloucester haddock vessels are obliged by the force of the tide to resort to another method of setting, which is called "double-banking the trawl." The tide is so strong that the trawls cannot be set in the ordinary way, for the buoys would be carried beneath the surface. Two dories are therefore lowered at once, and jointly perform the act of setting; only two tubs are set by each pair of dories. The set is made in the following manner: The men in one of the dories hold fast to the weather-buoy while the men in the other dory set the trawl. After the trawl is out, the dory which sets it holds fast to the lee buoy until by some signal, such as lowering the jib, the skipper of the schooner gives the order to haul. The trawls are left on the bottom fifteen or twenty minutes before they are hauled. The men in the two dories begin to haul simultaneously. The anchors are thus first raised from the bottom, and presently the bight of the trawl and the two

boats drift along with the tide, the distance between them gradually narrowing as they haul.

Haddock are often found so plenty on George's that it is not necessary to set more line at a time, even were it easier to do so, since a single tub of trawl will often bring up enough fish to fill a dory. Several sets of this kind can be made in a day, when the weather is favorable.

Some of the Maine and Swampscott vessels send out only one man in a dory; this usage is called "fishing single dories," and is, of course, practicable only in comparative moderate weather.

THE MANNER OF CARING FOR THE FISH.

As the fish are brought alongside they are pitched into the pens already described. As soon as the dories are discharged and taken on deck, and the vessel is under way, the men begin to dress the fish. The process of dressing differs entirely from that of dressing cod; there are no dressing-tables or dressing-tubs. The men distribute themselves among the pens. Four or five men are engaged in ripping the fish, this operation being performed by seizing the fish by the eyes or some part of the head with the left hand, and ripping them downward from the throat. The remainder of the crew occupy themselves in taking out the liver and roes, which are saved in barrels separately, and in removing the viscera. The fish are washed by pouring buckets of water over them as they lie in the pens on the deck, and are packed away in the hold or left on deck, unless, on account of distance from the land or mildness of the weather, it is necessary to ice them, in which case two or three men go into the hold and stow the fish away between layers of ice. The fish are iced with greater or less care according to the length of time expected to elapse before the arrival of the schooner at the market. All the vessels going to Le Have, George's, and Cape Negro carry from five to six tons of ice each trip.

PRODUCTIVENESS OF THE FISHERY.

The vessels of the Gloucester fleet in the winter of 1880–'81, obtained on an average 350,000 pounds of haddock, valued at

$6,000. The schooner Martha C. obtained about 600,000 pounds, stocking $11,500. The Edith M. Pew obtained 550,000 pounds, stocking about $11,000.

Captain S. J. Martin, of Gloucester, Mass., writes under date of February 12th, 1882, that the schooner Martha C. arrived yesterday with 90,000 pounds of haddock; she was gone eight days. Schooner Josie M. Calderwood, 85,000 pounds, gone seven days. Schooner H. A. Duncan, 80,000 pounds, gone seven days. Four vessels left Gloucester on Saturday and were back on Wednesday, each with 40,000 pounds haddock, having fished one day and a half. That is good and quick work.

"Schooner Mystic, Captain John McKennon, has stocked the year ending February 8th, 1882, $21,003. He claims high line of the shore haddocking fleet, and so far as we know this is the largest stock ever reported in this fishery. The crew shared $780.06. In 1880 he stocked $17,765, the crew sharing $765."—*Cape Ann Advertiser*, February 10th, 1882.

"The new schooner Dido, recently built at Essex for Mr. George Steel, of this city, has been engaged in the haddock fishery just one month to-day, during which time she has made three trips, stocking $3,750. On her last trip she stocked $1,400. Her crew shared for the month $138 each. The Dido is commanded by Captain William M. Wells. Schooner Richard Seester, Captain Ozro B. Fitch, on a recent haddock trip stocked $1,000."—*Cape Ann Advertiser*, February 10th, 1882.

THE LARGEST HADDOCK FARE EVER LANDED.

"The schooner Martha C., of this port, Captain Charles Martin, arrived at Boston on Friday from a George's haddock trip, stocking $1,943, the crew sharing $91, the result of two and a half days' fishing. Absent ten days. This is the largest catch and best stock ever reported in the haddock fishery."—*Cape Ann Advertiser*, February 24th, 1882.

The catches of the average Portland and Boston vessels were not, probably more than half as great. The Martha C., before alluded to, in thirteen hours' fishing caught 90,000 pounds of cod and haddock. The total amount of haddock carried into Boston into 1870 was 17,000,000 pounds; of this amount prob-

ably at least 13,000,000 were obtained by the winter haddock vessels. The total yield of this fishery does not, probably, fall below 18,000,000 to 20,000,000 pounds.

RUNNING FOR THE MARKET.

No class of vessels, not even halibut schooners, take more risks in running for market than do the haddock schooners. It is of the utmost importance to them to reach the market with their fish in good condition, and, if possible, to be in advance of other vessels engaged in the same business. In the stormiest of weather all sail that they will bear is crowded upon them, and harbors are made even in heavy snow and fog. The trips are short, averaging frequently not more than two or three days, and rarely not longer than a week or ten days ; they are, therefore, constantly running for the land, and are more accustomed to making the coast than the halibut vessels, and become so familiar with the harbors most frequently resorted to, especially with that of Boston, that they are able to enter them when no other vessels, probably not even pilot boats, would care to make the attempt. What has already been said about the dangers encountered by the halibut schooners will apply as well, in its fullest extent, to the haddock schooner.

THE MANNER OF OUTFIT.

In the winter haddock fishery every man supplies his own dory and outfit complete, besides paying his share of the provision bill. In the settlement of the voyage the vessel draws one-fourth of the net stock, or, in the case of the older vessels, according to the old system, only one-fifth, after certain stock charges have been deducted for bait, ice, wharfage and towage. The remaining three-fourths or four-fifths of the stock is divided equally among the crew, the owner paying the skipper's commission or percentage from the vessel's quarter. The average share of the Gloucester crews for the year 1880–'81 was about $290. The most successful shared $500 to $550. The largest stock ever made in one day's fishing in the winter shore fishery up to 1880 was that of the Eastern Queen, of Gloucester, which

carried to the Boston market, in 1873, 25,000 pounds of haddock, and stocked $1,100. This vessel also made the largest stock of that season, realizing in five months $10,250, clear of all expenses, the crew sharing $550 each. The crew of the schooner David J. Adams in March, 1881, shared $107 each in a ten days' trip in the haddock fishery.

THE HADDOCK FISHERY FIFTY YEARS AGO.

A writer in the "Fishermen's Memorial and Record Book" thus describes the haddock fishing in the early part of the present century:

".The fitting out of the fleet for the haddock fishery commenced about the first of April. The first move was to run the boats on the beach, or landing as it was then called, and have them caulked and graved. The latter process consisted in applying a coat of pitch to the bottem and burning it down with a tar barrel, which gave a smooth and glossy surface. Painted bottoms in those days were very rare.

"The time occupied in making a haddock trip was from two days to a week, the fish being mostly taken on Old Man's Pasture, Heart's Ground, and Inner Bank, about twelve miles off of Eastern Point. The fish were taken to Charlestown for a market, and purchased by the hawkers—among whom were Johnny Harriden, Joe Smith, Isaac Rich, and others, who took them over to Boston in handcarts, and retailed them at a good profit. The codfish were generally salted. The smallest were cured for the Bilboa market, and the largest were made into dunfish, as they were called, for home consumption. They were kept on the flakes several weeks, and thoroughly dried until they became of a reddish color, and were highly esteemed as an article of food. The haking fishing commenced in July, and the pollock fishery was prosecuted from September till the middle of November. Each boat carried three men—skipper, forward hand and cook, who went at the halves, as it was called, the crew receiving one-half the gross stock, and the owners the balance" (page 73).

A recess was then taken.

NOTES ON THE BREEDING, FOOD AND CAUSE OF THE GREEN COLOR OF THE OYSTER.

BY JOHN A. RYDER.

No mollusk known to naturalists, it appears, is consumed in such vast quantities as our native oyster, the *Ostrea virginiana* of systematic writers, hence the great economic importance and the scientific interest which it has recently awakened. It is much superior in flavor, size, and vigor of growth to the native oyster of Europe, and is simulated and approached only by one old continental form which I have seen and which is probably the *Ostrea rostralis* of Lamarck. The first attempt made in the artificial impregnation of the eggs of this noble mollusk was successful in the hands of our countryman, Professor W. K. Brooks, of Johns Hopkins University of Baltimore, who, in 1880, published a remarkable memoir on the subject in the annual report of Major T. B. Ferguson, one of the Fish Commissioners of Maryland. Professor Brooks' triumph was, however, not as complete as might have been desired, since his investigations have not yet enabled us to propagate the oyster by purely artificial methods, but his success was so much beyond what was attained by Dr. Davaine in his attempts at the artificial fertilization of the ova of the European oyster in 1851, that Brooks' achievement marks the most important era in the history of the subject. Others, as well as the writer, have repeated his experiments with more or less success, and the latter has been enabled to work out a portion of the developmental history of *Mya arenaria*, the common clam, "soft clam," "long clam" of the North, or "mananose," as it is called further South, from artificially impregnated eggs.

An earnest, and it is to be hoped, successful effort, is being made by the United States and Maryland Fish Commissions to introduce the most approved French methods into the waters of Maryland, and to supplement these by even more advanced processes, if practicable. The results of the observations and experiments of the writer during the last two years have been embodied, in part, in a report to the Maryland Commissioner,

T. B. Ferguson, for the year 1881, which has been favorably received. Additional papers have been contributed for the same report for 1882, and to the Bulletin of the U. S. Fish Commissioner, bearing mainly upon the anatomy, finer structure and development of the animal. An imperfect list of the published works on the subject has also been compiled by the writer ; a more complete catalogue, embracing its literature in all languages, will shortly be published by the Dutch government.

What has already been put upon record it will not be worth while to discuss, and we will therefore recapitulate only when necessary, adding new facts not yet recorded. To our knowledge of the early development of the animal we have added nothing, and the account as given by Brooks for the American, and Salensky, Gerbe, Fischer and Davaine for the European species, with little qualification, remain the same. The detachment of the ring or crown of vibratory filaments or cilia from the embryo oyster, as asserted by Davaine, has not been confirmed by any other observer. Hatschek has lately contributed some valuable researches in regard to the development of young bivalves, working, however, upon the young ship-worm. His studies have no direct bearing upon the development of the oyster, but they nevertheless throw considerable light upon the mode of formation of the gills, upper gill-chambers, liver, muscle, foot and nervous system of the great group to which they both belong. Hatschek's observations show that the conversion of a part of the velum or ciliary crown above and below the mouth into palps and gills, as held by Lankester, does probably not take place. The occurrence of ciliary bands running from the edge of the mantle on its inner side to the mouth, as observed by the writer in " spat " one-eighth of an inch in diameter, was supposed at first to confirm Lankester's view, but Hatschek's researches have made such an opinion untenable. The physiological function of these bands was, however, clear ; by the vibration of the filaments composing them they establish currents which hurl the microscopic food of the surrounding water down into the throat of the young " spat," thus serving, in fact, the same purpose as the velum adjoining the mouth of the " fry."

Brooks has represented the freshly-laid ova of the oyster with a spherical nucleus and nucleolus; the former is large and clear, and is embedded near the center of the egg, and inside of it the nucleolus is lodged somewhat to one side. I do not find the latter spherical, as described, but formed as if composed of a larger and smaller highly refringent pair of spheres, partly fused with each other, or of the same form as the nucleoli of the eggs of *Anodonta* as described by Fleming, and somewhat similar to those of the slipper limpet (*Crepidula glauca*) as observed by the writer. Some very singular figures of the eggs of the European oyster in Poli's work, published in 1795, renders it not improbable that he may have seen this singularly-formed nucleolus, which seems to characterize to a certain extent the eggs of bivalves.

The ova are not all ripe in all cases at the same time in the same ovarian follicle. The same condition of affairs is found in the ovary of the oyster as was observed in *Scrobicularia* by Von Jhering, that is, while some ova was mature, others in the same follicle were still very immature. The condition of the ovary varies considerably in different individuals; in some cases the most of the ova are ripe at about the same time, in others there is a greater difference between the time of maturity of the different eggs of the same follicle. It is also frequently observed that a portion of the generative organs of the same oyster are much more advanced toward maturity than others. It is also found that when the oyster is in its fullest spawning condition, the generative organ forms by far the greater proportion of the solid substance of the visceral mass lying between the heart space and the head and palps next the hinge; but the generative organs may be so undeveloped in winter as to form only a very small proportion of the substance of the visceral mass, and are present only as a fine reticulum or network of germinal cells. The ovaries and spermaries are therefore never entirely wasted away or atrophied, as would appear to the naked eye.

The full, engorged appearance which is noticed when the generative glands are full of ripe products is often due to a distension of the ducts which lead away from the follicles, and when

this is the case, if the handle of a scalpel is gently stroked over the distended ducts over the side of the body mass of the animal, as it lies in the shell, from the head end toward the posterior portion below the muscle, the ova, or spermatozoa, as the case may be, can be forced out of the open end of the outgoing generative canal into the upper gill or branchial cavity into which the former opens on either side, as described in the anatomical outline sketch given in my report to the Maryland Commission for 1881, page 15.

It has recently been asserted by some Dutch investigators that the generative products were not discharged by way of a single duct on either side of the animal, as described by Lacaze-Duthiers. What anatomical grounds these observers have for this statement I do not know; they appear to have been investigating the structure of the animal by means of sections or thin transverse slices, which they have examined microscopically. The simple experiment with a sexually ripe oyster, as described above, has invariably given the same result; never more than a single opening was found on either side. In every case the eggs were readily forced out of the ducts by gently stroking them with the handle of a smooth pencil or scalpel, and they were never seen to issue at more than one opening. So far, thin sections of the oyster, as observed by the writer, have not shaken his belief in the accuracy of the observations of Lacaze-Duthiers. There is no evidence of the existence of three generative openings on either side of the animal, as asserted by Davaine, nor is it worth while to more than notice Home's error with regard to the water-chamber above the gills, which he regarded as the oviduct.

At the time the oyster is full of spawn the generative organ completely envelops the viscera (liver, intestine and stomach), except a small portion at the anal end of the intestine and the head end of the visceral mass. All of the superficial ducts trend toward and join directly or indirectly the main duct on either side of the body, into which they pour their products as the latter are received from the immense number of follicles in which they are matured. We may repeat that at no time do we find the generative organs quite undeveloped; if they are not

apparent to the eye in winter, thin sections show the ducts and microscopical rudiments of germinal follicles as a network of strands of minute germinal cells, which traverse superficially in all directions the coarse connective tissue miscalled the "fat," in which all of the visceral organs of the animal are embedded. As the breeding season approaches the minute germinal cells of this network of rudimentary reproductive cells commence to grow, until they attain the development observed in the animal when full of ripe spawn. Some investigations conducted under the auspices of the Dutch government indicate that the structure of the generative organs of the European oyster is not as has been supposed strictly follicular, but that they may rather be regarded as a mass of anastomosing tubes of irregular caliber. The complete proof of this has been developed by the writer in the course of investigations carried out upon our native oysters, in which the generative organs were very immature during the winter season. Both Brooks and myself have spoken of the generative follicles as though they had been clearly made out; it now appears that we will be compelled to modify our terminology somewhat, in the face of the fact that I have sections of the immature generative organ which exhibits it as a network of germinal cells, as well as sections of the mature organs which show a more or less distinct tubular structure opening toward the surface into the superficial or surface outgoing canals. At the same time the tubes show more or less extensive junction or anastomosis with each other at certain points along their length, with a general tendency to be disposed vertically to the surface of the visceral mass. This arrangement reminds one somewhat of the more or less parallel disposition of the seminal tubules of the testicles or milt of fishes and higher animals.

We will endeavor to use the terms "fry" and "spat" in such a way as to avoid confusion. As soon as the egg has developed far enough to move about by means of the fine motile filaments with which it is partially covered, it may be considered to have reached the fry state of development, and to have hatched; but it is to be borne in mind that an oyster egg does not hatch in the same sense as the egg of a chicken or fish, that is, by breaking its egg-shell or membrane, because the oyster egg is without a

membrane such as must be cast off in the act of hatching in the former cases. As soon as it has ceased to rove about in the water and has fastened itself to some other fixed object, it has attained the age of development known to oystermen by the term "spat."

Our researches (see Maryland Report, 1881), show that the dimensions of the fry of the American oyster at the time of its affixation when it becomes "spat" is about one-eightieth of an inch, and that at that time the valves are characterized by a very remarkable symmetry, which is departed from as soon as the growth of the shell begins in its new fixed position. The manner in which the fry affixes itself to foreign objects has not been learned, but it is very probable that this is accomplished by means of a larvel byssus. Such a conclusion seems to be warranted from the fact that the young of most of the allies of the oyster are provided with a byssus or threads for their temporary anchorage, such as may be seen very strongly developed in the adult salt-water mussel, the numerous threads in this case being very strong, serving to hold the animal very firmly to any support it may have chosen.

All theorizing as to the mode of affixation aside, however, it now becomes a question of the most profound importance for us to endeavor by experiments to maintain artificially impregnated oyster eggs alive for a long enough time after they begin to swim so that they may attach themselves permanently. The experiments of those who have hitherto worked upon the development of the oyster have shown us that this does not yet appear possible. Various forms of apparatus have been tried with indifferent success. The experiment of using bibulous paper diaphragms through which sea-water was allowed to pass, at the same time not allowing the minute eggs of the oyster to escape with the former, was not found to answer; the pores of the paper soon became clogged with fine sediment so as to stop the flow of water and its renewal over the eggs. Bolting cloth does not have the meshes fine enough to confine the eggs, besides it is expensive and not durable. The use of a membrane of filtering paper between single thicknesses of fine nickel-plated wire cloth, forming the bottom of the hatching-box, which is placed

inside of another box, in which the water was made to rise and fall alternately by means of an intermittently active siphon of wide caliber, the supply being carried into the outer box in a constant stream through a smaller pipe. The oscillation of the water level in the outer box so arranged was depended upon to change the water in the inner boxes with the porous bottoms containing the eggs. The same difficulty presented itself, however, and the porous bottoms of the hatching-boxes soon became impervious, owing to the swelling of the fibers of the paper, as well as on account of the accumulation of slimy sediment in the substance of the latter. The outflow from the inner boxes was then impeded from the same cause, and as the siphon emptied the outer box the water in the inner one would not fall quickly enough to effect any considerable change. Here our experiments have broken down completely, and all the results so far reached with such apparatus have not been of sufficient value to make it desirable to repeat them, although conducted with the help of three different forms of apparatus.

Recently, Professor S. I. Smith, of Yale College, has succeeded in incubating the eggs of certain crustaceans in shallow plates without changing the water at all, but by simply areating and keeping it in constant circulation by means of jets of air playing constantly upon its surface. This mode of incubation appears to fulfil the requirements of the case fully, as far as I can now see, and it will be of the greatest importance to test this method at the earliest possible opportunity. By its use we will be able to avoid the loss of eggs which would follow from the employment of any method in which there is a current of water constantly running in and flowing out of the incubating contrivance, besides we would avoid contact with poisonous metallic surfaces, be enabled to keep down the temperature of the water by slow evaporation and prevent putrefaction by means of rapid oxidation.

Should we be able to artificially incubate the eggs of the oyster and keep them alive until the time when the embryos attach themselves to foreign objects, we will have attained such a success as will probably never be paralleled in fish-culture. The artificial impregnation of the eggs of the oyster may be accom-

plished to the extent of thousands of millions ; and should it be found possible to keep these hosts of young alive until they had passed certain critical periods of their embryonic existence, we would have practically succeeded in adding so many millions of spat to those already existing, from which seed might be supplied for the foundation of extensive beds where oysters had been previously unknown.

Brooks, in carrying embryo oysters up to the sixth day of their existence, encountered the same difficulties as those who have repeated his experiments. If, as I have good evidence for premising, when the young oyster ceases its wandering habits, its valves measure one-eightieth of an inch in their longest diameter, we have yet to find out how old it is when of this size. When we learn this, we will know how long it will be necessary for us to keep the young in the incubating apparatus. We can reach the answers to these questions only by the use of the proper sort of hatching arrangement, in which artificially impregnated eggs are used ; being careful, of course, to keep accurate records of the time of impregnation and the fluctuations of temperature of the air and water during the progess of the experiment. Facilities for the fry to fix itself may be provided by suspending strips of mica or glass in the water, watching the result from day to day, and as some are seen to have attached themselves, the transparent slips may be transferred to the stage of the microscope for examination to learn the nature of the attachment of the embryo.

With the finer questions of the anatomy of the embryos we have little to do—in fact, I do not see that they will help us much in the comprehension of how the hatching process is to be conducted, which goes without saying, however, that the experienced embryologist must be expected to determine whether the development is progressing normally and healthfully. When once we have achieved what has been indicated above, the embryologist will have an abundance of opportunity to make out the finer details of structure ; and let us remark here, in regard to the oyster, one of the most accessible of animals, that much still remains to be done by both the anatomist and embryologist.

Whatever may be the form of the apparatus which will finally be used in artificial oyster culture, it will also be necessary to provide some sort of cheap and effective method to favor the attachment of the young fry, in the shape of some substance or objects which may be transferred to nurseries or cages in open water where it is to undergo further development. Clean pebples at once suggest themselves as a cheap material, which can be graded to the right size through screens of the proper mesh. What is most suitable, however, will have to be learned by experiment.

The special merit of the proposed method of artificial culture from the egg upward, would be that we could probably do without the cumbrous tiles, slates, etc., covered with mortar, used as cultch to a large extent in France. In fact, if collectors are to be used at all after the French mode, it would appear to the writer that it would be just as well to use old oyster shells and the cheapest possible materials strewn over arable bottoms near productive spawning oyster beds, as is pretty extensively practiced on the coast of New England, especially Connecticut, and to some extent in places on the Chesapeake Bay. If any considerable advance is to be made in the culture of the oyster, this much is certain, that it is to be attained by a radical departure from the older methods, some of which have been in use for over ten centuries. The older methods are universally cumbrous, involving large outlays of labor in their practice, which is a serious item in their practical working in the United States, where labor is much more expensive than in continental countries. Not only is this objection valid, but a still more serious one is the uncertainty of the "set" of spat which may catch on any sort of natural or artificial cultch. In some seasons the collectors will be overcrowded, in others no spat will be found to adhere.

The same element of risk is encountered in the use of old oyster shells as cultch for the spat, and, as I have been told by oystermen, several thousands of dollars' worth of shells may be strewn upon good oyster bottom on which not a single spat will be found to adhere, thus involving a loss of both material and labor. I do not see that any method in which tiles or mortar-

covered slates are used will be a particle more likely to afford a nidus for spat than old shells, or the cheapest kind of cultch, except in some places where the latter is liable to be covered with mud or sediment.

This uncertainty of result can, it appears to the writer, be overcome by a totally different method of procedure, like that already outlined. We must have the temperature of the water and conditions of the artificially fertilized and confined embryos under control. The uncertainty which has hitherto attended ostraculture must disappear in the face of intelligent experiment, and it is to be hoped that in a few years more we will hear of oyster nurseries or incubating establishments in successful operation where millions of spat will be annually bred from artificially impregnated eggs to be sold as seed to planters who will enter upon the business of ostraculture on an entirely new and scientific basis.

Of no less moment than the introduction of radically new and more certain methods of propagation, is the question, "Upon what does the oyster feed?" and, what are the conditions of life which will most quickly bring the animal into a plump, marketable state? The most contradictory and confusing statements are made by different persons in regard to the feeding habits of the animal, and anomalous as some of them may at first appear, many of them doubtless have some foundation in substantial fact.

Prof. Leidy, at a recent meeting of the Academy of Natural Sciences of Philadelphia, stated it as his belief that oysters feed at times on the zoospores of certain algæ, as those of *Ulva latissima* (sea cabbage), which he knew from personal observation to be green, and which he thought might possibly be the cause of the green coloration of the soft parts of the animal as sometimes observed in certain localities. Very possibly this may be the case, but judging from what I have seen and heard from oystermen, as well as from what I have read in various publications relating to this matter, I am not inclined to regard this as the only source of the unusual green tint of the flesh of the oyster. I hope to be able to show that it is probably of vegetable origin, and therefore quite harmless. That it is not copper we may be

equally certain, as Prof. Lewis' tests have shown, for any such quantity of a copper salt as would produce the green gills, heart and cysts in the mantle, such as are often observed, would, without doubt, be as fatally poisonous to the oyster as to a human being. The source of the green has recently been investigated by two French savants, MM. Puysegur and Decaisne, who found that when perfectly white-fleshed oysters were supplied with water containing an abundance of a green microscopic plant, the *Navicula ostrearia* of Kützing, their flesh acquired a corresponding green tint. These investigators also found that if the oysters, which they had caused to become imbued with this vegetable green, were placed in sea-water deprived of the microscopic vegetable food, the characteristic color would also disappear. Whether this will finally be found to be the explanation in all cases remains to be seen, as some recent investigations appear to indicate that it is possible that a green coloration of animal organisms may be due to one of three other causes besides the one described above as the source of the green color of the oyster.

Patrick Geddes, in a recent number of *Nature*, has pointed out that the "list of supposed chlorophyll-containing animals, * * * breaks up into three categories; first, those which do not contain chlorophyll at all, but green pigments of unknown function (*Bonelia*, *Idotea*, etc.,); secondly, those vegetating by their own intrinsic chlorophyll (*Convoluta*, *Spongilla*, *Hydra*); thirdly, those vegetating by proxy, if one may so speak, rearing copious algæ in their own tissues, and profiting in every way by the vital activities of these." This latter is one of the most interesting and important of modern biological discoveries, that living animal bodies may actually afford a nidus for the propagation of green microscopic plants, and not be injured, but rather be benefited thereby. The oxygen thrown off by the parasitic vegetable organism appears to be absorbed by the tissues of the animal host, while the carbonic acid gas thrown off by the latter is absorbed by the vegetable parasite, thus affording each other mutual help in the processes of nutrition and excretion. This singular association and inter-dependence of the animal host and vegetable guest has received the somewhat cumbrous name

of *Symbiosis*, which may be translated pretty nearly by the phrase, associated existence. This is not the place for the discussion of the purely scientific aspect of this question as already ably dealt with by Dr. Brandt, Patrick Geddes and Geza Entz, and others, and we will therefore only notice their researches in so far as they appear to have a bearing upon the origin of the green color of the oyster.

Entz has discovered that he could cause colorless infusoria to become green by feeding with green palmellaceous cells, which, moreover, did not die after the death of their hosts, but continued to live, growing and developing within the latter until their total evolution proved them to be forms of very simple microscopic green algæ, such as *Palmella*, *Glæocystis*, etc., etc. My own observations on some green-colored infusorial animals have been of so interesting a character that I will here describe what I observed in a green bell-animalcule (*Vorticella-chlorostigma*). Upon investigating their structure, I found that next the cuticle or skin in the outer soft layer of their bodies known as the *ectosare*, at all stages there was a single stratum of green corpuscles very evenly or uniformly embedded. In another form (*Stentor*), as already noticed by Stein, the same superficial layer of green corpuscles was observed, reminding one very forcibly of the superficial layer of chlorophyll grains observed in the cells of some plants, as, for instance, *Anacharis*. Now, it is well known that certain animalcules are at times quite colorless and at others quite green ; this appears to be the case with *Ophrydium*. In this last case I have a suspicion that vegetable parasites may be the cause of the green variety, but as for the others, *Stentor* and *Vorticella*, I am not so sure that their green forms are so caused. In them the superficial positions of the green corpuscles and their behavior toward reagents, leads me to think that they must be regarded as integral parts of the creatures in which they are found.

A grass-green planarian worm (*Convoluta schultzii*), found at Roscoff by Mr. Geddes, was observed by him to evolve oxygen in large amounts, like a plant, and "both chemical and histological observations showed the abundant presence of starch in the green cells, and thus these planarians, and presumably, also,

Hydra, *Spongilla*, etc., were proved to be truly vegetating animals." While some organisms, like the foregoing, appear to have true chlorophyll grains imbedded superficially in their own substance, others, like the radiolarians, some siphonophores, sea-anemones and jelly-fishes, harbor true vegetable parasites, or preferably, vegetable guests.

That the green observed in a number of animal organisms is of the nature of chlorophyll, or leaf green, has been proved by Lankester by means of the spectroscope. A. W. Bennett, in alluding to Lankester's observations, says: "In all cases the chlorophylloid substance agrees in having a strong absorption band in the red—a little to the right or left—and, except in *Idotea*, in being soluble in alcohol, and in having strong red fluorescence, and in finally losing its color when dissolved."

The vegetable organisms which have been found to inhabit the lower forms of life alluded to in the foregoing paper have been regarded as belonging to two genera, which Dr. Brandt has named *Zoöchlorella* and *Zoöxanthella*, and which are probably in part synonymous with the genus *Philozoon*, afterwards proposed by Mr. Geddes. The latter gentleman, however, claims to have first demonstrated the truth of the view that the yellow cells of radiolarians and polypes are algæ; secondly, the foundation of the hypothesis of the lichenoid nature of the alliance between algæ and animal into a theory of mutual dependence; and thirdly, the transference of that view from the region of probable speculation into that of experimental science.

Hitherto apparently no one has noticed the occurrence of green vegetable parasites in bivalve mollusks except Prof. Leidy, who has very kindly permitted me to use the facts observed by him relating to *Anodon*, one of our common fresh-water mussels. In this animal he some years ago observed what must be considered to be algous parasites. He found them in great numbers infesting the tissues of the mussel and of a larger size than the nuclei of the cells of the host, in which they were embedded. They were also provided with a nucleus, and were, therefore, not a part of the animal, but a distinct vegetable organism. These facts observed a long time since, render it very

probable that Prof. Leidy was one of the first to notice the intercellular parasitism of a plant in an animal.

The green color of the oyster, as far as my experience goes, is not intense, as in many green animals, such as we observe in *Stentor*, *Spongilla*, *Hydra*, etc., but is a pale pea-green tint. This has been found to be the color of affected natives as well as of foreign ones, the gills and mantle being usually most distinctly tinged. Exceptionally the heart is affected, its color sometimes being quite intense.

In studying some oysters which were obtained from England through the kind offices of Messrs. Shaffer and Blackford, in response to a request coming from Prof. Baird, certain ones were found which were decidedly green. Of these the French specimens of *Ostrea edulis*, and a very singular form, labeled "Anglo-Portuguese," had the gills affected, and in some of the latter the liver, heart and mantle were very deeply tinged in certain parts, so much so that I decided to make as critical an examination as my resources could command.

Spectroscopic investigations gave only negative results, as it was found impossible to discern any positive evidence of chlorophyll from the spectrum of light passed through thin preparations made from specimens of green-tinted oyster, some of which, like those from the heart, are decidedly green to the naked eye. There was no absorption noticed at the red and blue ends of the spectrum, such as is observed when the light which enters the slit of the spectroscope first passes through an alcoholic solution of leaf-green or chlorophyll; indeed, the spectrum did not appear to be sensibly affected by the green substances which causes the coloration of the oyster. No attempt was made to test the matter with the use of alcoholic green solutions obtained from affected oysters, as the former are not easy to get with a sufficient depth of color, because of the relatively small amount of coloring matter present in the animals. Unstained preparations were used in all of these experiments.

Finally, in order to see if the color was due to the presence of some green compound of copper, Professor H. C. Lewis, of the Academy of Natural Sciences of Philadelphia, kindly made some delicate tests for me, using small, dried fragments of an

oyster very deeply tinged with green in various regions, especially in the liver, connective tissue and mantle. The fragments were burned in a bead of microcosmic salt and chloride of sodium on a clean platinum wire in a gas flame; this test did not give the characteristic sky-blue flame which should have been developed had there been the minutest trace of copper present. Dr. Taylor, chemist of the U. S. National Museum, has also recently called my attention to the fact that Dr. F. M. Endlich has made an exhaustive chemical investigation of the green substance found at times in oysters, and arrived at the conclusion that the coloring matter, whatever it may be, is entirely inert and harmless. Dr. Endlich's researches are noticed in the annual report of the Smithsonian Institution for 1879.

It is therefore clear that the substance, whatever it may be, is not a corrosive metallic poison derived from copper, which if present would almost undoubtedly be detected by a peculiar acrid metallic taste, which would be experienced when one ate such oysters. In making some practical tests as to the relative qualities of such oysters as compared with white-fleshed ones, opportunities for which were kindly furnished me by Mr. J. M. Carley, of Fulton Market, I failed to detect the slightest difference of flavor. Such also is Professor Leidy's verdict, who informs me that he made a similar experiment, and a restaurateur with whom I discussed the matter, declared that he was in the habit of selecting them for his own eating, preferring their flavor to that of the white oysters.

It has been objected that the green color could not be derived from diatoms, because these organisms are as a rule, apparently brown rather than green. This objection I find to be based upon a misapprehension of the structure of the *Diatomaceæ*, as may be gathered from the following general statement taken from Sachs' "Text Book of Botany," one of the latest and highest authorities. On page 222 he says: "The diatoms are the only algæ except the *Conjugatæ* in which the chlorophyll occurs in the form of discs and bands, but in some forms it is also found in grains, and the green coloring matter is concealed like the chlorophyll grains in Fucaceæ, by a buff-colored substance diatomine or phycoxanthine." It appears, then, according to the foregoing

quotation, that it is not impossible for diatoms to be the cause of the green tint in oysters, which, let me remark, is very nearly that of some pale green forms of those organisms which I have observed in water from oyster coves where I have conducted microscopic studies. Besides, sections through the intestine of the oyster frequently reveal the fact that diatoms must have constituted a very large proportion of the food of the animal, judging from the profusion of the empty frustules of these minute plants, which are very often found together with the indigestible, earthy and silicious particles with which the alimentary canal is packed.

I find the liver to be normally of a brownish red color in both the American and European oyster, sometimes verging toward green. When the flesh or gills of the animal is green, the liver almost invariably partakes of this color, but in an intensified degree. The green stain or tincture appears in some cases to have affected the internal ends of the cells which line the follicles or ultimate saccules of the liver. This color is able to survive prolonged immersion in chromic acid and alcohol, and does not allow carmine to replace it in sections which have been stained with an ammoniacal solution of that color, the effect of which is to produce a result similar to double staining in green and red. The singular green element scattered through the connective tissue remain equally well defined, and do not take the carmine dye. I at first believed these to be parasitic vegetable organisms, and I also supposed I saw starch granules in them, which physical tests with an iodine solution failed to confirm. These large and small green granular bodies in the connective tissue and those close to the intestinal wall, as well as those in the heart, I find present in fewer numbers in white-fleshed oysters, but simply with this difference, that they are devoid of the green color. It is evident, therefore, that they can not be of the nature of parasites, though the color is limited to them, only the surrounding tissue, except in the region of the heart, appearing of the normal tint. This condition of the specimens observed by me does not, however, disprove the possibility of the occurrence of vegetable parasites in the oyster, where there is as much, or perhaps more, likelihood of their

occurring than in some much more highly-organized animals.

It is a fact, however, that the oyster is singularly free from true parasites of all kinds; the oyster crab being perhaps the only creature which is ever frequently found within its valves, and then only as a harmless messmate. More recently it has been my good fortune to be able to study a second lot of European oysters, in two varieties of which the green color was unusually developed, especially in the heart. In a specimen of Falmouth oyster I found a large cyst or sack in the mantle near the edge, filled with green cells, which, like those in the heart, when opened readily separated from one another, being quite as independent of each other as the ordinary discoidal corpuscles in the serum of red blood. The hearts of affected specimens were found to have the wall of the ventricle abnormally thick, and covered inside with the readily detachable green cells in a thick layer and measuring 1-2000th of an inch in diameter. An application of the crucial test for starch with iodine gave a negative result. When iodine was first applied to these cells in strong solution, and then treated with sulphuric acid, with the result that the characteristic blue reaction was not developed, showed that there was no cellulose wall covering them, and that they were most positively not parasitic, algous, vegetable organisms. In potassic hydrate solution they underwent complete solution, a further proof of the absence of cellulose.

Their dimensions, 1-2000th of an inch, is the same as that of the blood-cell of the oyster. They are nucleated, with the nucleus in an eccentric position as in the blood-cell of the animal. Their occurrence in the heart and gills so as to tinge those organs of their own color is almost positive proof of their true origin and character. Furthermore, I find in sections that they sometimes occlude the blood-channel. In the cyst in the mantles, as in the heart, they are free, and in the normal untinged heart, they are not abundant. All of the foregoing facts indicate that these green bodies are in reality blood-cells which belong to the animal. How they become green is not easy to determine. The fact remains that no evidence of the presencc of green *Micrococci*, or *Microbia*, as independent existences could be made out. The fact that I found instances in green oysters

where an unusual greenish material was found in the follicles of liver, the living cells of which were also affected, would indicate that the color was probably absorbed from the food of the animal, which, as we know, consists largely of living vegetable matter. It is not improbable that the tinged nutritive juices transuded through the walls of the alimentary canal, acquired the color of the food which had been dissolved by the digestive juices.

How to account for the accumulation of the green cells in the heart and in cysts in the mantle is not, however, an easy matter, unless one be permitted to suppose that the acquisition of the green color by the blood-cells is in reality a more or less decidedly diseased condition, for which we have no ground in fact, since the green oysters are in apparently as good health as the white ones. They are found "fat" or "poor," just as it may have happened that their food was abundant or the reverse. They are also found in all stages of the "greened" condition. Sometimes they have only a very faint tinge of the gills, or they may be so deeply tinged as to appear unpalatable, with the heart of a deep green, or with green cysts developed in the mantle or with clouds of this color shading the latter organ in certain places. A vastly greater proportion of green oysters are eaten in this country, at all events, than is generally supposed, especially of those just faintly tinged in the gills.

If it be objected that the green color indicates an unhealthful condition of the animal, it may be stated that other color variations of the flesh have fallen under my observation recently. What is now alluded to is the yellowish, verging toward a reddish cast, which is sometimes noticed in the gills and mantle of both the American and European species. This, in all probability, like the green color, is due to the reddish-brown matter which is contained in much of the diatomaceous food of the animal.

Mr. B. J. M. Carley has also called my attention to these variations, and was inclined to attribute them to the soil in the vicinity of the beds. But if the classical writers are to be trusted, to the green, yellow and white-fleshed sorts we must add red, tawny and black-fleshed ones. Pliny tells us of red oysters

found in Spain, of others of a tawny hue in Illyricum, and of black ones at Circeii, the latter being, he says, black both in meat and shell. Horace and other writers awarded these the palm of excellence. However, the black appearance may only have been due to an abundance of the natural purple pigment in the mantles of the animal, which varies very much in different forms; some, judging from the dark purple color of the whole inside of the shell, must have the whole of the mantle of the same tint. The amount of color in the mantle, especially at its border, varies in local varieties of both the European and American species, as may often be noticed.

The most important glandular appendage of the alimentary tract of the oyster is the liver. It communicates by means of a number of wide ducts with a very irregularly formed cavity, which we may designate as the stomach proper, in which the food of the animal comes into contact with the digestive juices poured out by the ultimate follicles of the liver, to undergo solution preparatory to its absorption during its passage through the singularly formed intestine.

If thin slices of the animal are examined under the microscope we find the walls of the stomach continuous with the walls of the great ducts of the liver. These great ducts divide and sub-divide until they break up into a great number of blind ovoidal sacks, into which the biliary secretion is poured from the cells of their walls. A thick stratum of these follicles surrounds the stomach, except at its back or dorsal side. It is not correct to speak of the liver of the oyster as we speak of the liver of a higher animal. Its function in the oyster is the same as that of three different glands in us, viz., the gastric follicles, the pancreas and liver, to which we may add the salivary, making a total of four in the higher animals which is represented by a single organ in the oyster. In fact, experiment has shown that the secretion of the liver of mollusks combines characters of at least two, if not three, of the glandular appendages of the intestine of vertebrated animals. There are absolutely no triturating organs in the oyster for the comminution of its food; it is simply macerated in the glandular secretion of the liver and swept along through the intestine by the combined vibratory action of in-

numerable fine filaments with which the walls of the stomach, hepatic ducts and intestine are clothed.

In this way the nutritive matters of the food are acted upon in two ways ; first, a peculiar organic ferment derived from the liver reduces them to a condition in which they may be absorbed ; secondly, in order that the latter process may be favored it is propelled through an intestinal canal which is peculiarly constructed so as to present as large an amount of absorbent surface as possible. This is accomplished by a double induplication or fold which extends for the whole length of the intestine, the cavity of which, in consequence, appears almost crescent-shaped when cut straight across. On the concave side the intestinal wall is thrown into numerous very narrow longitudinal folds, which further serve to increase the absorbing surface. Such minor folds are also noticed in the stomach, and some of these may even have a special glandular function. There are no muscular fibres in the wall of the intestine as in vertebrates, and the sole motive force which propels the indigestible as well as digestible portions of the food through the alimentary canal is exerted by the innumerable vibratory cilia with which its inner surface is clothed. The intestinal wall is wholly made up of columnar cells which are in direct contact externally with the connective tissue which is traversed by numerous large and small blood-vessels devoid of specialized walls.

This apparatus is admirably suited to render the microscopic life found in the vicinity of the animal available as a food supply. The vortices created by the innumerable vibratory filaments which cover the mantle, gills and palps of the oyster, enables it to draw its food toward itself and at the same time the microscopic host is hurled into the capacious throat of the animal to undergo conversion into its substance as described above. The mode in which the tissues may become tinged by the consumption of green spores, diatoms or desmids, it is easy to infer from the foregoing description of the digestive apparatus of the animal ; and the colorless blood-cells, moving in a thin, watery *liquor sanguinis*, would, judging from their amœbiform character, readily absorb any tinge acquired by the latter from the intestinal juices.

I have already discussed in a desultory way the microscopic marine fauna of certain districts on the Chesapeake Bay, where I have been engaged upon the study of the oyster, under the auspices of the Maryland Commission, but what I have done has been simply preliminary and necessarily incomplete. Before we are ready to deal with the material on which the oyster feeds, we desire a more perfect acquaintance with the microscopic life which grows upon oyster beds and swims about in the adjacent waters. From the fact that the lower forms of life in fresh water often appear in great abundance one year, while in the next, from some unexplained cause, none of the same species will be found in the same situation, we may conclude that similar seasonal variations occur in the phases of the microscopic life of a given oyster bed and its vicinity.

Such yearly variations in the abundance of microscopic life are probably the causes of the variable condition of the oysters taken from the same beds during the same season of different years. Violent or sudden changes of temperature are probably often the cause of the destruction of a great amount of the minute life upon which the oyster feeds. Backward and stormy seasons doubtless also affect the abundance of the microscopic life of the sea. All of these questions have, however, as yet been scarcely touched, and, judging from the disposition of many of our students of zoology to be content merely with a description of new species and the compilation of lists, instead of also entering into investigations of the life-histories, the relative abundance of individuals, and the influence of surrounding conditions upon the forms they study, it will take some time yet before we get the information so much desired. When we arrive at this knowledge we will know why it is that oysters taken from a certain bed are in good condition for a season or two, and then for one or more years are found to be watery and of poor quality, as well as why it is that the oysters of certain beds, which for years have had a high reputation for their fine qualities, are suddenly found to be more or less green in the beard, as I have been informed is now the case with the oysters of Lynn Haven Bay, Virginia.

Speaking of the abundance of the *Navicula ostrearia* of Kütz-

ing, Mr. Benjamin Gaillon, in 1820, said that they inhabit the water of the tanks of "parks" in which the oysters are grown in such immense abundance, at certain seasons of the year, that they can only be compared to the grains of dust which rise in clouds and obscure the air in dusty weather. Dr. Johnson, speaking of the French oysters, says, that in order to communicate to them a green color, which, as with us (in England), enhances their value in the market and in the estimation of the epicure, they are placed for a time in tanks or "parks," formed in particular places near high-water mark, and into which the sea can be admitted at pleasure by means of sluices; the water being kept shallow and left at rest is favorable to the growth of the green *Canvervæ* and *Ulvæ;* and with these there are generated at the same time innumerable crustaceous animalcules which serve the oysters for food, and tincture their flesh with the desirable hue.

At any rate, without criticising the allusions to the crustacean food of the oyster, these observations give us some hints regarding the advantages arising from the cultivation of oysters in more or less stagnant water, in which, as in the French parks, or *claires*, an abundance of microscopic life would be generated in consequence of a nearly uniform temperature, higher in the early autumn months at least than the waters of the open sea, where cold currents would also tend to make it still less uniform and thus interfere with the generation of the minute food of the oyster. In other words, it would appear that the effect of the French method is to furnish the best conditions for the rapid and constant propagation of an immense amount of microscopic food well adapted to nourish the oyster. That, unlike oysters exposed to a rapid flow of water on a bottom barren of life, they grow and quickly come into a saleable condition.

In this country narrow coves and inlets with comparatively shallow water appear to furnish the best conditions for the nutrition and growth of oysters; and according to my own experience these are the places where we actually find minute animal and vegetable life in the greatest abundance, and, as might have been expected, the oysters planted in such situations appear to be in good condition early in the autumn, long before those

which are found in deeper and more active water, where their food has less chance to multiply. If the French mode applies successfully to an inferior species, ours, which grows so much more rapidly, ought to derive a proportionately greater benefit from being treated in the same manner.

As to the influence of brackish water in improving the condition of oysters let me observe here that those who hold to that opinion appear to forget to bear in mind that brackish water beds are often in the case just described; that being in shallow, relatively quiet water, an abundance of food is generated which is rapidly consumed by the animals, which quickly brings the latter into condition, the brackish state of the water getting the credit of the result.

In my report to Major Ferguson, I stated my belief in the practicability of establishing permanent oyster banks or ridges. During the last summer in the Cherrystone River, Virginia, I saw my idea practically realized. A heap of shells had been scattered so as to form a low, solid elevation, which was submerged twice a day by the tide; upon this spat had caught and grown until the whole in two years was as completely and solidly covered by living natural-growth oysters as any good natural bank. The desirability of using the poorly grown stock from natural and artificial banks as "seed" for planting appears reasonable, and could no doubt be made profitable where banks of a sufficient extent could be established, from which a supply of seed could be obtained.

Mr. Phillips.—This most interesting paper by Prof. Ryder will be read with much interest. The changes of color in the oyster has long attracted the attention of oystermen, but no valid causes have heretofore been given for them. Here in this vial is an oyster opened by Mr. Carley, in Fulton Market, and it is black. In the South they have a dark oyster which they call the mulatto oyster. Prof. Ryder has thoroughly investigated the subject of color, and has exploded the idea that the green color is caused by copper. There is no metal more easily found than copper, where it exists, and a dozen different tests are in the hands of every housekeeper, which would show its presence in

an instant. Prof. Leidy took what was supposed to be *diatomacæ*, which was said to give the green color, and proved that it was of vegetable origin. Ryder has found that it is a vegetable organism which enters the oyster. In regard to their artificial culture, Prof. Ryder believes that if the water is kept pure by flowing currents over the young, they can be reared. In his experiments they only survived six days, but his arrangements were incomplete. If this can be done we can replenish our oyster beds at our pleasure.

Mr. Hewlett.—Some oysters that are planted in the fall are white. Some are green when we get them, but if they do well the color comes right. It depends greatly on what the oyster feeds on.

Mr. Phillips.—The question of breeding is the most important one. It is now reduced nearly to the point that the fish-culturists have reached. Prof. Ryder has distinguished the male from the female, has taken the ova and fertilized it and developed it until the unfortunate sixth day. He has not yet carried them beyond that, but no doubt will accomplish it another season.

The President.—We would like to hear from Col. McDonald on the breeding of shad, and their relation to water temperatures.

Col. McDonald.—The reasons why fishes return to the waters where they are bred, are not well established. We have had many theories on the subject, some claiming that they are guided by memory, and others by scent. It is more likely that they are governed by temperatures, and the question of the relation of temperature to the migration of fishes is so important that several European governments, particularly England and Sweden, are engaged in investigating it and its particular relations to the migration of the herring. A difference of three degrees is often very important and may exclude a fish from our coast. The duration of the river life of shad is determined by temperature. The young leave the rivers on the arrival of a certain tempera-

ture, and not at a certain time. Adult shad enter rivers at a temperature of between sixty and seventy degrees. On the St. John's River, Fla., the height of the season is in December, yet observations at Jacksonville show that the shad do not enter the rivers until the temperature reaches seventy degrees, and, what is an anomaly, they enter when the temperature is falling, while on all other rivers with which we are familiar they enter when it is rising. Shad do not run out of Chesapeake Bay on fifty degrees, and let the temperature of Long Island Sound be fifty-five and the shad will probably remain there. I have a table of the temperatures at Old Point which gives the temperature of the bay on the land side between the gulf and the shore. I found the outside temperature below fifty. The Chesapeake is warmer, then, than the rivers. After warm rains come down the rivers they are warmer than the bay, between sixty and sixty-five, and the main run of shad begins and is between these figures. Tables show that fluctuations of catch and temperature are similar until the latter reaches eighty degrees, when the catch ceases. Food follows temperature, and fish follow food.

The PRESIDENT.—How about the salmon?

COL. MCDONALD.—There is little doubt but the salmon are affected by temperature. We have put out the California salmon all along our coast, and they have lived and gone to sea. May it not be that the temperature forbids their return? The Atlantic salmon, *S. salar*, enters rivers on a falling temperature, and the temperature of our rivers suits both the salmon and the shad, in their seasons, but our Atlantic streams are bringing down warm waters in July and August when the California salmon wish to ascend. On their own coast the short mountain streams are then cool from melting snows and they ascend. I know of but one exception to this state of affairs on the Atlantic coast. That is the Alabama River, which carries water colder than the bay into which it empties, and if we are to have the California salmon in any river of our Atlantic coast, that is the river.

The PRESIDENT.—Such observations, founded as they are on

the careful records of the United States Fish Commission, are of the greatest value. The migrations of salmon have been watched with interest in all countries which possess them. Mr. Atkins, in Maine, and Mr. Wilmot, in Canada, have attached tags to them in order to identify them on their return. This has also been done in Scotland, with interesting results.

Mr. Wilmot.—I feel it a duty to except to Col. McDonald's theory of the migration of salmon because the salmon is the highest migratory fish of the world, and by highest I mean the most intelligent. I have never heard this theory before, but it does not seem to be a correct one. Shad do not breed in New Brunswick, and I have not had as much experience with them as with salmon, but believe that they are moved merely by instinct, while the salmon are intelligent, or at least have stronger instincts. There is much difference in the strength of instinct. The horse has a stronger instinct than the ass. I am not prepared to enter into any extended argument on this subject, but will call attention to the fact that Mr. Livingston Stone says that the temperature is lower in California than in the rivers of the East, at the time when the eggs are gathered. He kept a daily record of the temperature and found it lower than our Canada rivers, because of the melting snows in midsummer. I do not think the temperature has much to do with the movements of salmon.

Col. McDonald.—I don't think that we disagree. If a salmon can choose between a temperature of sixty-five and seventy, no doubt it will do it and avoid the warmer one.

Mr. Wilmot.—Not if it is a native of it.

Col. McDonald.—It is a well-known and established fact that the movements of cod are regulated by temperature. If you go on the coast of Maine when the water is at a low temperature, you will find no cod ; not because they are cosmopolitan in their habits and move from place to place by caprice, but because of the temperature. When cod are there, a fall in the thermometer

of two or three degrees will send them off. The California salmon spawns when our waters are warm. Its own waters are warm also, and it is seeking colder ones, which it finds on the Pacific coast but not on the Atlantic. On our coast it lives in a temperature of sixty, and when it seeks to enter rivers it finds them up to eighty, and therefore they will not go in. They find no suitable waters to spawn in on our coast.

Dr. Hudson.—We have put 300,000 California salmon fry in the Merrimac River. They were ready for distribution in January. We afterward found hundreds of them three inches in length. They went down, and we have not seen them since. This shows that they found food and grew, but whether they fail to find food at sea or not, or if they do not find suitable waters for spawning, I don't know, but incline to think that Col. McDonald is correct.

Mr. Wilmot.—I may be laughed at for the statement, but will say that the Californian salmon may possibly become Atlantic salmon, and that I have always thought so, and that the Eastern salmon taken West would become the Californian salmon.

Mr. Evarts.—I agree with Mr. Wilmot. The salmon will change its color and the color of its flesh.

Mr. Mather.—It is impossible. Of course food and water will change color, but the quinnat or Californian salmon is a different fish, has a different structure, the most marked of which is more rays in the anal fin, at least six or seven more. And food and water would not change this in fifty generations of them unless hybridized. They are as different as our brook and lake trouts, which retain their distinct peculiarities in the same lake for years. The differences are not merely in color but in structure, as shown in the skeletons. Any one can see it in the teeth of the two trouts. Color counts for but very little in ichthyology, and a quinnat salmon differs from the *S. salar* as much as the horse and the ass.

Mr. Blackford.—There is no doubt of that. A Californian salmon could not change so as to be mistaken for an Atlantic one by an expert.

Mr. Wilmot then read extracts from his forthcoming report on the decrease of salmon in the maritime Provinces of the Dominion, but as it had not been published he took the paper with him.

The Secretary then read a paper from Prof. G. Brown Goode on "The Swordfish."

MATERIALS FOR A HISTORY OF THE SWORDFISH.

BY G. BROWN GOODE.

This essay upon the swordfish and its uses makes no claim to be considered a contribution to knowledge. In the course of six summers' study of fish and fisheries on the coast of New England and as many winters of research into ichthyological literature, a considerable quantity of notes concerning the swordfish have accumulated in the writer's portfolio. These are printed below, arranged in systematic order, with the hope that they may stimulate enquiry by showing at a glance what is now known about the habits of this mysterious fish, and what it is desirable should be learned. Such of the facts as have not previously been printed are, for the most part, drawn from the experience of fishermen, either by the writer or by others who have kindly responded to letters asking for information by interviewing their local authorities. Mr. John H. Thomson, of New Bedford; Mr. Willard Nye, of New Bedford; Mr. E. G. Blackford and Mr. Barnet Phillips, of New York; and Mr. C. B. Fuller, of Portland, have aided thus. Capt. Benjamin Ashby, of Noank; Capts. R. H. Hurlbert, John Rowe, and George H. Martin, of Gloucester; and Capt. I. H. Michaux, of New Bedford, veteran swordfishermen, have been asked questions innumerable, and their words are frequently quoted. As far as possible, all statements have been confirmed by personal observation; but for this there has been little opportunity. Few fishes are so difficult to observe, and a student may pass summer after sum-

mer in sight of a few dozen dorsal fins cutting through the water, a chance to measure and dissect a few specimens, a page or two of estimates of annual captures, and perhaps the experience of having the side of his boat pierced by one of the ugly swords.

This paper is the fourth of a series upon "The Natural and Economical History of American Food-fishes," the first, on the Scuppaug, and the second, on the Bluefish, having been published by Professor Baird in the Report of the United States Fish Commission, Part I. (1873); the third, on the Menhaden, in Part V. (1879) of the same report. "The History of the American Whale Fishery," by Mr. Alexander Starbuck, in Part IV., is also properly to be enumerated in this book.

POPULAR NAMES OF SWORDFISH.

The names by which the fish under consideration is known all have reference to its most prominent feature, the prolonged snout. The "Swordfish" of our own tongue, the "*Zwaardfis*" of the Hollander, the Italian "*Sifio*" and "*Pesce-epada*," the Spaniard's "*Espada*," "*Espadarte*," and varied by "*Pez de epada*" in Cuba, and the French "*Espadon*," "*Dard*," and "*Epée de mer*" are simply variations of one theme, repetitions of the "*Gladius*" of ancient Italy and "*Xiphias*," the name by which Aristotle, the father of zoology, called the same fish twenty-three hundred years ago. The French "*Empereur*," and the "*Imperador*" and "Ocean King-fish." of the Spanish and French West Indies carry out the same idea; the Roman emperor was always represented holding a drawn sword in his hand. The Portuguese names are *Agulha* and *Agulhao*, meaning "needle" or "needle-fish."

ZOOLOGICAL NAMES OF THE SWORDFISH.

This species has been particularly fortunate in escaping the numerous redescriptions to which almost all widely distributed forms have been subjected. By the writers of antiquity it was spoken of under its Aristotelian name, and in the tenth edition of his Systema Naturæ, at the very inception of binominal nomenclature, Linnæus called it *Xiphias gladius*. By this name it has

been known ever since, and only one additional name is included in its synonymy, *Xiphias Rondeletti*, Leach.

POPULAR NAMES OF ALLIED AMERICAN SPECIES.

The swordfish has been so long and so well known that its right to its peculiar name has seldom been infringed upon. The various species of *Tetrapturus* have sometimes shared its title, and this is not to be wondered at, since they closely resemble *Xiphias gladius*, and the appellative has frequently been applied to the family *Xiphiidæ*—the swordfish family—which includes them all.

The name bill-fish, usually applied to the *Tetrapturus albidus*, a fish of the swordfish family often taken on our coast, and described below, is objectionable, since it is in many districts used for the various species of *Belonidæ*, the "garfishes" or "green bones" (*Belone truncata* and others) which are members of the same fauna. Spear-fish is a much better name.

The "sail-fish," *Histiophorus americanus*, is called by sailors in the South the "Boohoo" or "Woohoo." This is evidently a corrupted form of "Guebucu," a name apparently of Indian origin, given to the same fish in Brazil. It is possible that the *Tetrapturus* is also called "Boohoo," since the two genera are not sufficiently unlike to impress sailors with their differences. Bleeker states that in Sumatra the Malays call the related species, *H. gladius*, by the name Joohoo (*Juhu*), a curious coincidence. The names may have been carried from the Malay Archipelago to South America, or *vice versa*, by navigators.

In Cuba the spear-fishes are called *Aguja* and *Aguja de Paladas*; the sail-fish, *Aguja Prieta* or *Agula voladora*; *Tetrapturus albidus* is specially known as the *Aguja blanca*, *T. albidus* as the *Aguja de Casta*.

In the West Indies and Florida the scabbard-fish or silvery hair-tail (*Trichiurus lepturus*), a form allied to the *Xiphias*, though not resembling it closely in external appearance, is often called "swordfish." The body of this fish is shaped like the blade of a saber, and its skin has a bright metallic luster like that of polished steel; hence the name.

The various species of sticklebacks, *Gasterosteus aculeatus*, *G.*

noveboracensis, and *Pygosteus occidentalis*, are known as "little swordfish" by the boys of Portland, Me., and vicinity. The spines, damaging in the extreme to small fingers of tyro fish-gathers, give reason to the name.

Sail-fish appear to occur throughout the tropical and southern parts of the Atlantic and the Indian Ocean. Their names, wherever they are found, point to its most striking characters. In Marcgrave's time the Portuguese of Brazil called it *Bicuda*, referring to its snout, and Rochefort, in his History of the West Indies, calls it the *Bécasse de Mer;* a *bécasse* being a long-snouted bird like a woodcock or a snipe, while in the Malay Archipelago the Dutch call it *Zee-snip* or "sea-snipe." The Malays of Amboyna called it the *Ikán-layer* or fan-fish, in allusion to the fan-like movements of its dorsal fin, while those of Sumatra called it *Ikan-jegan* or sail-fish. The French *Voilier* and the Dutch *Zeylfisch* and *Bezaan-fisch* mean the same; a *bezaan* being the sail upon the mizzen mast of a ship. The names "Boohoo" and "Woohoo" have already been referred to. The family name is "*Mylmeen*," signifying "peacock-fish."

POEY'S DESCRIPTIONS OF TETRAPTURUS ALBIDUS AND TETRAPTURUS AMPLUS.

It is quite probable that the larger species of *Tetrapturus*. *T. amplus*, Poey, which frequents the waters of Cuba, in company with the species now so often seen on our coast, may yet be found on the coast of the United States. It seems desirable, therefore, to quote here, in full, translations of the original descriptions. These species should both be critically compared with the *Tetrapturus Georgii*, described by the Rev. H. T. Lowe, from Madeira.

"It is very strange that the fishes known at Havana by the names *Aguja* and *Aguja de Paladar* have never been described in ichthyological works. Their size would naturally attract the attention of travelers, and since they are very common for four months in the year it would have been very easy to obtain them. Their flesh is palatable and always wholesome. They may have been confounded with *T. belone* of the Mediterranean, es-

pecially since the *Xiphias gladius*, here known as the Emperador, is often taken in our waters.

It is only necessary to glance at the figure of *T. belone* given by Cuvier and Valenciennes and to carefully follow the description, to be satisfied that it is another species. The *Histiophorus americanus*, which we call *Aguja prieta* or *Agujo voladera*, is also found on our shores. Of the true *Tetraptures* we have two species, very distinct, the *Aguja blanca* (*Tetrapturus albidus*) and the *Aguja de Casta* (*Tetrapturus amplus*).

Tetrapturus albidus is abundant during the month of June and up to the middle of July; some are taken in August. The ordinary weight is forty pounds, though they are sometimes taken of one hundred pounds weight.

Tetrapturus amplus makes its appearance at the end of July, and is most abundant during August. Its ordinary weight is two hundred to three hundred pounds, but it reaches a much greater size, and is often taken weighing four hundred to five hundred pounds, and even eight hundred.

The males are the smaller. These two species swim at the depth of one hundred fathoms. They journey in pairs, shaping their course toward the Gulf of Mexico, the females being full of eggs.

Only adults are taken. It is not known whence they come, where they breed, or how the young return; it is not even known whether the adult fishes return by the same route.

When the fish has swallowed the hook it rises to the surface, making prodigious leaps and plunges; exhausted at last, it is dragged to the boat, secured with a boat-hook, and beaten to death before it is hauled on board.

Such fishing is not without danger, for the *Tetrapture* sometimes rushes upon the boat, drowning the fisherman or wounding him with his terrible weapon.

The fish becomes furious at the approach of sharks, which are its natural enemies. They engage in violent combats, and when the *Tetrapture* is attached to the fisherman's line it often receives frightful wounds from its adversary.

The ovaries are large; the ova are small and yellow, and nearly one-eighth of an inch in diameter.

The Cuban fishermen agree in admitting under the name *Aguja blanca* two species, one called *Cabezona* (large-headed); the other smaller, the nape lower. I agree with them to some extent; yet, although I have drawn and measured many individuals of the two kinds, I do not dare to describe them as distinct, since I find remarkable variations, which lead me to suspend my judgment. I only describe one individual from those considered the large-headed variety."

EARLY ALLUSIONS TO THE SWORDFISH IN EUROPE.

The swordfish was known to Pliny, who writes: "The swordfish, called in Greeke Xithias, that is to say in Latin Glaudius, a sword, hath a beake or bill sharp-pointed, where with he will drive through the sides and plankes of a ship, and bouge them so, that they shall sinke withall. The experience whereof is scene in the ocean, near to a place in Mauritania called Gotta, which is not far from the river Lixos."*

Many other classical and mediæval writers made curious allusions to the swordfish. A very good summary of their views is given by Bloch, and is here quoted. The scepticism of this author is sometimes a little excessive:

"This fish is found in the North Sea and the Baltic, but is rare in those waters. In the Mediterranean, however, it is very abundant. It lives for the most part in the Atlantic, where in the winter it is found in mid-ocean. In spring it appears on the coast of Sicily, where its eggs are deposited on the bottom in great numbers. However, according to what I have been told by the illustrious Chevalier Hamilton, it is never seen in that region more than three or four feet long. The larger ones, often weighing four hundred or five hundred pounds, and eighteen to twenty feet long, are found on the coast of Calabria, where they appear in June and July. Pliny remarked that they often exceeded the dolphin in size. * * *

"Various writers have spoken of the 'Emperor of the Sea' as occurring in the Baltic. Olearius and Schelhammer record its capture near Holstein; Schoneveld mentions one from Mecklen-

* Holland's Pliny, ii., page 428.

burg ; Walbaum one from the vicinity of Lübeck ; Hanover and Klein one from the vicinity of Danzig ; Hartmann one from near Pillau ; and Wolf another taken near Königsberg.

"One mentioned by Schoneveld as taken near Mecklenburg, was so large that it required two strong horses to draw it from the water. The body, without the sword, was eleven feet long, the sword three. The eyes were as large as hen's eggs, and the tail was two feet broad. Of four seen by Professor Koelpin during his stay at Griefswald, one measured more than three and one-half feet in circumference. * * *

"These fish, according to the story of the Chevalier Hamilton, always appear in pairs as they approach Messina, a female and a male together."

[Then follows a description of the method of capture, very similar to that given below.]

"This fish lives upon marine plants and fish. It has such a terrible defensive weapon that other voracious fishes do not dare to attack it. According to Aristotle, it is, like the tunny, tormented by an insect, and in its fury leaps out of the sea and even into vessels. According to Statius Müller, the skin is phosphorescent at night. Although such large fishes are not usually well flavored, this one is considered palatable. Pieces of the belly and the tail are especially esteemed, and hence they are expensive. The fins are salted and sold under the name '*callo*.' * * *

"Aelian errs in saying that it enters fresh water, and in cataloguing it among the fishes of the Danube.

"Oppian and Ovid consider it on account of its sword, one of the most terrible denizens of the sea. It is not at all probable that, as Pliny and many other later ichthyologists have written, it pierces the sides of vessels with its sword and sends them to the bottom ; its sword is not sufficiently strong.

"Salviani, who gave the first figure of the fish, was wrong, like many writers who followed him, in giving two dorsal and two anal fins.

"Gesner, Aldrovandus, and Jonston have represented the species with two ventral fins. Bellon and Bomare were wrong in

classing it among the whales. Subsequent authors have failed to find the scales represented in the figure given by the former and the teeth of which the latter spoke."*

ALLUSIONS TO THE SWORDFISH IN AMERICA BY EARLY WRITERS.

The ancient city of Siena, secluded and almost forgotten among the hills of Northern Italy, should have a peculiar interest for Americans. Here Christopher Columbus was educated, and here, in the height of his triumphs as a discoverer, he chose to deposit a memento of his first voyage across the seas. His votive offering hangs over the portal of the old collegiate church, closed for many years, and rarely visited save by enterprising American tourists. It consists of the helmet and armor worn by the discoverer when he first planted his feet on New World earth, his weapons, and the weapon of a warrior killed by his party when approaching the American coast—the sword of a swordfish.†

It is not probable that Columbus or some of his crew, seafaring men of the Mediterranean, had ever seen the swordfish. Still, its sword was treasured up by them, and has formed for more than four centuries and a half a striking feature in the best preserved monument of the discoverer of America.

The earliest allusion in literature to the existence of the swordfish in the Western Atlantic seems to occur in Josselyn's Account of Two Voyages to New England, printed in 1674, in the following passage:

"First Voyage:—The Twentieth day, we saw a great number of Seabats, or Owles, called also flying fish; they are about the bigness of a Whiting, with four tinsel wings, with which they fly as long as they are wet, when pursued by other fishes. Here likewise we saw many Grandpisces, or Herring-hogs, hunting the scholes of Herrings; in the afternoon we saw a great fish called the Vehuella or Swordfish, having a long, strong and sharp finn like a Sword-blade on the top of his head, with which he pierced our Ship, and broke it off with striving to get loose; one of our sailors dived and brought it aboard."

* Bloch, Ichthyologie, iii., pp. 24–26.

† For this fact, which I do not remember to have ever seen on record, I am indebted to my friend Col. N. D. Wilkins, of the *Detroit Free Press*, who visited the locality in 1879.

A half century later I find a reference in Catesby's work.* Pennant, though aware of the statement made by Catesby, refuses the species a place in his List of the Fishes of North America,† supposing him to refer to the orca or high-finned killer-whale : "I am not certain whether *Catesby* does not mean the high-finned *Cachelot* by his Swordfish ; yet as it is found in most seas, even to those of Ceylon (Mr. Loten), I give it a place here."

Catesby's testimony was soon confirmed by Dr. Alexander Garden. This enthusiastic collector, through whose correspondence with Linnæus so many of our southern plants and animals were first brought to knowledge and named, writes to John Ellis from Charleston, S. C., March 25th, 1755 : "I have sent you one of the rostrums of a fish found on the Florida coast, which I take to be a species of the *Ziphias rostr. apice ensiforme, pinnis ventralibus nullis.*‡ I have been told that they are frequently found on the Carolina coast, though I have never seen any of them, and I have been all along the coast to the Florida shore."§

Another allusion occurs in a communication by Prof. S. L. Mitchill, of New York, to the American Monthly Magazine :

"An individual of this species was taken off Sandy Hook, by means of a harpoon, on the 19th of June, 1817. The next day it was brought to New York Market and cut up like halibut and sturgeon for food. The length was about twelve feet, and girth, by estimation, five. * * * The stomach contained seven or eight mackerel. The flesh was remarkably firm ; it was purchased at a quarter of a dollar the pound. I tasted a chop of it, broiled, and found it savory and excellent. It resembled the best sturgeon, without its strong and oily flavor. While I ate it I thought of veal cutlet. * * * I have been informed by my

* Historia Naturalis Carolinæ, etc., 1731.

† Arctic Zoology, vol. iii., 1784, p. 364.

‡ The name by which this fish was designated in the earlier editions of Linnæus' writings.

§ A selection of the correspondence of Linnæus and other naturalists, from the original manuscripts. By Sir James Edward Smith, M. D., F. R. S., etc., president of the Linnæan Society. In two volumes, London. Printed for Longman, Hurst, Rees, Orme and Brown, Paternoster Row, 1821. (Vol. i., p. 353.)

friend, John Renny, that a swordfish sixteen feet long was exhibited at New York in the year 1791."*

DISTRIBUTION OF XIPHIAS GLADIUS IN THE EASTERN ATLANTIC.

The swordfish is abundant in the Mediterranean† even as far east as Constantinople. Aelian said that it was frequent in the Black Sea, entering the Danube. Unfortunately, this is neither confirmed nor contradicted by any later writer whose works I have seen, except Bloch, whose scepticism is as unreliable as the statements of Aelian. Aelian says that this species, with several others, is frequently taken in the Danube at the breaking up of the ice in spring. This is so contrary to the known habits of the fish that it throws discredit on the whole story, for the present at least. From the entrance to the Mediterranean they range south to Cape Town. Berthelot saw great numbers of them off the Canaries. They have been frequently noticed on the coasts of Spain and France. They occur sparingly in summer in the British waters, even to the Orkneys and the Hebrides. They occasionally reach Sweden and Norway, where Linnæus observed them, and, according to Lutken, have been taken on the coast of Finmark. They are known to have occurred in Danish waters and to have found their way into the Baltic, thus gaining a place in the fauna of Russia. A number of instances of the occurrence of swordfish in the Baltic are mentioned above.

DISTRIBUTION ON THE COAST OF THE UNITED STATES.

Allusions have been made to the early accounts of the swordfish on the coast of the United States both in the work of Catesby and the letters of Garden to Ellis and Linnæus, also, to Mitchill's account of it in 1818. Though it is strange that this very conspicuous species was not recorded more frequently by early American authors, it is still more remarkable that its right to a place in the fauna of the Western Atlantic was either denied or

* American Monthly Magazine, ii., 1818, p. 242.

† Risso, Cuvier & Valenciennes, Guichenot, etc.

questioned, as late as 1826, by such well-informed authors as Sir John Richardson and MM. Cuvier and Valenciennes.*

Storer's "Report on the Ichthyology and Herpetology of Massachusetts," published in 1839, was the first American faunal list, since Catesby's, in which the swordfish was mentioned among the American fish.

The range of the species on the eastern coast of America can now be defined with some accuracy. Northward and eastward these fish have been seen as far as Cape Breton and Sable Island Banks.

Captain Rowe states that during a trip to George's Banks he has seen them off Chebucto Head, near Halifax, where the fishermen claim occasionally to have taken them with a seine.

Captain Daniel O'Brien, of the schooner Ossipee, took five swordfish on his halibut trawl, in two hundred fathoms of water, between La Have and Brown's Banks, in August, 1877.

Capt. Jerome B. Smith, of the schooner Hattie Lewis, of Gloucester, killed a swordfish off Cape Smoke, near Sidney, Cape Breton.†

Mr. J. Matthew Jones, of Halifax, N. S., writes, in 1877: "The swordfish is by no means common on our coast, and only makes

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*Richardson remarks, "The habits of the *Scomberoideæ* are quite in accordance with their great powers of natation. We found among them many fish that pass their lives remote from the land in the middle districts of the ocean, and the family may be termed *pelagii* with as much propriety as some of the preceding ones have been named after the countries where they most abound. The bonitos and dolphins, or *Coryphænæ* especially, roam about the tropics, pursuing schools of various kinds of flying fish. There is a greater number of species that cross the Atlantic belonging to this family than to any preceding one. Among these are *Scomber grix*, *Pelamys sarda*, *Trichiurus lepturus* *Elacate atlantica*, *Lichia glaucus*, *Caraux carangus*, and *Nomens mauritii*. Several not only traverse the Atlantic from side to side, but also range through other seas: thus *Thymus pelamys* and *Sariola cosmopolita* are known on both sides of the Atlantic and in the Indian Ocean. *Auxis vulgaris*, which is common to the Mediterranean and Carribbean Seas, also extends to the Indian Archipelago, if the *Taso* of New Guinea be the same species. *Vomer Brownii* visits both sides of the Atlantic, and also the sea of Peru. Many of the species mentioned above as traversing the Atlantic exists also in the Mediterranean; and there are several others which have an extensive range in the latter sea and through the whole eastern side of the Atlantic, though they do not cross to America, such as *Scomber icombrus*, *Lepidopus argyreus*, *Oiphias gladius*, and *Uanciates dactor*. * * * *Xiphias gladius* is enumerated by Dr. Smith, in his list of the fish of Massachusetts; but as he has included several other European species in his list on very insufficient grounds, further evidence is required of its being an American fish." (Richardson, Fauna Boreali-Americani, p. 78.)

† Capt. R. H. Hulbert.

its appearance at intervals along our harbors and bays. One was taken in 1864 in Bedford Basin, at the head of Halifax Harbor. September 6th, 1866, an individual weighing two hundred pounds was taken in a net at Devil's Island. November 12th, 1866, the Rev. J. Ambrose sent me a sword, three feet and six inches long, from a fish taken at Dover, N. S., a few days previously."

The swordfish has, once at least, penetrated into the Gulf of St. Lawrence. In September, 1857, Capt. J. W. Collins was one of the crew of the schooner Mary Ellen, of Truro, Mass., and harpooned a swordfish four miles southwest of the eastern part of Prince Edward's Land.

On the coasts of Maine, Massachusetts, and Rhode Island they abound in the summer months. Southward they are less frequently seen, though their occurrence off New York is not unusual. I have never known one to be taken off New Jersey, and in our Southern waters they do not appear to remain. Uhler and Lugger vaguely state that they sometimes enter the Chesapeake Bay.* This is apparently traditionary evidence.

Dr. Yarrow obtained reliable information of their occasional appearance near Cape Lookout, N. C.†

Mr. A. W. Simpson states, in a letter to Professor Baird, that swordfish are sometimes seen at sea off Cape Hatteras in November and December, in large quantities. They sometimes find their way into the sounds.

An item went the rounds of the newspapers in 1876 to the effect that a swordfish four feet long had been captured in the St. John's River, near Jacksonville. After personal enquiry in Jacksonville, I am satisfied that this was simply a scabbard-fish or silvery hair-tail (*Trichiurus lepturus*).

Professor Poey states that the fishermen of Cuba sometimes capture the *Pez de espada* when in pursuit of *Agujas* or spearfishes.‡

* List of the Fishes of Maryland. By P. R. Uhler and Otto Lugger, in Report of the Commissioners of Fisheries of Maryland, January, 1876, p. 90.

† Notes on the Natural History of Fort Macon, N. C., and vicinity (No. 3). By. H. C. Yarrow, in Proceedings of the Academy of Naturol Sciences of Philadelphia, 1877, p. 207.

‡ Synopsis Piscium Cubensium, Cataloga Razonado de los Peces de la Isla de Cuba, in Repertorio Fisico-Natural de la Isla de Cuba, ii., 1868, p. 379.

They have also been seen in Jamaica.

Lütken gives instances of the capture of young swordfish at various points in the open Atlantic.

OCCURRENCE IN THE PACIFIC AND INDIAN OCEANS.

We have no record of their occurrence on the eastern coast of South America, but the species is found on the Pacific coast of the same continent, and north to California.

Professor Jordan writes : "Occasionally seen about Santa Catalina and the Coronados, but never taken, the fishermen having no suitable tackle. One seen by us off Santo Monica, in 1880, about eight feet in length."

Mr. Willard Nye, of New Bedford, Mass., kindly communicates the following notes : Captain Dyer, of this port, says that swordfish are plentiful off the Peruvian coast, a number being often in sight at one time. The largest he ever saw was one caught by himself about one hundred and fifty miles from the shore, and which he estimates to have weighed nine hundred to one thousand pounds ; the ship's crew subsisted on it for several days, and then salted four hundred pounds.

Captain Allen also states that while cruising in the Pacific for whales he has found the swordfish very abundant on the coasts of Peru and Chili, from the immediate coast three hundred miles out, though outside of that limit they are seldom seen. They are most plenty during the month of January, when they are feeding on the common mackerel, with which those waters at that time abound. The largest he ever caught weighed about six hundred pounds.

Both Captain Allen and Captain Dyer have made several voyages as masters of whaling ships, and are perfectly familiar with swordfish on our coast ; both speak of seeing plenty of bill-fish in the Pacific, but they never had taken the trouble to catch them. Günther mentions them in his book on the Fishes of the South Sea.

In 1874, Dr. Hector discovered a swordfish snout in the museum at Auckland, New Zealand, and his announcement of the

discovery was followed by the publication of two other instances of its occurrence in this region.*

SWORDFISH ENTERING RIVERS.

Swordfish have been known to enter the rivers of Europe. We have no record of such a habit in those frequenting our waters.†

Aelian's improbable story that they were taken in the Danube in winter has been mentioned. Southey and others relate that a man was killed while bathing in the Severn, near Worcester, by one of these fishes, which was afterwards caught.

Couch states that a swordfish, supposed to weigh nearly three hundred pounds, was caught in the river Parrett, near Bridgewater, in July, 1834.‡

According to De la Blanchère, one of them was taken in the ninth year of the French Republic, in the river of Vannes, on the coast of Rhuys.§

In the great hall of the *Rathhaus*, in the city of Bremen, hangs a large painting of a swordfish which was taken in the river Weser by some Bremen fishermen some time in the seventeenth century.

Underneath it is painted the following inscription :

"ANNO, 1696. DEN 18. JULI. IST. DIESER

* Hector, Trans. New Zealand Inst., vii. (1874) 1875, p. 246; Hutton, ibid. viii., (1875) 1876, p. 211; Cheeseman, ibid. p. 219.

† They sometimes approach very near the shore, however, as is shown by the following extract from a Cape Cod paper:

A Swordfish in close quarters —Monday afternoon, while Mr. A. McKenzie, the boatbuilder on J. S. Atwood's wharf, was busily at work, his attention was attracted by a splashing of water under his workshop, as if a score of boys were swimming and making all the noise they possibly could by beating the water with their feet and hands. After this had been kept up a while, his curiosity became excited, and upon investigating the cause of the disturbance, discovered a swordfish among the rocks, where, in his attempts to escape, he had become bewildered and imprisoned. Quickly getting a harpoon, Mr. McKenzie fastened the fish, and with the aid of bystanders drew it alive upon the wharf, where it was visited by many spectators, and subsequently dressed and sold. It measured ten feet from the end of its sword to the tip of the tail, the sword itself being three feet in length. It is the first instance known of one of these fish being so near the shore, and why it should have been there at that time described is not easily explained.—*Provincetown Advocate*, *September 29th*, 1875.

‡ History of British Fishes, ii., p. 148.

§ Dictionnaire Général des Peches.

FISCH. EIN. SCHWERTFISCH. GENANNT. VON DIESER.
STADT. FISCHERN. IN. DER. WESER. GEFANGEN.
UND. DEM. 20. EJUSDEM. ANHERO. NAEHER.
BREMEN. GEBRACHT. WORDEN. SEINE. GANZE.
LENGTE. WAR. 10. FUSS. DAS. SCHWERT. WAR.
7½. VIRTEL. LANG. UND. 3 ZOLL. BREIT."

GEOGRAPHICAL RANGE OF THE SWORDFISH FAMILY.

Although it may not seem desirable at present to accept in full the views of Dr. Lütken regarding the specific unity of the spear-fishes and the sail-fishes of the Atlantic and Indian oceans, it is convenient to group the different species in the way he has suggested in discussing their geographical distribution.

The swordfish, *Xiphias gladius*, ranges along the Atlantic coast of America from Jamaica, lat. 18 deg. N., Cuba, and the Bermudas to Cape Brenton, lat. 47deg. Not seen at Greenland, Iceland, or Spitzbergen, but occurring, according to Collett, at the North Cape, lat. 71 deg. Abundant along the coasts of Western Europe, entering the Baltic and the Mediterranean. I can find no record of the species on the west coast of Africa south of the Cape Verdes, though Lütken, who may have access to facts unknown to me, states that they occur clear down to the Cape of Good Hope, South Atlantic in mid-ocean, west coast of South America and north to Southern California, lat. 34 deg., New Zealand, and in the Indian Ocean off Mauritius. Good authorities state that sperm-whales, though constantly passing Cape Horn, never round the Cape of Good Hope. Can this be true in the case of the swordfish?

The sail-fish, *Histiophorus gladius* (with *H. americanus* and *H. orientalis*, questionable species, and *H. putchellus* and *H. immaculatus*, youug), occurs in the Red Sea, Indian Ocean, Malay Archipelago, and south at least as far as the Cape of Good Hope, lat. 35 deg. S.; in the Atlantic on coast of Brazil, lat 30 deg. S. to 0, and north to Southern New England, lat. 42 deg. N.; in the Pacific to Northwestern Japan, lat. 30 deg. to 10 deg. N. In a general way the range may be said to be in tropical and temperate seas, between lat. 30 deg. S. and 40 deg. N., and in the western parts of those seas.

The bill-fish or spear-fish, *Tetrapturus indicus* (with the various doubtful species mentioned), occurs in the Western Atlantic from the West Indies, lat. 10 deg. to 20 deg. N., to Southern New England, lat. 42 deg. N.; in the Eastern Atlantic from Gibraltar, lat. 45 deg. N., to the Cape of Good Hope, lat. 30 deg. S.; in the Indian Ocean, the Malay Archipelago, New Zealand, lat. 40 deg. S., and on the west coast of Chili and Peru. In a general way, the range is between lat. 40 deg. N. and lat. 40 deg. S.

The species of *Tetrapturus* which we have been accustomed to call *T. Albidus*, abundant about Cuba, is not very unusual on the coast of Southern New England. Several are taken every year by the swordfish fishermen. I have not known of their capture along the Southern Atlantic coast of the United States. All I have known about were taken between Sandy Hook and the eastern part of George's Bank.

The Mediterranean spear-fish, *Tetrapturus belone*, appears to be a land-locked form, never passing west of the Straits of Gibraltar.

PERIODICAL MOVEMENTS OF THE SWORDFISH—TIMES OF ARRIVAL AND DEPARTURE.

Before entering upon a discussion of the movements of the swordfish and their causes, it seems desirable to bring together the facts which have been learned, by conversation with fishermen and otherwise, in one group. Each man's views are given in his own style, and as nearly as possible in his own words. There is no attempt at a classification of the facts. This will be made subsequently.

An old swordfisherman at New York informed Mr. Blackford that the season opens in the neighborhood of Sandy Hook about the first of June, and continues along the coast as far east as Martha's Vineyard and Nantucket Shoals until about the middle of September. He has heard of their being caught as far east as Cape Sable. At the first cold winds of September they disappear. They are, like the mackerel, at first very poor and lean, but as the season advances they grow fatter.

Mr. John H. Thomson, of New Bedford, who kindly inter-

viewed some of the local fishermen, writes: "The swordfish appear on our coast, south of Block Island, about May 25th to June 1st. They appear to come from the southwest, or just inside the track of the Gulf Stream. They gradually approach the Vineyard Sound and vicinity during June and until July 10th or 15th, then appear to leave, working to the southeast, and are to be found to the southeast of Crab Ledge about the middle of July. This school is composed of comparatively small fish, averaging about one hundred and fifty pounds gross or about one hundred pounds without head and tail, as they are delivered in the market. The smallest are four feet long, including the sword, and weigh from thirty to forty pounds; the largest eight and a half feet long, with sword, and weighing three hundreds pounds gross. These fish are of a light plumbeous hue, darker on the back and white on the belly.

"Of late years another school has appeared southeast of Cape Cod and George's Banks about the 1st of August. These fish are altogether different, being much larger, weighing from three hundred to eight hundred pounds gross, and are entirely black. I have this week conversed with an old smackman, M. C. Tripp, who has all his life been a fisherman, and has this year (1874) captured about ninety fish, and his opinion is that they are not the same school. They appear to be of about the same abundance in average years, the catch depending on weather, fogs, etc. They come and leave in a general school, not in close schools like other fish, but distributed over the surface of the water, the whole being called by the fishermen the 'annual school,' though it cannot be strictly so named."

According to Mr. Willard Nye, swordfish appear on the coast of Massachusetts from the 8th to the 20th of June, and are first seen southwest of Block Island. They begin to leave in August, but stray ones are sometimes seen as late as the last of October. The usual explanation of their movement is that they are following their food—mackerel and menhaden—which swarm our waters in the season named, and which are of course driven off by the approach of winter and rough weather.

Capt. R. H. Hurlbert took a very large swordfish on George's Banks, in November, 1875, in a snow-storm.

The first swordfish of the season of 1875 was taken June 20th, southwest of Montauk Point ; its weight was one hundred and eighty-five pounds.

One taken off Noman's Land, July 20th, 1875, weighed when dressed one hundred and twenty pounds, and measured seven feet. A cast was taken (No. 360), which was exhibited in the Government Building at Philadelphia.

Capt. Benjamin Ashby, of Noank, Conn., tells me that the New London and Noank vessels leave home on their swordfishing cruise about the 6th of July. Through July they fish between Noman's Land and the South Shoals Lightship. The fish "strike in" to Block Island and Montauk Point every year about the 1st of July. They are first seen twenty to twenty-five miles southeast of Montauk. At the end of August they are most abundant in the South Channel. Captain Ashby never saw them at any time so abundant as August 15th, 1859. He was cruising between George's Banks and the South Shoals. It was a calm day, after a fog. He could at any time see twenty-five or thirty from the masthead They turn South when snow comes.

Capt. George H. Martin, of East Gloucester, tells me that the Gloucester vessels employed in the fishery expect to be on the fishing grounds south of George's Banks by the 10th of June. They almost always find the fish there on their arrival, following the schools of mackerel. They "tend on soundings," like the mackerel. The first swordfish of 1877 was taken June 10th ; the first of 1878, June 14th.

The statements already quoted, and numerous conversations with fishermen not here recorded, lead me to believe that swordfish are most abundant on the shoals near the shore and on the banks during the months of July and August ; that they make their appearance on the frequented cruising grounds between Montauk Point and the eastern part of George's Banks some time between the 25th of May and the 20th of June, and that they remain until the approach of cold weather in October or early in November. The dates of the capture of the first fish on the cruising ground referred to are recorded for three years, and are reasonably reliable : 1875, June 20th ; 1877, June 10th ; 1878, June 14th.

South of the cruising ground the dates of arrival and departure are doubtless farther apart; north and east the season shorter. There are no means of obtaining information, since the men engaged in this fishery are the only ones likely to remember the dates when the fish are seen.

REASONS OF THE COMING OF SWORDFISH UPON OUR COAST.

The swordfish comes into our waters in pursuit of its food. At least this is the most probable explanation of their movements, since the duties of reproduction appear to be performed elsewhere. Like the tunny, the bluefish, the bonito, and the squeteaguc, they pursue and prey upon the schools of menhaden and mackerel, which are so abundant in the summer months. "When you see swordfish you may know that mackerel are about!" said an old fisherman to me, "Where you see the finback whale following food, there you find swordfish!" said another. The swordfish also feeds upon squid, which are at times abundant on our banks.

THE INFLUENCE OF TEMPERATURE UPON THE MOVEMENTS OF THE SWORDFISH.

To what extent this fish is amenable to the influences of temperature is an unsolved problem. We are met at the outset by the fact that they are frequently taken on trawl lines, which are set at the depth of one hundred fathoms or more on the off-shore banks. We know that the temperature of the water at those localities, and at that depth, is sure to be less than forty degrees Fahrenheit. How is this fact to be reconciled with the known habits of the fish, that it prefers the warmest weather of summer, and swims at the surface in water of temperature ranging from fifty-five to seventy degrees, sinking when cool winds blow? The case seemed clear enough until this inconvenient discovery was made, that swordfish are taken on bottom trawl-lines. In other respects their habits agree closely with those of the mackerel tribe, all the members of which seem sensitive to slight changes in the temperature, and which, as a rule, prefer temperature in the neighborhood of fifty degrees or more.

There is one theory by which this difficulty may be avoided. We may suppose that the swordfish take the hook on their way down to the bottom ; that in their struggles they get entangled in the line and hooks, and when exhausted sink to the bottom. This is not improbable. A conversation with some fishermen who have caught them in this way develops the fact that the fish are usually much tangled in the line, and are nearly lifeless when they are brought to the surface. A confirmation is found in the observations of Captain Baker, of the schooner Peter D. Smith, of Gloucester, who tells me that they often are taken on the hand-lines of the cod-fishermen on George's Banks. His observations lead him to believe that they only take the hook when the tide is running very swiftly and the lines are trailing out in the tide-way at a considerable distance from the bottom, and that the swordfish strike for the bottom as soon as they are hooked. This theory is not improbable, as I have already remarked, but I do not at present advocate it very strongly. I want more facts before making up my own mind. At present, the relation of the swordfish to temperature must be left without being understood.

The appearance of the fish at the surface depends apparently upon temperature. They are seen only upon quiet summer days, in the morning before ten or eleven o'clock, and in the afternoon about four o'clock. Old fishermen say that they rise when the mackerel rise, and when the mackerel go down they go down also.

PROBABLE WINTER HABITAT OF THE SWORDFISH.

Regarding the winter abode of the swordfish conjecture is useless. I have already discussed this question at length with reference to the menhaden and mackerel. With the swordfish the conditions are very different. The former are known to spawn in our waters, and the schools of young ones follow the old ones in toward the shores. The latter do not spawn in our waters. We cannot well believe that they hibernate, nor is the hypothesis of a sojourn in the middle strata of midocean exactly tenable. Perhaps they migrate to some distant region, where they spawn. But then the spawning time of this species in the

Mediterranean, as is related in a subsequent paragraph, appears to occur in the summer months, at the very time when our swordfish are thronging our own waters, apparently with no care for the perpetuation of their species.

MOVEMENTS OF INDIVIDUAL SWORDFISHES.

A swordfish when swimming near the surface usually allows its dorsal fin and the upper lobe of its caudal fin to be visible, projecting out of the water several inches. It is this habit which enables the fisherman to detect the presence of the fish. It swims slowly along, and the fishing schooner with a light breeze finds no difficulty in overtaking it. When excited its motions are very swift and nervous. Swordfish are sometimes seen to leap entirely out of the water. Early writers attributed this habit to the tormenting presence of parasites, but this theory seems hardly necessary, knowing what we do of its violent exertions at other times. The pointed head, the fins at the back and abdomen snugly fitting into grooves, the absence of ventrals, the long, lithe, muscular body, sloping slowly to the tail, fit it for the most rapid and forcible movement through the water. Prof. Richard Owen, testifying in an English court in regard to its power, said:

"It strikes with the accumulated force of fifteen double-handed hammers. Its velocity is equal to that of a swivel-shot, and is as dangerous in its effects as a heavy artillery projectile."

Many very curious instances are on record of the encounters of this fish with other fishes or of their attacks upon ships. What can be the inducement for it to attack objects so much larger than itself it is hard to surmise. Every one knows the couplet from Oppian:

> "Nature her bounty to his mouth confined,
> Gave him a sword, but left unarmed his mind."

It surely seems as if a temporary insanity sometimes takes possession of the fish. It is not strange that, when harpooned, it should retaliate by attacking its assailant. An old swordfisherman told Mr. Blackford that his vessel had been struck twenty times. There are, however, many instances of entirely

unprovoked assault on vessels at sea. Many of these are recounted in a later portion of this memoir. Their movements when feeding are discussed below, as well as their alleged peculiarities of movement during the breeding season.

It is the universal testimony of our fishermen that two are never seen swimming close together. Captain Ashby says that they are always distant from each other at least thirty or forty feet.

MOVEMENTS OF SPEAR-FISHES.

The spear-fish in our waters is said by the fishermen to resemble the swordfish in its movements and manner of feeding. Professor Poey narrate that both the Cuban species swim at a depth of one hundred fathoms, and they journey in pairs, shaping their course toward the Gulf of Mexico, the females being full of eggs. Only adults are taken. It is not known whence they come, or where they breed, or how the young return. It is not even known whether the adult fishes return by the same route. When the fish has swallowed the hook it rises to the surface, making prodigious leaps and plunges. At last it is dragged to the boat, secured with a boat-hook, and beaten to death before it is hauled on board. Such fishing is not without danger, for the spear-fish sometimes rushes upon the boat, drowning the fisherman or wounding him with its terrible weapon. The fish becomes furious at the appearance of sharks, which are its natural enemies. They engage in violent combats, and when the spear-fish is attached to the fisherman's line it often receives frightful wounds from these adversaries.

In *Land and Water* for August 31st, 1882, Col. Nicholas Pike, author of "Subtropical Rambles," at that time United States consul at Mauritius describes the habits of a species of *Tetrapturus* occurring in that vicinity. He states that they have the habit of resting quietly on the surface in calm weather, with their dorsals expanded and acting as sails. They are taken in deep water with hook and line or speared when near the surface, like swordfish. When hooked or speared they make for the boats, taking tremendous leaps in the air, and if care is not taken they will jump into the boats, to the consternation of the fisher-

men, or else pierce the boats with their bills. The fish is highly esteemed in the Mauritius, the flesh being of a salmon color near the vertebræ ; lower down it is red and like coarse beef. The spicies attains a large size, one having been seen measuring twenty-six feet.

MOVEMENTS OF SAIL-FISHES.

No observations have been made in this country, and recourse must be had to the statements of observers in the other hemisphere.

In the life of Sir Stamford Raffles there is the following account from Singapore, under date of November 30th, 1782 :

"The only amusing discovery we have recently made is that of a sailing fish, called by the natives *Ikan layer*, of about ten or twelve feet long, which hoists a mainsail, and often sails in the manner of a native boat, and with considerable swiftness. I have sent a set of the sails home, as they are beautifully cut and form a model for a fast sailing boat. When a school of these are under sail together they are frequently mistaking for a fleet of native boats."

The fish referred to is in all likelihood *Histiophorus gladius*, a species very closely related to, if not identical with our own.

MAXIMUM AND AVERAGE SIZE OF AMERICAN SWORDFISH.

The only individual of which we have the exact measurements was taken off Seaconnet, R. I., July 23d, 1874. This was seven feet and seven inches long, weighing one hundred and thirteen pounds. Another, taken off Noman's Land, July 20th, 1875, and cast in plaster for the collection of the National Museum, weighed one hundred and twenty pounds, and measured about seven feet. Another, taken off Portland, August 15th, 1878, was 3,999 millimeters long, and weighed about six hundred pounds. Many of these fish doubtless attain the weight of four hundred and five hundred pounds, and some, perhaps, grow to six hundred ; but after this limit is reached, I am inclined to believe larger fish are exceptional.

Newspapers are fond of recording the occurrence of giant

fish, weighing 1,500 pounds and upward, and old sailors will in good faith describe the enormous fish which they saw at sea, but could not capture; but one well-authenticated instance of accurate weight is much more valuable. The largest one ever taken by Capt. Benjamin Ashby, for twenty years a swordfisherman, was killed on the shoals back of Edgartown, Mass. When salted it weighed six hundred and thirty-nine pounds. Its live weight must have been as much as seven hundred and fifty or eight hundred pounds. Its sword measured nearly six feet. This was an extraordinary fish among the three hundred or more taken by Capt. Ashby in his long experience. He considers the average size to be about two hundred and fifty pounds dressed, or three hundred and twenty-five alive. Captain Martin, of Gloucester, estimates the average size at three hundred to four hundred pounds. The largest known to Capt. Michaux weighed six hundred and twenty-five pounds. The average about Block Island he considers to be two hundred pounds.

There are other stories of large fish. Capt. R. H. Hurlbert, of Gloucester, killed one on George's Banks, in September, 1876, which weighed when dressed four hundred and eighty pounds. Capt. John Rowe, of the same port, salted one which filled two and one-half barrels. This probably weighed six hundred pounds when alive. I have been told that a swordfish loses one-third of its weight in dressing, but I should think that one-fourth would be nearer to the truth. Capt. Baker, of the schooner Peter D. Smith, of Gloucester, assures me that he killed, in the summer of 1874, off Portland, a swordfish which weighed seven hundred and fifty pounds.

Mitchell and DeKay state that in 1791 a swordfish sixteen feet in length was exhibited in New York. It is questionable whether they often exceed this measurement. My own observations have been made on specimens from seven to twelve feet long. A stuffed specimen in the United States National Museum measures —— feet, and this seems to be very nearly the average size.

MINIMUM SIZE OF AMERICAN SWORDFISH.

The size of the smallest swordfishes taken on our coast is a

subject of much deeper interest, for it throws light on the time and place of breeding. There is some difference of testimony regarding the average size, but all fishermen with whom I have talked agree that very small ones do not find their way into our waters. I have collected several instances from the experiences of men long wonted to this fishery.

Capt. John Rowe has seen one which did not weigh more than seventy-five pounds when taken out of the water.

Capt. R. H. Hurlbert killed, near Block Island, in July, 1877, one which weighed fifty pounds, and measured about two feet without its sword.

Captain Ashby's smallest weighed about twenty-five pounds when dressed; this he killed off Noman's Land. He never killed another which weighed less than one hundred. He tells me that a Bridgeport smack had one weighing sixteen pounds (or probably twenty-four when alive), and measuring eighteen inches without its sword.

In August, 1878, a small specimen of the mackerel shark, *Lamna cornubica*, was captured at the mouth of Gloucester Harbor. In its nostril was sticking the sword, about three inches long, of a young swordfish. When this was pulled out the blood flowed freely, indicating that the wound was recent. The fish to which this sword belonged cannot have exceeded ten or twelve inches in length. Whether the small swordfish met with its misfortune in our waters, or whether the shark brought this trophy from beyond the sea, is a question I cannot answer.

Lütken speaks of a very young individual taken in the Atlantic, lat. 32 deg. 50 min. N., long. 74 deg. 19 min. W. This must be about one hundred and fifty miles southeast of Cape Hatteras.

SIZE OF SWORDFISH IN THE MEDITERRANEAN.

In the Mediterranean, near Sicily and Genoa, young fish, ranging in weight from half a pound to twelve pounds, are said to be abundant between November and March.

About La Ciotat and Martigues, in the south of France, many are taken too small to injure the fishing-nets, and very rarely reaching the weight of one hundred pounds.

From the statements of Bloch and later writers it appears that large swordfish also are abundant in the Mediterranean. Late Italian fishery reports state that the average weight of those taken on the coast of Italy is fifty kilograms (one hundred and ten pounds).

Of the coasts of Spain and Portugal, Steindachner remarks: "More abundant on the southern coasts of Spain than on the northern, western and eastern sides of the Iberian peninsula. We saw quite large examples in the fish-markets at Gibraltar, Cadiz, Lisbon, La Coruña and Barcelona, and at Santa Cruz, Teneriffe. The largest of three specimens in my possession is forty-three inches long, another twenty-four inches."*

RATE OF GROWTH.

Little is known about the rate of growth. The young fish taken in winter in the Mediterranean, ranging in weight from half a pound to twelve pounds, are thought to have been hatched during the previous summer. Those of a larger size, ranging from twenty-four to sixty pounds, taken on the New England coast in the summer, may perhaps be the young of the previous year. Beyond this even conjecture is fruitless. As in other species, the rate of growth depends directly upon the quantity of food consumed. It is to be presumed that a summer passed in feasting among the crowding schools of menhaden and mackerel in our waters would bring about a considerable increase in weight. That this is the case is clearly shown by the testimony of the fishermen, who say that in the spring swordfish are thin, growing fatter and heavier as the season goes on.

Dr. Lütken and Dr. Günther have lately made some exceedingly interesting observations upon the young of the swordfish and of the spearfish and sailfish.

Dr. Günther's studies were made upon very small specimens of undetermined species, belonging to either *Tetrapturus*, *Histiophorus*, or both. In his latest work, "The Study of Fishes," he summarizes the facts observed by him as follows:

"The swordfishes with ventral fins (*Histiophorus*) belong to the

* Sitzb. Ak., Wiss. Wien, 1868, p. 396.

Teleosteans of the largest size. In young individuals, nine millimeters long, both jaws are produced and armed with pointed teeth, the supraorbital margin is ciliated, the parietal and preoperculum are prolonged into long spines, the dorsal and anal fins are a long fringe, and the ventrals make their appearance as a pair of short buds. When fourteen millimeters long the young fish has still the same armature of the head, but the dorsal fin has become much higher, and the ventral filaments have grown to a great length. At the next stage, when the fish has attained to a length of sixty millimeters, the upper jaw is considerably prolonged beyond the lower, losing its teeth, the spines of the head are shortened, and the fins assume nearly the shape which they retain in mature individuals.

"Young swordfishes without ventral fins (*Xiphias*) undergo similar changes, and, besides, their skin is covered with small, rough excrescences, longitudinally arrayed which continued to be visible after the young fish has attained the form of the mature in other respects."

Dr. Lütken's description of the young swordfishes is an exceedingly valuable contribution to knowledge.

PUGNACITY.

The pugnacity of the swordfish has become a by-word. Without any special effort on my part, the following instances of their attacks upon vessels have, in the last six years, found their the way to the pigeon-hole labelled "A, III., 76, swordfish."

Aelian says (B, xxxii, C. 6) that the swordfish has a sharp-pointed snout with which it is able to pierce the sides of a ship and send it to the bottom; instances of which have been known near a place in Mauritania known as Cotte, not far from the river Lixus, on the African side of the Mediterranean. He describes the sword as like the beak of the ship known as the trireme, which was rowed with three banks of oars.

One of the earliest accounts is that given in the second part of vol. i., lib. ii., p. 89, 1615, of Purchas' Pilgrims.

"The sixth Circum-navigation, by William Cornelison Schovten of Horne: who Sovthwards from the Straights of Magelan

in Tierra-delfvogo, fovnd and discovered a new passage throvgh the great Sovth-sea, and that way sailed rovnd about the World," etc.

Off the coast of Sierra Leone:

"The fift of October we were vnder foure degrees seuen and twentie minutes, the same day about noone, there was such a noyse in the Bough of our Shippe, that the master, being behind in the Gallerie, thought that one of the men had fallen out of the Fore-ship, or from the Boe-sprit into the sea, but as hee looked out over the side of the Ship hee saw the Sea all red, as if great store of bloud had been powred into it, whereat hee wondred, knowing not what it meant; but afterward hee found, that a great Fish or a Sea monster having a horne had therewith stricken against the ship With most great strength. For when we were in Porto Desire where we set the Ship upon the Strand to make it clean, about seven foot under water, before in the Ship, we found a Horne sticking in the Ship, much like for thickness and fashion to a common Elephants tooth, not hollow, but full; very strong hard Bone, which had entered into three Plankes of the Ship, that is two thicke Plankes of greene and one of Oken wood, and so into a Rib, where it turned upward, to our great good fortune, for if it had entered between the Ribbes, it would happily have made a greater Hole, and have brought both Ship and men in danger to be lost. It strucke at least half a foote deep into the Ship and about half a foote without, where, with great force it was broken off, by reason whereof the great monster bled so much."

More than a century later C. Mortimer, M. D., records this experience:

"Mr. Bankley shewed me the *Horn* of a *Fish* that had penetrated about eight inches into the Timber of a Ship and gave me the following Relation of it: 'His MAJESTY'S Ship *Leopard*, having been at the *West Indies* and on the Coast of *Guiney*, was ordered by Warrant from the Honorable *Navy-Board*, dated Aug. 18, 1725, to be cleaned and refitted at Portsmouth, for Channel-Service: Pursuant thereto, she was put into the great Stone-dock; and, in stripping off her Sheathing, the Shipwrights found something that was uncommon in her Bottom, about eight

feet from her Keel, just before the Fore Mast; which they searching into, found the Bone or Part of the Horn of a Fish of the Figure here described; the Outside Rough not unlike *Seal-Skin;* and the End, where it was broken off shewed itself like coarse Ivory. The Fish is supposed to have followed the Ship, when under Sail, because the sharp End of the Horn Pointed toward the Bow: It penetrated with that Swiftness or Strength that it went through the Sheathing one inch thick, the Plank three Inches thick, and into the Timber four and a half inches.' "*

Don Joseph Cornide, in his "Essayo de Una Historia de los Peces de la Costa de Galicia," 1787:

"This fish is taken in the seas of Galicia, where it is more common toward the Rio de Vigo, where it is well known that the Balandia (a small fishing vessel) of S. M. le Ardilla was pierced in its side and sunk by the arm of one of these fishes, which is preserved in the Royal Cabinet of Natural History."

In 1871 the little yacht Redhot, of New Bedford, was out swordfishing, and a swordfish had been hauled in to be lanced, and it attacked the vessel and pierced the side so as to sink the vessel. She was repaired and used in the service of the commission at Wood's Holl. (Prof. Baird.)

Couch quotes the personal statement of a gentleman, who says:

"We have had the pleasure of inspecting a piece of wood cut out of one of the fore planks of a vessel (the Priscilla from Pernambuco), through which was struck about eighteen inches of the bony weapon of the swordfish. The force with which it must have been driven in affords a striking exemplification of the power and ferocity of the fish. The Priscilla is quite a new vessel. Captain Taylor, her commander, states that when near the Azores, as he was walking along the quarter-deck at night, a shock was felt which brought all hands from below, under the impression that the ship had touched upon some rock. This was, no doubt, when the occurrence took place."

The New York *Herald* of May 11th, 1871, states:

* An account of the horn of a Fish struck several inches into the side of a Ship, by C. Mortimer, M. D., F. R. S. Philos. Trans. xl., No. 461, p. 862, 1741.

"The English ship Queensberry has been struck by a swordfish which penetrated to a depth of thirty inches, causing a leak which necessitated the discharge of the cargo."

The London *Daily News* of December 11th, 1868, contained the following paragraph, which emanated, I suspect, from the pen of Prof. R. A. Proctor:

"Last Wednesday the court of Common Pleas—rather a strange place, by the by, for inquiring into the natural history of fishes—was engaged for several hours in trying to determine under what circumstances a swordfish might be able to escape scot-free after thrusting his snout into the side of a ship. The gallant ship Dreadnought, thoroughly repaired, and classed A1 at Lloyd's, had been insured for £3,000 against all the risks of the seas. She sailed on March 10th, 1864, from Colombo, for London. Three days later the crew, while fishing, hooked a swordfish. Xiphias, however, broke the line, and a few moments after leaped half out of the water, with the object, it would seem, of taking a look at his persecutor, the Dreadnought. Probably he satisfied himself that the enemy was some abnormally large cetacean, which it was his natural duty to attack forthwith. Be this as it may, the attack was made, and at four o'clock the next morning the captain was awakened with the unwelcome intelligence that the ship had sprung a leak. She was taken back to Colombo, and thence to Cochin, where she was hove down. Near the keel was found a round hole, an inch in diameter, running completely through the copper sheathing and planking.

"As attacks by swordfish are included among sea risks, the insurance company was willing to pay the damages claimed by the owners of the ship if only it could be proved that the hole had really been made by a swordfish. No instance had ever been recorded in which a swordfish had been able to withdraw his sword after attacking a ship. A defense was founded on the possibility that the hole had been made in some other way. Professor Owen and Mr. Frank Buckland gave their evidence, but neither of them could state quite positively whether a swordfish which had passed its beak through three inches of stout planking could withdraw without the loss of its sword. Mr.

Buckland said that fish have no power of 'backing,' and expressed his belief that he could hold a swordfish by the beak; but then he admitted that the fish had considerable lateral power, and might so 'wriggle its sword out of a hole.' And so the insurance company will have to pay nearly six hundred pounds because an ill-tempered fish objected to be hooked, and took its revenge by running full tilt against copper sheathing and oak planking."

The Gloucester schooner Wyoming, on a last trip to George's Banks, records the New York *World* of August 31st, 1875, was attacked by a swordfish in the night time. He assailed the vessel with great force, and succeeded in putting his sword through one of her planks some two feet, and after making fearful struggles to extricate himself, broke his sword off, leaving it hard and fast in the plank, and made a speedy departure. Fortunate was it that he did not succeed in drawing out his sword, as the aperture would undoubtedly have made a leak sufficient to have sunk the vessel. As it was, she leaked badly, requiring pretty lively pumping to keep her free.*

Another instance of a similar nature is this, which was recorded in the Liverpool *Mercury* about the year 1876:

"Mr. J. J. Harwood, master of the British brigantine Fortunate, in dock at Liverpool, reports that while on his passage from the Rio Grande, when in latitude 20 deg. 12 min. north, and longitude 47 deg. 9 min. west, this ship was struck by a large fish, which made the vessel shake very much. Thinking the ship had been merely struck by the tail of some sea monster, he took no further notice of the matter; but after discharging cargo at Runcorn, and coming into the Canada half-tide dock, he found one of the plank ends in the stern split, and on closer examination he discovered that a swordfish had driven his sword completely through the plank, four inches in thickness, leaving the point of the sword nearly eight inches through the plank. The fish in its struggle broke the sword off level with the outside of the vessel, and by its attack upon the ship lost nearly a foot length of the very dangerous weapon with which it was armed.

* New York *World*, August 31st, 1875.

There is no doubt that this somewhat singular occurrence took place when the vessel was struck as Captain Harwood describes."

Forest and Stream of June 24th, 1875, recorded the following incident:

"On Wednesday of last week a swordfish attacked the fishing boat of Capt. D. D. Thurlow while he was hauling mackerel nets off Fire Island, thrust its sword clear through the bottom, and stuck fast, while the fishermen took several half-hitches around its body and so secured it. It was afterwards brought to Fulton Market, and found to weigh three hundred and ninety pounds. Its sword measured three feet and seven inches, and its entire length was over eleven feet. The stuffed skin will adorn the Central Park Museum."

The *Landmark*, of Norfolk, Va., also mentioned a similar occurrence in February, 1876:

"The brig P. M. Tinker, Captain Bernard, previously mentioned as having arrived here from Richmond, leaking, for repairs, has been hauled up on the ways at Graves' ship-yard. On examination it was discovered that the leak was caused by a swordfish, the sword being found broken off forward the bands, about sixteen feet abaft the forefoot. The fish, in striking the vessel, must have come with great force, as the sword penetrated the copper sheathing, a four-inch birch plank, and through the timbers about six inches—in all about ten inches. It occurred on the morning of the 23d of December, when the brig was eighteen days out from Rio, and in the neighborhood of Cape St. Roque. She was pumped about four o'clock in the morning, and found free of water. About six o'clock the same morning she was again pumped, when water was obtained, and on examination it was found that she had made ten inches of water. The men were kept steady at the pumps until her arrival at Richmond, and while there, and on her trip here."

Mr. Willard Nye sends me this note:

"A few years ago Captain Dyer, of New Bedford, struck a swordfish from a thirty-foot boat, forty miles southwest of Noman's Land, threw overboard the keg, tacked, and stood by to the windward of it. When nearly abreast of it the man at the

masthead called out, 'Why, here he is, right alongside.' The fish was then about ten feet from the boat, and swimming in the same direction, but when he got where he could see the splash of water around the bow he turned and struck the boat about two feet from the stern and just below the water-line. The sword went through the planking, which was of cedar an inch and three-quarters thick, into a lot of loose iron ballast, breaking off short at the fish's head. A number of boats, large and small, have been 'stove' by swordfish on our coast, but always after the fish had been struck."

A nameless writer in *Harper's Weekly*, October 25th, 1879, narrates these instances, for which I am unable to give the original authority.

"In a calm day in the summer of 1832, on the coast of Massachusetts, a pilot was rowing his little skiff leisurely along, when he was suddenly roused from his seat by a thrust from below by a swordfish, who drove his sharp instrument more than three feet up through the bottom. With rare presence of mind, with the butt of an oar he broke it off level with the floor before the fish had time to withdraw it. Fortunately, the thrust was not directly upward. Had it been so, the frail boat would have been destroyed.

"A Boston ship hauled up on the ways for repair, a few years since, presented the shank of a swordfish's dagger, which had been driven considerably far into the solid oak plank. A more curious affair was brought to light in 1725 in overhauling His Majesty's ship Leopard, from the coast of Africa. The sword of this marine spearsman had pierced the sheathing one inch, next it went through a three-inch plank, and beyond that three inches and a half into the firm timber. It was the opinion of the mechanics that it would have required nine strokes of a hammer weighing twenty-five pounds to drive an iron bolt of the same dimensions to the same depth in the hull. Yet the fish drove it at a single thrust.

"On the return of the whale-ship Fortune to Plymouth, Mass., in 1827, the stump of a sword-blade of this fish was noticed projecting like a cog outside, which, on being traced, had been driven through the copper sheathing, an inch-board under-

sheathing, a three-inch plank of hard wood, the solid white-oak timber twelve inches thick, then through another two-and-a-half-inch hard-oak ceiling, and lastly penetrated the head of an oil-cask, where it stuck, not a drop of the oil having escaped."

Such instances could be found by the score, if one had the time and patience to search. The thing happens many times a year, and nearly as often affords a text for some paragrapher or local editor.

Captain Beechy in the narrative of the voyage of Her Majesty's ship Blossom, mentions the following incident which occurred in the Pacific, near Eastern Island: "As the line was hauling in, a large swordfish bit at the tin case which contained our thermometer, but fortunately failed in carrying it off."

PUGNACITY OF THE SPEARFISH.

The spearfish (*Tetrapturus albidus*, etc.) also strikes vessels. I am indebted to Capt. William Spicer, of Noank, Conn., for this note:

"Mr. William Taylor. of Mystic, a man seventy six years old, who was in the smack Evergreen, Capt. John Appleman, tells me that they started from Mystic, October 3rd, 1832, on a fishing voyage to Key West, in company with the smack Morning Star, Captain Rowland. On the 12th they were off Cape Hatteras, the wind blowing heavily from the northeast, and the smack under double-reefed sails. At ten o'clock in the evening they were struck by a 'woho' (*sic*), which shocked the vessel all over. The smack was leaking badly, and they made a signal to the Morning Star to keep close by them. The next morning they found the leak, and both smacks kept off to Charleston. On arrival they took out the ballast, hove her out, and found that the sword had gone through the planking, timber and ceiling. The plank was two inches thick, the timbers five inches, and the ceiling one and a half inches white oak. The sword projected two inches through the ceiling, on the inside of the 'after run.'* It struck close by a butt on the outside, which caused the leak. They took out and replaced a piece of the plank, and proceeded on their voyage."

* A hold under the cabin.

J. Matthew Jones, Esq., of Halifax, N. S., in his delightful little book, "The Naturalist in Bermuda," records the case of the Bermudian schooner, Earl Dundonald, arrived in the port of Hamilton, which was pierced by one of these formidable fish off the coast of British Guiana.

In the museum of Charleston College, Charleston, S. C., is preserved a fragment of the snout of a bayonet-fish, apparently *Tetrapturus albidus*. By the kindness of the curator, Dr. G. E. Manigault, I was allowed to examine it and copy the label, which reads as follows: "The brig Amsterdam, bound to Charleston, owned by F. C. Bray, was struck in the Gulf Stream by a monster or swordfish, which caused the vessel to leak considerably. By great exertion she was kept free, and gained the port in safety."

Messrs. Foster, Waterman & Co., of Boston, presented to the Boston Society of Natural History, in 1869, a plank of Southern pine perforated by and containing a portion of the sword of a swordfish (*Histiophorus*) from the side of the ship Pocahontas, owned by them. (Proc. Bost. Soc. Nat. Hist., xiii, 1869, p. 64.)

ATTACKS OF THE SWORDFISH UPON WHALES.

One of the traditions of the sea, time-honored, believed by all mariners, handed down in varied phases in a hundred books of ocean travel, relates to the terrible combats between the whale and the swordfish, aided by the thrasher-shark. The swordfish was said to attack from below, goading his mighty adversary to the surface with his sharp beak, while the thrasher, at the top of the water, belabored him with strokes of his long, lithe tail.

An early explorer of the Bermudas gives the following version of the story, with tone so fresh and enthusiastic that we might well believe him to have seen the occurrence with his own eyes. The passage occurs in "Newes from the Bermudas," a pamphlet dated "Burmuda, July, 1609," and reprinted in "Forces Historical Tracts," vol. ii:

"*Whale, Swordfish & Threasher.*—The swordfish swimmes under the whale, & pricketh him upward. The threasher keep above him, & with a mighty great thing like unto a flaile, hee so bangeth the whale, that hee will roare as though it thundered,

& doth give him such blowes, with his weapon, that you would think it to be a crake of great shot.*

Skeptical modern science is not satisfied with this interpretation of any combat at sea seen at a distance. It recognizes the improbability of aggressive partnership between two animals so different as the swordfish and a shark, and explains the turbulent encounters occasionally seen at sea by ascribing them to the attacks of the killer-whale, *Orca* sp., upon larger species of the same order.

There can be little doubt though that swordfish sometimes attack whales just as they do ships. The habit is mentioned by Pliny, and is the motive for one of the *Visions of the World* of Edmund Spenser.

> "Toward the sea turning my troubled eye
> I saw the fish (if fish I may it cleepe)
> That makes the sea before his face to flye
> And with his flaggie finnes doth seeme to sweepe
> The fomie waves out of the dreadful deep.
> The huge Leviathan, dame Nature's wonder,
> Making his sport, that manie makes to weep:
> A swordfish small, him from the rest did sunder,
> That, in his throat him pricking softly under,
> His wide abysse him forced forth to spewe,
> That all the sea did roar like heavens thunder,
> And all the waves were stained with filthie hewe,
> Whatever thing seems small in common eyes."*

[*Spenser's Visions of the World's Vanitie, 1591.]

* The following is a fair example of the average newspaper paragraphers treatment of the subject:

"*Combats of the ocean.*—Among the extraordinary spectacles sometimes witnessed by those who 'go down to the sea in ships,' none are more impressive than a combat for the supremacy between the monsters of the deep. The battles of the swordfish and whale are described as Homeric in grandeur. The swordfish go in schools like whales, and the attacks are regular sea fights. When the two troops meet, as soon as the swordfish have betrayed their presence by a few bounds in the air, the whales draw together and close up their ranks. The swordfish always endeavors to take the whale in the flank, either because its cruel instinct has revealed to it the defect in the carcasses—for there exists near the brachial fins of the whale a spot where wounds are mortal—or because the flank presents a wider surface to its blow. The swordfish recoils to secure a greater impetus. If the movement escapes the keen eye of his adversary the whale is lost, for it receives the blow of the enemy and dies instantly. But if the whale perceives the swordfish at the instant of the rush, by a spontaneous bound it springs clear of the water its entire length, and falls on its flank with a crash that resounds for many leagues, and whitens the sea with boiling foam. The gigantic animal has only its tail for its defense. It tries to strike its enemy, and finishes him at a single blow. But if the active swordfish avoids the fatal tail the battle becomes more terrible. The aggressor springs from the water in his turn, falls upon the whale, and attempts, not to pierce, but to

I give also a few lines from an old play, quoted by Scott as a heading to one of the chapters of "The Antiquary":

> "Who is he? One that for the lack of land
> Shall fight upon the waters—he hath challenged
> Formerly the grand whale: and by his titles
> Of Leviathan, Behemoth, and so forth
> He tilted with a swordfish.—Marry, sir,
> Th' aquatic had the best—the argument
> Still galls our champion's breach."*

Baron Lahontan, in a letter from Quebec, November 8th, 1783, described an engagement between a whale and a swordfish which took place within gunshot of his frigate. He remarks:

"We were perfectly charmed when we saw the swordfish jump out of the water in order to dart its spear into the body of the whale when obliged to take breath. This entertaining show lasted at least two hours, sometimes to the starboad and sometimes to the larboard of the ship. The sailors, among whom superstition prevails as much as among the Egyptians, took this for a prestige of some mighty storm."†

Another early observer wrote:

"Concerning the Death of the Whale, which hath been related to have been stranded upon *New England*, it is not very improbable but that it may have been killed by a certain *Horny Fish*, which is said by Mr. *Terry*, in his East India Voyage, to run his Horn into the *Whale's* Belly; and which is known sometimes to run his Horn into Ships, perhaps taking them for Whales, and there snapping it asunder, as happened not long since to an English Vessel in the West Indian Seas."‡

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saw it with the teeth that garnish its weapon. The sea is stained with blood; the fury of the whale is boundless. The swordfish harasses him, strikes him on every side, kills him, and flies to other victories Often the swordfish has not time to avoid the fall of the whale, and contents itself with presenting its sharp saw to the flank of the gigantic animal about to crush it. It then dies like Maccaæus (*sic*), smothered beneath the weight of the elephant of the ocean. Finally, the whale gives a last few bounds in the air, dragging its assassin in its flight, and perishes as it kills the monster of which it was the victim."

[* "Old Play," Antiquary, chap. xxx.]

† Travels in Canada, 2nd ed., London, 1785, 2 vols. 8vo.

‡ An account of whale-fishing about the Bermudas by an understanding and hardy *Seaman*. Phil. Trans. abr. ed. ii., p. 844.

"In the month of August, 1861," says Couch, "near Westra, one of the northernmost islands of the Orkneys, an individual of the smaller species of whales, known as the herring-hog, was attacked by a swordfish; and when thus compelled to leap out of the water, which it did to the height of six feet, it was observed that the sword had been thrust into the whale's body behind the pectoral fins. Its leaps continued, and then it was perceived that a thrasher was assailing it on the sides."*

Captain Crow, quoted by Parnell, relates the following incident as having occurred on a voyage to Memet: "One morning, during a calm, when near Hebrides, all hands were called up at 3 A. M., to witness a battle between several of the fish called thrashers or fox sharks and some swordfish on one side, and an enormous whale on the other. It was the middle of summer, and the weather being clear, and the fish close to the vessel, we had a fine opportunity of witnessing the contest. As soon as the whale's back appeared above the water, the thrashers, springing several yards into the air, descended with great violence upon the object of their rancour, and inflicted upon him the most severe slaps with their long tails, the sound of which resembled the reports of muskets fired at a distance. The swordfish in their turn attacked the distressed whale, stabbing him from below, and thus beset on all sides and wounded, when the poor creature appeared, the water around him was dyed with blood. In this manner they continued tormenting him and wounding him for many hours, and I have no doubt they in the end completed his destruction."†

The following is a story given to Frank Buckland by Mr. Hill, captain of an English trawling vessel:

"The thrasher sharks just do serve out the whales. The sea sometimes is all blood. A whale once got under our vessel—the Hurricane—to get away from these thrashers, and when she was there we were afraid to throw a rope overboard, almost to walk out, for fear she would chuck her tail and punch a hole in our vessel. She was full length in water, as clear as gin, right

* History of British Fishes, ii., p. 174.

† Parnell, Fishes of the Firth of Forth, 1838, p. 216.

under our bottom, and laid as quiet as a lamb for an hour and a half, and never moved a fin. Where they had been a-thrashing of her the sea was just like blood. I have seen these 'ere thrashers fly out of the water as high as the mast head and down upon the whale, while the swordfish was a-pricking of 'im up from underneath. There is always two of 'em, one up and one under, and I think they hunts together; and you can see the poor whale blow up in great agitation; and I be bound the pair of 'em don't leave him until they have their penn'orth out of him. It is just for wengeance they does it. Whether Master Whale has offended them or not, it's hard to tell. If they eats him they must have a tidy blow-out of him, but I don't think they like the oil. I saw one engagement off the Staples; it was all two or three hours they was at it. I don't think they leaves him till they kills him."

Egede puts on record the belief of Danish explorers of the last century:

"The *swordfish* who is the Whales greatest Enemy; and when he kills one eats nothing but his Tongue, leaving the rest to the Shark, Walrus and Birds of Prey."*

The last quotation is especially important, since it shows how the swordfish and the killer-whale have been confused. It is still held, on good authority, that the killers eat the tongues of their victims.

At a meeting of the Boston Society of Natural History, in 1864, in reply to a question of Dr. J. B. S. Jackson, about the thrasher or swingle-tail shark recently exhibited in Boston, Captain Atwood said that they were abundant at Provincetown,

* Hans Egede, Natural History of Greenland, 1741, p. 37.

"Three or four of these voracious animals do not hesitate to grapple with the largest baleen whales, and it is surprising to see those leviathans of the deep so completely paralyzed by the presence of their natural although diminutive enemies. Frequently the terrified animal—comparatively of enormous size and superior strength—evinces no effort to escape, but lies in a helpless condition, or makes but little resistance to the assaults of its merciless destroyer. The attack of these wolves of the ocean upon their gigantic prey may be likened, in some respects, to a pack of hounds holding the stricken deer at bay. They cluster about the animal's head, some of their number breaching over it, while others seize it by the lips and haul the bleeding monster under water; and when captured, should the mouth be open, they eat out its tongue. We saw an attack made by three killers upon a cow whale and her calf, in a lagoon on the coast of Lower California, in the spring of 1858. The whale was of the California gray species, and her young was grown to three times the bulk of the largest

though not so common as the mackerel shark. He also observed that he placed no confidence whatever in the stories current of attacks on the whales by the thrasher, believing them to be quite harmless and unable to hurt a dolphin. The story very likely arose from some peculiar movements made by the hump-backed whale. Swordfish, he believed, might attack a whale and kill him, from what he had seen of the force of their thrusts into the bottom of vessels, though he has no evidence that they ever do attack them. He was not aware, either, that the thrasher ever uses his tail for offensive purposes.*

Captain Scammon, in his "Marine Mammals," gives the following confirmation of Captain Atwood's views, speaking of the habits of the hump-back whale of the Pacific :

"In their wanderings they are addicted more than any other roqual to 'breaching,' 'bolting,' and 'finning.' In the mating season they are noted for their amorous antics. At such times their caressings are of the most amusing and novel character, and these performances have doubtless given rise to the fabulous tales of the swordfish and thrasher attacking whales. When lying by the side of each other the *Megapteras* frequently administer alternate blows with their long fins, which lovepats may, on a still day, be heard at a distance of miles. They also rub each other with these same huge and flexible arms, rolling occasionally from side to side, and indulging in other gambols which can easier be imagined than described."

ENEMIES.

Such a large animal as the swordfish can have but few antag-

killer engaged in the contest, which lasted for an hour or more. They made alternate assaults upon the old whale and her offspring, finally killing the latter, which sunk to the bottom, where the water was five fathoms deep. During the struggle the mother became nearly exhausted, having received several deep wounds about the throat and lips. As soon as their prize had settled to the bottom the three orcas descended, bringing up large pieces of flesh in their mouths, which they devoured after coming to the surface. While gorging themselves in this wise, the old whale made her escape, leaving a track of gory water behind. Instances have been known on the northwestern coast where a band of orcas laid siege to whales that had been killed by whalemen, and which were being towed to the ship, in so determined a manner that, although they were frequently lanced, cut with boat spades, they took the dead animals away from their human captors, and hauled them under water out of sight."– (C. M. Scammon, Marine Mammals, p. 89.)

* Proc. Bost. Soc. Nat. Hist., vol. x., 1864–'66, p. 82.

onists whose attacks would be disastrous. The tunny or horse-mackerel, *Orcynus thynnus*, other swordfishes, and sharks are its only peers in size, and of these the sharks are probably its worst foes.

Capt. N. E. Atwood exhibited to the Boston Society of Natural History, December 7th, 1864, the lower jaw of a large shark, taken at Provincetown, Mass., in whose stomach nearly the whole of a large swordfish was found. Some ten or twelve wounds were noticed in the skin of the shark, giving an idea of the conflict. The shark was doubtless *Galeocerdo tigrina.*

Couch was told by a sailor that he had watched with interest the anxious motions of one as it was followed closely and rapidly in all its turnings by a blue shark. Twice did it leap above the surface to escape the near approach of its pursuer, but with what success at last the observer had no opportunity of knowing.

Mr. John A. Thomson states that the billfish (probably *Tetrapturus albidus*) is their special enemy. Billfish, six to twelve feet long, appear about the last of the season, and their appearance is a signal that the swordfish are about leaving.

INVERTEBRATE PARASITES OF THE SWORDFISH.

Aristotle thus explains the leaping movements of the fish: "The tunny and the *Xiphia* suffer from the œstrus at the rising of the dog-star, for both these fish at this season have beneath their fins a little worm which is called œstrus, which resembles a scorpion and is about the size of a spider; they suffer so much from this torment that the *Xiphias* leaps out of the sea as high as the dolphin, and in this manner frequently falls upon ships."

This description of the parasite is somewhat vague; yet it is evident that allusion is made to one of the Lerneans or gill-lice, little crustaceans remotely resembling crabs and lobsters, which attach themselves to the gills and skin of many kinds of fishes, sucking the blood from their veins, and often causing death; dreadful to their victims as was their namesake, the fabled Lernæan Hydra, to the Argives of old, and not to be destroyed by any piscine Hercules and Iolaus.

In one of the early volumes of the Philosophical Transactions

is an account by S. Paulo Boccone of "an extraordinary *Sanguisuga* or *leech*, found sometimes sticking fast in the fish called *Xiphias* or *swordfish*." It is described as "about four Inches long, the Belly of it white, cartilaginous and transparent, without Eyes or Head, but instead of a Head it had a hollow Snout, encompassed with a very hard Membrane; which Snout it thrusts whole into the Body of the Fish, as strongly as an *Augre* is wound into a piece of Wood, and fills it full of Blood into the very Orifice." He names it "*Hirudo* or *Acus cauda utrinque pennata*."*

A specimen taken off Seaconnet, July 22nd, 1875, had fluke worms in the external coat of the stomach and in the air-bladder.

I am indebted to Mr. Frederick W. True for the following account of the parasites of the swordfish:

The swordfish is infested by many species of parasites. Some hang on the gills, others fasten themselves to different parts of the alimentary canal—the œsophagus, the stomach, and the intines—and others still, bore into the flesh. Several species, as might be expected from the size of the fish, are among the giants of their races. All undoubtedly cause more or less pain to their host, but especially those which attach themselves to the gills, disturbing their action and destroying their substance.

The parasites of the swordfish, for convenience, may be classified in two groups, the worm-like parasites (*Helminthes*) and the crustacean parasites.

a. The worm-like parasites (*Helminthes*).—Seven species of *Helminthes* from the swordfish have been described, of which one belongs to the group *Nematoda*, or roundworms, four to the *Trematoda*, or flukes, and two to the *Cestoda*, or tape-worms. [Description omitted.]

FISH PARASITES—THE SUCKERS OR REMORAS.

Several species of "stays-ships" or "remoras" occur on our coast. The ordinary kind, such as *Leptecheneis naucrateoides*, the

* The | Philosophical | Transactions | and | Collections | To the End of the Year MDCC | Abridged | and | Disposed under General Heads | —— | Vol. II. | —— | Containing all the | Physiological Papers | —— | By John Lowthorp, M. A. and F. R. S. |

one with a black stripe down its side and white corners to its caudal fin, appears to choose companionship with the sharks, while the oceanic species, *Echeneis remora*, is most often found clinging to ships.

A third species, *Remoropsis brachyptera*, is the particular parasite of the swordfish. I have several times identified it when found attached to the fish, and have never known it to be found on any other species. It has never come to us, moreover, from locality and season which would be inconsistent with a theory that it had been brought near shore by a swordfish.

Still another, *Rhombochirus osteochir*, seems equally inseparable from *Tetrapturus albidus*. This fact is known to the Cuban fishermen, who call it by the name *Pega de los agujas*, the parasite of the spearfish.

Perhaps the two species are not so fixed in their likings that they will change from *Xiphias* to *Tetrapturus*. My friend, Professor Giglioli, of Florence, who speaks of *R. brachyptera* as a fish new to the Mediterranean, obtained from Taranto a specimen said to have been taken from the gills (operculum ?) of *Tetrapturus belone*.

These parasites probably prefer to cling with their curious suckers to the hard exterior surface of the opercular flap of the swordfish.

THE LOCATION OF THE FISHING GROUNDS.

In what has already been said regarding the dates of appearance and local movements of the swordfish in our waters may be found all the facts relating to the location of the fishing grounds, for the fishermen follow the swordfish wherever they appear to be most abundant.

Early in the season the swordfish are most abundant west of Montauk Point, and later they spread over the shoal grounds along the coast, even as far north as the Nova Scotia Banks. They may be found wherever mackerel and menhaden are abundant, as may be inferred from the almost universal practice of carrying swordfish irons on board of mackerel vessels.

I quote the statements of three or four correspondents who have taken the trouble to interview the fishermen of their respective localities.

Mr. E. G. Blackford writes: "The following information I received from an old swordfisherman, a man whose statements may be relied on. The season first opens early in June in the neighborhood of Sandy Hook, and continues along the coast as far east as Martha's Vineyard and Nantucket Shoals until about the middle of September. They are said to have been caught as far north as Cape Sable. At the first cold wind blowing in September they disappear, and are not found again on the coast that season." This is the statement of a New York man.

Capt. Benjamin Ashby, of Noank, Conn., informs me that the swordfish vessels of Noank and New London are accustomed to leave the home port about the 6th of July, and throughout the month they find fish most abundant between Block Island and Noman's Land; in August between Noman's Land and the South Shoal Light Ship. They first meet the fish twenty to twenty-five miles southeast of Montauk Point. In August and September they are found on George's Banks. There is no fishing after the snow begins to fly.

A little farther east is the New Bedford fleet. Capt. I. H. Michaux, of the schooner Yankee Bride, tells me that swordfish strike in about Block Island in the middle of June, and stay in that vicinity until the 15th or 20th of August. North of Cape Cod they are taken up to the 20th of October.

The statements of Mr. John H. Thomson, of New Bedford, have already been quoted, but may be epitomized in this connection. From May 25th to June they are found south of Block Island, approaching the Vineyard Sound and the neighboring waters through June and to the middle of July. A little later they are more abundant to the southeast of Crab Ledge, and after August 1st to the southeast of Cape Cod and George's Banks.

The schooner Northern Eagle, of Gloucester, Capt. George H. Martin, when engaged in swordfishing, is accustomed to leave Gloucester so as to be on the ground south of Block Island by the 10th of June, and the fish are followed as far east as Portland.

Mr. Earll ascertained that the swordfish are mostly fished for on the coast of Maine from July 1st to September 1st.

Halibut vessels on La Have and Sable Island Banks occasionally take these fish upon their lines.

Mackerel vessels on the New England coast are always prepared for swordfish when cruising among mackerel schools. I am not aware that they are ever seen on the mackerel grounds of the Gulf of St. Lawrence.

APPARATUS OF CAPTURE.

The apparatus ordinarily employed for the capture of the swordfish is simple in the extreme. It is a harpoon with detachable head. When the fish is struck the head of the harpoon remains in the body of the fish, and carries with it a light rope, which is either made fast or held by a man in a small boat, or is attached to some kind of a buoy, which is towed through the water by the struggling fish and which marks its whereabouts after death.

The harpoon consists of a pole fifteen or sixteen feet in length, usually of hickory or some other hard wood, upon which the bark has been left, so that the harpooner may have a firmer hand-grip. This pole is from an inch and a half to two inches in diameter, and at one end is provided with an iron rod or "shank," about two feet long and five-eighths of an inch in diameter. This "shank" is fastened to the pole by means of a conical or elongated cup-like expansion at one end, which fits over the sharpened end of the pole, to which it is secured by screws or spikes. A light line extends from one end of the pole to the point where it joins the "shank," and in this line is tied the loop, by which is made fast another short line which secures the pole to the vessel or boat, so that when it is thrown at the fish it cannot be lost.

Upon the end of the "shank" fits somewhat securely the head of the harpoon, known to the fishermen by the names of swordfish iron, lily iron, or Indian dart. The form of this weapon has undergone much variation, as is shown in the series of figures of specimens in the National Museum. The fundamental idea may very possibly have been derived from the Indian fish dart, numerous specimens of which are in the National Museum. However various the modifications may have been, the similarity

of the different shapes is no less noteworthy from the fact that all are peculiarily American. In the enormous collection of fishery implements of all lands in the late exhibition at Berlin, nothing of the kind could be found. What is known to whalers as a toggle-harpoon is a modification of the lily-iron, but so greatly changed by the addition of a pivot by which the head of the harpoon is fastened to the "shank" that it can hardly be regarded as the same weapon.

The lily-iron is in principle exactly what a whaleman would describe by the word "toggle." It consists of a two-pointed piece of metal, having in the center, at one side, a ring or socket whose axis is parallel with the long diameter of the implement. In this is inserted the end of the pole-shank, and to it, or near it, is also attached the harpoon-line. When the iron has once been thrust point first through some solid substance, such as the side of a fish, and is released upon the other side by the withdrawal of the pole from the socket, it is free, and at once turns its long axis at right angles to the direction in which the harpoon-line is pulling, and thus is absolutely prevented from withdrawal. The principle of the whale-harpoon or toggle-iron is similar, except that the pole is not withdrawn, and the head, turning upon a pivot at its end, fastens the pole itself securely to the fish, the harpoon-line being attached to some part of the pole. The swordfish lily-iron head, as now ordinarily used, is about four inches in length, and consists of two lanceolate blades, each about an inch and a half long, connected by a central piece much thicker than they, in which, upon one side, and next to the flat side of the blade, is the socket for the insertion of the pole-shank. In this same central enlargement is forged an opening to which the harpoon-line is attached. The dart-head is usually made of steel; sometimes of iron, which is generally galvanized; sometimes of brass.

The entire weight of the harpoon-pole, shank, and head should not exceed eighteen pounds.

The harpoon-line is from fifty to one hundred and fifty fathoms longs, and is ordinarily what is known as "fifteen-thread line," At the end is sometimes fastened a buoy, and an ordinary mackerel keg is generally used for this purpose.

In addition to the harpoon, every swordfisherman carries a lance. This implement is precisely similar to a whaleman's lance, except that it is smaller, consisting of a lanceolate blade perhaps one inch wide and two inches long, upon the end of a shank of five-eighths-inch iron, perhaps two or three feet in length, fastened in the ordinary way upon a pole fifteen to eighteen feet in length.

THE MANNER OF FITTING A VESSEL FOR SWORDFISHING.

The swordfish are always harpooned from the end of the bowsprit of a sailing vessel. It is next to impossible to approach them in a small boat. All vessels regularly engaged in this fishery are supplied with a special apparatus for the support of the harpooner as he stands upon the bowsprit, and this is almost essential to success, although it is possible for an active man to harpoon a fish from this station without the aid of the ordinary framework. Not only the professional swordfishermen, but many mackerel schooners and packets are supplied in this manner.

The swordfish "pulpit" is constructed as follows: The harpooner stands upon the tip of the bowsprit, outside of the jibstay. At this point is fastened a square plate of iron as wide as the bowsprit. In the middle of this plate is a mortise two inches square, and extending three or four inches down into the wood, forming a socket for an upright iron bar two inches square and three feet high. At the top of this bar is a bow of iron bent backward in semicircular form to surround the waist of the harpooner, the ends of the bow being separated by a distance of perhaps two feet. In the ends of the bow-iron are holes through which are passed irons to hold the dart when not in use. Through these same holes are sometimes passed ropes, by which is suspended a swinging seat for the use of the harpooner when not in action. When not in use the dart is lashed in a horizontal position to the top of the "rest." The lance is usually allowed to rest against the jibstay, to which it is secured by passing it through loops of rope arranged for the purpose. Upon the tip of the bowsprit, at the base of the *rest*, is a platform of wood about two feet square, large enough to afford a firm foot-hold to

the harpooner. The harpoon-line is coiled upon the bow of the vessel, the buoy usually resting upon the bulkhead or close at hand. A second harpoon-line, attached to the reserve or second harpoon is coiled upon the other side.

The structure above described is usually called a "rest," though not infrequently the "pulpit." Captain Benjamin Ashby always called it the "oresembo." I was unable to obtain from him any derivation of this remarkable word. He informed me that he had always used this name because the thing looked to him as if it ought to be called by that name, and that he had never heard anyone else call it so except the members of his own crew, who had learned the word from him. This is a curious illustration of the arbitrary manner in which fishermen are accustomed to coin names for new articles of apparatus. Although many archaic and provincial terms whose etymology is plainly traceable are in use among our seafaring men, there are numerous others for whose meaning and origin it would be vain to search.

I have been unable to learn when and by whom this peculiar piece of apparatus was devised.

MANNER OF CAPTURE.

The swordfish never comes to the surface except in moderate, smooth weather. A vessel cruising in search of them proceeds to the fishing ground and cruises hither and thither wherever the abundance of small fish indicates that they ought to be found. Vessels which are met are hailed, and asked whether any swordfish have been seen, and if tidings are thus obtained, the ship's course is at once laid for the locality where they were last noticed. A man is always stationed at the masthead, where, with the keen eye which practice has given him, he can easily descry the tell-tale dorsal fins at a distance of two or three miles. When a fish has once been sighted the watch "sings out," and the vessel is steered directly towards it. The skipper takes his place in the "pulpit," holding the pole in both hands by the small end, and directing the man at the wheel by voice and gesture how to steer. There is no difficulty in approaching the fish with a large vessel, although, as has already been remarked,

they will not allow a small boat to come near them. The vessel plows and swashes through the water, plunging the bowsprit through the waves, without exciting their fears. Noises frighten them and drive them down. Although there would be no difficulty in bringing the end of the bowsprit directly over the fish, a skillful harpooner never waits for this. When the fish is from six to ten feet in front of the vessel it is struck. The harpoon is never thrown, the pole being too long. The strong arm of the harpooner punches the dart into the back of the fish, right at the side of the high dorsal fin, and the pole is withdrawn and fastened again to its place. When the dart has been fastened to the fish, the line is allowed to run out as far as the fish will carry it, and is then passed in a small boat which is towed at the stern. Two men jump into this, and pulling in upon the line until the fish is brought in alongside; it is then killed with a whale lance or a whale spade, which is stuck into the gills.

The fish having been killed, it is lifted upon the deck by a purchase tackle of two double blocks rigged in the shrouds.

The fishermen have a theory to the effect that the swordfish can see nothing directly in front of him on account of the peculiar location of the eyes, and there are instances of their having been approached and killed by men in a skillfully managed dory.

THE PERILS AND THE ROMANCE OF SWORDFISHING.

The pursuit of the swordfish is much more exciting than ordinary fishing, for it resembles the hunting of large animals upon the land, and partakes more of the nature of the chase. There is no slow and careful baiting and patient waiting, and no disappointment caused by the accidental capture of worthless "bait-stealers." The game is seen and followed and outwitted by wary tactics, and killed by strength of arm and skill. The swordfish is a powerful antagonist sometimes, and sends his pursuers' vessel into harbor leaking, and almost sinking, from injuries which he has inflicted. I have known a vessel to be struck by wounded swordfish as many as twenty times in one season. There is even the spice of personal danger to give savor to the chase, for the men are occasionally injured by the infuriated fish. One of Captain Ashby's crew was severely wounded by a sword-

fish which thrust its beak through the oak floor of a boat on which he was standing, and penetrated about two inches in his naked heel. The strange fascination draws men to this pursuit when they have once learned its charm. An old swordfisherman, who has followed the pursuit for twenty years, told me that when he was on the cruising ground he fished all night in his dreams, and that many a time he has bruised his hands and rubbed the skin off his knuckles by striking them against the ceiling of his bunk when he raised his arms to thrust the harpoon into visionary monster swordfishes.

A LANDSMAN'S DESCRIPTION OF SWORDFISHING.

Mr. C. F. Holder, of New York, published in *Forest and Stream*, February 17th, 1876, the following description of a trip after swordfish in Block Island sound:

"Lying all night in the harbor of Wood's Holl, we had ample time to prepare for sport, and at three o'clock in the morning our little sloop was swinging around, and, gathering herself together, headed for Gay Head. The vessel was a common sloop of about sixty tons, its only peculiarity being a stanchion, with a curved top, to hold the harpooner, rigged on the extreme end of the bowsprit. At nine o'clock we were out of sight of the Vineyard. The wind settling, I was informed that I could go aloft and use my weather-eye, and the better I used it the more fish we would get. After not a few attempts to climb the greasy pole of a mast, I found myself aloft, with a firm grasp upon the throat of the gaff, my weather-eye, contrary to orders, full of tar, and my port on the lookout for the game. We were just moving along, and I was taking in the horizon for miles around when the man at the bow uttered a sound, which was a sort of a cross between a cluck and a groan, which I saw meant 'port,' and that something had been sighted. The old craft fell lazily away, and I then saw two dark forms, with their razor-like fins out of the water, slowly moving along ahead of us. The captain signaled at once for me to come down, and as I reached the deck the fun commenced. The man waited until we were almost upon them, and as one of them turned, as if in idle curiosity to see what the great shadow meant, he hurled a spear, and the

next moment the huge fish sprang from the water, and with a furious twist tried to shake out the iron. So great was the effort that it fell on its side with a crash, and for a moment was still, but it was only for a second, the line jumped into activity and rushed out so you could not follow it, now swaying to and fro, making the water fly like rain. About fifty feet of line had gone out when six of us managed to get a fair hold on the line, and attempted to try our strength. If six individuals were ever jerked around in a more vivacious manner, they have my utmost sympathies. Now the swordfish would land us altogether in a heap, then slacken up and take us unawares, throwing us to the deck with a force that fully came up to my preconceived ideas of the sport. He would undoubtedly have dragged us all overboard if the rope had not been sure and fast. This sort of *fun* was kept up for about fifteen minutes, when the fish perceptibly weakened, and the long rushes to the right and the left grew feebler and feebler, until we ventured to haul in. At last we had the brute alongside. A rope was rigged from the peak and fastened around the long sword, and the monster was rolled on board the sloop. We measured our game, which was nine feet, six inches long. Though I have frequently caught sharks which measured thirteen feet, I never saw any that showed near the strength of this peculiar creature.

"We cruised all day in the vicinity, and succeeded in capturing three more, varying in length from six to nine feet, and as we returned to Wood's Holl I felt that I had well earned my experience."

THE CAPTURE OF SWORDFISH BY HOOK AND LINE.

One or two instances are on record of the capture of swordfish upon an ordinary hand-line, and it is probable that this is much more common than has been usually supposed. Captain George H. Martin, of Gloucester, informed me that he had seen seven caught in this manner in one day in the South Channel. They were caught in water fifteen to twenty-five fathoms deep, on the old-fashioned George's cod-hook, with a six-inch shank. Mackerel were used for bait; these were split down the tail so that the shank of the hook could be entirely hidden in the gash.

I have been told that they are also taken in this way about Block Island, and a similar method of fishing is described by Italian writers.

Within the past three years it has not been unusual for swordfish to become entangled in the long lines of the halibut fishermen on the northern banks. The manner in which this occurs has already been discussed above.

I have collected several instances. In 1877, in the month of August, Captain Daniel O'Brien of the schooner Ossipee, of Gloucester, fishing in two hundred fathoms of water, between Le Have and Western Bank, caught, in one voyage, five swordfish.

At about the same time Captain R. L. Morrison, of the schooner Laura Nelson, fishing in 275 fathoms, on Sable Island Bank, caught three swordfish. Another vessel in August, 1877, fishing on Le Have, in from 175 to 180 fathoms, caught twelve, as well as three or four more in September. August 17th, 1878, Captain Joseph W. Collins, of the schooner Marion, fishing in the southwest prong of Banquereau, in two hundred fathoms of water, caught one swordfish; again, on October 1st, fishing southeast of Sable Island, in 175 fathoms, caught one swordfish on his trawl, and saw several others swimming at the surface; October 8th, caught another on Banquereau, in the locality first mentioned. In August, 1878, Captain Greenleaf, of the schooner Chester R. Lawrence, of Gloucester, fishing in 140 fathoms, caught thirteen in one trip. I cannot learn that this manner of capture was ever known before 1876, but it has since become so frequent that it excites no remark for a halibut-catcher to unload several swordfish among its halibut. This manner of taking the swordfish is, of course, purely accidental, and is rather a vexation than otherwise to the fishermen. It is probable that the fish take the bait when the line is being set, and they are swimming near the surface, and they are involuntarily carried down by its great weight.

The vessels engaged in swordfishing are sloops and small schooners of generally less than fifty tons. The crew is also small, consisting of two or sometimes three men besides the cook and a boy. Although many vessels are employed in this

fishery for several successive years, there are many others which fit out for a single season or for a part of a season. Others, on the south coast of New England, divide their time between fishing for seabass and hunting for swordfish, all warm and quiet days being devoted to the latter pursuit. Six or eight vessels from New London are thus employed, as well as others from Noank and Bridgeport. On the coast of Maine, as has already been mentioned, many of the smaller fishing vessels fitted for the capture of mackerel and cod, devote a part of the season to swordfishing. Other vessels, among them occasionally a gentleman's yacht, enter the field for a cruise or two in the course of a summer. To do this is a favorite recreation for old swordfishermen engaged in other work. Numerous mackerel schooners carry the swordfish "pulpit" on their bows, and so do various coasters and packets.

It has therefore not been thought desirable to attempt to make a list of the vessels engaged in the swordfishery, or even an exact enumeration of them. In 1879 estimates by careful men engaged in the business fixed the number belonging in different ports as follows:

New York (hailing from New London)	2
Greenport (sloops)	2
New London	8
Newport	1
Fall River	2
Cuttyhunk	2
Westport	2
New Bedford	13
Dartmouth	2
South side of Cape Cod	5
Total	40

In 1874, according to Mr. Thompson, New Bedford had twelve vessels in this fishery. In 1877 the estimates of total number of vessels made by different men varied between thirty and forty.

To show how uncertain the continuance of vessels in this fishery may be, I will refer to the annals of Gloucester. In 1876, one schooner, the Meteor, was engaged; in 1877, the schooner

Champion; in 1878, the schooner Northern Eagle; while in 1879 and 1880 the field is abandoned by this port.

FINANCIAL PROFITS TO FISHERMEN.

I have before me the record of a single schooner for the season of 1878, from which it appears that in the season of four months eight trips were made, averaging about twelve days in continuance. One hundred and sixty-three fish were taken between June 8th and September 20th, weighing in the aggregate, in round numbers, about 47,000 pounds, dressed. These were sold at an average price of three cents per pound. The gross stock of the season would amount to about $1,300. From this must be deducted the expense of living, the interest on capital invested, and the wages of the cook and the boy. The remainder would probably not exceed eight or nine hundred dollars, and the profits have to be divided among the two or three men composing the crew and the owner of the vessel. It is not probable that many vessels stock as large a proportionate amount as did the Northern Eagle. The success of one New Bedford vessel in the season of 1878 was spoken of as extraordinary, the return being $311 to each of the crew's share.

The price of swordfish is low, and the success of the voyage is always somewhat precarious. A few small vessels with experienced skippers apparently succeed in making a fair living, but that the profits are not great is clearly indicated by the fact that there is no great increase in the number of vessels engaged, and that so many are constantly undertaking and abandoning the swordfishery.

HISTORY OF THE AMERICAN SWORDFISHERY.

There are few data on which to found conjecture as to the time when the swordfish came to be regarded as sufficiently useful to be sought for by fishermen. One of the earliest records of its use for food is found in the Barnstable *Patriot*, of June 30th, 1841, in which it is stated that the fishermen of the island south of Cape Cod take a considerable number of these fish every year by harpooning them, and that about two hundred pounds a year are pickled and salted at Martha's Vineyard.

Captain Atwood remembers seeing swordfish on the coast of Maine as early as 1826, although up to the time of his retirement from active participation in the fisheries, in 1867, no effort was made by the fishermen north of Cape Cod to capture them.

The fishery apparently sprang into existence and importance between the years 1840 and 1855, upon the south coast of New England. Captain Ashby first engaged in it in 1859, when it was apparently a well-established industry. In 1861 it is reported that some thirty vessels in New Bedford were profitably engaged in this business on the favorite ground, fifteen to twenty miles southeast of Noman's Land.*

Mr. Earll ascertained that little attention was paid by the fishermen of Portland, Me., to swordfish until within two or three years. This fishery is carried on at odd times by mackerel gill-net fishermen, and by cod-trawling vessels when their regular industry is interfered with by the abundance of dogfish. The season for dogfish is also the time for swordfish, and at the present time, when the price of swordfish justifies it, smaller fishermen, when they are driven from their regular work by the dogfish, make trips for the express purpose of capturing swordfish. Mackerel-seiners are beginning to carry swordfish irons, and are often very successful in killing the fish.

At the present day, and for five or six years past, perhaps much longer, there has been very little change in the number of vessels engaged, this varying from thirty to forty approximately in different years.

Captain Epas W. Merchant, of Gloucester, who has been familiar with the fisheries since 1804, tells me that the first swordfish ever brought to Gloucester within his recollection, was caught on George's Bank about the year 1831, by Captain Pugh, who brought it in and sold it at the rate of eight dollars a barrel,

* Swordfish have been taken this season in large numbers. New Bedford vessels have made a good thing in them. Few of the boats failed to take one or two daily. Captain Cobb, of the pilot boat Vision, in a day and a half took nine, the largest weighing four hundred pounds. Thirty vessels are fifteen miles south and east from Noman's Land, or sixty miles out from New Bedford, and same distance from Nantucket. The season extends from June to September. The fish generally weigh four hundred or five hundred pounds, and are from ten to twelve feet long. They are sold in New York. After a fish is harpooned it scuds away, with a coil of rope paying out, and sometimes an hour is used before he is brought on board. —*Barnstable Patriot*, *August 20th*, 1861.

salted. Fishermen had before that been very much afraid of them, but afterwards a good many were caught.

THE CAPTURE OF THE SWORDFISH IN THE MEDITERRANEAN.

M. Victor Meunier, in his treatise "Les Grandes Peches," p. 141, describes the various methods formerly and at present in use in the fisheries in the Mediterranean. The Greeks were accustomed to use boats with projecting bows, modeled to resemble a swordfish, and painted with its peculiar colors. This the unsuspecting fish would approach, thinking to meet one of its own kind. The fishermen, taking advantage of the mistake, would pierce it through and through with their lances. Although surprised, the swordfish would defend itself with vigor, striking the treacherous boat with its sword and endangering its safety, while the fishermen strove to seize it by the head and, if possible, to cut off its sword. Having overcome their captive, they would fasten it behind their boat and carry it ashore. Oppian compared this method of fishing to a military strategem. This ruse was known also to the Romans, and in their time the swordfishery was one of the most important. They also captured these fish in *madragues*, in which they were easily entangled while pursuing tunnies and other fishes of the mackerel tribe. "Although he is able to break the nets," said Oppian, "he shrinks from it; he fears some snare, and his timidity counsels him ill; he ends by remaining a prisoner within the ring of the net, and becomes the prey of the fishermen, who with united effort drag him to the shore." This does not always occur, to be sure, for often, to the grief of his would-be captors, he breaks the walls of his sepulcher, liberating also the other fishes buried with him.

There is at the present day a fishery in the Straits of Messina, continuing on the Calabrian shore from the middle of April to the latter part of June; on the Sicilian shore from the first of July to the end of September. The Calabrian fish appear to approach by the Pharos, the Sicilian ones by the southern entrance of the straits. This summer fishery has for its object the capture of the large fish, which are killed with a lance. The boats used are about eighteen feet long, four feet deep, and

broader at the stern than at the bow. There is a single mast, seventeen feet high, surmounted by a brace of a curved form, intended to support the lookout, who gains access to it by steps fastened to the mast. The lookout from this elevated station views the movements of the fish, and by voice or gesture directs the movements of the oarsmen. At the proper time he descends, and standing on a narrow thwart amidships he aids the waist oarsmen and performs the office of steersman.

At the bow stands the man who strikes the fish. His lance is about twelve feet long, with an iron head, which, from the vague description of Meunier, appears to resemble closely the American lily-iron. This is detachable, and to it is fastened a line as thick as one's little finger and six hundred feet long (two hundred meters).

Two guards are also stationed on the shore. On the Calabrian coast they climb upon high rocks and cliffs; on the opposite shore, where there are none, they stand on a tower, built expressly for this purpose, about eight hundred feet in height.

"Everything being arranged," says Spallanzani, "behold the order of the fishery. When the two watchmen perched upon the tops of the rocks or of the mast judge that a swordfish approaches from afar, by the change in the color of the water, at the surface of which he swims, they signal with the hand to the fishermen, who row toward it with their boats, and they do not cease to cry out and to make signs until the other lookout on the mast of the boat has perceived the fish and follows it with his eye. At the voice of the latter the boat veers now to the right, now to the left, until the lancer, standing at the bow, weapon in hand, catches sight of the fish. Now the lookout descends from his mast, stations himself among the oarsmen, and directs their movements in accordance with signals given him by the lancer; he seizing a favorable opportunity, strikes the fish, often at the distance of ten feet. Immediately he slackens out the rope, which he holds in his hands, while the boat, with the force of all its oars, follows the wounded fish until he has expended all his strength. Then he rises to the surface; the fishermen, approaching, fasten to him with an iron hook and carry him to the shore. Sometimes the fish, furious from his wound, strikes the boat and

pierces it with his sword, so the fishermen stand on their guard, especially if the animal is large and active.

The young fish are captured in nets about three hundred feet long, called *palimadaris*. These are stretched between two boats with lateen sails, moving along, entangling in their meshes everything which they touch. Spallanzani protested vehemently against this fishery. It is carried on from October to March.

Oppian describes a method of capture used in the Mediterranean. A bait was fastened with a sliding noose to the line at a distance above the naked hook, and the whole was so contrived that when the swordfish seized the bait with its mouth the hook seized it from behind with great force. This story is declared by writers of the present day to have been fanciful and without foundation.

I am indebted to Mr. Frederick W. True for the following translation from Prof. Adolfo Targioni Tozetti's essay on "The Fisheries of Italy," published in 1870,* which gives briefly a description of the methods now employed in the vicinity of Messina and elsewhere on the Italian coast :†

"Swordfish are taken from time to time, together with the tunnies, in the *tonnare* ;‡ but hook-and-line and gill-net fisheries are also carried on, the methods of which we may describe somewhat at length.

"Two very distinct fisherises are prosecuted—one by day, the other by night. The former is carried on by means of peculiarly constructed nets called *palamitare* ; the latter by the use of harpoons, or *draffniere*, as they are called. The harpoon fishery is prosecuted in the Straits of Messina, on the coasts of Calabria and Sicily, and among the Eolian Islands.

"The fish appear earliest along the coasts of Calabria, between Givia, Tauro, Palmi, Bagnara, and Scilla, and hence it is in these

* La Pesca nei Mari d'Italia e la Pesca all'Estro Esercitata do Italiani. <Catalogo degli Espositori e delle core esposte Sizione Italiana, Esposizione Internazioneale di Pesce in Berlino. 1880, Firenze Spamperia Reale, 1880, pp. xv-cxxxvi.

Swordfish Fishery—Pesca della Pesce spada, pp, lxix-lxxiii.

† The author states that the material for the following article is derived from the writing of Duhamel, Oppian, Spallanzani and Vetrioli.

‡ A kind of pound net constructed for the capture of tunnies or horse mackerel (*Orcynus thynnus*).

localities that the fishery first begins. It is prosecuted later in the season on the Sicilian coast, between S. Teresa al Faro, Gazzi, Salvatore del Greci, and Capo Palero.

"The net fishery on the Calabrian coast is carried on most extensively between Palmi and Scilla, the harpoon fishery between Palmi and Capo delle Volpi. On the Sicillian coast nets are principally between S. Teresa and Gazzi, but between Salvatore die Greci and Capo Pelero, where the management of nets would be very difficult on account of the deep water and rapid currents, the harpoon fishery prevails.

"The season of the regular fishery in Calabria extends from the middle of April to the end of June, and in Sicily from the middle of July to the middle of August. The capture of young swordfish, however, continues to increase long after this time, the season often extending to the middle of October. Fish weighing little more than a single kilogram are frequently taken, and the practice, therefore, has been strongly censured. In the latter part of October both adult and young fish disappear, retreating, as many suppose, to the depths of the ocean. They reappear in spring, prior to spawning time, and remain on the fishing grounds throughout the entire season.

"Fisheries are also carried on, but with more or less irregularity, among the Liparian Islands, near Tropea, in Calabria, in the tunny-nets of Nulazzo, Alliveri and S. Giorgio, near Patti, and in the waters of Sardinia.

"The fishery on the Sicilian and Calabrian coasts is prosecuted at certain fixed stations. At some of the stations, such as station 25, in Calabria, net and harpoon are carried on with equal success; but at others, as for instance at station 21, in Sicily, only the harpoon fishery can be prosecuted, and at others, again, as at station 20, the net fishery alone prospers.

"The stations are occupied by the gangs (*poste*) of fishermen. The conformation of some portions of the coast of Calabria is such that the day fishery with nets cannot be carried on, and at these points each gang comprises two boats, or feluccase, of from ten to sixteen tons, two skiffs for each felucca, and one additional skiff used in carrying on communication between the boats.

"The *Palamitara* is set from time to time, and at each station is fitted up in the manner deemed most suitable by the fishermen. It is made of strong hemp twine, and is hung to two ropes, the upper being buoyed by cork floats, and the lower weighted with leads. The length of the net varies between six hundred and eight hundred meters, the breadth is sixteen meters, and the area 14,000 to 15,000 meters, more or less, according to the depth of water, which on these coasts varies between forty and six hundred meters; the mesh measures about seventeen centimeters far. Each end of the upper rope is tied to a large cork buoy, to which a bell is attached, which sounds with every motion of the net.

"By these arrangements the net has sufficient play, so that it is not liable to injury by the sea. At the same time, when a fish strikes the net and is gilled, the more it struggles to get free the more it gets entangled. In the meantime the ringing of the bell gives the fishermen the signal that a fish is captured, and they hasten to free the net and set it again.

"The methods of the harpoon fishery are very different. Two watchmen are employed, one having his station on the cliffs overlooking the water, and the other at the masthead of the felucca. The mast of the felucca is usually twenty or more meters in height, and the watchman climbs to his station by means of a rope ladder. The watchman on the cliffs scans the sea far and near, and when he perceives a swordfish gives the signal to a lookout, called fariere, foriere, or foliere, standing at the masthead of some one of the boats, or *loutro*, at the station.

"The watchman indicates the movements of the fish by certain signals. For instance, he cries out '*va susu*,' meaning that the fish goes yonder, or toward Il Faro; or '*va jusu*,' he goes down, that is, toward Messina; or '*va forra*,' he goes out, or toward Levante; or sometimes '*va u'terra*,' meaning that the fish is swimming toward the shore.

"The lookout, at first obeying these signals, and then relying on his own observations, guides the *loutro* toward the fish. When the boat has approached sufficiently near, the harpooner strikes the fish with his *draffiniera*, or harpoon.

"The *draffiniera* consists of a wooden staff twelve feet long,

furnished with an iron seven inches in length. The iron has two wings, and is constructed in such a manner that when it strikes the fish the point enters the flesh and the wings spread in the wound.* A rope, or *protese*, often six hundred feet or more in length, is fastened to the harpoon head, so that it may be recovered when the fish, weakened by loss of blood, is captured and brought into the boat.

"A short warp is tied to the staff of the harpoon, by which when the head is detached it is brought back into the boat. After the fish is struck, the *loutro* puts back to the station, leaving the chase and capture of the wounded fish to a second boat. Usually he is easily captured, but sometimes by dashing against the boat or by other movements he manages to free himself and make his escape.

"A fishery very similar to that carried on at the present time was described by Polibius, according to Strabo, more than two thousand years ago. The account of the fishery at Messina given by Oppian† is somewhat fanciful and inaccurate, but in the last century Spallanzani gave a more strictly technical description of it.‡ Recently the fishery has been accurately described in elegant Latin verse by Vetrioli.§

THE CAPTURE OF THE SWORDFISH IN THE MEDITERRANEAN.

"The following table gives the number of fishermen, and boats, engaged in the swordfish fishery on the Sicilian and Calabrian coasts :

1. *The Harpoon Fishery.*,

	Calabria.	Sicily.
Large boats (or feluche)..	6	52
Small boats (loutri).....	26	52
Small boats (barche).....	...	52
Fishermen,.....	275	384

* This iron resembles closely the American lily-iron.

† Oppiano, Della Pesca, lib. iii.

‡ Spallanzani, Niaggi alle due Sicillie ecc. vol. iv., p. 308, et seq.

§ Vetrioli, Xiphias Carmen, Naples, 1870.

2. *The Gillnet Fishery.*

	Calabria.	Sicily.
Boats of three tons burden	80–90	50
Fishermen	650	400

"The fishery is extremely productive. On the coasts of Sicily a gang of fishermen frequently capture fifty fish, each weighing from one hundred to two hundred kilograms, in a single day, and on the Calabrian coast twenty fish.

"The following table shows the average annual catch in Sicily and Calabria:

1. *The Harpoon Fishery.*

	Kilograms.
On the Calabrian coast	60,000
On the Sicilian coast	40,000

2. *The Gillnet Fishery.*

On the Calabrian coast	25,000
On the Sicilian coast	15,000

"The products of the fishery are consumed principally in Sicily and on the mainland of Italy. A portion, however, is preserved in salt or oil, and sometimes exported. The flesh of the swordfish is excellent when fresh, and is not so liable to become soft when canned as that of the tunny or horse-mackerel. It therefore always commands a high price.

"It has been claimed that, in order to prevent a decline in the fishery, hook-fishing should be prohibited from the middle of January to the first of April, and that a fine should be imposed on those who capture the young fish. It has been suggested, also, that no nets should be allowed to be set in the Straits of Messina within two hundred meters from the shore.

"The result of the experiments in artificial hatching of swordfish in certain enclosures and marshes in the vicinity of Il Faro appears to be somewhat uncertain; but, at all events, they may open the way for more practical and successful operations in the future."

RECORD OF A GLOUCESTER SCHOONER FOR THE SEASON OF 1878.

As an example of the manner in which a season of swordfishing is passed, and of the yield of a very successful period of

work, a record is here given of the trips of the schooner Northern Eagle, of Gloucester, Capt. George H. Martin.

TRIPS OF NORTHERN EAGLE, CAPT. GEORGE H. MARTIN.

No. of trips.	Date of start.	Length of trip. Days.	No. of fish taken.	Where sold.	Price. Cents.
1	June 7... ..	10	16 (5,000 lbs.)	Boston. ...	3
2	June 19.....	7	22 (6,600 lbs.)	do.	4½
3	June 30	14	12 (3,700 lbs.)	Newport...	2½
4	July 12.....	11	20 (5,800 lbs.)	Boston	3
5	July 27.....	18	37 (9,000 lbs.)	do.	5
6	August 15...	15	26 (6,500 lbs.)	do.	3
7	Sept. 1... .	16	16 (5,600 lbs.)	do.	(2)
8	Sept. 20.....	14	14 (4,500 lbs.)	do.	(3)
			163 (46,700 lbs.)		

RESULTS OF TRIPS BY OTHER VESSELS.

Capt. Benjamin Ashby went swordfishing in the schooner N. H. Dudley two successive years, in 1859 and 1860. In July and August, 1859, he took one hundred and eight fish ; the next year eighty-eight.

The schooner Yankee Bird, of New Bedford, boarded in Provincetown Harbor, August, 1879, had already that season taken sixty fish.

Mr. Earll reached Portland in the progress of the fishery census investigation, July 29th, 1880. On this day, he writes, thirty-five to forty fish were brought in, and on the first of August two hundred more were landed, sixty by one vessel.

STATISTICS OF CAPTURE.

It is at present only possible to give estimated statistics of capture, though a year hence, when the returns of the fishery census, now in progress, shall have been tabulated, much more accurate figures will be attainable. Putting the number of vessels regularly employed in swordfishing at forty, estimating their annual catch at eighty fish each, which is only half the quantity taken by the Northern Eagle, as shown in the preced-

ing paragraph, the aggregate number of fish taken would be three thousand two hundred.

Competent authorities estimate that each vessel in the mackerel fleet captures and brings in an average quantity of eight barrels of pickled fish, or perhaps eight fish each. The number of vessels in the mackerel fleet is at least four hundred. Allowing four fish to each there is an aggregate of 1,600 fish. Estimating one for each vessel in the halibut fleet yearly, we add fifty more in the aggregate.

Mr. Earll judged that in 1878, as for several years previous, two thousand swordfish had been brought into Portland, Me. Allowing one thousand of these to the regular swordfishermen and the mackerel vessels, we have a remainder of one thousand taken by the occasional fishermen of Portland already spoken of, and to be added to the aggregate, which now amounts to five thousand eight hundred and fifty.

Add one hundred and fifty more for the coasters, seabass fishermen, and pound-tending vessels of southern Massachusetts, Rhode Island, and Connecticut, and the sum is 6,000.

The average weight of a swordfish dressed is estimated by several persons, Captain Ashby, Mr. Earll, Mr. Thompson, and others, to be three hundred pounds, and that this is not far from the truth may be seen by referring back to the records of the Northern Eagle. If the average weight is assumed to be two hundred and fifty pounds, the aggregate weight of a year's catch of swordfish amounts to 1,500,000 pounds, valued at $45,000, the average price being estimated at three cents per pound.

To estimate the number of men employed is almost impossible, since the season continues only four months, and many are employed for a much shorter period. The crews of the forty vessels number from one hundred and sixty to two hundred; the number of men employed for shorter periods it seems scarcely necessary to estimate.

In 1874 the annual catch for the United States was estimated by Mr. E. G. Blackford at 2,000 fish, weighing 1;000,000 pounds.

SWORDFISH AS AN ARTICLE OF FOOD.

"The small swordfish is very good meat," remarked Josselyn,

in writing of the fishes of New England in the seventeenth century. Since Josselyn probably never saw a young swordfish, unless at some time he had visited the Mediterranean, it is fair to suppose that his information was derived from some Italian writer.

It is, however, a fact that the flesh of the swordfish, though somewhat oily, is a very acceptable article of food. Its texture is coarse; the thick, fleshy, muscular layers cause it to resemble that of the halibut in consistency. Its flavor is by many considered fine, and is not unlike that of the bluefish. Its color is gray. The meat of the young fish is highly prized on the Mediterranean, and is said to be perfectly white, compact, and of delicate flavor.* Swordfish are usually cut up into steaks, thick slices across the body, and may be broiled or boiled.

Considerable quantities of swordfish are annually salted in barrels in Portland, Gloucester, Boston, New Bedford, and New London. Swordfish pickled in brine is in considerable demand in certain sections of the country, and particularly in the Lower Connecticut Valley, where a barrel may be found in almost every grocery store. By many persons it is considered much more palatable than salted mackerel.

MARKETS.

Mr. Thompson remarks: "Previous to 1862 the market for fresh fish was limited to New Bedford, Fall River, Providence, and the adjoining towns, and a large proportion of the fish then taken was salted and shipped to the West Indies and the Southern States. This was especially the case with those taken about Noman's Land and Martha's Vineyard. Now nearly all are consumed fresh, and the average price is somewhat higher than formerly."

The Gloucester *Telegraph* of September, 1850, contained the following item, which shows that swordfish were eaten in Boston at least thirty years ago, and highly esteemed:

* The flesh, which is much esteemed by the better classes at Palerma, is dressed in almost as many modes as that of the tunny, and fetches a higher price. During our sojourn there it was as two to one. The fiber is invitingly white, and the round segments look, as they lie in rows along the stall, like so many fillets of veal. Four to six felt is the usual run of those taken off the Trinærian coast and displayed in the fish markets of Sicily.—*Badham.*

"A swordfish weighing about two hundred and fifty pounds was caught near our cape on Tuesday. It was taken to Boston and retailed out from Quincy Market, by Messrs. Covill, at 12½ cents per pound. The sword, measuring from the eye to the tip, is thirty-seven inches in length."*

Mr. John H. Thompson writes: "At present the great bulk of the catch is sold fresh. Most of the fish are brought to this port, and a few are carried to New London. Until within a *very* few years nearly all were disposed of in this vicinity. About 1864 a few were sent to Boston on trial, and the consumption of swordfish in that vicinity has since rapidly increased. Still, the principal market for fresh swordfish may be said to lie between New London and the eastern end of Massachusetts. Providence, R. I., consumes a large quantity."

Mr. Earll writes· "About 2,000 swordfish, averaging in weight three hundred pounds dressed, have been landed yearly in Portland for several years. Most of them are sent to Boston fresh, and the remainder are cut up and salted here."

Mr. Eugene G. Blackford informs me that the swordfish are not much esteemed in New York market, and that in 1874 not more than 2,000 pounds in the aggregate were consumed.

PRICES.

Regarding the price of fresh fish at New Bedford, Mr. Thompson remarks: "When the fish arrives here it is eagerly sought at twenty cents a pound, retail. In 1873, within forty-eight hours of the arrival of the first one, fifty-two were brought in, bringing the general retail price down to eight and ten cents. At this price, clear of bone, they are usually retailed throughout the season. The wholesale price is about twelve cents for the first catch falling rapidly to two or three cents. This is for 'clean fish,' without head, tail, and viscera. Fish from George's Bank are sometimes brought here from Boston. They then retail at fifteen and twenty cents."

According to the record of the Northern Eagle, the price in June, 1878, ranged from two to four and a half cents, in July

* A swordfish weighing over seven hundred pounds was one of the sensations at Faneuil Hall Market last week.—*Gloucester Telegraph*, *August* 13th, 1870.

from three to five cents and in August from two and a half to three.

In July, 1879, Mr. Earll found the price in Portland, Me., four cents, but the arrival of two hundred fish on August 1st brought the price down to one and a quarter cents. He estimates the average wholesale price at two cents.

In New London, according to Captain Ashby, the price has varied within his recollection from three to eight cents, the latter high price being paid in 1877.

According to Captain Martin, the price of salt swordfish in Gloucester is always about the same as that of No. 3 mackerel. In July, 1878, there being no mackerel in the market, they were valued at seven dollars a barrel.

TREASURER'S REPORT.

Dr. *American Fish Cultural Association in account with Eugene G. Blackford, Treasurer.* **Cr.**

To Membership dues since last report, -	$164 00	1881. By balance as per last report, -	$ 26 73
		April 1st, " Cash paid messenger, -	2 10
		" 21st, " " " for chair hire, -	5 00
		May 4th, " " " " 2 zinc signs,	4 50
		" 26th, " " " J. M. Davis, for printing, - -	15 00
		1882.	
		March 2d, " " " J. M. Davis, for printing reports,	161 68
		April 3d, " " " J. Partridge, for chair hire, - -	6 25
			$221 26
		By balance due Treasurer, -	57 26
	$164 00		$164 00

New York, April 3d, 1882.

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TRANSACTIONS

—OF THE—

AMERICAN FISH-CULTURAL ASSOCIATION.

TWELFTH ANNUAL MEETING,

HELD AT COOPER INSTITUTE, IN THE CITY OF NEW YORK.

June 6th and 7th, 1883.

NEW YORK.

1883.

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TWELFTH ANNUAL MEETING

OF THE

Fish-Cultural Association.

FIRST DAY.

The Annual Meeting of the Association was held in the Farmers' Club rooms of the Cooper Institute, New York, on Wednesday and Thursday, June 6th and 7th, President Page in the chair. On opening, the President said:

"A year has rolled round since our last meeting, and there are evidences on every hand that the good work is progressing. It can be said with truth that, since the beginning of fish-culture in the United States, there is no other branch of industry that has made such progress. It has spread from Maine to California, and from Minnesota to Texas, until nearly every State and Territory has its Fish Commission, and most of them have an appropriation to work with. These funds have been put in the hands of Commissioners, who give their time and energies to the work, and but few receive any compensation for it other than the knowledge that they are doing good to their fellow men. It will be needless for me to go into detail in this matter, for I see before me men who have for years carried on the work in its broadest form for the National Government, and who are familiar not only with the work which they have been engaged in, but are also familiar with the whole literature of the subject, and know what fish-culturists in other lands have done. I might, however, be permitted to refer to the efforts in stocking waters heretofore unknown to the black bass, which has come to be known as the American game fish. In the West and in the

South it is found in the creels of the angler and on the slabs in the markets. They are now so abundant in Maine and the New England States, where they were unknown a few years ago, that they can be bought in the markets at a price within the reach of the poor man.

"Coming recently from the interior, I had an opportunity of examining the markets in St. Joseph, Mo., and found among the marketmen frequent acknowledgements of the work of fish-culturists, and of the teachings of this Association, and a thorough knowledge of the fact that, if the bass are protected in the spawning season, they become, like the commoner fishes, plentiful everywhere, and tend to lower the price of other fishes.

"We who live on the shad rivers, mark the manner in which the supply is kept up, in spite of the increasing demands of a growing population. Col. McDonald now has one hundred thousand shad eggs in process of hatching at Mr. Blackford's in Fulton Market, which he brought on from Washington to show the process. After they are hatched, they will be taken charge of by Mr. Mather, of the New York Fish Commission, and deposited in the Hudson, near Troy, where Prof. Baird sent a car load of one million a fortnight ago.

"Pardon me for relating a bit of my personal experience abroad: Happening in London at the inception of the plans of the Fisheries' Exhibition, now in progress there, I met many of the officials conected with it. At that time it was not known that our Government would make a display, and by request, as there was only three days before the passage of the yearly appropriation bill, I cabled to Senator Frye, of Maine, on the subject, and also sent a duplicate message to Prof. Baird. At this time there were many bills trembling in the balance, yet in two days an appropriation was introduced into both Houses, and was signed by the President. Our exhibit at London is a most creditable one, and it is generally acknowledged that no nation shows so favorably. Another fact: Making the acquaintance of Sir James Maitland, of Stirling, near Edinburgh, I found that within seven years he had achieved great results in fish-culture. He had hatched 997 trout out of 1,000 eggs, all alone, without assistance from any of his men. His extensive ponds have cost sixty

thousand dollars, and he has made fish-culture a success in Scotland. Up to April, of this year, he has sold ten thousand dollars' worth of young trout and salmon, and his example has been largely followed in England, Ireland and Scotland."

The Secretary then read the report of last meeting, and the following new members were proposed: W. H. Schieffelin, Frank D. Butler, and Col. M. A. Bryson.

A FEW FACTS IN RELATION TO THE FOOD AND SPAWNING SEASONS OF FISHES ON THE ATLANTIC COAST.

BY E. G. BLACKFORD.

For a number of years past at the meetings of this Association, inquiries have come up as to the time or season of the spawning of striped bass, sheepshead, and bluefish, but no one was able to answer these questions with any accuracy, and the amount of knowledge on this important subject was apparently very limited.

During the summer of 1882, the Senate Sub-committee on Foreign Relations visited several fishing points on the coast, for the purpose of taking evidence from the fishermen, dealers and others, as to the food and habits of the menhaden, and also as to the fact that this fish formed one of the principal sources of food for the bass, bluefish, and other valuable fishes of our coast. The results of this inquiry conclusively proved that no accurate information could be obtained upon which to base any national legislation for the protection of the salt-water fisheries.

At the suggestion of Prof. Spencer F. Baird, I determined to avail myself of the facilities afforded by Fulton Market to begin a careful examination of the viscera of all the important fishes that came through my market. My numerous business engagements precluded my giving personal attention to this important work, and I was fortunate enough to obtain the assistance of

Prof. H. J. Rice, a gentleman who is peculiarly well qualified to make these investigations, and have now his report on the subject brought down to this date. It is proposed to continue these investigations for at least two years, and longer if it should be deemed important.

BROOKLYN, June 4th, 1883.

Mr. E. G. Blackford:

DEAR SIR.—I beg leave to report to you as follows in regard to the work which I have been carrying on under your direction during the past few months, in the line of ascertaining the food of the various food fishes and their time of spawning. I began operations upon the 24th day of February last, and up to the present time (June 4th) have worked upon two hundred and five (205) specimens of eighteen different species, divided as follows: 52 striped bass, 14 cod, 30 mackerel, 33 bluefish, 17 shad, 19 sea bass, 12 sheepshead, 8 porgies, 6 weakfish, 4 eels, 3 black bass, 1 smelt, 1 flounder, 1 angler fish, 1 mossbunker, 7 salmon, 1 sturgeon, and 1 moonfish.

Of the 52 striped bass 12 were males, varying in weight from 2 up to 46 lbs., and the rest were females, varying in weight from 3 up to 78 lbs. The first which I examined showed very little ripeness, and excepting a few scales, only a thick chyle-like material in the stomach; but gradually more evidences of feeding, in the shape of backbones, scales etc., presented themselves, and on the 23rd of March a fish was taken in the Chesapeake Bay weighing 66 pounds and having eight large alewives in its stomach. Since then rarely a fish has been examined that did not have in its stomach from one to seven fish in various stages of digestion. The species which I have been able to identify were alewives, eels, flounders, menhaden, and, in one instance, one of its own species. In this last case I found in the stomach of the small bass, which was about six inches long, a considerable quantity of shrimp. In only two other instances have I found any evidence that the food of the striped bass was anything but fish, and these were, first, in finding the claw of a small rock crab among some fish remains in the stomach of one of the large bass, and it may be that this claw had been swallowed by one of the fishes which the bass had swallowed, rather than by the bass itself; second, in finding two small shrimp in the stomach of a large male from Sing Sing on the Hudson. Among the males the spermaries gradually softened, until on May 11th, I found two, one of 22 and one of 26 lbs. in weight, and on the 12th one 18 lbs., which were spent. In the females the ovaries began to ripen somewhat earlier than with the males, one being taken on May 5th, off Governor's Island, weighing 46 lbs. and partially spent. Another

was taken on May 11th of 7 lbs., quite ripe, and one on May 12th of 36½ lbs., from which the ova were running. On May 22nd one of 6 lbs. was found spent, and another of 3 lbs., which showed signs of ripeness.

Of the fourteen codfish which were examined, all except two were spent fish, accordingly all investigation was directed to find out their food. The two exceptions were that on March 28th, a female thirteen pounds in weight was found with perfectly ripe ovaries, and on May 12th, one was taken in which the ovaries were quite soft and some of the ova transparent. The food of the cod is quite miscellaneous, consisting, so far as I have noticed, of various kind of fishes, such as alewives, flounders, whitebait, etc., and sea-anemones, rock-crabs, razor-shells, small shrimp, hermit crabs, sea-cucumbers or holothurians and mussels. In fact, anything that is handy may find a resting place in a cod's stomach. Of the above-mentioned fishes, the first striped bass and cod were examined on February 24th, the last cod on May 16th, the last striped bass on May 26th.

The results as obtained from examination of the rest of the fishes may be summarized somewhat briefly as follows:

March 2nd. Smelt.—Ovaries quite ripe; piece of a marine worm in stomach.

March 21st to April 27th. Eels.—3¾–5¾ pounds; ovaries quite soft; nothing in stomach.

March 24th. Flounder.—Two pounds; nothing in stomach; ovaries nearly ripe.

March 31st. Angler fish.—Yellow perch in stomach; ovaries very large and very soft.

April 14th to May 19th. Mackerel.—Up to May 4th the ovaries and spermaries gradually became softer, upon which date one nearly ripe ovary was found. On May 11th others, both ovaries and spermaries were found, and on May 19th, the last examined, one quite ripe ovary was found. The stomachs of most of the specimens examined were filled with small reddish crustacea, copepods, small shrimp, small shells, and in the last two specimens examined, the stomachs were literally packed with the ova of some other fish.

April 20th to May 16th. Shad (North River, 16).—Ovaries not examined; stomachs of part of them with small shrimp, and a few fish scales. In some, the stomachs were full of the shrimp. In one Southern and three Connecticut shad nothing in stomach.

May 4th. Menhaden.—Male; first of season, spermaries not showing very much evidence of ripeness. Stomach with decomposed material.

May 4th to May 19th. Porgies (8).—3 males, 5 females; ovaries and spermaries getting quite soft. Stomachs with gelatinous chyle-like material.

May 5th. Salmon.—Female from the Penobscot; small gammarus and some gelatinous material in stomach. Ovaries small—just beginning to develop.

May 5th. Black Bass (3).—Males; stomachs empty, spermaries getting soft.

May 11th to June 2nd. Sea-bass.—11 males, 8 females; stomachs generally with small fish; one with crab. Ovaries and spermaries of most were soft. On May 21st one male ripe and flowing; on June 22nd two ovaries nearly ripe.

May 12th. Bluefish, North Carolina (20).—Apparently all males; stomachs literally crammed with fish—small bluefish, weakfish, butterfish, kingfish, menhaden, Lafayettes and gurnards.

May 26th. Bluefish (13).—All males; spermaries small; stomachs full of half digested fish remains.

May 21st to June 2nd. Sheepshead.—6 males, 6 females; stomachs all empty, but in intestines of one remains of crabs. Spermaries and ovaries mostly somewhat soft, and one, on May 2nd, appearing spent.

May 21st to June 2nd. Weakfish (6).—5 males, one female. Three males quite ripe; female and other males nearly so. Stomachs with fish and shrimp.

May 22nd. Sturgeon, Gravesend Bay.—Female, 200 pounds; ova nearly ripe.

June 2nd. Moonfish.—Female; stomach empty, ovaries apparently just spawned.

Very respectfully,

H. J. Rice.

Mr. Blackford.—I will state that the time covered by the investigations was so short that we are not prepared to draw conclusions as to the general food of the fishes examined, but they will be continued, and next year Prof. Rice will also observe the times of spawning of the fishes. Fulton Market is probably the best place in the country to pursue these studies, as there are specimens from all parts of the coast found there.

Mr. Page.—This question of the food of our fishes is a most important one, and one in which there has been much interest taken lately on account of the discussions which have been going on in the *Forest and Stream* and other papers concerning the menhaden fisheries. It has been claimed that the capture of the menhaden for oil is depriving the striped bass and other valuable fishes of their natural food. The menhaden fishers have

denied that the striped bass eats the menhaden, but it is generally believed that they subsist largely on this fish. It is evident that the general government must investigate this question before long.

COL. MCDONALD.—I would call the attention of the Association to the following extracts from a letter from Mr. S. P. Worth, Superintendent of Fisheries of South Carolina, on the spawning of the rockfish or striped bass, in the Roanoke River. He writes under date of June 2nd, 1883, and says:

"In regard to the propagation of rock I am gratified to mention successful operations. Last year I caused an examination to be made of these fish in the market at Weldon. Eleven ripe fish were reported. Having spawned, in 1880, a fifty-seven pound fish, the eggs of which reached the number, according to my estimate, of 3,000,000, I regarded the capture of eleven ripe fish at Weldon, within a brief period, quite sufficient reason for placing spawn-takers there this season. On May 9th, with confidence, I put in position at Weldon sixty-five McDonald jars, and while there nine ripe fish were found, the weights varying from thirty-five pounds to as low as five pounds. Four of these were taken by the fishermen before the jars arrived. The spawn was taken from three afterward captured, while two other fish were unwittingly sold, their ripeness not being detected by the possessors. Six hundred and sixty-five thousand eggs were taken, impregnated and hatched. The plant was twenty thousand fish put in the Roanoke, at Weldon. I estimated the rock eggs at 20,000 to the liquid standard quart, regarding them of the approximate size of shad eggs. I observed the following points, viz., that viewed in water the yolk only can be seen; that the yolk, or embryo fish, by gravitation, always occupies the lower portion of the egg; that the egg shell contains an oil globule, which causes it to float without reversing its position; that the eggs are very oily and appear to undergo greatest loss in the progress of impregnation, suggesting that they should be taken in water; that a loss of forty per cent. took place before hatching began; that the unimpregnated egg is of a decided green color, the yolk of the impregnated egg being a paler,

though beautiful shade of green; that a glass tube filled with impregnated ova and tightly corked at either end remained over night, a period of twelve hours, at a temperature of about 65 to 70 degrees, without change of water, and that the same eggs on a tray produced fish. I was particularly struck with this. Also, that the liberated fry is about 3-16 of an inch long; that the body projects beyond the posterior end of the sac only 1-22 of the total length; that in water at 75 degrees the sac is absorbed in four days and the length of the fish is then only ¼ inch; that during the ten days' confinement in jars, in water varying from 69 to 82 degrees, the fry gained but little growth, yet considerable dark coloration, and were constantly striking, as if to feed on drifting particles; that the eyes at time of hatching, after close scrutiny with a pocket glass, revealed no pigment, even among those hatched slowly on trays. I further observed that the catch of rock at Weldon this year reached 4,500. I was told that last year five times as many were caught; that several years back as many as 300 fish of thirty pounds weight have been taken on one slide in a single day; that the numbers of the fish have steadily declined; that the river is infested with innumerable catfish, reaching to millions, the great majority, in fact, nearly all, not exceeding a hand's length."

SUNFISH: THEIR HABITS AND EXTERMINATION.

BY FRED MATHER.

A pest which the fish-culturist who has large ponds often has to contend with is the little fish, or fishes, for there are several species, which are popularly called sunfish, pondfish, pumpkinseed, etc. These fish belong to the family *Centrarchidæ*, and are closely related to the black bass, both in structure and habits, an intermediate link being found in the "red eyes," "rock bass" and the "war-mouth" of the South. Within the district east of

the Mississippi and north of North Carolina, Prof. Jordan, in his "Manual of the Vertebrates," enumerates eleven genera and twenty-six species of sunfishes, and this region would be several millions of dollars richer if there were none.

The sunfish is among the first of the scaly acquaintances made by the boyish angler in his Saturday trips to the mill-pond; and although there is a feeling of sentiment in favor of a fish that is connected with early angling, and on whose account I was many times called into the wood-shed by a stern parent to account for absences from school, I now look upon the little fish as a great nuisance. Sentiment has no place in the struggle to produce food, and the sunfish consumes a vast amount and produces nothing. It does not even furnish food to other and better fishes to any extent, for its strong spines, which are erected when in danger, make it a thorny mouthful. Even when these fins are trimmed off it is the poorest of baits, for the pike and bass know the fish by sight, and do not seem to investigate its improved condition and thus learn that the individual before them has been disarmed. There are comparatively large species, which in some waters grow to a quarter of a pound in weight; but take the fish as they run in the ponds, they seldom reach two ounces.

The food of the sunfish is worms, flies, crustaceans, fish eggs, and small fish, especially those which have soft fins, for they do not relish their own spinous relatives. Consequently they are formidable competitors for the food of the young of valuable fishes, even if they did not devour them; but when their predatory habits are added to their consumption of other food, and their fecundity is also known, they at once become recognized as among the most injurious foes to fish-culture.

My attention was strongly called to this fish this spring. Near the hatchery at Cold Spring Harbor, Long Island, of which I have had charge this year, are the mill ponds belonging to the Messrs. Jones, by whose liberality the hatchery was leased for a nominal sum to the New York Fish Commission. I had some young land-locked salmon, and Mr. Townsend Jones wished to try some of them in the lower pond, which is deep and cold, but is infested with sunfish. I recommended placing the fish in

the upper pond where the trout are more plentiful, and where the spring streams would afford food and protection to the fry, until large enough to run down into the two lower ponds. Mr. Jones feared they would interfere with the trout, and we compromised the matter by placing some in each pond. In the lower pond, where the sunfish are most plentiful, we placed 3,500 young land-locked salmon, of an inch or more in length, by setting them out in the springs bordering the pond. We watched them, and saw the sunfish waiting for those which went down into the deeper water, but could not see that any were caught. The next day Mr. Jones captured a sunfish which had thirty-five young salmon in its stomach, just one per cent. of the plant! At this rate it would only require one hundred sunfish to consume the entire lot in one day, and we estimated that there were tens of thousands of sunfish in the large pond.

About the middle of May, in this vicinity, the sunfish makes its nest near the shores or on shallows, by sweeping a spot twelve or fifteen inches in diameter in the gravel. The male and female occupy the nest and fight off all intruders. In the pond mentioned there is a spot near the flume where a space twenty-five feet long by fifteen wide contains over two hundred nests, lying as thickly as it is possible for circles to lie. On the first day of June I noticed that they were spawning, the female slowly turning round in the nest, and the male going around outside of her. They would come together and lie upon their sides, with their vents in contact and their heads apart, and, by motion of their tails turn round on a point of which her dorsal fin was the pivot. I incline to think that all the eggs are not laid at one time, but that altogether each female deposits from five to ten thousand eggs in the season. There are probably ten thousand such nests in Mr. Jones's pond, as they can be seen all along the shores in from two to four feet of water seldom deeper than five feet.

In the course of my fish-cultural life, I have been applied to many times by persons who wished to stock ponds with valuable fish, to know how to get rid of sunfish. They have often asked if explosion would not be effective, and I have told them that it

would, but it would also kill every other living thing in the water, and that their pond would be barren of all such valuable fish-food as insect, larvæ and crustaceans, and that the remedy was as bad as the disease All that then suggested itself was persistent netting, and this entails much labor and seldom catches the last fish. This spring, while watching the nests, it occured to me that the young crop could be effectually killed off by rowing around the ponds and dropping a piece of quicklime as large as a robin's egg upon each nest, perhaps through a tube, which would deliver it exactly. This plan would not interfere with the waters in the deeper parts, nor with the fishes, and if pursued until the original stock died out would appear to be effectual. I have recommended this plan to Mr. Jones, and, if time permits, will assist him in carrying it out.

LOBSTERS.

Mr. Phillips.—I have here a paper on lobster culture, by Mr. S. M. Johnson, of the firm of Johnson & Young, the large lobster dealers of Warren Bridge, Boston, but think it best to preface it by some extracts from a report on the Collection of Economic Crustaceans, Worms, Echinoderms, and Sponges, sent to the Great International Fisheries' Exhibition at London, by Mr. Richard Rathbun, Curator of the Department of Marine Invertebrates in the United States National Museum. The report says:

"The lobster is by far the most important crustacean occurring upon the coasts of the United States, and gives rise to an extremely valuable fishery. It is confined to the Atlantic side of the continent, and ranges from Delaware in the south, to Labrador in the north. The most southern fishery is a small one in the neighborhood of Atlantic City and Long Branch, New Jersey. Lobsters were once moderately abundant in New York Bay, and were taken there for market, but the pollution of the waters of the bay by numerous factories and other causes

have combined to nearly exterminate the species. At numerous places through Long Island Sound, lobsters are sufficiently plentiful to permit of limited fisheries, which are mainly confined to supplying the local demand. Further east, on the southern New England coast, in the region of Block Island, Montauk Point, the Elizabeth Islands, and Martha's Vineyard, they become much more abundant and afford a very profitable fishery, extending through the spring, summer, and early fall. The entire coast line of Massachusetts abounds in lobsters, whenever the character of the bottom is suitable for them, but overfishing has nearly depleted some of the shallow water areas, which were once prolific, as at Provincetown. The sandy shores of New Hampshire furnish only a moderate supply of lobsters. Lobsters are very much more abundant on the Maine coast than anywhere to the southward, and the yearly fishery exceeds in quantity and value those of all the other States combined. This State is, in fact, the main source of supply for all the principal markets in the United States. The fishery continues in some localities throughout the year, but is most active during the spring, summer, and fall, and especially from April 1st to August 1st, when the canneries are open.

"The lobster fishery, as a distinct industry, commenced on the Massachusetts coast about the beginning of the present century, and on the Maine coast about 1840. It has rapidly developed to the present time. At first, lobsters were frequently found during the summer, in some favorable localities at or near low-water mark, especially on the Maine coast, where they could be gaffed out from under the protection of overhanging rocks and seaweads. They rarely occur in such situations now, and the fishery is mainly carried on in depths of a few fathoms to 20 or 30 fathoms, but sometimes in depths of 40 to 60 fathoms. On the coast of Nova Scotia, lobsters are about as common as on the Maine coast, but further to the north they become less abundant again. They have been taken on some of the outlying fishing banks, such as George's Bank, but are not fished for at any great distance from land.

"The lobster fishery is regularly carried on by means of wooden framework traps, or pots, generally constructed of

common house-laths. They are usually made semi-cylindrical in shape, being flat below, rounded at the sides and above, and with a net-work or wooden funnel-entrance at each end, or at one end only. The ordinary size is four feet long, and about 18 inches broad and high, with two funnels; smaller sizes with one funnel, and larger sizes with four funnels are occasionally used, as are also rectangular-shaped pots The old style of lobster pot, employed when lobsters were more abundant and the fishery less important, consisted of a wooden or iron hoop, of variable size, up to 4 feet or more in diameter, carrying a net which sagged but little, and furnished above with a cross-hoop arrangement, or with twine leaders, to which the line for lowering it, as well as the bait, was fastened. This style of pot has now almost entirely disappeared from the coast, as it required constant attention, and only a few could be tended by each fisherman. The lath or cylinder pots are baited in the center with cheap or refuse fish, which are fastened on an upright spear-like holder. They are weighted with stones, and lowered and raised by means of a rope attached to the end of the pot. The number of pots used by each fisherman varies in different localities, ranging all the way from 8 or 10 to 100. The average number may be said to be about 50 or 60. The pots are set either singly or attached together in trawls, the character of the bottom, abundance of lobsters, and custom regulating this matter. When set trawl-fashion, the pots can be handled much more easily than otherwise, and this method is generally preferred on the coast of Maine, wherever lobsters are abundant and the bottom not too rough. The pots are fastened together in strings of 10 or a dozen to 50 or 60, at distances apart of 15 to 20 fathoms, and have a long buoy line at each end. The fisherman pays out his lobster trawl in a straight line, beginning at one end, and marks the ends with kegs or small wooden buoys. After remaining down a sufficient length of time, generally twenty-four hours, he proceeds to examine his pots, beginning at one end of the trawl and underrunning it to the other. The general arrangement of the trawl is not, therefore, disturbed; but the pots, after they have been examined, fall back again into nearly the same places which they prèviously occupied. In

setting the pots singly, each has a separate buoy line and buoy, and the fisherman passes in succession from one to the other. Where lobsters are much scattered, this is the preferable way of setting the pots, as they are shifted slightly every time they are hauled, and are supposed thereby to fish much better. The latter method is probably the one most universally employed along the entire coast. It is customary to visit the pots early every morning, or, otherwise, when the tide serves best.

"The principal lobster markets in the country are Portland, Boston, and New York. Three-fourths of all the lobsters disposed of to the fresh trade are carried by well-smacks or railroads to one or other of these three centers, where they are sold locally or distributed through the country, either alive or boiled, but generally in the former state. The dealers have large cars, in which a considerable stock can be stored awaiting orders Lobsters are in season during the entire year, but are much more abundant in the markets, and much more highly prized as food during the late spring, summer, and early fall. For most lobster fishermen the season is of short duration, lasting only about two, three, or four months, after which time, and until the next season, they engage in other fisheries, or in farming, mining, or other pursuits. Their season's stock seldom exceeds a few hundred dollars.

"The canning of lobsters in the United States is entirely confined to the coast of Maine; and most of the provincial canneries are controled by American capital. Without its canning interests the Maine lobster fishery would lose much of its prestige as the majority of the lobsters canned are below the regulation size established by custom for the fresh markets. The market-smacks will seldom buy lobsters measuring less than ten or ten and a half inches in length, and those under this size are sold to the canneries. The canning industry was first started about 1840, at Eastport, Me., but several years elapsed before it was successfully introduced. In 1880 there were twenty-three canneries in Maine, with a total capital of $289,000, remaining open from about April 1st to August 1st, and giving employment to about 650 factory hands and 2,000 fishermen. The quantity of fresh lobsters used amounted to about 9,500,000 pounds, valued

at $95,000 to the fishermen. The value of the canned products was $238,000, an enhancement in value by the process of canning of $143,000. Seventeen provincial canneries are owned by Americans, as follows: One each in New Foundland, the Magdalen Islands, and Prince Edward Island, three in New Brunswick, and eleven in Nova Scotia. The total amount of capital invested in 1880 was $213,000; 10,000,000 pounds of fresh lobsters were consumed that year, and the value of the canned products was $246,000. These products are all exported to Europe and other foreign countries, none passing into the United States.

"The total catch of lobsters on the Maine coast for 1880 amounted to 14,234,000 pounds, valued at $268,000, first-cost, or fishermen's prices. The catch for Massachusetts was 4,315,000 pounds, valued at $158,000, and that of the entire coast of the several lobster States was 20,128,000 pounds, worth $483,000, first price. The quantity of lobsters handled by the several large fresh markets during 1880 was as follows: Portland, 2,000,000 pounds; Boston, 3,637,000 pounds; New York, 2,500,000 pounds; a total of 8,137,000 pounds. The enhancement in value of these lobsters in passing through the large markets was $105,000, making the total value of the lobster products, as they entered the hands of the smaller wholesale and the retail dealers, $732,000. The prices received by the fishermen for lobsters vary greatly, according to their size and the season. Canning lobsters, which average about one pound each, bring about one cent per pound, but those above ten inches in length are worth from four to seven cents each.

"Legislation relative to the lobster fishery is entirely under the control of the several interested States, all of which excepting New Jersey, have passed protective laws. The Maine law is the most lax of all, permitting the capture and sale of lobsters of any size between the 1st of April and the 1st of August, and of lobsters above 10½ inches in length the balance of the year. The remaining State laws prohibit the taking of lobsters at any season below a certain size (ranging from 8 to 10 inches), and make other restrictions as to a close time, etc.

"The propagation of the American lobster by artificial means has been attempted, but so far without much success. Unsuc-

cessful attempts to transplant the same species to the California coast have also been made."

LOBSTER CULTURE.

BY S. M. JOHNSON.

Your kind invitation to prepare a short article on lobster culture was duly received, and I hereby briefly comply with your request:

The true sportsman angler when he carefully releases the fingerling trout and returns it to the stream, intuitively recognizes the true economy of fish-culture. With an application of this same law to lobsters, we claim that great good might be done. By returning to the grounds all that are immature, and placing the limit so as to allow time for reproduction, a constant and sufficient supply would be insured, which result, I think, can be accomplished in no other way. The merits of this plan seem to be very generally understood, but the great difficulty is in determining what good has been, or may be, accomplished, arises from the fact that the laws of the different States are not uniform, and that, moreover, they are often disregarded altogether; so that no satisfactory knowledge of the benefit derived is possible until these difficulties are adjusted.

There is a plan which, as far as I know, has never been tried as a means of protection, and which, if adopted, would effectually accomplish this purpose, and it would often serve to overcome an objection often raised by the fishermen to the present law, namely, that by returning to the grounds the lobsters below the required standard, they are obliged to retake them again and again. For these, and other reasons, I would respectfully submit for the consideration of the Association and all others interested, the following:

That all traps or pots be so constructed that the laths or sticks shall be sufficiently far apart to allow all small lobsters to

escape, and that a funnel hoop shall be used of not less than five and one-half or six inches in diameter. The adoption of this principle, which is used in many kinds of net fishing, to the lobster industry, would be perfectly just to all, and the chances for replenishing the grounds would be greatly augmented. I hope that whenever and wherever the subject of protection for lobsters is brought under consideration, this plan may receive the attention its importance demands.

The disposal of the spawn-bearing lobster is important and worthy of consideration also. My individual opinion, however, is that if the limit fixed is large enough, a sufficient quantity would be included in the number returned to the grounds to provide for breeding necessities. This is a matter of no small consequence, and should be carefully looked up. The plan of having a close time is frequently advanced, and I do not wish to be understood as altogether opposed to it, but I am unable to find a good and sufficient reason for adopting it. I will briefly consider some of the difficulties that appear in selecting the time.

Suppose we take April, May and June, the months when lobsters are most numerous, there seems to be no necessity for a close time then, because at this season the supply is equal to the demand, and any reasonable limit could be applied without hardship to either fishermen or consumers. We find then no reason for a close time during these months. Now suppose we select the other extreme, January, February and March, the months when fewest lobsters are caught. Here they are a law unto themselves, and enough cannot be captured under the most favorable conditions to interfere with or in any way endanger the future supply. The correctness of this statement seems to be confirmed by the fact that although the time mentioned is when the consumption is least from lack of supply, the price advances. So I fail to find a reason for a close time during these months also.

In the cases alluded to, the economic and commercial aspect appears prominent. We may seek for a scientific or natural reason, and find ourselves still undecided, being unable to say when the lobster spawns or when the eggs are hatched. In fact, it is very generally conceded that these events—which are

separate and distinct—may, and do, occur at all seasons. So, if a close time be advocated, it would be extremely difficult to choose such a time, as it is impossible to show that any better results would be obtained at one time than at another.

I leave this part of the subject without further discussion, except to say that I am open to conviction.

The difficulty in the way of procuring reliable statistics in regard to the benefit derived from the laws we now have, arises from the fact that even were these laws strictly enforced, the catch is so much influenced by the weather and the number of men engaged in fishing at different seasons, that what comes to the market gives no real information as to their relative scarcity from one year to another. It is not a matter of conjecture, but it is a settled fact that lobsters are becoming more and more scarce every year, and it is of the greatest importance that a new interest in the matter should be awakened, and that continued and increased efforts for their protection should be made.

Mr. Mather.—It seems to me that Mr. Johnson has solved the problem of lobster protection, and the only wonder is that no one has thought of making the lobster pots with apertures large enough to permit the small ones to pass out before this time. Perhaps some some of the men engaged in the fishery may have thought of this, but as they sell the small lobsters to the canneries, it is their present interest to catch them. If the States will regulate the apertures in the lobster pots as they do the meshes in fish nets, then the small ones will have a chance to grow.

Mr. Page.—Mr. Johnson's long experience as one of the largest lobster dealers in the country certainly gives great weight to his propositions, which seem to me to be eminently practical. Probably if this Association brings this matter to the notice of the different Fish Commissioners, some such laws regulating the catching of lobsters may be enacted.

Mr. Blackford moved that the election of officers be postponed until the next day, on account of the small attendance,

which he thought was caused by the heat and the change of the time of meeting. Carried.

The meeting then adjourned until 2.30 P. M.

When assembling again the following paper was read:

ON THE DISTRIBUTION OF THE BLACK BASS.

BY DR. J. A. HENSHALL.

In this brief paper the writer intends merely to give the facts, as they exist, relative to the distribution of the black bass species, without attempting to draw any conclusions therefore from the laws which govern the geographical distribution of fresh-water fishes, or to offer any theory concerning the same. A study of the habitat of the black bass, however, will, no doubt, aid the biologist very materially in solving the problem of the distribution of animals.

The geographical distribution of the black bass is remarkable for its extent; the original habitat of one or other of the two species ranging from Virginia to Florida, and from Canada and the Red River on the north to Louisiana and East Mexico. In other words, it might be stated that the original geographical range of this representative American fish embraced the whole of North America, south of the British possessions and east of the Rocky Mountains, except the waters flowing into the Atlantic in New England and the Middle States, thus far excelling any other fish of America in its distribution. Of the two species, the large-mouthed bass had the widest distribution, occurring all through the vast scope of territory mentioned above. The small-mouthed bass had a somewhat limited range in comparison, not extending east or south beyond the Alleghany Mountains, though occurring everywhere else with the large-mouthed species.

At the present day the habitat of the black bass has been extended by transportation, and by means of artificial canals, so that it may be said to inhabit every State of the Union. It has also been successfully introduced into England, Scotland and

Germany, thus occupying a wider range than any fresh-water fish in the world.

The fact that the original habitat of the black bass does not embrace New England and the Pacific slope is not remarkable, for the characteristically American forms of fishes, as has been observed by Prof. Jordan, are, generally speaking, rare or absent in the waters of these sections. This fact was noticed by Prof. Louis Agassiz, who called New England "a zoological island," on account of its faunal peculiarities as compared with the rest of the United States. Thus, of more than a hundred genera of fresh-water fishes now known to occur in the waters east of the Mississippi River, only about one-fourth occur in New England, and of these all except a half-dozen genera are represented by but a single species each; and not more than thirty-five genera occur in the waters of the Pacific slope. Almost any stream of any extent of the Ohio or Mississippi basins will furnish double the number of genera and species as the entire waters of either of the above named sections. Thus, as Prof. Jordan states, "In the little White River at Indianapolis, seventy species, representing forty-eight genera, are known to occur—twice as many as inhabit all the rivers of New England."

The distribution of the black bass does not seem to be much affected by geological formations, climatic influences, or the character of waters; for although one or both species may have been absent originally in certain localities, they readily adapt themselves to the waters of these sections when transplanted, and rapidly increase.

Originally both species were at home among the primordial rock of the eozoic period of Lake Champlain, Northern Wisconsin, and along the Appalachian chain in the Carolinas and Northern Georgia. They flourished amid the paleozoic rocks of the Great Lake region and the Mississippi Valley, and in the coal measures of the Ohio, Illinois and Missouri river basins. While in the marine tertiary formations of the cenozoic period, along the Atlantic and Gulf slopes of the Southern States, the large-mouthed bass alone occurs. Thus, while the small-mouthed bass seems to be restricted naturally to the older formations, the large-mouthed bass roams at his own sweet will

through the regions of metamorphic and stratified rocks and glacial drift, down to the recently formed coral rocks of the peninsula of Florida.

Climatic influences do not seem to affect the distribution of the large-mouthed bass in any degree, in the United States, and of the small-mouthed bass only to a small extent. The original habitat of the species extended through twenty-five degrees of latitude and thirty degrees of longtitude, the small-mouthed bass alone not occurring in the extreme ten degrees of southern latitude, and the ten degrees of extreme western longitude of this range. Thus, while the small-mouthed bass is naturally restricted to cold and temperate waters, the large-mouthed bass bids defiance alike to the ice-bound streams of Canada, the tropical lagoons of East Mexico, and the sunny streams of Southern Florida. He flashes his bright armor under the firs and birches of the St. Lawrence basin, and erects his spiny crest in the grateful shade of the palms and live oaks of the southern peninsula. To him it is given—

> "To bathe in fiery floods, or to reside
> In thrilling regions of thick-ribbed ice."

The character of waters has but little influence upon the distribution of the species, less upon the large-mouthed bass than upon his small-mouthed congener. If the water is reasonably pure, both species will thrive in it; but, as has just been intimated, the small-mouthed bass naturally seeks cooler and clearer waters. Thus, while he is found in the headwaters of certain rivers flowing into the Atlantic (notably those of the Alleghany region of the Carolinas, Georgia and Alabama), co-existing with the large-mouthed bass, the latter only occurs in the lower portions of the streams. (There are several rivers in Hernando county, on the Gulf coast of Florida, that burst out from the base of a sandy ridge running parallel with the coast and some twelve miles from it, whose sources are large springs fifty or sixty feet deep, and of half an acre in extent. Their waters are remarkably clear and cool, with a strong current until tide water is reached; and I have no doubt but the small-mouthed would thrive wonderfully well in the upper portions of the streams if

introduced into them, as the conditions all seem favorable, and the large-mouthed bass is very abundant in them).

As we approach tide water the small-mouthed bass disappears. The large-mouthed bass, however, true to his cosmopolitan nature, descends the streams to their mouths, where he seems to be as much at home in the brackish waters of the estuaries as in the pure and crystal rapids of the highlands.

The black bass being in a manner omnivorous, is probably not restricted in its range to any great extent by the supply of any one article of his food; though it would be affected, of course, by an abundance or scarcity of its food, as a whole. Crawfish and minnows are the principal food of adult black bass, and these are more or less plentiful throughout the waters of the United States. In addition to these they feed upon insects, larvæ, frogs, etc. Prof. S. A. Forbes, in his studies of the food of fishes, ascertained that the food of young bass, when less than an inch in length, consisted entirely of minute crustacea (*Entomostraca*). When from one to four inches long they feed almost wholly upon insects; while crawfish and small fishes constituted the principal diet of adult bass, the small-mouthed species showing an especial fondness for the former. The great prevalence of crawfish in clear, rocky streams may throw some light upon the preference of small-mouthed bass for such waters.

I wish to say a word in this connection in reference to objections heretofore urged before this Association against the introduction of the black bass into eastern waters, upon the theory that the presence of the voracious bass would militate against the increase of shad and salmon. The objections are not valid or founded on fact, for the black bass prefers a diet of crawfish, when he can get it, varying it with minnows, insects, larvæ and frogs, and in eastern waters he would not object to young eels. The pike, pickerel, pike-perch and garfish are almost entirely piscivorous in their habits, which might be expected from the character of their teeth, and their sins have no doubt been charged to the black bass. But while the bass will take in a young shad or salmon, if it comes his way when hungry, he will not make them special objects of pursuit, like the canine-teethed fishes above-named.

The failure to restock such streams, if any such failure exists, must be attributed to other causes than the introduction of the black bass, prominent among which is the unrelenting pursuit of the young fry by the predatory fishes mentioned. They are only exceeded in their destructiveness by the genus *homo*, with his miles of gill-nets at the mouths of the streams, to prevent the return of the shad or salmon during the breeding season; and should a few run the gauntlet and succeed in depositing their spawn in the upper reaches of the rivers, the eels, bull-heads and suckers take good care of it. All of which is truly deplorable, and deplorably true. But in your just and righteous indignation do not make a scape-goat of so good a fellow as the black bass.

In Western waters where the bass exists with the usual varieties of fishes, there is no perceptible decrease in the numbers of either. If any species suffers it is always the black bass on account of over-fishing, spearing, etc. I know of isolated lakes in Wisconsin where the black bass has co-existed with the cisco (one of the salmon family), longer than the memory of man runneth to the contrary, without a decrease of the latter fish. If then the bass cannot "get away with" the cisco in confined waters, how can he "clean out" the shad or salmon in large flowing streams? Moreover, I know of a small stream that abounded in black bass and crawfish, in which brook trout were introduced to the discomfiture of the former fish, for the trout increased while the numbers of the bass grew smaller by degrees and beautifully less.

If then there are waters in which the brook trout or the rainbow trout will not thrive, do not hesitate to aid in the further distribution of the black bass by introducing that desirable species. It is easily done, and success is already assured. You have only to look at the Potomac, the Susquehannah, the Delaware, and many other streams for evidence of its rapid increase in new waters.

The black bass is excelled by no other fish that swims for gameness, and among fresh-water species by but one, the white-fish, for the table. And furthermore, he will not eat the spawn of his mate, or that of his fellows' mates. His natural food is

the crawfish and the minnow; he prefers them, and they are easily procured. On them he will wax and grow fat, increase and multiply. The man who alleges that he depopulates the streams of valuable food fishes, or asserts that he "kills for the love of it," has never looked into the mouth of the bass with his eyes open.

Mr. Endicott.—I have listened with great attention to the interesting paper by Dr. Henshall, and I feel constrained to take issue with him on the subject of introducing the black bass into trout waters. Dr. Henshall is well known as the apostle of the black bass, and he therefore defends him against all charges of bad habits. It is a deplorable fact that the introduction of black bass into some of the Adirondack waters, notably in Raquette Lake, has resulted in the thinning out of the trout, so that angling for bass is all that can be looked for with any certainty of sport. There is no doubt of the value of the bass in all waters that are not inhabited by trout, but the latter is so far the superior of the bass as a game fish that it is vandalism to place bass in trout streams or lakes. In regard to large shad rivers I can agree with Dr. Henshall, for those rivers contain other predatory fish which may be kept in check by the bass, for it is well known that in many waters the bass have thinned out the savage pickerel. The learned doctor, living far from trout streams, and having caught the bass for years and learned to love them, does not seem to place as high a value upon the trout as we do, for he evidently considers the bass the equal, if not the superior, of the trout. This is an assumption which I cannot assent to, nor will trout anglers generally. Years ago while fishing in the Adirondacks for trout I was annoyed by the continued rise and capture of small black bass, and turned to my companion and said: "The trout must go, for the black bass is more fatal to them than the sunfish are."

Col. McDonald.—I agree with Mr. Endicott concerning black bass in trout waters, but do not think they have any bad effect in shad rivers.

Mr. Endicott.—I regard the black bass as the bluefish of

fresh waters, and Professor Baird has characterized the bluefish as more ravenous than the shark.

COL. MCDONALD.—The black bass is of great value to some rivers. I sent to the Holston River for bass to stock New River, Virginia, and the bass were so lively that they jumped the seine, but we caught some, and it was a great gain. They increased and made a summer resort of the river, where hundreds now go to fish. The black bass are worth five dollars per pound to the people who keep hotels and boats, for they get that, on an average, indirectly from the anglers, and others who resort there.

MR. MATHER.—I do not think that Dr. Henshall has advocated the placing of black bass in trout waters. He is very enthusiastic on the bass as a game fish, and personally may prefer it to trout, but he is too well-informed not to know that trout anglers do not agree with him. I know of a gentlemen in this city who has taken trout for years, and only fished for black bass for a limited time, who prefers the bass. For myself I prefer trout fishing, but think very little of either trout or black bass for the table. For me a fresh codfish is far ahead of them. I would never put black bass in good trout waters, but our large rivers are not trout waters, and the bass there will prove the most valuable of fishes to the angler.

FOOD FISH AND FISH FOOD.

BY A. N. CHENEY.

Repeated experiments and close and intelligent observation for years, has enabled the fish-culturist to lay down certain principles and formulæ which, if adhered to, make the artificial hatching of fish an improvement upon nature's ways to the same end.

Nature is said to be, and is, a bountiful provider; but at one time it seemed as though the natural and acquired habits of de-

structiveness in man, and his small boy, had not proper representation in the great place, and nature, too heavily handicapped, must give up the contest so far as fish were concerned, at least in certain localities.

The science of fish-culture came to the relief of outraged nature, and it was then seen that a part of the great plan was to use man as an instrument to prevent the extinction of certain, if not all, species of food fishes of our inland waters.

Fish-culturists have done their work well to make over ninety fish grow where only five, or less than that number, were grown before, but their labors are not completed with the stocking of public waters with food fish for the people. Many waters, from the merciless warfare that has been waged against their finny inhabitants at all seasons, have become totally barren; others only partially depleted; but in both instances radical changes may have taken place, with an equally important item in the fish-culturist's plan to reinhabit which may prove a bar to success—the item being fish food. The purity and temperature of the water may remain suitable for artificially-hatched food fish, but the fish food may have taken its departure, and remain only as a legend. Still there may be food in plenty for certain species of fish, but a desire for a certain kind may render the stocking or restocking of some waters a failure. To be sure this error would only be made by one not versed in the requirements for the well being of the different kind of fishes, but many fish are, of necessity, sent out from State hatcheries to be deposited as the judgment of those sending for the fish may dictate. With the exercise of the greatest care mistakes will be made, as in instances that have come under my notice. An abundance of proper food introduced into a body of water, barren of fish food, changes the food fish thereof from a very indifferent fish to a more excellent one for the table.

My attention was called to the importance of fish food more than twenty years ago in a very practical manner. Near where I live was an artificial pond, on a stream that had once been a trout stream. I could recollect when the brook contained trout, but I could not remember when the dam, that formed the pond, was built. Neither contained trout at the time to which I refer.

Thinking that here, near at hand, was a body of water that only required trout to be introduced for the species to propagate and grow to a proper size to afford good fishing, I obtained permission from the owner of the pond to use it as a fish storehouse. I then introduced a quantity of brook trout from six to eight inches long, and waited patiently for the fulfillment of the programme as I had marked it in my mind. Water, trout and time, all the conditions to insure success. I think it was only a year afterward, when I found that I had neglected a very important ingredient—something for my trout to eat. Their growth was so slight that I failed to discover it, and a friend suggested that I add more fish, but this time a more common kind, those generally known as minnows. The canal was near at hand, and I procured and put into the pond a large quantity of small bait fish, I did it entirely out of sympathy for the trout, for at the same time I noticed that my scheme was a failure. A number of years later a piscatorial friend informed me as a great secret, that there were some great trout in Perine's Pond, and we at once proceeded there in a body. As I caught trout after trout—great lusty, fat fellows—the scales fell from my eyes, and fish food became of as much interest to me as food fish had been, and afterward the mere creeling of fish, that showed by their condition a lack of proper food, failed to satisfy the angling spirit that was born within me, for I was confident that a little labor would bring a change that the fish, and afterward the angler, would appreciate.

At the first meeting of the Schroon Lake Fish-Culture Association I urged the importance of introducing food for the fish with which it was proposed to stock the waters from whence the association derived its name. In reply, it was stated that the lake already contained whitefish, the natural food of lake trout, and the latter fish was the only one we proposed to deposit the first year, to keep up the supply of the disappearing native trout. Whitefish here may have been bad, they must have been few in numbers comparatively, for the lake trout would come on the shoals for the yellow perch, and were taken in August while trolling for bass near weedy shallows. As the home of this trout is in the cool depths of the lake, hunger alone would force

them into the warmer surface water during the warmest month in the year. Besides one only required the use of his eyes to see that the trout taken from the lake were in poor condition as compared to trout from more favored waters. In our interior lakes, whitefish seem to be pre-eminently the food for lake trout. They will not take the hook, and as the law forbids the use of nets, they have only to multiply to do good to their conscience and fellow fish. Inhabiting, as they do, the deeper waters of the lakes with the trout, the young whitefish come to the surface only where the water is deep, and at a season when other fish cannot utilize them as food. Undoubtedly they are sacrificed to the appetite of other fish at spawning time, but they do not contribute to this demand in a manner to destroy their usefulness as trout food. I never yet have found a whitefish inside of any fish but the lake trout, and I have examined the contents of the stomachs of hundreds of bass and pike taken in autumn from waters inhabited by whitefish. A species of whitefish has, since the memories of man, been found in greater or less quantities in the waters of Lake George, N. Y.

Previous to the introduction of artificially hatched trout to this lake, the native trout were hardly in what is called good condition, and this state of affairs was unchanged until the New York State Fish Commission deposited 100,000 young whitefish (*Coregonus clupeiformis*). Then the trout began to "take on fat," until now I do not know of a lake in Eastern or Northern New York that can furnish such fine, fat lake trout as are taken from Lake George, and the whitefish are seen in myriads.

The frost-fish, found in a few of the Adirondack waters, notably Blue Mountain and Raquette lakes, have been likened as fish food to the blue-back trout, that is supposed to be a prime factor in the immense growth of the Rangeley trout. The frost-fish—a species of whitefish, so said—is somewhat similar in its habits to the blue-back trout, resorting in great numbers in the fall—just before ice is formed on the lakes, hence the name—to the shallows and inlets for spawning purposes. They generally move in the night, and their numbers are so great that they make a noise as though the surface of the water was being threshed. They are in themselves a delicious food fish. Other

than the above facts, the habits of the frost-fish for the balance of the year are as little known as those of the blue-back trout; only, like the latter, they are a deep-water fish.

Within a few days I have examined lake trout from Blue Mountain Lake and compared these with Lake George trout. The former, although good-conditioned fish, lacked the abundance of fat inside the abdominal cavity, and the cream-like curd between the flesh flakes that the Lake George trout possesses. I understand fully that this one instance of comparison does not decide the merits of either the frostfish or whitefish as fish food. One lake may provide fat-giving properties that the other does not, but the fact remains that lean trout in Lake George become fat trout after the arrival of the whitefish from the Caledonia hatchery.

The qualities of the alewife or "saw belly" as fish food, have been praised because it is a spring spawner, and the alewives resort to both deep and shoal water, thus giving fish, other than the lake trout, an opportunity to test their edible qualities.

The "saw belly" is found in some Western lakes, and has been introduced into others, and investigation may prove that it is, from its accommodating habits, superior to the whitefish as general fish food. Spawning in the spring is in its favor, as also the short time required for its eggs to hatch.

Crawfish or crayfish are excellent food for black bass, and multiply more rapidly than a like number of "bait fish" would; but an angler might as well bait his hook with a cork as to use a crawfish in waters where previously it was unknown. Bass must be educated to eat them, and it is the same with the helgramite, or dobson, and the bass. There were 18,000 crawfish placed in Lake George as food for fish, but it was three years before the bass would pay any attention to them on the hook. Schroon Lake abounds with crawfish, and it is one of the best bass baits that can be used.

In the above statement I refer to the small-mouthed black bass, *M. dolomieu* of Henshall, and I take into account the capricious nature of the bass as a biter. I have read several accounts of ponds or streams that contain black bass that will not take the baited hook, because the waters have such an abundance of food

minus the barbed steel intestine. It does not seem possible for any water to contain more food, in the shape of minnows, than a small pond in Northern New York; still this pond has yielded the largest small-mouthed bass of which I ever heard, and the fishing is always good in season, and the bass are so fat that they seem stall-fed. Yellow perch appear to be a favorite food of the black bass, even in waters where other small fish are as plentiful as the perch. In the pond mentioned above are silver or gold shiners and "minnows" in swarms, and perch in equal quantities, but nearly every large bass that has been caught on a hook has been taken with yellow perch for bait. In dressing bass caught in this pond, in Schroon Lake, in Lake George, in the Hudson River, and in Sacondaga River, I have found that a large majority of the bass have perch inside of them, when they have anything that can be identified.

It is certainly more satisfactory to anglers to catch well-conditioned fish, and it is more satisfactory to eat such fish, and I have no doubt but it gives the fish-culturists pleasure to provide such fish, when the means at his command will enable him to do so.

Mr. Page.—This paper by Mr. Cheney is a most interesting and timely one. Although the subject is not a new one it is one that will bear continued agitation. Too many people make ponds and put fish in them either to starve or to drag out a miserable existence. The cases cited by Mr. Cheney are to the point and show conclusively that attention should be paid to fish food as well as food fish.

Mr. Mather.—There is a popular idea that fish can live on water, an idea that it is unnecessary to tell this association is erroneous. That fish will live long without food is shown by that persecuted fish—the goldfish, which is kept for months in glass globes without food, the owners declaring that they live "on what they get from the water." That newly hatched fish and small species get some microscopic food in ponds and streams is well known, but a fish a quarter of a pound weight requires something more substantial; besides fish do not breathe

in their food, at least our game fishes do not, but first see it and then seize it. It is doubtful if a trout or bass of a quarter of a pound weight can see the minute daphnia and the other small animal life on which it first fed.

Col. McDonald.—The paper of Mr. Cheney presents interesting facts. In our plantings of whitefish and shad, we have left out the food question entirely. I remember that years ago Mr. Seth Green made the statement that shad could be produced in such numbers as to flood the James River when they returned full grown. Perhaps this could have been done if the fish went to sea for their food as soon as they began to feed, but they remain in the rivers for six or more months and must have food. To this food there is a natural limit. Take the Hudson, for instance. At Troy and below there is only a certain amount of food, and only a certain number of fish can live and grow. All above this number will be insufficiently fed. The only manner in which an extra quantity of shad can find food is to open the gates and let the fish go higher.

Mr. Benkard.—At the South Side Club we have kept trout in preserves, and found that small preserves would not support many fish without additional food. We have also let out young trout into our streams to seek their own food. I do not think that any one will question the fact that fish should be provided with food, yet it seems from the discussions and reports that insufficient attention has been paid to this important item in fish-culture by some beginners.

Mr. Endicott moved that a vote of thanks be given to Mr. Cheney for his interesting paper. Carried.

Mr. Blackford moved that on account of the heat and small attendance, the election of officers be postponed until to-morrow.

Carried.

The meeting then adjourned until the following day.

SECOND DAY.

HISTORY OF THE EXPERIMENTS LEADING TO THE DEVELOPMENT OF THE AUTOMATIC FISH-HATCHING JAR.

BY MARSHALL MCDONALD.

The work of practical pisciculture was, until a comparatively recent period, confined for the most part to the hatching of the different species of the salmonidæ. The incubation of the eggs was at first effected in troughs having the bottoms covered with a layer of gravel, upon which the eggs were placed, and over which a current of fresh water was allowed to flow.

In succession followed the "grill system" of M. Coste and the different devices of movable trays now in common use for handling this class of eggs. In all these various methods the separation of the dead eggs from the live ones was effected by means of hand-picking. The necessity for the separation, although not so urgent in the case of the eggs of the salmonidæ as in that of those eggs which develop in warmer waters and in much shorter periods of time, still entail a vast amount of labor in connection with the hatching operations.

Although the ingenuity of our fish-culturists has greatly improved the forms of hatching-apparatus for these heavy eggs, yet up to a comparatively recent period no other effectual means of separation than that above indicated has been found practicable. The United States Fish Commission, in the development of its work, had presented to it the necessity of dealing with the eggs of the whitefish and the shad upon a scale unprecedented in the history of fish culture. Millions of eggs were to be hatched where fish-culturists formerly handled only thou-

sands, and the old methods of hand-picking were soon found to be impracticable.

In all the forms of apparatus for bulk-hatching, no adequate means is employed for the separation of the dead eggs from the living. All, as they come from the fish, the unimpregnated as well as impregnated, are placed in the apparatus and remain together.

In the case of the whitefish, and more especially in the case of shad eggs (which run through their period of incubation in a much shorter time), fungus rapidly develops among the dead eggs, communicating itself to the living, and large numbers of them, which would otherwise reach the period of hatching, are destroyed. The percentage of loss produced in this way is always considerable. and in many cases none of the eggs undergoing incubation are saved. The attention of fish-culturists was early directed to the serious losses thus arising, and various experiments have been made with a view of effecting the separation of the dead from the living eggs.

In 1878 Mr. F. N. Clark, the superintendent of the United States Hatchery at Northville, Mich., attempted to effect the separation by introducing a gate into one side of the Bell and Mather cone, through which the shells and fish and dead eggs might go out into appropriate receptacles. This device, so far as it served for the collection of the young fish, was quite successful; but it was not found capable of doing the work for which it was first planned by Mr. Clark, and was abandoned. Similar experiments, looking to the same result, were made by him with the Chase jar—the form of apparatus employed for the whitefish work at the Northville Station. The result of these experiments, however, led Mr. Clark to the conclusion that an automatic or self-picking arrangement for effecting the complete separation of the dead from the live eggs was not practicable, and a paper to that effect was written and published by him in Vol. I., Bulletin of the United States Fish Commission (1881, p. 62). The present method employed by him for the separation of the dead whitefish-eggs is to siphon off the dead eggs and such live eggs as are necessarily drawn over with them, and to transfer them to what

he terms "hospital jars," the live eggs thus drawn over being left to take their chances with the dead ones.

This mode of treatment undoubtedly has served to diminish materially the percentage of loss in the eggs thus treated by him, as in this way, by the sacrifice of a small proportion of the eggs, he secured the complete separation of all elements of contamination and disease from the great bulk of the eggs.

In 1881, while I was in charge of a shad-hatching station on the Potomac River, and in position to observe closely the performance of the hatching apparatus in use, the question of the separation of the dead from the living eggs was taken up systematically, with the view of devising a form of apparatus which would accomplish the purpose, and which would be of such shape as to be of easy and convenient use in practice. Knowing that there was an apparent difference in the specific gravity of the living and the dead eggs, I determined to see if I could not avail myself of this difference to effect the separation. The first form of apparatus employed is presented in fig. 1.*

In the use of this apparatus, I found that a fair separation could be effected, but to accomplish this required perfect stability of the vessel and careful manipulation. When the barges were lying quietly on the water, and there was no tide swell in the river, the separation went on perfectly, the dead eggs being continually thrown off from the mass of living eggs, and swept by the current over into the exit trough and carried off from the apparatus. The slightest oscillation, however, of the barge, produced by waves, would derange the orderly movements of the

* This consists essentially of an oblong trough with wooden ends and sloping glass sides, glass being used in order to be able to observe the movement of the eggs under the influence of the currents. This trough rests upon a rectangular box made of boards, which serves at once as a firm base for the support of the trough, and as a chamber for the equable distribution of the water pressure. The water which enters the rectangular box forming the base of the apparatus through the supply pipe I, passes to the trough proper through a slot extending the whole length. The influx of the water to the trough is regulated by the valve V V, which, by means of the set rods S S, can be pushed down so as to cut off the flow of water entirely. By setting so as to have the opening between the valves and the glass sides about one thirty-second of an inch, the water enters the hatching trough in thin sheets which are directed up the glass sides of the trough. The effect of this is to give the eggs a continuous movement in the direction shown by the arrows. The water flows over the edges of the central trough, and escapes from the apparatus at O. The dead eggs in their circuit float higher than the living, and the force of the entering current may be so regulated that the former will be swept out by the escaping water.

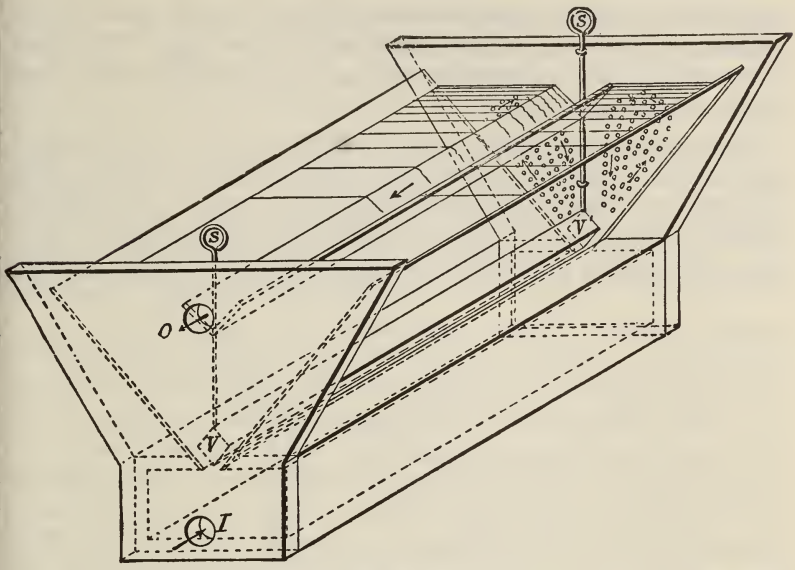


Fig. 1.—Original form of apparatus employed in the experiments. Used May, 1881, on the Potomac barges.

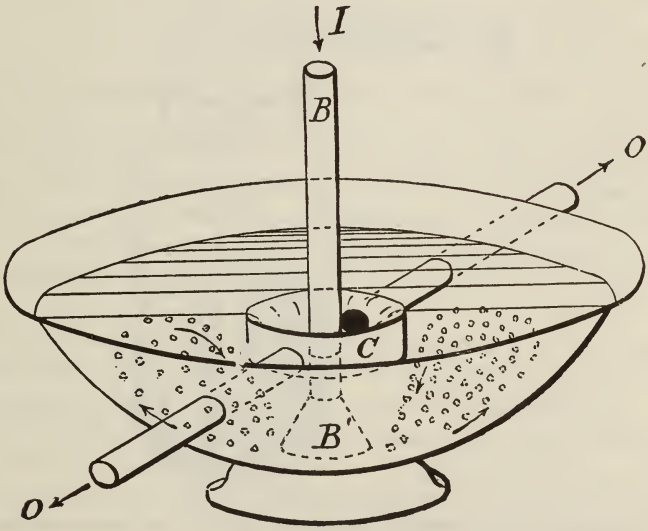


Fig. 2.—An alternate form, used in the spring of 1881.

eggs, and required continual watchfulness on the part of the attendant to prevent considerable losses of live eggs. A second form of apparatus, looking to the accomplishment of the same result, is shown in ffg. 2.

The results with these forms of apparatus were not satisfactory in developing a method which could be conveniently applied in practice, yet they pointed the way to it. Later in the spring, near the close of the hatching season, at the suggestion of Professor Baird, and in conjunction with Professor Ryder, we insti-

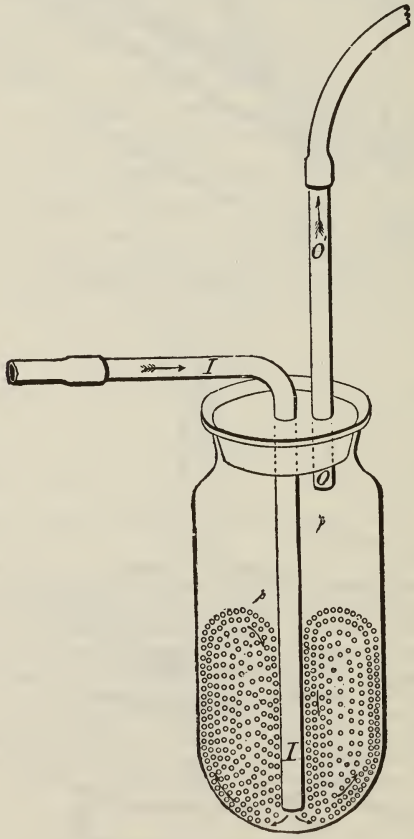


Fig. 3.—Original form of apparatus in which the method for automatic separation of dead from living eggs was demonstrated.

tuted, in the basement of the Smithsonian Institution, a series of experiments in order to determine the limit of healthy retardation of development that could be effected by lowering the temperature of the water employed. In order to subject the eggs conveniently to the action of the current of cold water, they were placed in small two-ounce laboratory flasks, closely corked. Through the centre of the cork was passed a glass tube which descended to within a short distance of the bottom of the flask, and through which the current of water was admitted to the apparatus. This is shown in fig. 3.

An exit tube, the lower extremity of which extends a short distance below the neck of the bottle, provided for the escape of the water. Whilst this form of apparatus had been devised by me in connection with the experiments on retardation above referred to, I had no sooner fixed upon the apparatus than I felt at once I had arrived at the solution of the question of automatic separation of the dead from the living eggs. An eight-ounce wide-mouthed glass jar, such as is used in the National Museum for holding alcoholic specimens, was fitted up as indicated (fig. 3).

Six thousand shad eggs were placed in this apparatus and a current of water turned on and regulated. The movement of the current established a regular rolling, boiling motion on the eggs, which brought all in succession to the surface. The dead eggs remained there, forming as they were freed from the mass a layer upon the upper surface of the others. By pushing down the exit tube a suitable distance, I found that the dead eggs were taken up by the escaping current—were by degrees drifted under the lower end of the tube, lifted through it by the current, and swept out, leaving an absolutely clean mass of live eggs in the jar.

This lot of eggs was successfully hatched, and at the time of hatching not a dead egg was found in the bottle, nor do I think a live egg was lost in the whole course of the experiment.

The first experiments had been framed solely with reference to the assumed slight difference in the specific gravity of the living and the dead eggs. Attentive study of the movement of the eggs in the jar showed a still more potent influence for

separation than the difference in the specific gravity. It is true there is a slight difference in this respect, but it is hardly appreciable. The more important difference, and that upon which the success of the apparatus depends, is the close adhesion which exists between the living eggs, the effect being that the live eggs rolling in mass are always in contact, even when they reach the surface, and are by this adhesion carried around in regular sequence. On the other hand, the dead eggs having once reached the surface, their adhesion to the underlying layer of eggs is not sufficient to draw them along with it in its regular movement; consequently when they once reach the surface of the mass they remain their until they are carried off by the exit tube. Several experiments made with different lots of eggs gave uniformily the same satisfactory results.

In May, 1881, the apparatus in actual operation was exhibited before a meeting of the Biological Society held in the basement of the Smithsonian Institution. These experiments were so decisive that I did not hesitate to recommend and urge the adoption of the new method in the work of the United States Fish Commission.

In the spring of 1882, it was determined to convert the old Armory building into what is now known as the Central Hatchery and Distributing Station. Professor S. F. Baird was pleased to manifest his confidence in the success of the new form of hatching apparatus by authorizing me to equip the station with them. The working form of apparatus not having been then even designed on paper, it was not possible to prepare the drawings and to have the jar complete in all details ready in time for the shad-hatching season. An improvised form was devised in which cork stoppers were substituted for the screw cap and metal tops employed in the form now fixed upon. Ten tables suitably planned to receive the waste water from the jars and carry it off from the building were constructed; the pipes for the distribution of water supply to the tables were introduced, and the station was equipped with 300 of the jars. Each jar having a capacity of 60,000 to 70,000 shad eggs, gave a total hatching capacity to the station of 21,000,000 eggs at one time, or 900,000,000 for the entire shad-hatching season. This was,

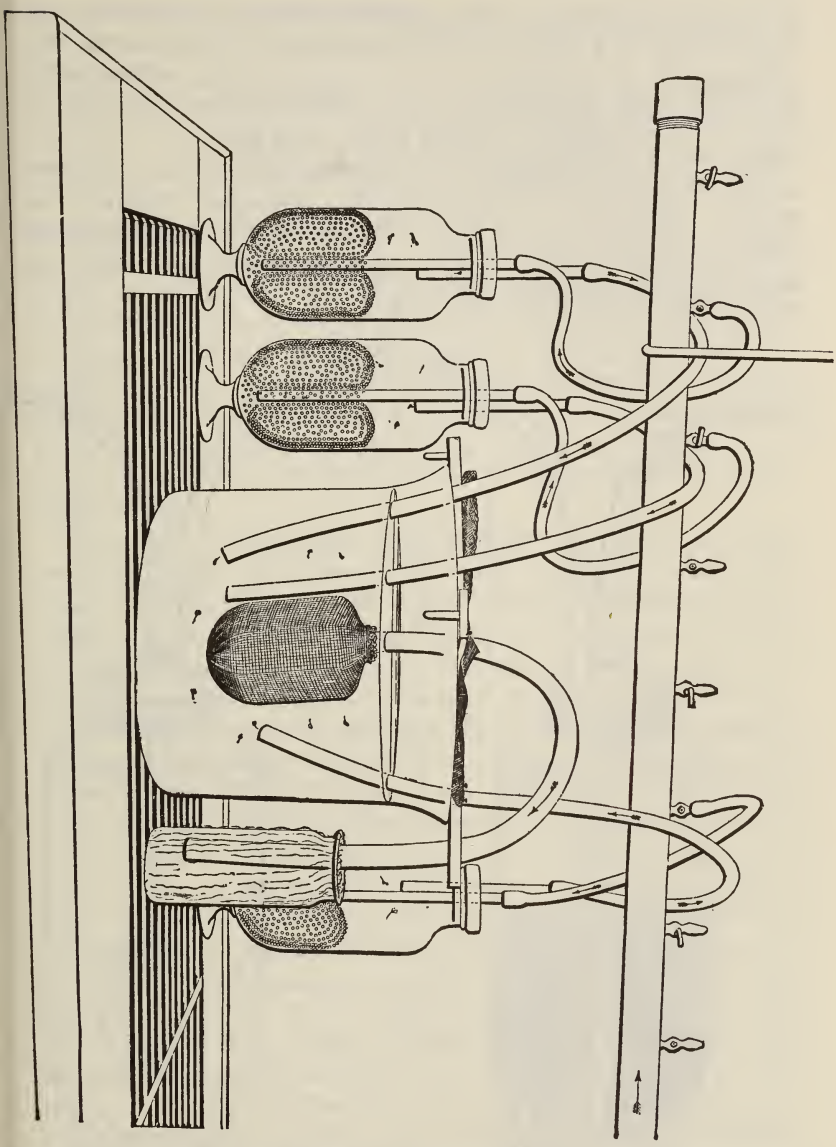


Fig. 4.—Details to illustrate hatching and transfer of shad fry to collectors.

of course, in excess of any expected production; but in the organization of a shad station it is necessary to provide for the contingency of the great bulk of the eggs coming within an interval of a few days of each other. The form of hatching apparatus used during this season is shown in fig. 4.

The general arrangement of a hatching-table for the collection of the young fish as they hatch in appropriate receivers or aquaria, is also shown in fig. 4. The present form of apparatus and the form contemplated in the first design, but only completed recently, is indicated in fig. 5.

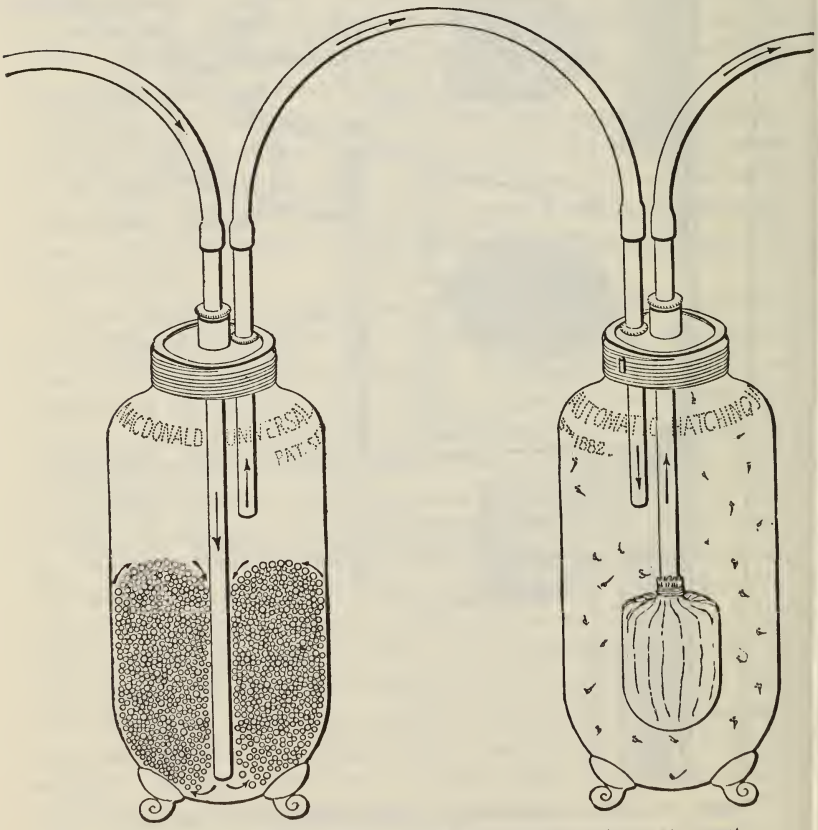


Fig. 5.—Arrangement of jars for hatching and collecting, as in use at present.

In this figure we have shown a pair of jars fitted up, one for the hatching of the eggs, the other for the collection of the young fish.

The jar consists essentially of a cylindrical glass vessel with hemispherical bottom. These are not blown, but pressed, in order to secure perfect regularity of the interior surface, upon which depends to some extent the perfect working of the jar. The glass foot which is shown in the improvised form has been omitted in the form now in use, the jar being supported upon a tripod of three glass legs, this form of attachment being adopted to prevent the distortion of the bottom of the jar which would necessarily result from the attachment of a single foot to it.

The top of the jar is made with threads to receive a screw cap, and both the bottom and the top surfaces are ground so that the plane of each shall be perpendicular to the axis of the jar, and so that when the jar is resting upon its feet its axis shall be perfectly vertical.

These are all-important considerations to secure the proper working. The top of the jar is closed by a metallic disk perforated with two ⅝-inch holes—one perfectly central, which admits the tube that introduces the water into the jar; the other equally distant from the central hole and from the edge of the plate. A groove in the inner surface of this metallic plate carries a rubber collar, and when the plate is in place the tightening of the metallic screw cap shown in the figure seals the opening hermetically. Both the inlet and outlet tubes pass through stuffing-boxes, by which means the tubes can be slid up and down easily, and tightened firmly in any desired position. The construction of the jar is such that when the metallic disk is in place the central tube takes the central position necessarily; by loosening the screw cap of the stuffing-box, the central tube can be slid up or down so as to produce just such movement of the eggs as is desired. If the quantity of water entering be small, or the head of water slight, without changing the feed of water we may vary at will the force and velocity with which it enters the jar. By pushing the tube down so as to be almost in contact with the bottom of the jar, we make a relatively small quantity of water do the work of a larger quantity in producing mo-

tion. Moreover, as in the season of shad-hatching, a full supply of water is needed and not a great deal of motion, this is arranged for by increasing the feed and raising the lower end of the central or supply tube, so that the delivery of the water from it will be under less pressure. This central tube is connected by a rubber pipe with the pet cock, which furnishes a supply of water under a constant head.

The exit tube serves a double purpose—first, as an outlet for the water; and secondly, at our pleasure to remove the layer of dead eggs from the surface. This is accomplished at stated intervals, say once in twenty-four hours, by loosening the screw of the stuffing-box so that the tube will slide readily, pushing it down until the dead eggs nearest to the lower end are seen to begin to pass off. By allowing it to remain in this position a few minutes the layer of dead eggs is swept off entirely. They may be either allowed to pass off in the waste, or better, collected by screens and fed to the fish in the aquaria, thus serving the double purpose of preventing the fouling of the water and furnishing a very appropriate food for many varieties of fish. When the period of hatching approaches, instead of allowing the water from the hatching jars to pass directly into the sinks, it is necessary to conduct it through the collecting jar. This is precisely similar in construction to the hatching jar. Indeed it is the natching jar with some special arrangements to adapt it to its new purpose. The water passes from the hatching jar through the rubber tube into the eccentric opening of the receiving jar. The tube and opening then serve for the inlet instead of the outlet of the water. On the lower end of the central tube is placed a wire frame, over which is drawn a bag made of cheap cotton, the texture of which is such as to permit the water to strain through, but the meshes of which are so fine that the suction of the water will not hold the young fry against it, as would be the case if a wire screen were used.

The surface of this strainer should be as large as is convenient. It is adjusted to the lower end of the central tube in such position that the end of the tube is in the centre of the wire cage, or as nearly so as possible, the object of this being to make the draw of the water equal in all directions. The water is allowed

to pass out of this second receiving jar out into the waste. The young fish, if they be whitefish or shad, as soon as they burst their shells, begin to swim around vigorously in the hatching jar, drifting with the current. They pass into the exit tube and are carried over into the receiver, in which they may be collected to any number desired, being retained there without injury until it is convenient to make a shipment.

In extensive work in hatching I have found it more convenient to make use of large glass aquaria for receivers, four or five hatching jars being disposed around one, which serves as a common collector for the young fish from all. A siphon, arranged as shown in fig. 4, with a wire cage and strainer on the shorter end, serves to give free discharge to the water, while the strainer prevents any fish from passing out. I have found the hatching jars to be a very compact form of apparatus for handling the eggs of the salmonidæ. In this case it is not desired to nor do we give any motion to the eggs. The jar is filled with them from one-half to two-thirds full. The current of water being introduced at the bottom filters up through them, enveloping each egg in a stratum of fresh water, and placing each under the best possible conditions of development. From fifteen to eighteen thousand eggs may be readily placed in each jar. Of course, in the case of these eggs, we must have recourse to hand-picking. This is readily accomplished by opening the jars, placing the hand over the mouth to prevent the escape of water, inverting and placing the mouth under water over a broad shallow tray. The eggs by gravity flow out and spread over the bottom of this, and when picked over are returned to the jar, the precaution being observed to have the jar full of water, and to use a broad flat funnel to return the eggs. They may be poured from the tray into the jar in bulk without any injury.

From the experience had during the winter of 1882, in hatching this class of eggs at Central Station, I am convinced that large numbers of eggs up to the very period of hatching can be handled in this jar

The necessity of arriving at methods of hatching the light or floating eggs of many of our salt-water fishes has for several years impressed itself upon the United States Fish Commission

No form of apparatus heretofore devised has been satisfactorily operated to the accomplishment of this purpose. The experiments made during the summer of 1882 in the Chesapeake Bay, with the eggs of the Spanish mackerel, led to the hope that the hatching jar, fitted up as a receiver, may be with equal advantage employed in hatching this class of eggs. The number of eggs obtainable was not enough to give results sufficiently decisive to establish this assertion. But these eggs, being subjected under the conditions presented in the receiving jar, to a current of salt water, being confined so as to prevent escape, and this confinement effected without the use of appliances that would injure the delicate membrane of the shell, there seems to be no reason why we may not use the jar as successfully with this class of eggs as with those of the whitefish and the shad.

UNITED STATES FISH COMMISSION,

Washington, D. C., April 6th, 1883.

TRANSPORTATION OF CRUSTACEANS.

BY FRED MATHER.

Of late years those who have stocked trout ponds and streams have realized the necessity of furnishing their fish with a permanent diet of natural food in the shape of crustacean life. A few years ago, Mr. James Annin read a valuable paper on this subject before this Association, and it awakened much interest in the subject. Since that time, Mr. Annin has sent out many thousands of the so-called "fresh-water shrimp" from his Caledonia ponds. Such life has usually been sent in cans of water and plants, I believe, and is therefore somewhat bulky, and the express charges are an item in the cost. This winter I have received at the Cold Spring Hatchery many thousands of whitefish and trout eggs from Mr. Frank N. Clark, of Northville,

Michigan. The eggs came on the usual flannel trays, with mosquito netting, and I noticed several shrimps, *Gammarus*, etc., among the eggs, at different times, and in all cases they were alive. As they will live so long out of water if packed in a damp medium, there seems to be no reason why they cannot be sent in quantity in this manner. This would cheapen the transportation on them, and do away with the return of cans. I would recommend that they be packed on trays and covered with netting and moss, precisely as eggs are packed.

MR. PAGE—This is certainly a new and inexpensive way of stocking waters with fish food from a distance, and one that will no doubt be followed. There are often small things which are of the greatest value, and this short note by Mr. Mather may be classed among them.

THE BEGINNING OF FISH CULTURE IN AMERICA.

BY DR. T. GARLICK.

BEDFORD, O., May 13th, 1883.

Barnett Phillips, Esq., Secretary American Fish-Cultural Association:

DEAR SIR—Your esteemed favor of the 21st inst. is received. If possible, I will write a brief article to be read at the meeting of the American Fish-Cultural Association on the 7th and 8th of June next. I am very sick, and write this note lying on my lounge; and it may be probable that I shall not be able to write even a short paper. I have been sick twenty years last January, and am almost worn out with age and disease. I was 78 years old on the 30th of last March. I mail to your address to-day a copy of the second edition of my little book on fish culture, which I present to the Association through you. In case I am unable to write anything to be read, perhaps you may find something in the prefaces and introduction of the book that may answer the purpose of the paper. You mentioned the fact that I had been made an honorary member of the Association. I shall esteem it an honor to be a member of the American Fish-Cultural Association.

T. GARLICK.

BEDFORD, O., May 25th, 1883.

I do not believe it possible for me to write a paper to be read at the A. F. C. A., as requested by the Executive Committee. I am suffering at this moment indescribable torture, and last night was a night of dreadful suffering. Were I able to write a paper, it would be on the topics named by you in your letter.

My attention was first called to artificial methods of propagation of fishes by seeing a notice in a newspaper of the methods employed by the two fishermen of the Vosges. I saw, or thought I saw, in this discovery one of the most important discoveries of modern times. And I at once determined to make the same experiments, but not with the remotest view of making money by it, but simply to demonstrate an important discovery. The history of my experiments are all recorded in the book I sent you a few days since, also in the published proceedings of the old Cleveland Academy of Natural Sciences.

My experiments were eminently successful. I exhibited both young and old fish at two of our State fairs, one at Cleveland and one at Cincinnati.

This was, no doubt, the beginning of breeding fish by artificial methods in the United States. When we look at what has grown out of these experiments through the active agency of the fruitful brain of Professor Spencer F. Baird, we begin to realize the value of this discovery. I have never regretted the hard work, precious time, nor the money it cost me to make the experiments. I believe that artificial fishculture is only in its infancy at this time. When we consider the vast extent of our inland waters, our mighty inland seas, great rivers, down to the little streamlets and springs, we can guess what will follow. Hoping you may have a pleasant and a profitable meeting,

I am truly yours,

T. GARLICK.

Mr. Phillips read extracts from the book mentioned, and a vote of thanks was given to Dr Garlick, the pioneer of American fishculture.

EXPERIMENTS IN OYSTER PROPAGATION.

BY H. J. RICE, SC. D.

During the past three or four years a number of efforts have been made by different individuals to ascertain the practicability of propagating the American oyster (*Ostrea virginiana*) by methods similar to those already so successfully employed with a large number of both fresh and salt water fishes, or, in other words, to assist "Dame Nature," first, in giving an existence to a greater number of embryo bivalves than would be found under ordinary conditions, and, secondly, in bringing to maturity a goodly proportion of those "immigrants" which, if not "assisted" during their rotation for existence, would inevitably, as the Germans so forcibly express it, "zu grunde gehen." This expression, however, of "assisting nature," ought not to be misunderstood, since nature has many ends to accomplish in her methods of increase among the lower tribes, while for man there is but the one end—to supply raw material to recuperate the ranks so incessantly and ruthlessly devastated for his use, and it is with this end in view, and by reason of the rapid deterioration of the productive beds in various parts of the country, that artificial propagation is desirable, if it can be rendered practical. The first work in the direction of strict orthodox oyster propagation, so far as I am aware, was performed by the writer in the summer of 1878, at the Chesapeake Zoological Laboratory at Fort Wool, in conjunction with Dr. Brooks, the director of the station. The work at this time was confined chiefly to ascertaining whether or not it was possible to impregnate the eggs of the oyster by taking portions of the generative organs of the two sexes and mixing them together in a little water, after having cut them into fragments, so as to allow the generative products to get out of the retaining cavities or tubules. But this attempt did not prove successful, neither did those which I made later in the season, when I had moved my quarter in conjunction with the U. S. Coast Survey, to Pocomoke and Tangiers Sounds, in the upper part of the bay.

In both places numbers of experiments were made, but we

were using oysters all this time from shoal water, and it has since been pretty well established that oysters in shoal water shed their generative products earlier, on account of the generally higher temperature of shore waters, than those found along the deeper portions of the coasts.

This is not true in all cases, but probably is true in a large majority of instances. Accordingly, we were using oysters which had shed their ripe products, and the only practical results that I obtained for the first season's work were to ascertain beyond a doubt that the American oyster is bi-sexual, and that as a rule they do not carry the young in the gill-chamber upon the "beard," as appears to be the case with the European oyster, for out of hundreds examined I only found two with young upon the gills and mantles, and even in these instances it may not have been the normal position of the embryos.

The next season, Dr. Brooks located himself at Crisfield, Md., early in May, and getting oysters which had not spawned, was immediately successful in impregnating the ova, and in keeping the young alive for a few days, but in no case did he succeed in keeping them longer than a week. He found it impossible, with any means at his command, to arrange vessels which would retain the embryos, on account of their minuteness, and at the same time permit of a current of water to pass through the vessels, and thus give food to the growing animals. Others have repeated the experiments, but no progress beyond that already noticed above had been made when I began my experiments last summer. I had been present during a portion of the time Dr. Brooks was carrying on his investigations at Crisfield, and noted the difficulties with which he had to contend, and it was not until later in the season that I thought of a method of arranging apparatus which seemed feasible for the end in view.

I did not, however, have an opportunity to test this new arrangement until last summer, when being in New York, Mr. Blackford, who is so well known among you for his enthusiasm in scientific fish work, kindly placed at my disposal, not only a room at the Fulton Market for the purpose of continuing my experiments, but with great liberality arranged to supply me with such specimens of oysters and such amount of sea-water,

from the neighborhood of Sandy Hook, as I should need in my experiments. Thus equipped I began work early in July, and was able before I left the city to present to the gaze of those interested in this class of bivalves, young oysters which had been kept alive for fourteen days, and were at that time apparently strong and healthy. Unfortunately I was obliged to leave the city at this stage of the experiments, and thus they were brought abruptly to an end sooner than desirable, but not without demonstrating that the process on a small scale was at least partially successful. In arranging my apparatus I had in view two things: first, the necessity of a nearly constant flow of water and, so far as possible, water that had not been previously used; and, second, of such an interchange that the entire mass of water in the vessel should be set in motion a number of times during the day. The first was the more difficult of accomplishment, since, in order to get a flow of the water, an outlet to the vessel was necessary, and any outlet, however guarded by screens, was liable to allow the escape of the young during the free-swimming stage, when, for the most part, they congregate at the surface of the water. To obviate some of the difficulty, I concluded that it was necessary during the earlier periods, at least, to draw the water from the bottom of the vessel, and in order that the flow from the vessel should be steady and of a nature not to permit of the escape of the young, I determined to employ capillary attraction as exhibited in the fibres of various cloths when immersed in liquids. For the first week, I was employed principally in experimenting with various kinds of cloths, as to their capacity for transferring water from one vessel to another, their continuous action and the effect of the sea water upon the coloring-matter and the coloring-matter upon the sea water.

Some of the fabrics employed did not allow of sufficient water to pass through them, or in other words the capillary action was not strong enough; others were too coarse and were liable to allow the young oysters to become entangled in the meshes, and remain there as in a cage, or be carried over and out of the vessel in the outflowing current, while others lost a portion of their coloring material and thus discolored the water, and while I

cannot say that this would prove injurious to the young animals, I did not think it desirable to try experiments in this direction. As the result of this labor I finally concluded to try a fine quality of white flannel used in strips and laid over the side of the vessel containing my young animals. As a rule the pieces extended to the middle of the inside of the vessel, and I found by carefully manipulating these strips as to position and size, that the breeding vessel would be practically self-regulating, since the nearer the liquid was to the top of the vessel, the greater the flow of water on account of the less distance it would have to be raised by capillary attraction. But by having my outlet strip freely suspended in the liquid, the absorbing surface extended throughout its whole length, or at least of that portion in the hatching vessel, and hence the young animals might be drawn against the flannel and either killed or carried over from mesh to mesh. To prevent this, I introduced a small lamp chimney of the Argand pattern and placed my flannel upon the inside of this. The end of the lamp chimney resting upon the bottom of the vessel allowed water to pass out only by going in at the bottom of the chimney, working up the flannel and so out at the top. In this manner no young oyster could get into the current of outflowing water, or into the meshes of the flannel except those few that might be directly under the end of the chimney. The inflow of water was arranged in a similar manner but without the chimney, simply allowing the piece of flannel to pass over from a supply tank into the breeding vessel.

As a whole, my apparatus then consisted of two vessels, two strips of flannel and a lamp chimney. The large vessel or supply reservoir was kept full of sea water; from this a strip of flannel passed over and down to the small breeding-vessel, keeping it full and constantly supplied with fresh water so long as the reservoir was well supplied. The chimney was placed upon the opposite side of the breeding vessel from the entrance or inlet strip, and the second piece of flannel passed from it out and over the side of the vessel, allowing the overflow to take place into a waste tank placed some distance below the apparatus.

With this arrangement and with strips of flannel about three inches in width, I found that I could pass about two gallons of

water per day, through a small tumbler which I used as my breeding-jar. I also introduced water several times a day by means of a small sponge.

I found that with this arrangement of the vessel I had no difficulty in keeping my young oysters alive, and so far as I could tell I lost none in the outflow.

Practically then, the difficulty of maintaining a circulation of the water had been overcome, and I maintained an equable temperature by placing all my vessels, that is, both supply tank and breeding vessel, in a constant stream of water flowing from the hydrant; the temperature of the water in the vessels thus changing only with the change of the surrounding stream, which was, during the course of the experiments, from 74 to 80 degrees. On the 25th of July, with a temperature of the water at about 74 degrees, I placed my first hatching of young oysters in the apparatus.

My method of impregnating the eggs was as follows: Upon opening the oysters, I took a small portion of the generative products and examined to see whether the specimen was a male or female, and if ripe. Having thus selected a good specimen of either sex, I slit the ovaries and spermaries lengthwise with many gashes, and then pressed out the products, and gathering with a knife, placed them together in a small watch glass and mixed them with a little water. Afterward they were transferred to a larger vessel containing more water, when they were allowed to remain quiet for a considerable time. The surplus of milted water was then siphoned off and thrown away, and the vessel again filled with fresh water. During the time the water in the vessel is quiet, most of the ova settle to the bottom, and remain there as a thin layer, which with care will remain undisturbed, while the light ova and the unused spermatozoa are drawn off from above. The ova can be washed several times if thought necessary, in order to thoroughly cleanse them from any particles of organic matter and spermatozoa which may be at the bottom, and which by decaying might tend to affect the water unfavorably. By the method which I adopted of slitting the ovaries and spermaries, and then pressing out the contents, I obviated the necessity of cutting the parts to pieces, and after-

ward cleaning the ova from the minute fragments of tissue before allowing development to go on. Another method which I have employed, and one which is even better than this, is to clear the animal from all flesh, such as gills, mantle aud muscle, by cutting off the parts with a pair of small scissors, then taking the body between the fingers, place the outlet of the generative organs against the side of the small vessel or plate, and with a flat instrument of some kind, such as a dull knife, gradually manipulate the sides of the organ, and press the products down and out into the dish. In this manner, if the specimen is ripe, you will have a clear milky liquid, with none or only a very slight admixture of foreign material. The mixing of the male and female elements can then be performed as already explained. After thoroughly cleansing the ova they were left quiet for some considerable time, and in from two to four or six hours a layer of embryo could be seen at the surface of the water, each individual moving about in a very brisk "go-as-you-please" sort of fashion. These were then siphoned off into a larger vessel, and after several layers had been disposed of, the assembly was placed in the breeding-jar, and the water set in motion through their new locality. In the case of the experiment begun on the 25th of July and above mentioned, specimens were examined every few hours in order to denote the development, and during one such examination on the 17th inst., about forty-four hours after the ova had been impregnated, one of the young oysters, which had developed so far as to be entirely enclosed by its two shells within the field of the microscope, thrust out a portion of the velum and firmly secured itself to the glass slide upon which it had been placed. Further observation seems to show that this is their normal mode of attachment, that is, to thrust out the velum from between the shells and adhere to whatever is within reach, afterward the animal falls over to one side, generally the left, and the shell of that side gradually forms around and out beyond this attachment of the young animal. Later a portion of shell material forms under the attachment and firmly solidifies the shell proper to the attached substance, and the fleshy attachment atrophies, so that while at first the animal itself is attached to the outer world, later in life the shell is the part at-

tached, and the animal itself becomes attached to the shell, but in an entirely different place from where the first attachment was made.

During this first period of attachment, when the shell itself is not firmly attached, but simply held firmly down to the substance with which it is in contact, the young animal gets its food, or a portion of it, by means of a sort of proboscis, of elongation of the mouth part, which is capable of being moved about freely within the shell cavity. This proboscis stage lasts until the gills are fully formed and become of sufficient size to supply food to the animal, when the proboscis, or, rather, its flexible end, is transformed into the labial palps, which become closely connected with the gill-leaves. It will thus be seen that the life of the oyster can be practically divided into three portions. First, a free swimming condition which lasts for a longer or shorter time, in accordance with the temperature of the water, and during which time the young animal can move about with perfect freedom, although generally at or near the surface, and in a somewhat limited range. It is, during this stage, subject to the greatest dangers. Second, a condition when it is covered by a shell, is unattached, but is not capable of moving freely from point to point, except to whirl about, and thus roll around upon whatsoever substances it may rest; and third, its condition when attached to some permanent and stationary object, and including of course, the "proboscis stage." During its first condition it can be affected by its own movements and the movements of the tides; during its second condition, chiefly, if not solely by the tides, and during its third condition by neither, except in so far as the tides bring food to it in its resting-place.

All efforts at artificial propagation should then take into consideration these three conditions. First, to guard it from escape during the first period; second, although perhaps not absolutely necessary, except in so far as it resembles tidal action, to move it about during the second period, until it can attach itself to some solid support; and third, to afford food for it during all periods.

With the apparatus which I have described to you the first two ends were accomplished, that is with the aid of the syringe with which I introduced strong currents into the breeding vessel

several times per day. This was clearly demonstrated by keeping a large number of the young animals alive for fourteen days. How many of the number were attached to the bottom and sides of the dish I have no means of knowing; but if one attached itself on the second day, it is perhaps fair to infer that others attached themselves to various portions of the vessel during the period they were confined in it. In regard to introducing food it is probable that not a very large amount went through the flannel strip, but some was put in the water with the syringe. So far then it appears that we can maintain a circulation in our breeding vessel without losing our young animals, and we can also introduce food by introducing fresh sea water which has been reduced to the temperature of that of the breeding vessel, and which has not passed through the flannel sifters.

The practicability of the artificial cultivation of the oyster, then, seems to hinge upon the care with which these steps or processes are carried out. Oysters seem to feed upon the inflowing tide, and if an apparatus is so arranged that the water can be drawn down steadily by means of the capillary attraction exerted through flannel or some other substance, until low in the dish, and then brought in with a steady stream of evenly-tempered water, with sufficient strength to move the young oysters about from place to place, and carry food about with it, it would appear as if practical success could be attained. In such an apparatus pieces of glass or small fragments of shells could be suspended, to which the young animals could attach themselves, and these pieces could be withdrawn and examined from time to time for the purpose of tracing the progress of the hatching. I propose to continue my experiments in this direction the coming summer as occasion may permit, and although the disadvantages are great of working with animals so small that a microscope has constantly to be used, yet I hope to be able to show that with care and good weather something practical can be accomplished.

A NEW SYSTEM OF FISH-WAY BUILDING.

BY MARSHALL M'DONALD.

It is a well established fact that the river fisheries of the Atlantic States have steadily decreased both in value and annual production for many years past. In some instances, species that were at one time common in certain of our rivers, are no longer taken. Indeed, the annual run of these fish which still continue their migration to the rivers, has undergone alarming decrease; and in many cases become too insignificant to furnish the motive or material for organized fisheries. Several causes, probably, have concurred in producing this decrease.

First—The capture of the greater portion of the run each year may not have left sufficient to maintain production under natural conditions.

Second—The erection of dams or other obstructions in the rivers, has in some cases, absolutely excluded certain species from their spawning grounds; the result being eventually to exterminate the species referred to in those rivers. In all cases the existence of such obstructions, has determined a decrease in the natural productiveness of the stream *pro-tanto*, with the diminution of the breeding and feeding area.

The remedy for the condition of things above indicated is to be found:

First—In the enactment of such legislation as will control excessive, and prohibit destructive modes of fishing.

Second—In compensating for the insufficient natural supply by artificial propagation and planting.

Third—In extending the area for breeding and feeding, by overcoming natural obstructions by means of fish-ways.

If the anadromous fishes only entered our rivers for the purpose of spawning, and their progeny spent no part of their life in our fresh waters, then the increase which we could determine by artificial propagation would be practically without limit. The fish-culturist, in order to maintain supply, would only have to produce the young fry in numbers sufficient to replace losses by capture or by casualty.

As regards all the anadromous species, however, which are the object of commercial fisheries, viz.: the salmonidæ, the shad, the herring or alewife, etc., it is necessary that the young, after hatching, should remain for some time in our fresh waters, feeding and growing, and of course, finding the necessary food in these waters. The extent of the breeding and feeding area of any river basin is, therefore, necessarily the measure of its possible productiveness. A given area when pressed to its maximum of production cannot provide for more than a given number of individuals. The extension of the area of production is, therefore, the rational means by which we may determine permanent increased productiveness. Hence arises the necessity for fish-ways, which are, in short, various constructions designed for the purpose of enabling different species of fish to surmount obstructions which would be otherwise impassible to them.

A fish-way to be effective must fulfill certain conditions, which are clearly stated by Mr. C. G. Atkins in an admirable article on the subject of fish-ways, published in the anuual report of the United States Fish Commission for 1872–73, as follows:

"First—It must be accessible; that is, the foot of the fish-way must be so located that fish will readily find it.

"Second—It must discharge a sufficient volume of water to attract fish to it.

"Third—The water must be discharged with such moderate velocity, that fish may easily enter and swim against the current."

To the conditions above stated we may add: Fourth—The route to be travelled by the fish should be as short and as direct as possible, and the floor of the fish-way should simulate as nearly as may be the bed of the stream.

The first condition may be always fulfilled in the location, by arranging so as to have the discharge of water from the fish-way in a line with or in the immediate vicinity of the obstruction. The second condition is more embarrassing. The larger the volume of water discharged through the fish-way the better it will be.

In the plans of fish-ways which are common throughout New England, the volume of the discharge is necessarily limited by

condition inherent in the constructions ; is compelled to travel a circuitous channel, and usually is delivered from the fish-way in such a sluggish current that it offers no sufficient invitation to the fish to enter and ascend it. As before stated, the difficulty of a limited capacity for water is inherent in all of these fish-way constructions.

The attention of fish-culturists and fish-way builders has been heretofore chiefly directed to different devices for controlling the velocity of the water in the fish-way. All these devices may be referred to one or two general forms :

First—In what is known as the "step" or "pool and fall" fish-way, the water is brought down from its elevation by a series of short drops or falls with intervening pools ; the pools being of such dimensions in comparison with the volume of water entering them, as to bring it practically to rest after each drop, so that the whole volume of water is eventually delivered from the lower end of the fish-way, with no greater acceleration than it obtains in falling from one pool to the next. This form of fish-way is very common in England and upon the Continent. Possibly some examples of such constructions may be found in the United States, but I have no information of any.

Second—In what Mr. Atkins terms inclined plane fish-ways, the descent of the water is effected by a regular inclination of the floor of the fish-way, instead of by "steps" or "pools and falls."

In order to control the tendency to acceleration under the action of gravity, the base of the incline is made very long in proportion to the height, and by a series of alternating transverse or oblique partitions, the water is constrained to follow a narrow tortuous path with continual changes of direction; the friction developed in its movement being sufficient to overcome the tendency to acceleration.

Of this second general form we have many examples in the United States, especially in New England. The common rectangular fish-way, the Brackett, the Foster, Pike's, Atkins', Swozey's, Brewer's, and Roger's, are examples of the various designs that have been employed, each differing in minor details of construction, but all belonging to a common system. Most

of these forms may be built either on an incline leading straight down from the dam, or with a return section so as to deliver the discharge from the fish-way close up to the foot of the dam, or they may be built in spiral form and boxed over so as to be made secure against floods and ice.

The fish-way of Mr. J. D. Brewer is peculiar in the fact, that the channel to be followed by the fish is a zig-zag groove excavated or framed in the floor of the incline, which is built either of masonry or strong timbers. The strength of the construction being such, it is presumed, as to prevent its destruction by floods or ice. The Roger's fish-way is recessed into the dam, and boxed over the lower end, discharging the water on a line with the face of the dam. This construction could, however, be applied to any of the forms above indicated and has been proposed in several of them.

The experience of fish-way builders in New England has shown that for dams ten feet in height or more, it is not allowable to build the incline with a rise of more than one foot in twelve to sixteen, requiring a length of incline of 140 feet for a ten-foot dam. The actual path, however, travelled by the water and traversed by the fish ascending, would be some two or three times the length of the incline, so that fish passing up an inclined plane fish-way rising ten feet vertically, would necessarily travel a distance forty to fifty times the height of the dam. For example, in the fish-way over the Hadley Falls Dam on the Connecticut River, the total length of the incline is about 450 feet. The distance to be travelled by the fish ascending it is not far short of 1500 feet, to overcome an ascent of about 29 feet.

All the different designs of fish-ways constructed according to the incline plane system, have when judiciously located, proved more or less successful in passing certain species of fish. In all, however, the labrynthine route to be traversed, and the insignificant flow of water through them, constitute very serious objections.

AN IDEAL FISH-WAY.

If it be possible, by any practical construction, to deliver the whole volume of a stream, over a dam or other obstruction with

such moderate velocity, that the weakest and least adventurous fish could readily swim against it, we would practically destroy the obstruction, and would establish for the migratory species a passage up to their spawning grounds as free and unrestrained as if no obstruction existed.

In practice, of course, this ideal can be realized only in exceptional cases, for industrial necessities or consideration of cost will necessarily limit the dimensions of the fish-way, and the amount of water that may be discharged through it, but just in proportion as we approximate this ideal in our fish-way constructions, do we approach more nearly the solution of the problem of free circulation of the anadromous fishes in continental waters.

When the Commission of Fisheries was inaugurated in the State of Virginia, in 1875, one of the most important questions presented to it was, how to make adequate provision to get the anadromous fish over the innumerable dams that obstruct the main water courses of the state, and all their tributaries.

The white shad (*Alosa sapidissima*) is one of the most important food fishes in all the tributaries of the Chesapeake, and in times past has furnished the motive of immense and profitable fisheries. The restoration and maintenance of this valuable fishery was one of the most serious questions presenting itself to the consideration of the Commission. The James and the Rappahannock Rivers were obstructed at the head of the tide by insuperable dams, interposing effectual obstructions to the further upward migration of the anadromous species.

Years ago, before obstructions existed, the migration of the shad in James River extended into the heart of the Alleghaneys two hundred and fifty miles above tide water, and in the Rappannock to the very base of the Blue Ridge Mountains. The curtailment of the breeding area by the erection of dams on both rivers, had determined a corresponding reduction in the productive capacity of the streams, and in concurrence with the irrational and unrestrained methods of fishing pursued, had rendered franchises, once valuable, worthless; industrious, once profitable, precarious and unproductive. A fish-way that would freely pass shad up over these obstructions, and recover to pro-

duction the breeding area of water from which they had been excluded, promised the means of restoring these most valuable fisheries.

The gentlemen who were then Commissioners of Fisheries for the State of Virginia, were pleased to select me to visit the Centennial Exposition, at Philadelphia, with instructions to make a careful study of the models of all the forms of fish-ways there exhibited, with the view of finding one that would be adapted to our purpose. A careful study of all was made, and I was reluctantly forced to the conclusion that none of them fulfilled the necessary conditions of successful operation, and I returned discouraged, with the conviction that an efficient shad-way was a thing of the future.

The conditions to be satisfied in a successful fish-way construction are as follows :

First—The water should be delivered down a straight unobstructed channel.

Second—In sufficient volume to invite the entrance of fish.

Third—With such moderate velocity as to permit their ready ascent.

Fourth—With a view to economy in construction, it is important that the inclination or slope of the way, should be much more considerable than in the ordinary inclined plane fish-way.

How to construct so as to fulfill these conditions was the problem to be solved. Two methods suggested themselves. It was possible to make the water do work in its descent and thus control velocity. A fish-way could be constructed on this principle by an evident modification of the ordinary turbine wheel, and such a fish-way could be made to serve both as a passage-way for fish and as a motive power for machinery. This idea, however, was soon abadoned for the double reason of its complexity, and the limitation of its application that would necessarily exist.

The second fruitful idea was that if each molecule of water could be compelled to traverse a constrained path, its final direction in any one circuit being against gravity, it could be brought to rest at a lower level—the friction developed in movement having neutralized in part the force of acceleration.

The molecule falling from its second position of rest through

a similar circuit, and in succession through any number of circuits, would finally reach any defined lower level with no greater velocity than that attained in the first circuit described. Were it practicable to subject every molecule of water passing through a fish-way to the constrained movement above indicated, the result would be a descending current, the average velocity of which would not exceed the average velocity of a molecule in

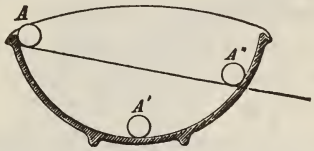


Fig. 1.

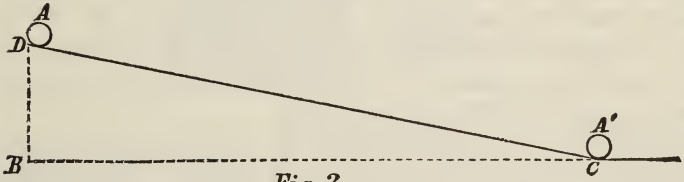


Fig. 2.

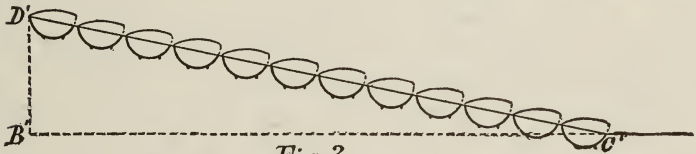


Fig. 3.

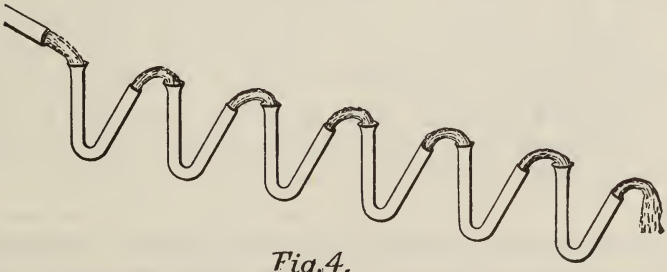


Fig. 4.

passing to consecutive positions of rest under the conditions above stated. How this idea has been realized in practical constructions, will be understood by references to the figures and descriptions.

If we take a hemispherical bowl (fig. 1) and holding a marble at A, upon the edge of the bowl, we release it, it will fall under the influence of gravity through A^1 to A^2, coming to rest at A^2, some distance below the edge of the bowl The vertical distance between the positions A and A^2, measures the force of acceleration that has been counteracted by friction by traveling the constrained path A, A^1, A^2.

If now, we take a number of similar bowls and cut them off to the line $A\ A^2$, and arrange them as in fig. 3, and start a marble at D^1, it will pass from D^1 to C^1, reaching C^1 with no greater velocity than that acquired in passing from A to A^2. If, however, the marble was allowed to roll unobstructed from A to A^1 down the incline plane D, C, (fig. 2) it will have acquired a velocity equal to $8\sqrt{Db}$, approximately.

We see, then, in this case how it is possible to deliver a molecule from a given position to a definite lower position, without the increase of velocity that would arise if the molecule fell freely under the action of gravity or rolled down a smooth incline. If it be possible to compel every molecule of water descending through a fish-way to submit to the conditions above indicated, then the problem how to control the velocity of a descending current would be solved. Now to apply this to liquids, we arrange a series of bent tubes, shown in fig 4. By suitable arrangements we keep the longer branch of the higher tube of the series full of water. The water escaping from each tube will rise against gravity until it comes to rest; then falls into the longer branch of the adjacent tube in the series, and after passing through the entire series be finally discharged from the shorter branch of the lowest bent tube, with no greater velocity than it acquired in passing through the first member of the series.

Construct a series of these tubes with branches brought close together, cut away obliquely the upper end of the longer branch

of each member of the series, so as to permit access of water pack them side by side, in oblique position in an inclined

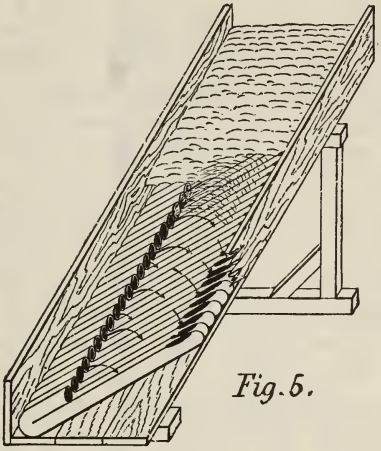


Fig. 5.

sluice, as shown in fig. 5, and we have the solution of the problem with which we started. For if we suppose a current of water to be running through the inclined trough or sluice-way, the first effect will be to fill the tubes with water and establish a flow through them; the water entering the longer branch of each tube will escape from the shorter branch with a velocity due to the head or vertical distance between the two ends of the tube. This final direction being obliquely up the slope, each particle of water will describe a path as is indicated by the curved arrows shown in fig. 5. The effect will be that we will have an ascending current in the sluice—on that side of the sluice where the shorter branches of the tubes are situated. The velocity of this ascending current will become less and less as we pass towards the middle of the sluice, where there will be a line or section of practically eddy water, and beyond a descending current, becoming more rapid as we pass to the further side of the sluice, where we find a current descending with uniform velocity, the maxium limit of which will be the velocity of the water escaping from the shorter branches, provided the supply of water and the capacity of the tubes are properly pro-

portioned. The illustrations here given present briefly and graphically the principles applied in the McDonald system of fish-way building.

The flexibility of the system adapts it to the widest range of conditions occurring in practice. An effective passage may be provided for the fish over obstructions, with the supply of water that will flow through a cross section six inches square, or the fish-way may be expanded so as to take the entire discharge of a river. Constructed roughly of boards, it furnishes at a nominal cost the means of reestablishing our innumerable trout streams to the natural conditions of reproduction.

These fish-ways may be made so light as to be readily portable, so that, in the season when the fish are not running, they may be stored away under shelter and thus protected from decay or destruction by ice or floods. In public parks and trout preserves, where considerations of cost are not controlling, the fish-way may be built of iron in ornamental designs, and while serving its essential purpose, made to contribute to the picturesqueness of the landscape. Solidly built of stone and iron, and of dimensions proportioned to the volume of the stream, it may be made strong enough to resist the utmost force of floods and ice, and by furnishing an easy passage for shad, salmon and other anadromous species of fish, make possible the restoration and maintenance of our valuable river fisheries, in spite of the obstructions which are the inevitable and necessary adjuncts of civilization.

As an example of construction, we have given in fig. *6a* the elevation, and in fig. *6b*, the plan of a double fish-way built of timbers. It consists of an inclined sluice-way of boards, the sides and bottom of which are supported by suitable framing. The sluice has in this case an inclination of one foot in three. The upper end is let into the dam so that its upper line is flush with the crest line of the dam. The lower end descends to the water below the dam, and is firmly anchored by being secured by bolts either to the rocky bed of the stream, or to piles suitably placed, or by other suitable means. Intermediate supports may be provided, by trestling, as shown in the figure, by log cribs or by rubble masonry. The incline flume or sluice thus established

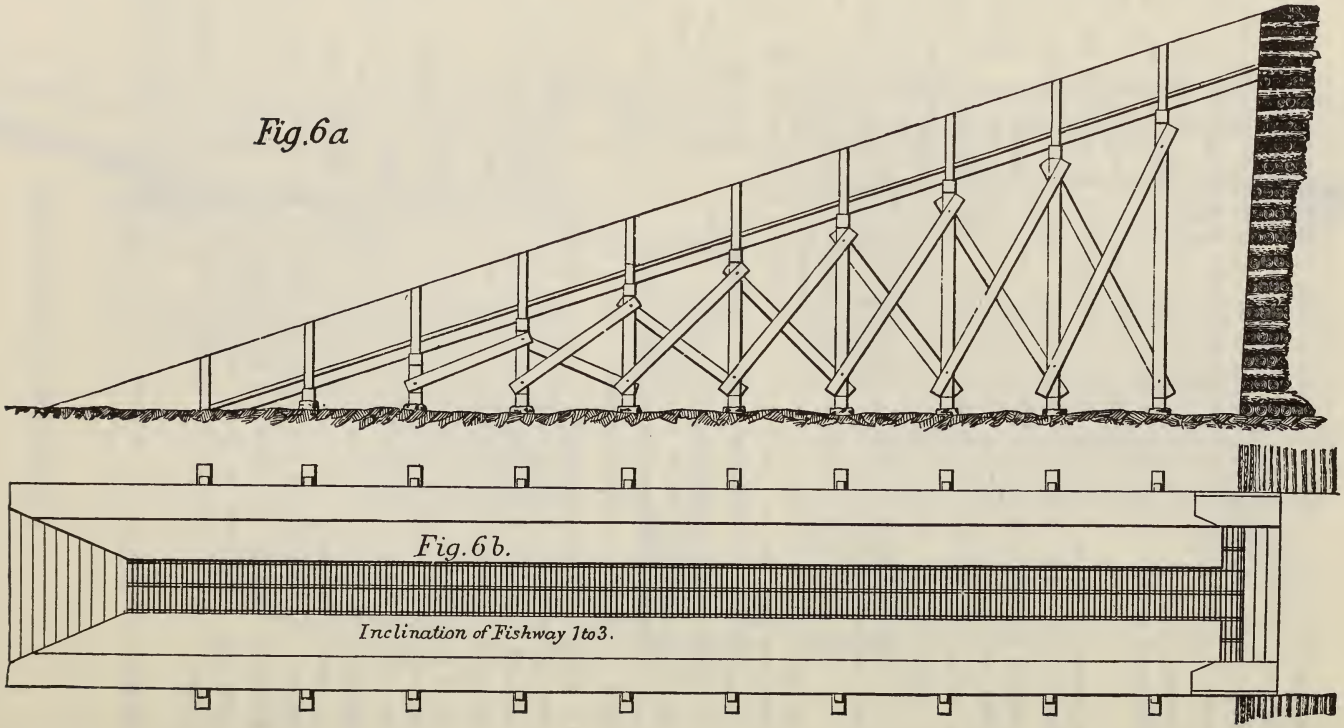


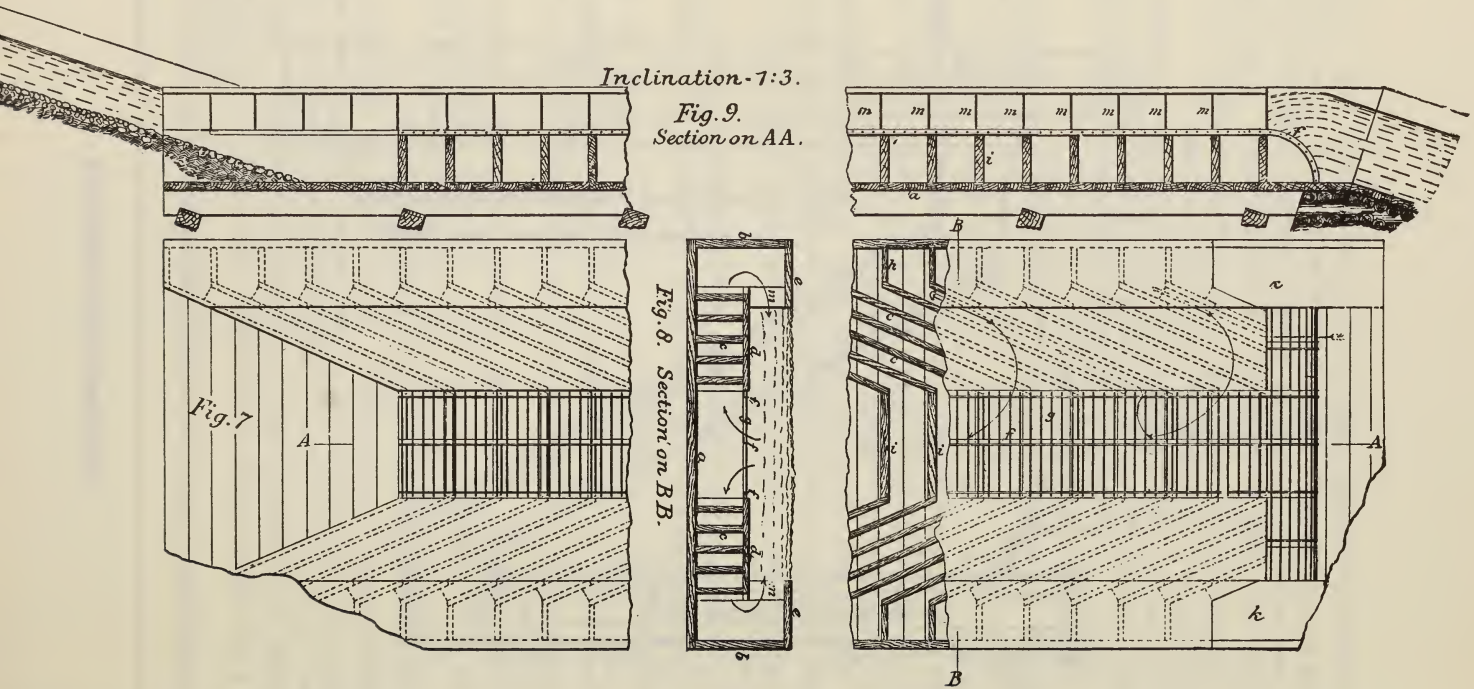
Fig.6a
Fig.6b.
Inclination of Fishway 1 to 3.

furnishes the foundation for the structure of the fish-way proper which is placed within it.

Details of construction are given in figures 7, 8 and 9, which are on a scale of one-fourth of an inch to the foot. The substructure having been established, we begin by setting up along the centre line of the trough or sluice, the bulkheads *I*, *I*, *I*, and *C*, at intervals of twelve or fifteen inches. These are made of planks one and a half inches thick, two feet long and fifteen inches wide. These are firmly attached to the flooring of the sluice either by spikes or bolts. Posts *H*, H^1 and *C*, of one and a half inch stuff, nine to twelve inches wide, and extending from the floor to the upper edge of the inclined trough, are now set up at similar intervals of twelve to fifteen inches, and firmly secured to the sides and bottom of the trough. To the posts *H*, *H*, and bulkheads *I*, *I*, the fifteen inch joists are securely nailed or bolted. The floor *D*, fig. 8, of one and a half inch plank is next laid and nailed to the inclined joists as shown in figures 7 and 8, upon the floor *D*. Next set up the short return buckets *M*, *M*, and *C*, figures 8 and 9, securing the same to the parts *H*, *H*, and to the floor by nailing or other suitable means. The cap *E*, *E*, fig. 8, made of a single two inch plank is fastened securely to the sides *B*, *B*, the posts *H*, *H*, and the return buckets *M*, *M*, thus completing the construction.

We have here realized in timber the same construction and secured the same control of the descending current as shown in the experimental apparatus, fig. 5. The course of the water is shown by the arrows. When a sufficient supply of water is brought to the head of the fish-way, we will have an average depth of water way above the floor, *D*, of ten to twelve inches. Any excess of water over the amount needed to fill the fish-way will be shed over the sides, and the fish-way will continue in efficient operation in any stage of water.

In the drawings figures 7, 8 and 9, the open spaces between the bulkheads *I*, *I*, and *C*, and also the head of the fish-way where the water passes under the floor *D*, directly from the dam, is represented as guarded by a wrought iron grating. This is only necessary where the exposed position requires that the weak points be protected from injury by ice or drifting timbers


Inclination - 1:3.
Fig. 9.
Section on AA.
Fig. 7
Fig. 8. Section on BB.
A
B
m
i
a
r
k
g
f
c
e
b

The grating may be dispensed with where other safeguards are made use of.

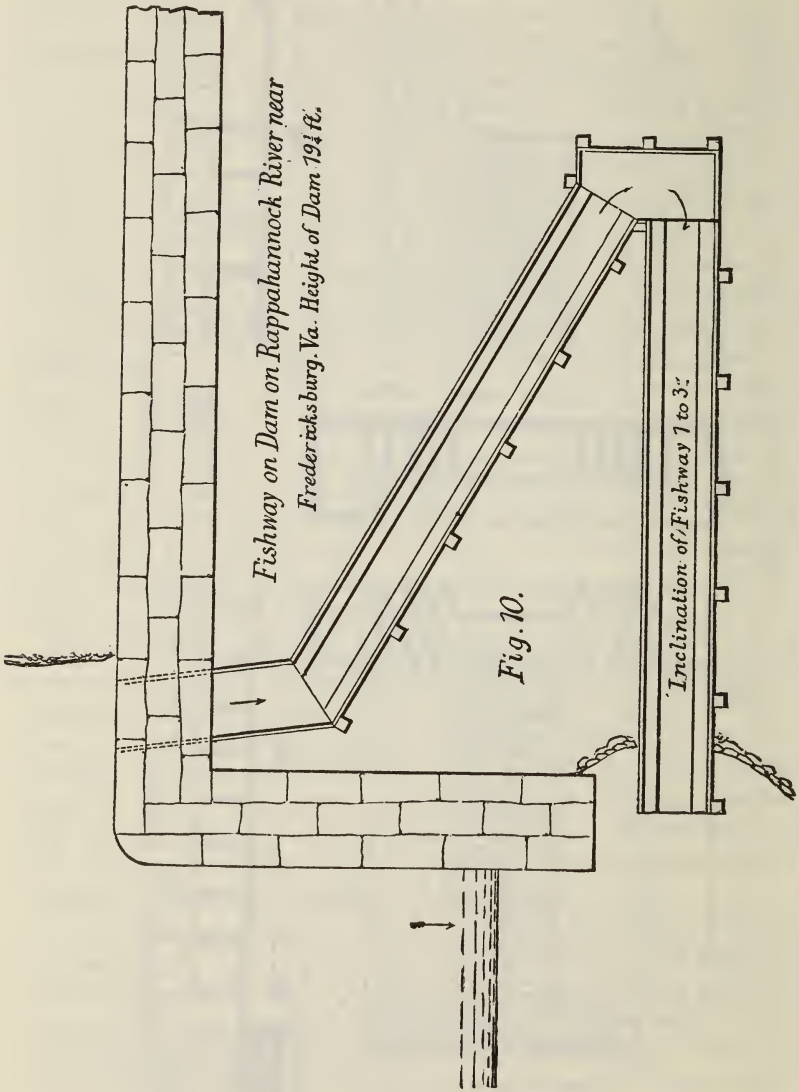


Fig. 10.

LOCATION.

The proper setting or location of the fish-way is a matter of prime importance to secure satisfactory operation. Where the cost of the construction is considerable, the location should be made under the direction of a competent engineer, and after a careful study of the locality. In all cases the following conditions are to be observed in the construction:

First—The water capacity of the fish-way must be in proportion to the volume of the stream. The more water we can discharge through the fish-way the more satisfactory it will be in operation.

Second—The upper end of the fish-way must be set at such a level as to run full at ordinary spring stages of the stream.

Third—The discharge from the fish-way should be made close to the face of the dam.

Fourth—The fish-way must be so located as to be sheltered from ice and drift, or when this is impracticable it must be built strong enough to resist injury.

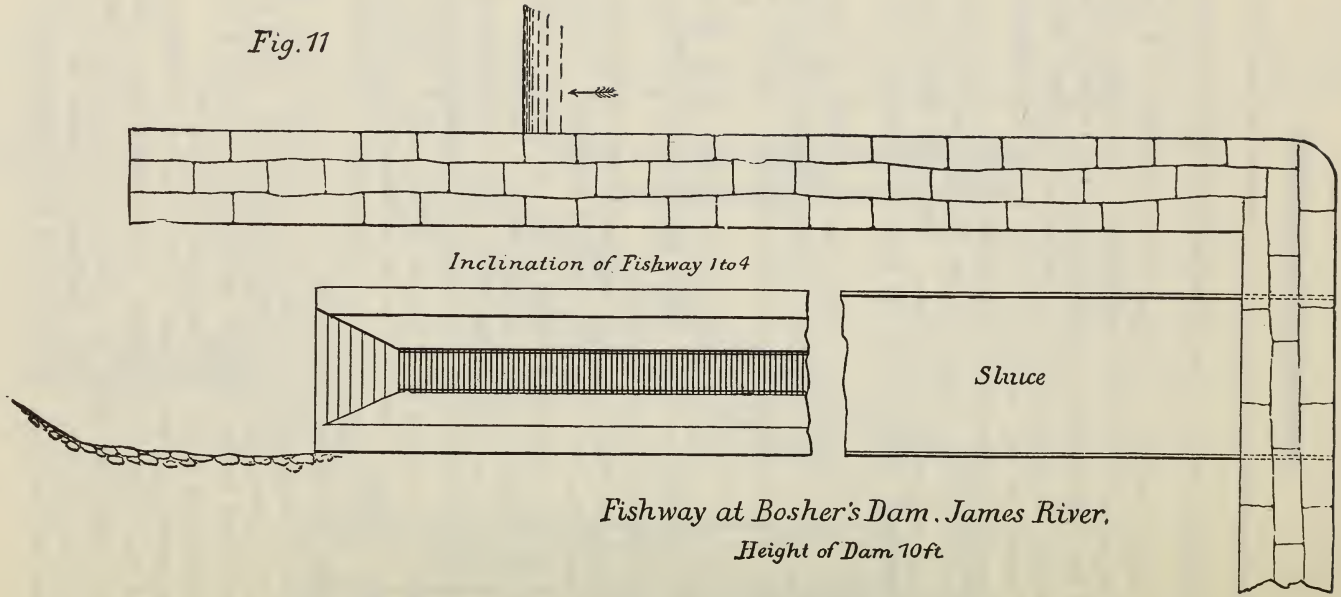
Where these conditions are realized in the construction, complete satisfaction in operation may be expected. In figures 10, 11 and 12 are presented three plans of actual constructions, which will furnish useful suggestions as to location.

Figure 10 shows plan of fish-way on the Rappahannock River, near Fredericksburg, Va. The water is brought to the head of the fish-way by a culvert piercing the flood wall. The fish-way is built on a slope of one foot in three, and in two sections, so as to bring the discharge close to the abutment. This has been in successful operation two seasons.

Figure 11 shows plan of fish-way at Bosher's Dam on James River, Virginia, nine miles above Richmond. This is a later and improved design, though embodying the same principles of construction as shown in the Fredericksburg way.

Here advantage was taken of the locality to shelter the way behind the high flood shown in the drawing. Two arched culverts admit the water to a sluice which conducts it to the head of the fish-way. This discharge of water is too far from the face of the dam to secure the best results, and it will be

Fig. 11



Fishway at Bosher's Dam, James River.

Height of Dam 10 ft.

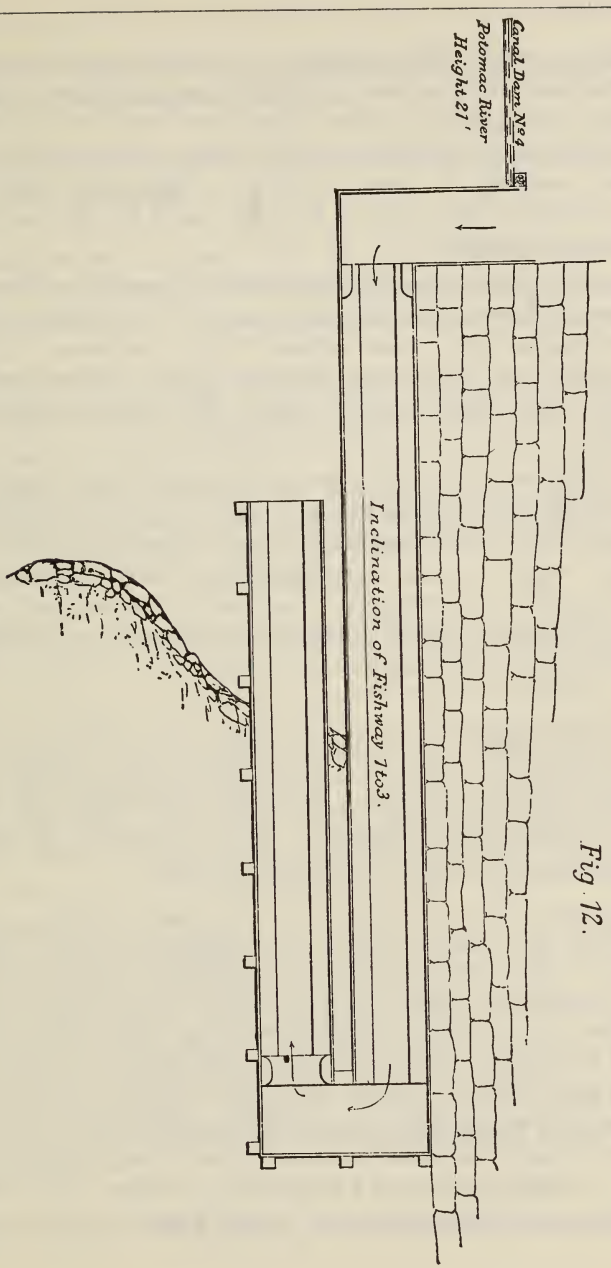

Canal Dam No. 4
Potomac River
Height 27'
Inclination of Fishway 1 to 3.

Fig. 12.

necessary to erect a deflecting wall at the lower end, to turn the current around the abutment. This fish-way has been in operation since the middle of May, 1883, and since the water has been turned on, all the river species except the shad, have been observed passing in large numbers. Very few shad have reached the dam this season; the total catch by the nets being less than two hundred.

Figure 12 shows plan of fish-way on Canal Dam No. 4, on the Potomac River, near Sheperdstown, W. Va. This was built in the winter of 1882, stood without injury, the heavy ice drifts and floods of the late winter, and during the season just past, has given full satisfaction to those who have watched its operation.

The black bass and other river species have been observed to pass it in numbers and with ease. In this case the fish-way is sheltered behind the abutment on the Maryland side of the river, the upper section being suspended to the abutment by stout wrought iron brackets. The water is conducted to the head of the fish-way from the crest of dam by a trunk leading around the face of the abutment.

Mr. Page: There has heretofore been no certainty about the action of fishways, but it is now generally acknowledged that Col. McDonald has invented one that will accomplish all that is sought in effecting the passage of fish over dams in the easiest and best manner, and also at the least expense.

Mr. Phillips: I would bring to the notice of this Association the death of M. Charbonnier, the very celebrated fishculturist of France, whose reputation was world-wide. He was particularly interested in introducing and acclimatizing foreign fishes, either of value as food or ornament, and was the first to introduce the gourami into France. During the siege of Paris, when fuel was scarce and the weather too cool for his gourami, he burned his furniture to warm them, and so saved them through those dreadful days. Originally he was a tin-smith, but came to love nature and study it, until his name was widely known in both hemi-

spheres for his practical knowledge, and he was elected to membership in many learned societies.

Resolutions of sympathy and regret at the death of M. Charbonnier were passed.

Mr. Benkard: I would like to bring up the subject of the pollution of our waters, which brings many of our fishcultural efforts to nought. I would respectfully offer the following:

Whereas: It is the sense of this Association that the continual and increasing pollution of the waters of New York bay from the refuse of certain factories, threatens eventually to kill or drive away all fish, shellfish and bivalves natural to said waters;

Therefore, be it resolved that this Association beg to call the immediate attention of the Fish Commissions of the States of New York and New Jersey, also of the members of their legislatures, to this impending calamity.

Mr. Blackford seconded the resolution, and said that it was important that our labors should not be destroyed, as they would be if some way were not found to prevent this pollution. Complaints are made that the shad taken in the harbor taste of kerosene and that the pollutions have driven out the shrimp. New York bay, adjoining Jersey City, formerly produced lobsters, there are none there now. Each year they deteriorated in quality, became watery, with bad flavor, and finally disappeared. But few are found at Hell Gate now, and even the clams are scarce, probably because of the refuse from the Standard Oil Works. Near Rockaway and Barren Island the oysters and clams are about exhausted and the fish driven away. The fishermen have called on the Fish Commissioners for action, but the latter have power only to cultivate, not to protect. The substance called sludge acid pollutes the water about New York, in addition to the filth of the city. I hope the secretary will put himself in communication with the legislatures of New York and New Jersey.

Col. Bryson: The Supreme Court has decided that the State

has no jurisdiction over navigable waters. We should communicate with the general government at Washington, and the States should have concurrent legislation.

MR. PAGE: Mr. Blackford referred to Hell Gate. Nearly all the Standard Oil Works are near there, at Hunter's Point. The residuum must amount to 25,000 barrels, emptied into the East River in twenty-four hours. 100,000 barrels are swept through the kills into Newark bay, and the oysters are destroyed.

COL. BRYSON: I am a stockholder in the Standard Oil Company, but think it will be profitable to them to be forced to find some use for their refuse.

MR. BLACKFORD moved that the Recording Secretary take charge of the papers and prepare them for speedy publication. Carried.

COL. BRYSON moved that if the indebtedness was not cancelled within ten days that the Treasurer receive voluntary subscriptions. Carried.

The meeting then adjourned.

TREASURER'S REPORT.

Dr. *American Fish Cultural Association in account with Eugene G. Blackford, Treasurer.* **Cr.**

By Membership dues received, - -	$146 00	1882. To balance from last report, -	$57 26
		Dec. 30th, " Cash paid J. M. Davis, for printing Reports, etc. -	175 00
		1883.	
		Jan. 2d, " Cash for Stamped Wrappers, -	1 59
		May 12th, " " " Postage, - -	1 30
			$235 55
By balance due Treasurer, - -	$89 55		
	$235 55		

New York, June 7th, 1883.

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American Fish-Cultural Association.

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Lyman, Theodore, Brookline, Mass.
Mather, Fred., *Forest and Stream*, New York.
Mathews, W. C., Toronto, Ontario.
Mallory, Charles, foot Burling Slip, New York.
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Middleton, W., Fulton Market, New York.
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Miller, Ernest, Fulton Market, New York.
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Mull, B. E., Fulton Market, New York.
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Townsend, Thomas D., Toronto, Ontario.
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Thompson, John H., New Bedford, Mass.
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Trimble, Dr. J. P., 221 East 12th Street, New York.
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Van Siclen, G. W., 99 Nassau Street, New York.
Ward, George E., 43 South Street, New York.
Webber, Samuel, Manchester, N. H.
Weeks, Seth, Corry, Erie Co., Pa.
West, Benjamin, Fulton Market, New York.
Wharton, W. F., Union Club, New York.
Whipple, John, Union Club, New York.
Whitcher, W. F., Ottawa, Ontario, Canada.
White, David T., Mayor's Office, New York.
Whitney, Samuel, Katonah, N. Y.
Wilbur, E. R., 40 Fulton Street, New York.
Wilcox, W. A., 176 Atlantic Avenue, Boston, Mass.
Willetts, J. C., Skeaneatles, N. Y., or 1 Grace Court, Brooklyn, N. Y.
Wilmot, Samuel, Newcastle, Ontario.
Wiman, Erastus, 312 Broadway, New York.
Wood, Benjamin, New York City.
Woodruff, G. N., Sherman, Conn.
Woods, Israel, Fulton Market, New York.
Yarrow, Dr. H. C., U. S. A., Washington, D. C.

TRANSACTIONS

—OF THE—

AMERICAN FISH-CULTURAL ASSOCIATION.

THIRTEENTH ANNUAL MEETING.

Held * at * the * National * Museum, * in * Washington, * D. * C.

MAY 13TH AND 14TH, 1884.

NEW YORK.

1884.

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CONSTITUTION

OF THE

American Fish-Cultural Association,

WITH ALL ITS AMENDMENTS AND CHANGES FROM ITS ORGANIZATION TO ITS LAST MEETING IN 1883.

COMPILED BY FRED MATHER.

Original Constitution, as adopted at the first annual meeting, New York, December 20th, 1870. From the first report of proceedings, 1872; pp. 3, 4.

ARTICLE I.—NAME AND OBJECTS.

The name of this Society shall be "The American Fish Culturists' Association." Its objects shall be to promote the cause of fish-culture; to gather and diffuse information bearing upon its practical success; the interchange of friendly feeling and intercourse among the members of the Association; the uniting and encouraging of the individual interests of fish-culturists.

ARTICLE II.—MEMBERS.

All fish-culturists shall, upon a two-thirds vote of the Society, and a payment of three dollars, be considered members of the Association, after signing the Constitution. The Commissioners of the various States shall be honorary members of the Association, *ex-officio*.

ARTICLE III.—OFFICERS.

The officers of the Association shall be a President, a Secretary, and a Treasurer, and shall be elected annually by a majority vote. Vacancies occurring during the year may be filled by the President.

ARTICLE IV.—Meetings.

The regular meetings of the Association shall be held once a year, the time and place being decided upon at the previous meeting.

ARTICLE V.—Changing the Constitution.

The Constitution of the Society may be amended, altered, or repealed by a two-thirds vote of the members present at any regular meeting.

AMENDMENTS.

First Amendment. [*Meeting at Albany, February 7th*, 1872.]

"On motion of Mr. Livingston Stone, the Constitution was amended by striking out the word 'and' after the word 'Secretary' in Article III., and inserting after the word 'Treasurer' the words 'and an Executive Committee of three members.'" First Report, page 10.

Second Amendment. [*Meeting at New York, February 10th*, 1874.]

"On motion of Mr. F. Mather the Constitution was so amended that the list of officers should include a Vice-President." Third Report, page 3.

Third Amendment. [*Meeting at New York, February 10th*, 1874.]

"On motion of Mr. Stone, all those who had paid five dollars and signed the Constitution, were made members of the Association without further action." Third Report, page 4.

Fourth Amendment. [*February 11th*, 1874.]

"Mr. H. J. Reeder moved that the Constitution be amended by striking out the last paragraph of Article II., relating to honorary members. Carried." Third Report, page 5.

Fifth Amendment.

"Mr. Page moved that the Executive Committee consist of five. Carried." Third Report, page 5.

Sixth Amendment. [*February 11th*, 1874.]

"Mr. George S. Page moved to amend Article II. by striking out the words 'all fish-culturists,' and inserting the words 'any person.' Carried." Third Report, page 5.

SEVENTH AMENDMENT. [*February 9th*, 1875.]

"Mr. Page moved that Article II. be amended by making the annual dues three dollars. Carried." Fourth Report, page 4.

EIGHTH AMENDMENT. [*February 28th*, 1878.]

"The Secretary (Mr. B. Phillips) proposed the following amendments to the Constitution:

"First: That the name of The American Fish-Culturists' Association be changed, and that of The American Fish-Cultural Association be adopted. Carried."

Second: "That the number of the Executive Committee be increased from three to seven members. Carried." Seventh Report, page 76.

[A foot note at the end of the proceedings says: "In changing the name of the Association from Fish-Culturists' to Fish-Cultural, the Secretary proposed that in the Constitution, after the final word 'Fish-Culturists'' the following be added: '*and the treatment of all questions regarding fish, of a scientific and economic character.*' This change and addition to the Constitution was adopted." Report of seventh annual meeting, February 27th, 28th, 1878; page 118.]

NINTH AMENDMENT. [*February 26th*, 1879.]

"Mr. Phillips moved for an amendment to Article III. of the Constitution, so as to include a Recording Secretary." Carried. Eighth annual meeting, page 50.

RESOLUTION. [*March 30th*, 1880.]

Mr. Phillips offered the following: "That in case members do not pay their fees, and are delinquent for two years, they shall be notified by the Treasurer, and if the amount due is not paid within a month, that they be, without further notice, dropped from the roll of membership." Carried. Ninth annual meeting, page 34.

TENTH AMENDMENT. [*March 30th*, 1881.]

Mr. Mather proposed to amend the Constitution to permit honorary members to be elected by a two-thirds vote, the same to be added to the Constitution as a part of Article II., relative to members, and to read as follows: "Any person shall, upon a two-thirds vote of the Society, be considered as an honorary member of the Society. Tenth annual meeting, page 3.

ELEVENTH AMENDMENT. [*April 3rd*, 1882.]

Mr. Evarts moved to amend the section relating to the election of officers by making those which are largely honorary, as the President and Vice-President, vacant after one year, and those holding them ineligible for the same office until after an interval of one year. Adopted. Eleventh annual meeting, page 4.

CONSTITUTION,

AS AMENDED UP TO AND INCLUDING THE TWELFTH ANNUAL MEETING IN 1883.

ARTICLE I.—NAME AND OBJECTS.

The name of this Society shall be "The American Fish-Cultural Association." Its objects shall be to promote the cause of fish-culture; to gather and diffuse information bearing upon its practical success; the interchange of friendly feeling and intercourse among the members of the Association; the uniting and encouraging of the individual interests of fish-culturists; and the treatment of all questions regarding fish, of a scientific and economic character.

ARTICLE II.—MEMBERS.

Any person shall, upon a two-thirds vote and a payment of three dollars, become a member of this Association. In case that members do not pay their fees and are delinquent for two years, they shall be notified by the Treasurer, and if the amount due is not paid within a month, they shall be, without further notice, dropped from the roll of membership. Any person may be made an honorary member upon a two-thirds vote of the members present at a regular meeting.

ARTICLE III.—OFFICERS.

The officers of the Association shall be a President and a Vice-President, who shall be ineligible for election to the same offices

until a year after the expiration of their terms, a Corresponding Secretary, a Recording Secretary, a Treasurer, and an Executive Committee of seven, which, with the officers before named, shall decide upon the place of meeting and transact such other business as may be necessary when the Association is not in session.*

ARTICLE IV.—Meetings.

The regular meetings of the Association shall be held once a year, the time and place being decided upon at the previous meeting.†

ARTICLE V.—Changing the Constitution.

The Constitution of the Society may be amended, altered, or repealed, by a two-thirds vote of the members present at any regular meeting.

[The revised Constitution may be found in reports 1879, page 61, and 1880, page 66. All honorary members were abolished in the third report, page 5, and the Constitution was amended to allow of the appointment of such members at the tenth annual meeting (page 3). The "Order of Business" adopted by the Association will be found in the reports for 1877, page 7; 1878, pages 3 and 116; 1879, page 51; 1882, page 4.]

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* This is not the exact wording of the Constitution, but it is the spirit of it. The original Constitution does not mention an Executive Committee. One is provided for in an amendment in the first report, page 10, and is afterward increased from three to five, (Third Report, page 5), and again to seven (Seventh Report, page 76). It has been the custom for the President, Vice-President, Secretaries and Treasurer to be members, *ex officio*, of the Executive Committee, and such a law may have been passed. If so, I have missed it. F. M.

† In the published reports there is no record of any date of meeting, so fixed. The first reference to such mode of appointing dates of meeting will be found at the close of the fifth annual meeting of the Association in New York, February 8th, 1876 (Fifth Report, page 7). The second reference to this clause will be found in the report of the special meeeting of the Association in Philadelphia, February 14th and 15th, 1877, page 9. The third date of meeting appointed is left indefinite as to the days, but indicates February, 1879 (Report of Seventh Annual Meeting, February 27th and 28th, 1878, page 118). In the proceedings of the eighth meeting, February 25th and 26th, 1879, it will be seen that (page 60) "the meeting adjourned to meet again in March or April, 1880, at the call of the Executive Committee." In the proceedings of the ninth annual meeting, page 65, these words occur: "the meeting then adjourned to next year, the date to be fixed at some future time by the Executive Committee." The report of the tenth annual meeting merely says: "The meeting adjourned." The eleventh report does not mention the adjournment, while the last one, June 7th, 1883, page 76, says: "The meeting then adjourned." This appears to me to sanction the appointing of the time and place of meetings by the Executive Committee. F. M.

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Thirteenth Annual Meeting

OF THE

AMERICAN FISH-CULTURAL ASSOCIATON.

FIRST DAY.

The opening session of the Thirteenth Annual Meeting of the American Fish-Cultural Asssociation was held on the morning of May 13th, in the lecture room of the United States National Museum, Washington, D. C. Among those present at the opening session were Mr. James Benkard, President of the Association; Mr. Eugene G. Blackford, Treasurer; Mr. Fred Mather, Recording Secretary; Messrs. Francis Endicott, G. Brown Goode, Marshall McDonald and Chas. B. Evarts, of the Executive Committee, and Messrs. George Daniels, Commissioner of Fisheries, Toledo, Ohio; Livingston Stone, Geo. Shepard Page, Dr. C. A. Kingsbury, Dr. J. C. Parker, Frank N. Clark, Charles G. Atkins, W. O. Atwater, H. J. Rice, and others. The Corresponding Secretary, Mr. Barnet Phillips, was unfortunately prevented from attending.

The President in calling the meeting to order, remarked that the interest taken in the subject of Fish-Culture was plainly evidenced by the presence of so many distinguished men of science. The Association was indebted to the United States Commissioner of Fish and Fisheries, for having suggested Washington as the place where the Association should meet this year.

The minutes of the last annual meeting were then read by the Recording Secretary, Mr. Mather, after which the Treasurer,

Mr. Eugene G. Blackford, reported upon the financial state of the treasury of the Association.

The following gentlemen were at different times proposed for membership in the Association and were elected:

Charles G. Atkins, Bucksport, Me.; Tarleton H. Bean, Washington, D. C.; Prof. A. S. Bickmore, New York; Dr. H. H. Carey, Atlanta, Ga. A. Nelson Cheney, Glens Falls, N. Y.; Frank N. Clark. Northville, Mich.; J. W. Collins, Washington, D. C.; W. V. Cox, Washington, D. C.; Hon. Thomas Donaldson, Philadelphia, Pa.; R. E. Earll, Washington, D. C.; H. W. Elliott, Washington, D. C.; W. E. Garrett, New York; A. A. Hayes, Washington, D. C.; Dr. J. A. Henshall, Cynthiana, Ky.; George S. Hobbs, Washington, D. C.; E. S. Hutchinson, Washington, D. C.; A. J. Kellogg, Detroit, Mich.; Hon. E. G. Lapham, M. C., New York; W. L. May, Fremont, Neb.; Hon. H. P. McGown, New York; Dr. J. C. Parker, Grand Rapids, Mich.; Hon. R. G. Pike, Middletown, Conn.; Richard Rathbun, Washington, D. C.; Hon. Ossian Ray, M. C., New Hampshire; Prof. J. A. Ryder, Washington, D. C.; Carl W. Schuermann, Washington, D. C.; Col. James Stevenson, Washington, D. C.; Joseph Willcox, Media, Pa.; Lieut. Francis Winslow, U. S. N.; S. G. Worth, Raleigh, N. C.

FRESH AND SALT-WATER HATCHING AT COLD SPRING HARBOR.

BY FRED MATHER.

The new station of the New York Fish Commission, designed for hatching both salt and fresh water fishes, is situated on the north side of Long Island, thirty-two miles east of New York city by railroad. The harbor was formerly a whaling station, and many old buildings connected with that industry still remain there unoccupied. The line between the counties of Suffolk and Queens runs through the center of the harbor, and while the village and post-office is in the former county, the hatcheries are in the latter. There are two points of especial excellence in the site which will at once commend it, and these are the

elevation of the springs, one of which is fully fifty feet above the hatchery, and the proximity to salt water, which at half tide is only two hundred yards away.

The work at the station was begun on January 1st, 1883, by the joint operations of the United States and the New York Fishery Commissioners, and has been continued by both commissions since. The grounds were given, rent free, by Mr. John D. Jones and his brothers Townsend, Samuel and Edward, and the upper spring by Dr. O. L. Jones, and in addition to this, Mr. Townsend Jones has given stone from the Connecticut quarries to build a sea wall to hold the tide at all times. Two old buildings have been fitted up as hatcheries, and the work done in the short space of time will bear close inspection and comparison with older establishments. Maps of the grounds will be found in the last report of the New York Fish Commissioners by those who care to know more of the station.

In the fresh water department the present capacity of the house has been nearly taxed by the hatching of 500,000 salmon, 10,000 landlocked salmon, 38,000 rainbow trout, 50,000 European trout and 1,000,000 whitefish. The fact that the European trout were in five different lots, which will be enumerated further on, rendered it necessary to place them in separate troughs, even though as small a lot as 2,000, taken from one English stream, were kept separate in a trough which could just as well have accommodated 30,000. The whitefish table will hatch 4,000,000 as well as 1,000,000, so that at present we can say that the capacity of the hatcheries is 800,000 salmon and 4,000,000 whitefish, or 1,000,000 salmon and the whitefish. This can be increased, if necessary.

TROUT.

Our native brook trout were formerly plenty in the ponds on this place, but owing to a lack of protection, they were very few when the land was leased to the Fish Commission; about fifty fish being the extent of their number. Eggs of the rainbow trout have been received from three different places, viz: Direct from the U. S. hatchery, at Baird, Shasta County, California; from the U. S. station at Northville, Mich., and from the New York station at Caledonia. They have grown well, but are a

fish that I have never fancied much, and am in greater doubts as to their value since reading the last report of the New York Fish Commission, which says:

"A good deal is to be learned yet respecting temperature and other local conditions affecting fish. Till the past year not enough had been done in stocking with rainbow trout to warrant a judgment of their ultimate success in the waters on the Atlantic side. Their time of spawning occurring at a different season from that of the native brook trout, it would not seem to be policy to plant them in waters inhabited by that fish. The protective seasons would need to be different, and inhabiting the same waters one kind might be taken often when the other was fished for, and thus unintended violations would be liable to occur. An obstacle to their ready success in our waters presents itself in the circumstance that at the season the fry are ready to plant, all other fish are greedily feeding, and consequently a considerable share of the fry are liable to be nipped in the bud. This, however, may be avoided by providing places where the fry can be free from the presence of predatory enemies till they are able to look after their own safety.

"From the circumstance that they have not been readily found always in the second year, where the plants have been made, it has been surmised that they are a migratory fish—working their own way, as soon as they attain any considerable growth, down stream toward the ocean. Their disappearance, however, may be accounted for by the other cause stated. Further experiments will be necessary to solve all the problems connected with their establishment in the Eastern waters; but the promise continues to be that they will prove themselves a fish of great value in stocking large streams whose temperature is too high for brook trout."

An editorial note in FOREST AND STREAM of May 1st, written by myself, says of the rainbow trout:

"We would call attention to the paragraph in our notice of the report of the New York Fish Commission concerning these fish. It is beginning to be learned that they are migratory, and do not remain in brooks. We have never been much in favor of this fish, because we have known, what is not popularly known,

that the fish is strongly suspected to be a salmon. There is no difference that an ichthyologist can find between the *Salmo iridea* and the salmon known as 'steelhead,' 'hardhead,' and 'salmon trout' on the Pacific coast, the *Salmo gairdneri*. Although this is the case, and the species *iridea* is a doubtful one, yet it has been thought best not to combine them for the present. We have been waiting and watching the habits of this alleged trout with great interest in order to learn if its habits might not show it to be in some respect different from the steelhead. The evidence of the Commission tend to show that it is a migratory fish, and if so it may escape to sea and be lost, as the other California salmon was. We believe that Mr. Roosevelt has not seen the rainbows which he planted in streams emptying into the Great South Bay, Long Island, since they were yearlings."

If this fish has to be confined by screens to prevent its migrating and perhaps entirely disappearing, as the quinnat salmon did, then it will be useless in our open brooks. The promise of the rainbow trout was that in it we had a quick growing fish, which was not as sensitive to warm water as our own *fontinalis*, a desideratum which now promises to be filled by the brook trout of Europe, *Salmo fario*. I would here call the attention of the Association to some specimens of this fish, which jumped out of the ponds last October, when they were six months old. They are, as you see, full six inches long, and are plump, handsome and finely formed. The eggs from which they came were sent to me as a personal present last year by Herr von Behr, President of the Deutschen Fischerei Verein, one of the most earnest and enthusiastic fish-culturists in the world. Two varieties were sent, one from the deep waters where they grow large, as in our Maine lakes, and the other from the swift mountain streams of the Upper Rhine, where they are smaller. This year he has repeated his gift by sending some to the United States Fish Commission, in my care, and some to Mr. E. G. Blackford, Commissioner for New York. Last year, when the fish were sent to me personally, I gave some of them to Mr. F. N. Clark, Superintendent of the U. S. station at Northville, Mich., and to Mr. M. A. Green, of the New York station at Caledonia. Both report them as doing well.

This year I repeated these divisions of the German eggs, and also received ten thousand eggs of the same species from Mr. R. B. Marston, editor of the *Fishing Gazette*, London. Five thousand of these were labelled "our best trout," 3,000 were from the Itchen, and 2,000 from the Wye. Both last year and this season the large German trout hatched well, but have died freely before taking food, while the small variety has thrived and been distributed to waters not named in this article. The large English trout have done splendidly and will be kept at the station for breeders. This European brook trout has, as you may see, a larger scale than ours, and to my eye is a more beautiful fish than our own trout. It is a fish that from its habit in Europe should live in the Hudson from North Creek, or above, down to Troy. In Europe it is found plentiful in the south of England, while the charrs, of which our so-called trout is one, are only found in the deep cool lakes of the North. I believe that we have the necessary conditions of the Atlantic coast to successfully acclimatize this fish, and I have always been skeptical about habituating the *Salmonidæ* of the short streams of the Pacific coast, with their snow-fed waters in mid-summer, to our longer and warmer rivers, and this skepticism has increased since I have suspected the so-called rainbow trout to be identical with the steelhead salmon, *S. gairdneri*, which is a migratory fish.

WHITEFISH.

The great surface exposure of the reservoir at this station is favorable to the late hatching of the whitefish. The temperature of the water in the hatchery for the month beginning February 23rd, and ending March 23rd, varied from 34 degrees to 48 degrees, the mean being 38½. Shipments of whitefish were made this year to Great Pond near Riverhead, Long Island, on February 15th, and to Lake Ronkonkoma on March 19th. This is as late as the fish are hatched in the cold lakes, and the young will find food when planted in March.

THE SALT WATER WORK.

The cold weather caused us to suspend out-door work before

the completion of the great tidal reservoir, but we were enabled to hold the water as high as half tide and to begin work. The hot air engine worked very well, and we hatched the eggs of the little tomcod (*Microgadus tomcodus*), locally known as "frost-fish" in the fall of the year, and as tomcod in the spring. I sent some of these eggs to Prof. T. J. Ryder, at the Central Hatching Station of the United States Fish Commission, and he hatched them in artificial sea water. The spawning season of this fish is in November and December, and they had finished spawning before our engine was in position, but we gathered the eggs from the seaweed, to which they are attached, in bunches the size of a hen's egg, and are easily obtained by the oystermen when raking for oysters.

We also obtained several millions codfish eggs from the cars at Fulton Market, but none of them were good. They showed the shrunken vitellus which gives both them and shad eggs a "speckled" appearance, which indicates that there is no possibility of impregnating such an egg. In every case the parent fish had been brought in the well of a fishing smack, and after being dipped out had been thrown into the floating car alongside, falling from four to six feet, usually on the abdomen. This, in my opinion, is more than the delicate cod egg can stand.

The membrane, or shell, covering the egg of the codfish, is so delicate that a light touch of the finger, when the egg is on any hard substance, will burst it like a soap bubble, while a trout's egg will bear the hardest squeeze that can be given between the finger and thumb. It is possible that the eggs will have to be obtained from the fishing grounds and be taken when the fish are first hauled in, although they may possibly be found to be good after the smacks arrive and before the fish are put in the cars.

POSSIBILITIES OF THE STATION.

In addition to the salt-water fishes mentioned, it is possible to hatch many other species. The density of the water varies from 1.018 to 1.022, sea water being 1.028 and distilled water 1. The temperature of the water in the hatching jars has, during the months of January, February and March, varied from 33 to

48 degrees Fahr., the mean being 42¾. The water is clear and pure, and everything seems to be favorable for doing much good work. Spanish mackerel and other valuable fishes may be attempted, while in the opinion of Prof. H. J. Rice, the situation is most favorable for oyster-culture. The harbor is part of the celebrated Oyster Bay, and oysters and clams are usually abundant and excellent. The past year, however, has not been a good one for either of these products, but the difficulty, whatever may have been the cause, is probably a temporary one.

It is to be hoped that the State of New York will adopt some such system as Connecticut has, and which is now in good working order and giving general satisfaction, and in addition, begin experiments looking to the production of seed oysters At a comparatively small expense these experiments can be conducted on the grounds at Cold Spring Harbor, where the machinery for pumping salt water is now in position, and where the situation is favorable for making such ponds as may be necessary.

The experiments of the gentlemen who have devoted their time to the impregnation of the eggs of the oyster, have proved that they can be fertilized and hatched in laboratories, and there seems to be no obstacle to the work being carried on, in a suitable location, on a larger scale.

Mr. Mather added: There has been much discussion in regard to this early hatching of the white-fish. At Caledonia and Northville, for instance, the young fish are put out so soon that some fish-culturists claim that there are no crustaceans hatched at that time for them to feed on. That is a question I cannot go into here, but I will state that at Cold Spring Harbor we can hatch out the fish much later.

The President: I would say that my experience with California trout has been somewhat different. The original eggs sent from the Smithsonian Institution were hatched out by us at the South Side Sportman's Club of Long Island, four years ago, in the month of April. This last winter we had fry out in January. Probably the locality is a point to be considered in this connection.

Mr. Blackford: I would like to hear Professor Ryder express his views in regard to the eggs of the cod-fish.

Prof. Ryder: My experience with cod-fish eggs, both at Fulton Market and at Wood's Holl, has been quite considerable. Our greatest success in handling these eggs has been in comparatively salt water, as Colonel McDonald can testify. The eggs taken at Wood's Holl were from fish that had been kept under the same conditions as those in Fulton Market. At the former place the eggs would float as they should normally, but at Fulton Market they had no tendency to float as did the eggs from the more northern locality. I also observed that in most cases the eggs had an abnormal appearance. The vitellus was disorganized, and the vitelline matter and germinal material were pulled out of shape. The germinal disc was formed, but defectively; in many instances, after formation, it had been broken into irregular fragments, which were certainly not characteristic of normal segmentation. What the cause was I cannot say, but I believe that the confinement of parent female fishes of any species would have a tendency to interfere with the fertility of the ova. That has been the experience at Havre de Grâce with the shad, and I should not be surprised if the confinement of female cod in the wells of the fishing smacks and the cars, would not tend to cause the eggs which were mature, and still contained in the ovaries, to become, to a certain extent, disorganized, and therefore incapable of fertilization. My conclusions have been formed deliberately, although the data have been very imperfect. There was this important difference between the eggs taken at Wood's Holl and Fulton Market. The latter exhibited a decided tendency to sink, which in our Wood's Holl experiment we always associated with a condition indicating that such eggs would never hatch. We invariably noticed this to be the case, and concluded to accept it as *prima-facie* evidence that whenever a cod egg went to the bottom, that was the last of it, so far as its capacity for development was concerned.

Mr. Mather: I have observed that the cod-fish eggs which I have taken at Fulton Market, New York, had a tendency to sink, as just stated by Professor Ryder. When I removed them from

the pan into a jar, the same thing occurred, and you could see the upper line of the eggs about half way up the jar. When placed in the McDonald hatching jars, they acted like white-fish eggs, except that they were a little lighter. The moment the circulation of the water stopped, they all sank to the bottom. I confess to having been somewhat skeptical about "floating eggs" of cod-fish, although I understand from Professor Ryder and Colonel McDonald, that at Gloucester the eggs actually floated on the surface, resembling in appearance a honey-comb, and that they were so buoyant that a portion of the egg would literally stand out of the water. I attributed the failure to impregnate the eggs taken at Fulton Market, to the shock which the fish suffers by being thrown into the cars from the fishing smacks. They are cast from the deck to the surface of the water, a distance of from four to six feet, and usually strike on their bellies. The cod egg is exceedingly delicate, and breaks like a soap-bubble at a touch.

Col. McDonald: The fish from which the eggs at Wood's Holl were taken, were, as far as I know, handled very carefully, being transferred from the smack to the car with as little violence as possible. But may not the difference in the results of the observations made at Wood's Holl and Fulton Market, be explained by a difference in the density of the water at the two places? Of course the buoyancy of the cod egg depends upon the density of the water in which it is placed. Now at Wood's Holl, where the water opens out to the ocean, it surely must be much more dense than at New York harbor, and the effect of this difference upon the eggs is clearly proved by the fact that those eggs which floated at Wood's Holl sank at New York. In regard to the eggs taken at New York, they were sent on in hermetically sealed jars to Washington, where on arrival they were found to be impregnated and a small proportion developing. They were then put into salt water artificially prepared, (5 oz. of salt to the gallon of water). Development went on, I think, for fifteen or sixteen days until the embryo was moving and the heart beating, and yet after all we did not succeed in hatching them. Up to that time their development, I believe,

was normal. The embryological investigations were carried on by Professor Ryder, who perhaps will add a few words.

Prof. RYDER: You do not mean to say that all the eggs taken were fertile, but that the greater portion of them were. There were large quantities that I know would come to nothing. The vitellus had turned to a brownish hue, and the germinal disc was disorganized.

SALT AS AN AGENT FOR THE DESTRUCTION OF THE FISH FUNGUS.

BY PROF. H. J. RICE.

There are very few persons who have ever had anything to do with the artificial rearing of fish; especially if the rearing is carried on in comparatively quiet and warm water; or who have ever had very much to do with fish in aquaria, but have been more or less exercised over the decorations and ravages of that very insidious and annoying vegetable parasite, commonly known as fish fungus, although it occurs, indeed, on many other objects than eggs and fishes. Many means have been employed for its destruction, and innumerable efforts made to dislodge it from the tanks where it had obtained a firm foothold. Asphalt, tar, salycilic acid, salt and various other simple or compound agents of destruction have been employed, and while each and all of them have been pronounced beneficial, yet most of them are difficult to apply, and after being applied much care is necessary in order that the agent shall not be the means of doing that which they were employed to prevent; that is, cause the death of the eggs or fish experimented with. Of all the agents thus far employed for the purpose of destroying this fungus, or *saprolegnia*, common salt is, taking everything into consideration, probably the most useful, since it can always be easily obtained and quickly manipulated. But it is always well to bear in mind that with whatever agent the work is carried on,

the agent will perform its part only when associated with vigilance, persistence and zeal on the part of the operator.

Having had occasion, during the past season, to make certain experiments in the direction of dislodging and exterminating this undesirable form of vegetation, which had secured too firm a hold in certain tanks and upon certain animals and fishes in the laboratory at Fulton Market, New York, I determined to try the effect of the continued use of a strong solution of salt, and to note carefully the results. The work was thus merely supplemental to what has already been done in this direction, and, so far as it goes, corroborative of such previous efforts. The animals upon which I experimented, personally, were goldfish of the Japanese variety, black bass and specimens of *Necturus lateralis*, or the mud puppy. I also induced Mr. Geo. Ricardo, fish warden of Bergen County, N. J., to undertake some experiments as to the efficacy of salt in destroying the fungus which collects so plentifully upon the trays and bunches of eggs in the smelt hatching operations. The experiments with the goldfish were begun during the month of January, and continued several months. The specimens operated upon were from a lot brought over from Japan and China in December by Capt. Jones, of the steamer Oxfordshire, and placed immediately upon their arrival in tanks of running water at the stand of Commissioner E. G. Blackford in Fulton Market. The fish had been very severely handled during their ocean voyage, many of them having large numbers of the scales knocked from their sides, evidently from being thrown against the sides of their vessel as the steamer struggled in the rolling waves.

From this cause, and undoubtedly also from the fact that the water into which they were placed was too cold for their warmth-loving constitution, they commenced to die, one by one, within a day or two of their landing on our shores. Those that died first were hardly more than still before the velvet-like plush of the *saprolegnia* spotted their bodies or fins, or in some cases, literally enveloped them in a robe of white. Soon not only the dead, but the living were similarly decorated, and it became evident very quickly that if something was not done the *saprolegnia* would, before long, claim them all its victims, although it

is hardly more than justice, perhaps to state that the fungus in all probability was in these cases, whatever it may be in the other cases, a secondary rather than a primal cause of death. While death was thus making sad havoc in the ranks of these beautiful fishes which were kept in the running Croton water down-stairs, those which I had taken, very soon after their arrival up-stairs into the laboratory and placed in a small aquarium of moderately warm water, were getting along nicely and were not troubled at all with the fungus. I then requested that four or five of these specimens affected with the fungus should be taken from the tank and sent up to me to be treated with a salt bath. I prepared the bath by placing three or four handsful of coarse salt in a small quantity of water, and then heated it over the fire until the salt was all dissolved.

Cold water was then added until the whole was a temperture of about 60 degrees, when the fish were taken very gently out and placed in their new location. At first the change was not apparently agreeable, as they darted about in a furious manner, but some became quiet and were taken out after an immersion of about one minute and returned to fresh water; but not to the same from whence they had been taken. In the course of half an hour or an hour the fungus began to loosen from the body in quite large patches, showing that the connection of the hyphæ, or rootlets, with the skin had been destroyed, and the next morning I picked out quite a large number of these discarded fungus flakes which the fish had thrown off into the water during the night. In order to make sure that the hyphæ should be entirely destroyed, and not leave relics from whence new crops might be generated, I gave each fish two additional baths of the strong salt water, and until they were moved from their aquarium and injured at a later period, I found no traces of fungus on any of them. It is true that in some of the cases experimented upon, the salt water did not cure the fish, but the salt water certainly killed the fungus, and undoubtedly if the fishes had not been very much debilitated before the bath was given them, their lives might have been prolonged as in the case of some of the others. The black bass which was experimented with, was literally loaded with a fluffy plating of fungus when

it was first placed in the bath. It acted much in the same manner as did the goldfish, except that from its size and strength it produced a much greater commotion in the water. It was left in the bath about ten minutes and then replaced in the tank from whence it had been taken. The next morning the entire surface of the body looked as if a card had passed over it and had raked the fungus out into long filaments and strings and streamers ready to be pulled off with scarcely an effort. Two days after a second bath was administered, but while still more of the fungus was loosened, the parasite had evidently been too long at work, the hyphæ had penetrated too deeply and drawn for too long a time upon the tissues of the flesh for it to recover, and in two days more it ceased to move.

The next animals to be experimented with were nine specimens of the mud puppy, or *Necturus lateralis.* These had all been more or less injured about the mouth with the hook in their capture, and two or three had their tails badly mutilated. Some of them were very much matted with the fungus when they arrived, while others were only slightly attacked. They were all placed in the bath and the fungus was loosened or killed upon all of them, but the salt water had the effect, in the cases of those severely injured, of aggravating the injury, and by increasing the rawness of the wounds, prepared the field for a new crop of the fungus, since the water was full of the *saprolegnia* spores, ready, and indeed anxious to continue the old condition of affairs whenever opportunity offered. In such cases the new crop of fungus sprang up with a rankness and a velocity which was truly surprising, and if I had not known that the salt water would kill the fungus, I should have been inclined to think that in these cases salt water acted as a fertilizer for the hyphæ. I am inclined however to think that the true condition of affairs was that the salt water killed a part of the hyphæ, and at the same time rendered the wounded surfaces much more suitable localities than ever they were before, for the growth of the fungus, and then when the animals were replaced in the fresh water, the spores, which were there in countless numbers, finding suitable territory in which to develop, took root, and, together with the rem-

nants of the old hyphæ, grew with wonderful rapidity. At any rate I succeeded in destroying the fungus only on those animals which were not badly wounded. The rest died.

In the spring of 1877, while engaged in studying the embryology of the smelt at New Brunswick, N. J., under the auspices of the Maryland Fish Commission, I found that one of the most serious drawbacks in the manipulation of the jars in which the eggs were placed, was the collection and growth of the *saprolegnia* upon the trays and upon the eggs, especially whenever the eggs were much massed together, as they often were in clusters of the size of a large walnut or larger. With the arrangements which we then had, we could not try the effect of salt upon this growth of fungus, but in my report to the Commission I expressed my opinion in favor of testing the salt-water bath, as soon as arrangements for its use could be made.

An opportunity to test this method with the smelt eggs did not occur until this spring, when in talking with Mr. Ricardo, who was then engaged in manipulating smelt spawn upon the Hackensack, I suggested that he should try the effect of immersing the small eggs in strong salt water, particularly such of them as had any fungus attached to them. The method employed by Mr. Ricardo in attaching the smelt spawn, which is similar to that employed by Mr. C. G. Atkins in Maine, some years ago, that is by taking blades of sedge or water grass and dipping them into the pans of milted spawn, prevents to a great extent, if not entirely, the massing together of the eggs, since the rough surface of the blades allow only a single layer at most to adhere to the surface; the result is a pretty even distribution of the eggs over the blades, and not much change for the attachment of the fungus, except on the dead eggs and the dead portions of the grass. Still there always is a greater or less amount of fungus present, and vary much in proportion to the greater or less flow of water over the eggs.

Acting upon my suggestion, Mr. Ricardo prepared some salt water, strong enough, as he said "to bear up a potato," and placed some of the egg-bearing grass blades in it. He took those blades which had considerable fungus upon them, and after leaving the blades in the water for fifteen or twenty minutes, he took

them out and found that the fungus had been killed so completely that it could be stripped from off the eggs like a slough, leaving the eggs nearly, if not quite as clean as when first taken. From that time on until the eggs hatched out, which was, I believe, a period of about two weeks, he gave them a bath every day or every other day, and no more fungus appeared, and only about five per cent. of the whole number failed to hatch. Every experiment which he tried seemed to show the advantage of the salt bath in the destruction of the fungus, and that little or no harm resulted to the embryo fish. In order to test the effect of continued immersion upon the embryo, he placed some ova in the salt water and kept them there for forty-eight hours. At this time they were all in good condition, and it was not until they had been kept constantly immersed for from sixty to seventy hours that the embryos were unfavorably affected.

Short immersions seem to have very little effect upon either the embryo or the adult fish, and, while there is a point beyond which we cannot safely go in our experiments with either the one or the other, yet of the two the embryo seems to be able to stand a longer immersion than the adult, especially than these species which are not anadromous. Short and moderately frequent immersions, then, will in all probability accomplish what is desired, so far as the destruction of the fungus is concerned. This, at least, seems to have been the case in my experiments, but it is much better, in every case where it is practicable to do so, to give this salt bath as soon as any fungus is discovered and before the hyphæ have penetrated very deeply into the tissues, for it seems to be beyond question that the *saprolegnia* is one of these parasites that causes tissue destruction, as I have seen in numerous instances the gradual extension of the velvety carpeting of hyphæ branches, from some minute wound on one side of the body of an animal, until the entire body was girdled. By taking the animal in hand early, and, in case there is no serious wound to be aggravated by the salt, by using a strong solution and using it for a short time and often, it seems to me that salt may be a valuable agent in the hands of those who wish to rid their aquaria or their hatcheries of what is often an intoler-

able pest. And above all must it be borne in mind, that when water is used that comes from rivers and lakes, like the Croton water of New York city, no matter how clear of fungus they may get their tanks or aquaria, the spores are in the water, and any wounds in the fishes, or decaying or dead matter which may at any time afterward get into the water, offer fertile fields for renewed growths, which can only be disposed of by a new resort to the salt wash.

THE ARTIFICIAL PROPAGATION OF SALMON IN THE COLUMBIA RIVER BASIN.*

BY LIVINGSTON STONE.

Every one has heard of the immense quantities of salmon that are annually canned on the Columbia river. It is not necessary to go into details. The general facts known to all prove that an enormous number of salmon have been accustomed to ascend the Columbia river every year, and it is probably safe to say that the Columbia has been the most productive salmon river in the world.

This is one side of the subject. The other side is this: Such enormous quantities of salmon taken from a river must ultimately endanger the productiveness of it. The situation is not, however, quite as bad as it looks, for it seems at first sight as if the stock of a salmon river would be diminished in proportion to the number of salmon taken out of it, but this is not wholly true, for a compensating element of great weight comes in to disturb the calculation. Nature, perhaps more aptly speaking, Providence, in the case of fish, as well as numberless other creatures, produces great quantities of seed that nature does not utilize or need. It looks like a vast store that has been provided for nature, to hold in reserve against the time when the

*The salmon referred to in this paper is the *Oncorhynchus chouika*, the spring salmon of the Columbia, the chinook salmon, quinnat salmon, the common salmon of the Sacramento river.

increased population of the earth should need it and the sagacity of man should utilize it. At all events nature has never utilized this reserve, and man finds it already here to meet his wants.

If this were not so, if there were no reserved stock of seed provided beyond what nature uses every year, or to apply the hypothesis to the subject before us, if the salmon produced no more eggs every year than what are needed to keep the places of the parent fish filled, then it would be time that a river's stock of salmon would diminish just in proportion to the number of salmon or salmon eggs taken out of it. As it is, the parent salmon in a state of nature, probably produce three thousand times as many eggs as would be needed if all became full-grown reproductive fish. The calculation is a very simple one. For instance, the quantity of salmon in any specified river, before they were molested at all by man, unquestionably remained constant from year to year. Making allowance, of course, for exceptional years, the average of any one decade has been, without doubt, about the same as that of the previous or next succeeding decade. It follows, of course, that evey pair of full-grown fish have produced during their lives just two, or their own number of full-grown fish of the next generation, in order to keep the whole river supply good from year to year.

If they produced more uniformly, the salmon in the river would increase till the river would ultimately become full of fish; if less, the stock for the reverse reason would be ultimately exhausted.

Now, as one pair of salmon produces yearly, say six thousand eggs, it follows that there are deposited each year three thousand times as many eggs as would be needed, supposing that every egg became a full grown, reproducing parent. I should add that this computation is based on the supposition that all the parent salmon die after spawning and never reproduce again. This is true of the bulk of the Pacific coast salmon. If any do live to get back to the ocean after spawning and reproduce again, it increases the ratio of the number of eggs deposited to the number of salmon that reach maturity.

The value to food-requiring man, of this reserve seed stock,

becomes particularly apparent when we consider the effect of the fishing of a salmon river. The first thousand fish taken out of the river, though it deprives the river of three million eggs, makes no perceptible difference with the future supply, because there are so many eggs left that this abstracted quantity, great as it is absolutely, is relatively insignificant—the number of eggs left being so vastly greater.

The first hundred thousand salmon taken from the river makes no difference, partly because there are so many eggs left, and partly because one of nature's compensations comes in by making the struggle for existence among the diminished number so much easier, that the eggs that are left go as far toward replenising the river's stock as the larger number did under the less favorable conditions of a comparatively over-crowded river.

So great is the reserve stock of seed originally provided, and so effective are the compensations of nature, that even the first million of parent salmon taken from a great river like the Columbia seems to make no difference in the annual run of salmon up the river.

We might go further, perhaps, and say that the first two millions would make no difference, but we need not take the trouble to prove this, for it would not help to illustrate the point if we did; the point being that if the annual catch goes on increasing, the limit will ultimately be reached when the number of eggs in the fish that are left will not be enough, even with the help of nature's compensating agencies, to keep up the river's stock.

I need hardly remind a body of fish-culturists and Commissioners that when this limit is passed, the decrease of the fish proceeds at a rapidly accelerated rate. It is burning the candle at both ends, for while the diminished stock of the river keeps diminishing from an inadequate supply of seed, the destructive capacity of the engines of capture are constantly increased to offset the poorer fishing that results.

Then begins a geometrical ratio of yearly decrease which is startling, and of which the end is complete extinction.

Some intelligent people thought that the limit just mentioned had nearly been reached in the Columbia several years ago. Many more persons think it has now. Still, the resources of

the great Columbia are so wonderful that, although upwards of two thousand million eggs are annually abstracted from the river, there seems to be a doubt remaining yet whether the eggs that are left are not sufficient to keep up the stock.

However, if the fish-eating world does not go backward, the danger limit will soon be passed, if it has not been already, and it is none too soon to consider the question of taking measures to guard against the danger by artificial propagation.

What has been done in the Sacramento in this direction is well known. I take the liberty to quote from an article bearing on the subject, by Mr. C. A. Smiley, of the United States Census Bureau. Mr. Smiley, after mentioning some of the difficulties of fish-culture says:

"I will close with citing one of the most remarkable of the successes thus far attained. The salmon canneries of the Sacramento river annually increased in number until by 1870 the entire run of salmon was being caught and utilized. The greatest natural capacity of the river under these circumstances may be considered to have been reached in 1875, when the yield to the canneries was 5,096.781 pounds.

"The first possible fruits of fish-culture were in 1876, when the young of 1873 may be supposed to have returned.

"The United States hatchery was established in the latter year at Baird, Shasta County, California, and a half a million young released in 1873 and again in 1874.

"In 1875 the number was increased to 850,000, in 1876 to 1,500,000, and during each of the years 1878, 1879, 1880, 1881, two million young fry were placed in this river. From an annual catch of 5,000,000 pounds the river has come up to the annual catch of over 9,500,000 pounds, which figure has been maintained during the past four years.

"The figures were:

	Pounds.
1880	10,837,000
1881	9,600,000
1882	9,605,000
1883	9,586,000

"Allowing the three years which it takes for salmon to come to maturity and enter the river for spawning purposes, the increase in yield to the canneries for ten years has been almost exactly proportionate to the increase in the disposition of fry. Taken into consideration the cost of hatching 2,000,000 salmon annually, and the value of the increase of 4,500,000 pounds, it will be seen," Mr. Smiley

concludes, "that there is a very large per cent. of profit in artificial fish-culture, when conducted under circumstances as favorable as these."

What man has done man may do, and what has been done in the Sacramento can be duplicated in the Columbia, and in as much larger proportion as the Columbia is larger than the Sacramento.

An effort was made in 1877 to hatch salmon on the Clackamus river, a tributary of the Columbia.

This location seemed to combine every advantage for the hatching of salmon on a large scale. The river heads, as you are aware, in the perennial snows of Mt. Hood, and the coldness of its snow-fed waters is very attractive to the ascending salmon. Just above its mouth, on the Wilhamette, into which it empties, are the impassable falls of Oregon City, which prevent the salmon from going up the Wilhamette any further, and naturally turns them back into the Clackamus, if they missed that river in the first place. Then, if necessary, the Clackamus can be so obstructed that every salmon coming up can be stopped in front of the fishery. The river is a favorite resort of the salmon, as it must necessarily be, with its cold, clear, and swift running water; and before canning on the Columbia began, the Clackamus was famous for its hundreds of thousands of magnificent spring salmon that used to swarm up its channel to spawn.

But the establishment of the station came too late. Already—this was in 1877—there were fifteen or twenty canneries on the Columbia below the mouth of the Wilhamette, and with their thousand miles, or nearly, of drift nets waylaying the ascending fish, the main river became so depleted of parent salmon, that those that reached the Clackamus in 1877, were but a sorry fragment of the immense shoals that originally came up the stream to spawn.

It was too late. Had the station been established twelve years before, twenty million eggs of the best variety of salmon in the Columbia river could have been taken there every year. The time has now gone by for that, and only a few million eggs can be taken in a season on the Clackamus, until some legisla-

tion allows a larger proportion of the parent salmon to reach the river.

This station was partly destroyed by a hurricane a few years ago, and has been abandoned for the present.

Unfortunately the same objection which applies to the Clackamus river as a hatching station, for producing young salmon on a large scale, viz., the enormous yearly catch of salmon on the Columbia below the Clackamus, also applies to all other good locations in the Columbia river basin, or rather what were originally good locations. Twenty years ago there were scores of places on the affluents of the Columbia where ten to twenty million salmon eggs could have been obtained annually, because such an enormous quantity of salmon ran up the Columbia that they swarmed in thousands into each of these spawning streams to deposit their eggs.

Now that every season as the salmon come up to spawn, hundreds of thousands of them, I might almost say millions, are caught for canning, there are not enough left to distribute themselves in very great numbers in each of their thousand spawning-beds up the river, and it will never again, in my opinion, be very easy to find more than one or two places in the Columbia river basin, where twenty million salmon eggs can be annually obtained, unless some legislation protects the salmon on their upward journey, or artificial hatching, simultaneously carried on at various independent localities, increases the number of salmon in the river.

I have made three explorations of the Columbia river for the purpose of finding a good place for getting salmon eggs on a large scale; (the last time under the direction of the United States Commissioner of Fisheries). Following the Columbia, except around the Great Bend, all the way from the Rocky Mountain divide, where you can step across it (here called Deer Lodge river), to the bar as its mouth where it is fifteen miles across, and I am convinced that the salmon do not now come up to any one of their famous original spawning grounds in such quantities as to make it an easy thing to get twenty or even ten million eggs a year from any of them.

I must except some places (notably the foot of Shoshone Falls

in Idaho) on the tributaries of the Snake river, now difficult of access, where it is possible, perhaps, if the attempt is made soon enough, to obtain sufficient spawners for large operations in hatching. I will also except the mouth of the Little Spokane river in Washington Territory, where there is a most excellent location for a hatching station, and where perhaps ten million eggs a year could be collected, if the statements made about the number of salmon that come up the river are at all true. These statements have not been substanstiated yet for want of opportunity, and all we can say is that thousands and thousands of breeding salmon used to frequent this natural and favorite spawning ground, and perhaps the canners leave enough now in the Columbia to still make the Little Spokane a good collecting place for their eggs. As my report to Prof. Baird recommends this point as a favorable location for a hatching station, a description of some of its advantages may not be out of place here, and the first I will mention is its accessibility. Eight miles from the mouth of the river, over a remarkably hard and level road, is the town of Spokane Falls, a new, but thriving and promising settlement of, perhaps, 3,000 inhabitants. This town is situated on the line of the Northern Pacific Railroad, and is in daily communication with the rest of the world by mail, telegraph and railroad, the railroad being one of the great transcontinental thoroughfares of the country.

These general facts alone are sufficient to show the accessibility of the location without the necessity of mentioning details.

The water supply at the mouth of the Little Spokane for hatching the eggs is practically unlimited. As there is a strong current in the river, and as the water does not rise till after the spawning season and hatching season are over, the water can be safely raised from the river itself by a current wheel, as at the McCloud river station, and this being the case, any required quantity of water can be brought to the hatching house at a small expense. The location is also favorable for obtaining water conveniently. The river does not ever rise more than a few feet, and consequently the hatching house can be erected not very far above the low water mark. A small current wheel will,

therefore, be sufficient to raise the water to the hatching house, and the adjacent land is so favorable for building on, that the wheel can be placed very near the hatching house, which will render unnecessary the construction of a long flume from the wheel to the hatching house. As the river does not rise till the hatching season is over, the wheel need not be protected from drift wood, nor arranged with reference to the rising and falling of the water.

These are great conveniences, and on the whole it may be said that the water supply may be safely depended upon in every respect. The location is also remarkably favorable as to availability. Fortunately, the adjacent country is still in its primitive state. When I visited the place in July, 1883, many Indians were encamped on the river bottoms; but I saw no white men. It is true some claims near the river have been taken up by white men, but they are not valuable, and could be bought without much expense. It is, therefore, very probably that the site of a salmon building station could be obtained without much cost; and as there are very few settlers up the river, and no towns or villages, no objection would probably be raised to collecting the parent salmon during spawning season by means of a dam across the river.

The Little Spokane, is also of such a character that it would be an easy matter to capture the breeding fish. Indeed, I think a seining ground could be arranged, so that nearly all the spawning fish that come up to the river could be caught; and furthermore, it being close to the main Spokane river it would not be difficult to run two seining grounds, one on each side, which would undoubtedly somewhat increase the yearly catch of breeders.

It would be a very easy matter to build a dam or salmon rack across the river to keep the breeders on, or near the seining ground. Indeed the frail structure that we saw the Indians successfully erecting across the river, shows how easy it would be for white men, with their superior appliances, to put a salmon rack across the river, such as would be required to answer the purpose of a breeding station. There being no drought or freshet on the river during the season's operations at the station.

and, indeed, no material change at all in the river, a very simple and readily-constructed dam would be perfectly safe. This is a great advantage, as it often proves a very difficult matter in a river subject to freshets in the hatching season, to put in an obstruction that is perfectly safe.

And last, but not least, the maximum rise of the river during the year is so inconsiderable, that there will never be any danger of the hatching house and other buildings being washed away, even if they are placed, as it is desirable that they should be, close to the river.

Besides possessing the essential qualification just enumerated for a salmon breeding station, the Spokane location has many convenient features about it to recommend it. In the first place, it is in a good timber country, where lumber can be easily and inexpensively obtained for building. Then the roads in all directions are hard and good, even during the rainy season, which is a merit which can be fully appreciated only by those who have lived in other parts of the Pacific coast, where the roads become practically impassable during the rainy season, on account of the great depth of the mud. The ground is also almost level from the mouth of the Little Spokane to the town of Spokane Falls, which would make communication with the town, and freighting to and from the breeding station, very easy. The climate is also a great recommendation to this place. It is never very cold nor very hot, but the temperature is quite even, and consequently very favorable for work of any kind.

By glancing over what has just been said about the mouth of the Little Spokane, it will be seen that it is known to be in all essential points an unusually favorable location for a salmon breeding station. If it should prove to be capable of furnishing an abundance of breeders, I should not hesitate to recommend it emphatically as one of the best situations to be found anywhere for taking and distributing salmon eggs. If, however, it should fail to supply the required quantity of spawning salmon, I do not know where we could look for any one place on the Columbia river, or its north fork, which, by itself, would be adequate and satisfactory, and I think we should be reduced to

the necessity of going further from the railroad, or erecting two or three separate stations at different points.

Before closing, allow me to mention a fact which may possibly be as much of a surprise to many of you as it was to me. It is that there are no salmon in the whole of that portion of the North or Clark's Fork of the Columbia, which flows through Western Montana and Idaho, including that magnificent body of water, Lake Pend d'Oreille in Northern Idaho.

This fork of the Columbia known as it flows westward under the various names of Deer Lodge river, Hellgate river and Missoula river, has a length of about three hundred miles before it reaches the falls of Senniacwateen, just below the outlet of Lake Pend d'Oreille, where it is believed the ascending salmon are finally stopped from going any further, and in the long stretch of river above this point clear to the Rocky Mountains no salmon whatever are found. I was not aware of this fact, and when we had crossed the continental divide, which was accomplished then in a wretched mud wagon (called by courtesy a stage), and had descended the western slope of the Rocky Mountain range far enough for the Deer Lodge brook to have become a respectable river, I expected to find salmon very abundant, but to my great surprise the people there were as unfamiliar with salmon in their natural haunts as the people of this city are, and were nearly as far from them.

I found that there were three principal obstructions which kept the salmon from ascending the river. The first one from the ocean is Kettle Falls, in Washington Territory, on the main Columbia, 711 miles from its mouth. These falls are about twenty-five feet in height at low water, but they are not wholly impassable, for on the east side they are broken into a series of cascades, through which the salmon can and do get above the falls at certain stages of the water, and possibly at all times.

Forty-two miles above Kettle Falls, the Pend d'Oreille river (Clark's Fork of the Columbia from Lake Pend d'Oreille to the main river is called Pend d'Oreille river) empties into the main Columbia. Near its mouth, at a distance variously stated from a few rods to twenty miles, is another fall which is undoubtedly a serious obstruction to the salmon. This fall (it being on the

Great Bend, I did not see it myself) is said to be ten or fifteen feet in height.

I heard of salmon being caught all the way up to the falls of the Senniacwateen—so the salmon are obviously not all stopped at the falls of the Pend d'Oreille, though probably not a very large proportion get by them.

About one hundred and fifty miles above these nearly impassable falls, and not far below the outlet of Pend d'Oreille lake are the falls of the Senniacwateen, which, though not over eight or ten feet in height, probably head off the comparatively few salmon that reach them and mark the highest point, the *ultima thule* of the upward migration of the salmon of Clark's Fork of the Columbia. I mention these facts, partly because when I was in Idaho and Montana, there was a strong feeling among some of the residents on Clark's Fork in favor of opening a way for the ascending salmon through the obstructions just mentioned, and allowing them to come up into Idaho and Montana, which they would undoubtedly do if they could, although it is nearly twelve hundred miles from the mouth of the Columbia to Deer Lodge City.

I will merely add in this connection that a movement has been started for obtaining the intervention of the territories interested, and if possible of the United States, for the purpose of opening a passage for the salmon through the formidable obstructions at the mouth of the Pend d'Oreille river, but in my opinion these falls will be found to lie in British territory, and the undertaking mentioned will require the co-operation also of the Dominion government.

I need hardly say in conclusion, that in my judgment the sooner we get about this work of hatching salmon on the Columbia the better. We have waited too long already. The great opportunities of twenty years ago are all gone, and every year makes the matter worse.

Mills are going up, settlements are forming, railroads are being built in this trans-Rocky Mountain region with surprising rapidity—all accelerating the decrease of the salmon—and in a short time we may be glad to even get opportunities that we scorn now. A great industry as well as an immense food supply is at stake, and something ought to be done very soon.

THE WHITE FISHES OF NORTH AMERICA.

BY TARLETON H. BEAN, M.D., M.S.

Curator of the Department of Fishes in the United States National Museum.

The white-fishes, properly so-called, all belong to the genus *Coregonus*, which, however, admits of division into several minor groups, based chiefly upon the character of the mouth and the form of the body. We have, in North America, twelve recognizable species, one of which is now apparently for the first time distinguished by name. These species are usually of wide distribution, and subject to great variation with age and surroundings, making it difficult for the student to sharply define them by the use of characters which are generally believed to have specific value. An attempt is made, on a subsequent page, to set forth the relations of these twelve species by calling attention to the peculiarities which seem to be most important and least subject to variation. The form of the mouth, the structure of the gill-rakers, the size of the species, and, in some cases, the length of the fin-bases, appear to serve the purposes of classification best; but it is difficult to apply any fixed formulæ of definition and little to be wondered at that most of our common forms have been described over and over again since they were originally introduced into the literature.

I have placed along with the white-fishes that magnificent species, the finest of all the fishes closely related to *Coregonus*, the *Inconnu* of the McKenzie and Yukon regions. This well-flavored species grows to four feet in length and is known to have reached fifty pounds in weight. From an examination of the Russian *Stenodus leucichthys*, I am inclined to think that the American *Inconnu* is identical with the species of Güldenstadt, and, if so, the range of the species is much more extensive than we have supposed. It may be, also, that several of the Alaskan species of *Coregonus* will prove to be identical with Siberian forms; but we are unable to state anything definite about this at present.

The white-fishes are among the most important, economically, of all fishes. I need refer only to the fisheries of our great lakes

to verify this statement. In the northern regions of America, also, they constitute one of the chief sources of food supply. These fishes possess many natural advantages over other inhabitants of the waters—they do not prey upon one another and their movements are not checked by dams and similar obstructions. They yield vast numbers of eggs, which are readily developed artificially, and it has recently been demonstrated that the young fry can be reared in confinement. All of the species but two have excellent food qualities and they exist in great abundance. We may well protect and cultivate these fishes whose importance and possibilities can scarcely be overestimated.

North American Species of Coregonus.

A. Lower jaw included; gill-rakers about thirty or fewer, moderately long, or short and thick.

a. Gill-rakers moderately long; maxilla $\frac{1}{4}$ head, or more.

b. Tongue with teeth; gill-rakers 23 . . . . . *labradoricus.*

bb. Tongue toothless, or nearly so.

c. Nape arched and thick; gill-rakers 26-29. *clupeiformis.*

cc. Nape arched and much compressed; gill-rakers 26 . . . *nelsonii.*

aa. Gill-rakers short; maxilla $\frac{1}{5}$ head ($\frac{1}{4}$ in *williamsonii.*)

d. Mouth inferior.

e. Body elongate; maxilla about $\frac{1}{5}$ head; gill-rakers 17 . . . *quadrilateralis.*

ee. Body oblong; maxilla about $\frac{1}{4}$ head; gill-rakers 23 . . *williamsonii.*

dd. Mouth not inferior; jaws nearly equal; maxilla about $\frac{1}{5}$ head; gill-rakers 22 . . *kennicottii.*

AA. Lower jaw projecting, or jaws subequal; gill-rakers more than 30, long and slender.

f. Body deep; scales little convex behind; gill-rakers 48 . . . . . *tullibee.*

ff. Body oblong or elongate; scales strongly convex behind.

g. Eye moderate ($\frac{1}{4}$ to $\frac{1}{6}$ length of head).

h. Dorsal base longer than post-orbital part of head; gill-rakers 36 . . . . . *laurettæ.*

hh. Dorsal base shorter than post-orbital part of head.

i. Teeth on premaxillaries and tongue; gill-rakers 39-44 . . . . *nigripinnis.*

ii. Premaxillary and tongue toothless; gill-rakers 46-52 . . . *artedi.*

gg. Eye large ($\frac{2}{7}$ to $\frac{1}{3}$ length of head); size small.

k. Anal rays 10; gill-rakers 55 . . *hoyi.*

kk. Anal rays 14; gill-rakers 45 . . *merki* subsp.

1. *Stenodus mackenzii* Rich. Inconnu.

Luciotrutta Mackenzii Gunther, Cat. Fish. Brit. Mus., vi., 1866, p. 164. Mackenzie's River and its tributaries; Yukon river, Alaska.

A food-fish of great value; the largest of the white-fishes.

Growing to four feet in length, and reaching 50 pounds in weight. "It is full of spawn from September to January, when it disappears."—Dall.

2. *Coregonus labradoricus* Rich. Lake Whiting.

Great Lake Region; lakes of the Adirondacks, of mountains of New England and north-eastward, preferring clear, cold lakes.

It is abundant in cold, clear lakes, and in Labrador the species frequently reaches the length of eighteen inches, but in New England the average size is somewhat below this. This species may be regarded as certainly nearly related to the common white-fish, *C. clupeiformis*, from which it differs chiefly in its somewhat more decided lingual dentition and its slenderer body. It seems besides never to reach so large a size as the typical great lake form. It would seem that the size of the species increases somewhat in the northern portion of its habitat. This species has been erroneously placed in a group characterized by numerous long and slender gill-rakers; as a matter of fact the gill-rakers are not more numerous in this species than in *williamsonii* and *kenicottii.* The oldest name for this species is the one here employed, but the New England form has since been described by Prescott in the American Journal of Science and Arts, 1851, under the name of *Coregonus eohantoniensis.*

3. *Coregonus clupeiformis* (Mitch). Milner. Common white-fish. Great lakes. British America.

This is the most important of all the white-fishes; it has been extensively reared by artificial methods and distributed as widely as New Zealand. The Otsego lake form is said to be the most southerly in the United States, but *williamsonii* occurs in rivers of Utah.

This is the common white-fish, and is the object of the most important of the fisheries of the great lake region. We have the typical form of this species from Lake Champlain to the eastward, and from Manitoba to the westward. The range of this species has also been greatly extended by artificial introduction. The maximum weight of the species is said to be twenty-two pounds, but the average weight will perhaps scarcely reach ten pounds. The reported occurrence of this species in the Yukon river, Alaska, is apparently unwarranted, a re-examination of our Alaskan material showing that the supposed *C. clupeiformis* of the Yukon is really *C. kenicottii*, a species which grows to even a larger size than *C. clupeiformis*, but which is really not very closely related to that species.

It is worthy of mention that the young of *C. clupeiformis* have a much greater number of scales in the lateral line than the adult, some examples of which are here exhibited showing as many as ninety scales while the average number in the adult is but seventy-five.

The following additional information about the white-fish has been extracted from the published writings of Mr. J. W. Milner:

The fishes are not evenly distributed throughout the lake, but range in large colonies and run near the shore at different points, while the majority of localities may be destitute of fish.

The statistics of nine principal fish-markets on the lakes show the proportion of lake-herring handled to be one-sixth, while the low rates herring command in the markets would produce only about one-thirtieth of the amount realized from the whole quantity of fish handled. This shows the small value of the herring to the fishermen, in the herring localities. In the whole product of the lakes it would be of much less consequence.

The white-fish is found in all depths in more or less abundance, not only in the spawning season, but at all times. Young white-fish seek the surface, and they are strong and vigorous from the time they leave the egg. In their early life, therefore, they are not much preyed upon by voracious fishes, and the swarms of cyprinoids and *Chirostoma* (?) which are abundant at

the surface at the same time, form a large part of the food of such predaceous species as do come to the surface.

4. *Coregonus nelsonii* Bean. Hump-back white-fish. Bean, Proc. U. S. Nat. Mus., VII., 1884, p. 48.

Known from Alaska only, occurring from the Bristol Bay region northward to the extremity of the territory.

This species which was until recently undescribed, has long been known from Alaska, but it has been confounded with a Siberian species, *C. syrok*, from which it is really very different. The Russian name of the species is "*Korabati.*" The Tinneh tribes of the Yukon call it "*Koloküh.*" Mr. Dall, in the report of the Commissioner of Agriculture for 1870, p. 386, speaks of it as a common species characterized by the strongly arched back and broad tail. He says it is rather bony and inferior in flavor, and that it is generally used for dog food, except in times of scarcity.

This species is related to *C. clupeiformis* and *C. labradoricus*. From *clupeiformis* it may readily be distinguished by its greatly arched and much compressed back. The body is oblong and compressed; the head is one-fifth as long as the fish without the caudal; the maxilla extends to the front margin of the eye and is about one-fourth as long as the head; the gill-rakers are only moderately long, the longest a little more than one-half length of eye, and their number is about twenty-six. The greatest height of the body is a little more than one-fourth of the total length in the typical example, which is about fourteen and one-half inches long to caudal base. The adipose fin is large and scaled for nearly half its height. The ventrals are a little nearer the tip of the snout than to the root of the caudal. They are about as long as the head without the snout; D. 12; A. 12; scales 10—88—10. The type of the species is No. 29,903, taken at Nulato, Alaska, by Mr. E. W. Nelson, to whom the species is dedicated in recognition of his important zoological researches in that territory.

5. *Coregonus quadrilateralis* Richardson. Round white fish. (?) Krug (Russian). Shad Waiter; Round-fish.

Lakes of New England Upper Great lakes; Slave Lake; Kodiak; Yukon River; rivers of Arctic North America. (Gunther).

C. quadrilateralis is apparently the most widely distributed of all the white-fishes and naturally is subject to much variation. In the Yukon river region the form of the head is somewhat different from that of the ordinary eastern type, and, strangely enough, this variation of the head is repeated in some of the Maine lakes. The appearance of this species on the Island of Kodiak which is separated from the mainland of Alaska by a wide and deep ocean channel is one of the most interesting of recent discoveries in the ichthyology of Alaska. *C. quadrilateralis* is a small and slender species, seldom exceeding fifteen inches in length, but its quality is excellent. It is noteworthy that this species has a smaller number of gill-rakers than any other species of the North American white-fishes. Prescott, in the journal already referred to, redescribed this white fish under the name *Coregonus novæ-angliæ.*

6. *Coregonus williamsonii.* Girard. Rocky Mountain white-fish; Chief Mountain white-fish.

Coregonus couesii. Milner. Rept. U. S. Comm. Fish. for 1872—1873 (1874), p. 88.

Clear streams and lakes from the Rocky Mountains to the Pacific, northward to Oregon; found also in tributaries of the Saskatchewan and of the upper Missouri. Recently received from Mill Creek, Oregon, whence it was sent by Col. I. R. Moores. This is an abundant and valuable food-fish.

The size of *Coregonus williamsonii* is small, about equal to that of *C. quadrilateralis*, which it closely resembles; it has, usually, a larger maxilla and less elongate body, and the number of gill-rakers is somewhat larger. The Chief Mountain white-fish (*C. couesii*, Milner) is now known to be identical with *Coregonus williamsonii.*

7. *Coregonus kennicottii.* Milner. Broad white-fish.

Known in Alaska from the Kuskoquim basin to Meade river in the extreme northern part of the territory.

This is the *Muksun* of the Russians, a name transferred from a Siberian species of similar appearance. The broad white-fish reaches the weight of thirty pouuds, ranking next in size to the *Inconnu* only. It has a short head, remarkably small, subequal jaws, and its body is very thick. It is a food-fish of great excel-

lence. Dall states that it is abundant in both winter and summer, spawning in September in the small streams falling into the Yukon.

8. *Coregonus tullibee* Rich. Tullibee.
Great lakes and northward into British America.

This singular and handsome species is said to grow to a length of eighteen inches. Its body is deeper than in any of the other white-fishes, and the scales are deep but very narrow, giving the fish a unique and unmistakable appearance. Richardson had a specimen from Pine Island lake, in north latitude 54 degrees.

9. *Coregonus laurettæ.* Bean. (?) *Morskoi ciga* (Russian).
Kuskoquim region, and northward to Point Barrow, Alaska.

This species is not large, rarely exceeding three pounds in weight, but it is a very important source of food wherever it occurs. It resembles the lake herring, *C. artedi*, somewhat, but has fewer gill-rakers and a much longer dorsal base. In the Yukon it is particularly abundant and is one of the best-flavored of the *Coregoni*, becoming the staple article of food in winter, according to Mr. Dall.

10. *Coregonus nigripinnis* (Gill) Jor. Blue-fin; Black-fin.
Lake Michigan, in deep water; deep lakes of Wisconsin, known from the vicinity of Madison, Wisconsin, whence it has been sent by Fish Commissioner Welch.

This species is locally abundant, as, for example, in Grand Traverse bay. Milner reported as follows concerning it: *Coregonus nigripinnis* is most abundant in seventy or more fathoms and is seldom taken in the fishing season, even in as great a depth as fifty fathoms. At Grand Haven, Mich., where a line of steamers keeps the harbor open throughout the winter, the fishermen take the black-fin in quantities within thirty or forty fathoms in the month of December.

The black-fin grows to eighteen inches in length, surpassing *C. artedi* in size and differing from it, also, in having evident teeth on premaxillaries and tongue.

11. *Coregonus artedi* Le Sueur. Lake herring; Cisco; Michigan herring.

Great lakes and northeastward to Labrador, the eye becoming larger and certain other characters varying to the northeastward. This species has considerable commercial importance.

12. *Coregonus artedi*, var. sisco Jordan Cisco.
Small lakes of Michigan, Wisconsin, and Indiana.
A form of the preceding modified by residence in small, deep lakes.

13. *Coregonus hoyi* (Gill) Jordan. Lake moon-eye; Cisco (Lake Michigan); Smelt (Western New York).
Lake Michigan and Lake Ontario, in deep water; lakes of Western New York, where it sometimes dies mysteriously in great numbers.

14. *Coregonus merkii* Gunther, subsp. *Nulatoski ciga* (Russian).
Known from Yukon river and Hotham Inlet, Alaska.
A small species, thin and bony, rarely exceeding a half pound in weight; little used as food in Alaska. It differs from typical *merkii* in several particulars.

15. *Coregonus lavaretus* L. Maræne.
Great lakes of Switzerland, Tyrol, Pomerania, Mecklenberg, and Sweden.

This fine, large species, the type of the genus *Coregonus*, comes into the series containing our common white-fish (*C. clupeiformis*). It has about thirty gill-rakers of moderate length, and the lower jaw is included. In size and in extent of distribution as well as in amount of variation, as expressed by the numerous synonymes of the name *lavaretus*, the two bear a strong resemblance to each other. The maræne in its adult condition is readily distinguished at sight by its numerous and rather deep scales; but I suspect that it will be difficult to separate the young of the two, especially since we have common white-fish from Lake Superior with as many as ninety scales, the usual number in some of the variations of *lavaretus*.

Four hundred and nine were placed April 14th, 1877, in Lake Gardner, Otsego Co., Michigan. The history of the maræne since its introduction into America by the U. S. Fish Commissioner is not known to me.

NOTES ON LAND-LOCKED SALMON.

BY CHARLES G. ATKINS.

NOMENCLATURE AND RANGE.

The term "land-locked salmon," though it may be, and probably is, a misnomer so far as it implies any forcible detention of sea-going salmon in fresh water, has come to be generally accepted as applicable to all those salmon of Eastern North America and of Europe that pass their entire lives in fresh water. They are all, according to the most recent conclusions of our American ichthyologists, members of the great species, *Salmo salar*, the common river salmon of the tributaries of the North Atlantic. In America they are found in a number of restricted localities, of which, besides several in the Canadian provinces, there are four in the State of Maine; namely: 1st, the waters of the Saint Croix; 2nd, of one branch of Union river, Hancock County; 3rd, of Sebec River, a tributary of the Penobscot; and 4th, of Lake Sebago and tributaries, in Cumberland County.

The results of some inquiries that I have made relative to the salmon of Lakes Champlain and Ontario indicate that these, also, should be added to the list, though I believe that the salmon of Lake Champlain are now extinct.

I have little knowledge of the salmon of any of these localities but those in the State of Maine, and their descendants in other States, and any general remarks I may have occasion to make, must be understood as applying especially to them.

A COMPARISON WITH ANADROMOUS SALMON.

To the anatomy of the land-locked salmon I have given none but the most superficial attention, and am not able to say whether there exist any distinguishing marks by which they may be unerringly separated from the normal *Salmo salar*, or from each other. The general impression made upon the fish-culturist who views them in their separate haunts is that the external difference of form and color are sufficient to enable him easily to separate those of the several districts should they be presented in a promiscuous heap, but I confess that I should not dare to

indicate the points of difference; and granted that the impression of dissimilarity is correct, it still remains in doubt whether when bred in other waters, either variety will retain its peculiarities.

However, when we came to place the land-locked salmon of either district by the side of the normal form of *Salmo salar*, and to include in our survey other than anatomical features, there are not wanting data for an interesting comparison.

In the first place, we find a general resemblance in form and color. The young fry are so closely alike that the eye fails to separate them if mixed together. As they grow we find further that the reproductive functions of the males are in both forms active at a very early stage. while yet in what is known as the parr-stage, marked externally by the presence of bright red spots and dark transverse bars or "finger-marks" upon the sides; and at Grand lake stream may be observed several other stages of growth closely resembling those of the migratory salmon. The adults have identical habits in the spawning season, and the same remarkable external changes take place in the adult males at that season of the year,—the deepening of the body, the lengthening of the head, the curving of the jaws, the growth of the wonderful hooked bony process on the tip of the lower jaw, the assumption of brighter colors—though these changes are generally not quite so marked in the land-locked as in the anadromous varieties. The color of the flesh is also the same, and there is a similarity, though not an identity of flavor.

On the other hand, we find certain well marked differences. Some things favor the theory of an arrested development. For instance, the dark bars on the sides, which are very prominent marks in the young fish, but entirely disappear in the adult migratory salmon, are always retained on the inner skin of the land-locked fish and may be found by stripping the skin off. I have also observed among the Sebago fish, some cases of a retention of the external bars in at least one individual thirteen inches long; whereas, normally they become invisible from without when the fish is about eight inches long.

As might be expected, the inferior size of the land-locked salmon is accompanied by a lower rate of fecundity, but this

would not lead us to expect the individual eggs of the smaller fish to be of a larger size. This is, however, the actual fact, the difference being quite noticeable, and amounting to say twenty per cent. in weight. Among the migratory salmon of the Penobscot, ovarian disease is very rare; but with the land-locked salmon of the Schoodic lakes it is very common. In 1883, by careful observation we learned that 18 per cent. of the female fish were affected with some disease of the ovaries, resulting in defects of the eggs which were apparent to the eye,—in some instances involving the entire litter, but in general a very small number of eggs. This phenomenon was observed before artificial breeding began at Grand lake stream, and does not appear to be influenced thereby.

The habits of the two forms of salmon afford the strongest contrasts. The anadromous salmon has its home in the sea, and there, exclusively, are its feeding grounds; it visits the fresh water only for the purpose of breeding, and during its stay there abstains from food and constantly falls away in flesh. Its young on attaining the age of one or two years and a weight of two or three ounces, descends to the sea to complete its growth. The land-locked salmon never visits the sea except accidentally, and makes its home in the fresh water lakes. It has its feeding grounds in the lakes and rivers, and instead of fasting six months or a year at a time, curbs its ravenous appetite for but a few weeks at the spawning season.

My observations on the date of spawning lead to the conclusion that it is a week later with the land-locked than with the anadromous salmon. In approaching the spawning ground, the land-locked salmon move either up into an affluent stream or down into an effluent stream, being governed, so far as I can see, by the peculiar circumstances of each case. There are not wanting some indications that they prefer an effluent, but I think that the phenomena admits of a different explanation. The young fry in most instances move up the stream to gain the lake which is to be their future home, but in some instances quite the reverse. It does not appear that in any of these phenomena we have uncovered any essential difference in habits and instincts, but when the sea salmon attains the age for the seaward migration, an in-

stinct begins to govern his actions to which the land-locked is forever a stranger.

Of less theoretical but more practical importance is a comparison of size. The average of adult Penobscot salmon is about thirteen pounds, though there are some fluctuations from year to year—the mean for a season being sometimes above sixteen pounds, and sometimes below twelve pounds. If we excluded the Ontario and Champlain salmon, we know of no land-locked salmon in America that average half as large. The Sebago fish are the largest; a score of thirteen taken with hook in the Sougo river in 1880 averages five pounds, and this is probably about the usual size, though individuals of great weight are sometimes taken. The above score contained one weighing 10¾ lbs. One thirty and a half inches long and weighing 15½ lbs. was taken with hook in May, 1883. One found stranded and dead in Rogers brook in Bridgton in 1883, was thirty inches long and weighed twenty-five pounds. The Reed's pond salmon are next to those of Sebago in size,—indeed, possibly, are fully equal. The salmon of the Sebec region vary much in the different waters of the system, as do also those of the St. Croix, but the average growth may be taken to be about the same as at Grand lake stream, where some hundreds were measured in the autumn of 1883, with the result that the mean weight of the males was 3.2 lbs., and of the females 3 lbs., while the salmon taken in May and June are perhaps a quarter of a pound lighter

AN AUGMENTATION OF MEAN SIZE.

In connection with this part of my subject I have some very interesting statements to present, with reference to a dreaded change in the mean size of the Grand lake salmon.

A Philadelphia sportsman who fished at Grand lake stream nearly thirty years ago, furnished Mr. Thaddeus Norris memoranda from which the following averages may be deduced. In June, 1856, the average weight of 634 salmon was 1.38 lbs.; in June, 1857, the average of 432 salmon was 1.49 lbs.; in the same month of 1858, the average of 575 salmon was 1.42 lbs. In May, 1865, Hon. Harvey Jewell with one companion took 379 salmon weighing 502¼ lbs., and averaging 1.33 lbs., and remarks that

this was the average weight of those taken by other parties in each of the years 1864 and 1865.

In 1867, I personally visited the fishing ground and know that the size of the fish had not materially changed since 1858. The maximum was then believed to be four or five pounds, but the capture of so large specimens was extremely rare. The autumn weight may have been a little above that of June, (which corresponds to a length of 16½ inches) but did not exceed 1¾ lbs.

In 1875-6, the average weight of some hundreds of males taken at the spawning season was 1.6 lbs. and 1.8 lbs respectively, and of the females 1.9 lbs. each year. In 1878, the males averaged 2.3 lbs. and the females 2.2 lbs.

In 1882, the males and females weighed respectively 3.1 and 3.08 pounds; in 1883, 3.2 and 3.0 pounds. There has been a corresponding, but perhaps not equal augmentation in the size of the fish caught in May and June; seventy salmon taken in May, 1883, averaged 2.7 lbs., a little more than double the weight of Mr. Jewell's fish of 1865. Accompanying this increase in size, we have found a corresponding improvement in the fecundity of the salmon. The eggs are no larger, but nearly twice as many are now obtained from a single fish.

These figures apply only to the salmon of Grand lake stream. In other parts of the Schoodic waters the fish are of various sizes —some larger and some smaller than those described. At Dobsis stream, in the spring of 1872, a score of Mr. Jewell's shows that twenty-six fish taken below the dam in water communicating with Pocumpus lake, averaged 1 4-10 pounds, while eighteen taken above the dam, in the waters of the Dobsis lake averaged 2 6-10 lbs. In after years this distinction was maintained and indeed emphasized. In the Dobsis lake in 1876, they were about as heavy as they are now in Grand lake. In West Musquash lake they are larger than in either of the above. In the lakes of the east branch of the Saint Croix (the Chepedneck lakes) they are generally larger than in any of the waters of the west branch, with the possible exception of West Musquash, and there has been known a single specimen of 10½ pounds. In Pleasant lake, on the west branch, are the smallest specimens of all the Schoodic region. In February, 1883, I obtained thirteen

specimens said to represent fairly those that winter, through the ice, except that some very small ones had been excluded from the lot. These had the form and color of adults, but the largest of them weighed only eighteen ounces and measured only fifteen inches in length, and from this size there was a very regular descending series down to 10¼ inches in length and 5 ounces in weight.

It is much to be regretted that we do not possess the data requisite to the discussion of the causes that have led to this diversity of size between the fish of different parts of the same lake system, or to the recent increase in the size of the Grand lake fish.

RATE OF GROWTH.

At Grand Lake Stream, at the spawning season, we have found six distinct classes of salmon, distinguished mainly by size, as follows:

First class. This is equivalent to the "parr" or "pink" stage of anadromous salmon. It is characterized by the presence of dark transverse bars and brilliant red spots on the sides. In size they are very uniform. Of nineteen of them captured October 15th, the smallest was 2 9-16 inches long, the largest 3⅞ inches long, and the average 3¼ inches. Their weight was not ascertained but must be about 2-10 ounce. They have thus far been observed only on the gravelly shallows of the stream. They were present before artificial breeding began, and undoubtedly represent a normal stage of growth. Parr of about the same size are also found in the stream at the beginning of summer, and occasionally in great numbers. Such was notably the case in 1882, and also, though not to an equal extent, in 1883. Mr. Munson, our foreman, who is very careful and exact in his statements, reported that in June, 1882, at the time when the driving of logs through the gates was in progress, there were great numbers of these little fish below the dam. While the gates were open and the stream full of water, they were little inclined to bite, but when the gates were closed and the water fell they eagerly pursued any line, crowding each other and leaping out of the water after an approaching fly or other bait. Meeting

one day a young fellow crossing the dam with a long string of these little fish that would more than fill a peck measure, Munson took out his rule and measured about half a dozen of them, and found them to vary little from three inches in length. These young fish were taken that season in numbers that threatened to seriously affect the abundance of the adults, and upon petition, the legislature at its next session forbade their capture. The occurrence of parr of the same or nearly the same size in the fall as in the spring, is a noteworthy and at first a puzzling circumstance. Spawning takes place but once a year, that is beyond question. Do the young fry grow unequally, part of them attaining in six months the same size that others do in a year, or is there a lapse of six months in their lives without any considerable growth? I think the first supposition is not admissible, because we have never met with the intermediate sizes that must have been present. It seems possible, therefore, that their growth is almost wholly accomplished in the warm season and is nearly suspended in the winter.

Second class. Seven to eight inches in length and weighing three to four ounces; bars and red spots still plainly visible, and nearly as distinct as in the first class. They yield a copious supply of milt, and a few of them are found commonly on the spawning beds, attending or seeking to attend the female salmon in the act of spawning. They occur at the same time, though not commonly in company with the smaller fish of class one, both in fall and spring.

Third class. A little larger than class two, measuring about ten inches, and weighing seven or eight ounces. Bars and spots still visible but very faint. All males, and yielding milt copiously. Observed occasionally in October and November. This form approaches closely the "smolt" of the river salmon.

Fourth class. About thirteen inches in length and one pound in weight. Reproductive functions dormant, organs little developed and sex unknown. They are uniform in appearance as well as size, but are not numerous and appear irregularly, rarely more than half a dozen of them in a single season. Barren individuals of larger size, sometimes as large as seventeen inches in length, and thirty ounces in weight, met with rarely, and only

in autumn. Whether there is a corresponding class in May and June, I am unable to say, but judging from the weights of captures shown by some scores submitted to me, I think it quite likely.

Fifth class. Adults. There is a great range in size, and doubtless some are of advanced age and belong to an additional class, but as there seems to be an unbroken series from the smallest to the largest, I am unable to separate them, and were a separation possible and the fish classified according to age it is not unlikely that the different classes would be found overlapping each other in respect to size,—that is, the larger fish among those that are in their first year of adult-hood may be larger than the smallest of those that are a year older than the smallest adults on my record were.

Now what conclusions are we to draw from these data? On the supposition that each of the first four classes represents a separate stage of growth, with intervals of one year in each case, the fifth or adult class must be, when caught in November, five years of age from the date of the deposit of the egg, or four and a half years from the date of hatching. I have, however, some doubts as to the validity of the distinction between classes two and three, the former being equivalent to the male parr of the British salmon and the latter having not yet fully attained to the "smolt" stage, which should be distinguished by entire absence of any external bars or spots. The position and significance of class four (13 inches, barren) is also not entirely free from doubt. It is possible that such fish are of adult age, but barren from some unknown cause, and on the supposition that such is the case there will appear to be no intermediate form between the third class (that has almost reached the smolt stage) and the adults, and hence the interval of time separating these two becomes more than ever a matter of conjecture; but as we are tolerably certain that a year (from impregnation) is required to attain three inches in length, and another to attain eight inches, it is hardly reasonable therefore to suppose that the growth from eight inches to the adult stage would be accomplished in a single year.

My conclusion is that the following is the most probable

outline of the life of the salmon of Grand lake; taking the time of impregnation as a starting point, the embryos hatch at six months of age, attain a length of three inches at one year; of eight inches at two years; of thirteen inches at three or four years; and of complete maturity (fifteen inches or more in length) at four or five years. Specimens twenty inches or more in length and weighing three pounds or upwards, I am inclined to regard as fish on their second visit to the spawning grounds, and on the assumption (of which there is, however, no direct proof) that they are like the anadromous salmon, biennial spawners—such fish are six or seven years old.

Whether the same rate of growth prevails among the land-locked salmon in their other native haunts, there are no data to determine, but it is very probable that the entire period of growth is about the same, and accordingly that, in the case of the larger salmon of the Sebago the rate is greater.

GROWTH IN NEW HOMES.

When introduced to new haunts they have often grown to an unwonted size and sometimes at an accelerated rate. I will cite some instances:

In Saipsic lake, Connecticut, in May, 1881, was captured a specimen twenty-two inches long and weighing 3 lbs., 14 oz. This was the growth from Schoodic fry, the first of which were planted in 1874. If this specimen was from the first planting it had grown to an unusual size for Schoodic fish. September 23rd, 1881, another specimen was taken in the same lake, weighing 6 lbs., 2 oz. One of 6 lbs., 8 oz. was reported to have been taken about the same time from one of the Twin lakes in Salisbury.

In Shrewsbury pond, near Rutland, Vermont, specimens have been taken, I am told by Dr. C. H. Barber, weighing 6¾ lbs. One party caught twenty-three in one day, the smallest of which weighed 1½ lbs., and the largest 6¼ lbs. This lake is one mile long, one-half mile wide and 160 feet deep.

Woodhull lake, Herkimer County, N. Y., was stocked with fry of Schoodic salmon, in the summer of 1879. In the spring of 1881, soon after the disappearance of the ice, several specimens

were taken, one of which weighed nearly a pound. In the winter of 1882, a number of specimens were taken by fishing through the ice, and some of them were eighteen inches long, probably weighing two or three pounds. In the fall of 1882, a specimen weighing over four pounds was taken in the stream below the lake—this fish was thus four years old from impregnation, and had attained a size double that calculated for a Schoodic salmon of that age in Grand lake.

In the Rangely lakes in Maine, about fifty domesticated Schoodic salmon about two years of age, were introduced from breeding ponds in Alna; fry of Sebago salmon were introduced as follows: 2,000 in 1874; 5,000 in 1875; 3,000 in 1877; 18,000 in 1877. In 1877 a single specimen weighing five pounds was captured. As to further results I will quote Mr. Stanley's letter to the *Forest and Stream*, October 26th, 1882: "I am happy to state that the salmon put in an appearance in the Rangely stream this fall in considerable numbers and for the first time. Some of them were very large. I saw five of them in a pool which I estimated would run from four to ten pounds each. Over forty were taken last June in the Rangely lake alone, of from 2½ to 4½ lbs. each. They have also been taken in the lakes below. For the short time that has elapsed since they were introduced, and the small number of eggs, the success has been remarkable." As it is impossible to determine absolutely whether these captures came from the early planting of Schoodic fish, or the later planting of Sebago fish, nor yet their age, we can only remark that the size attained is very satisfactory, and from the numbers captured and seen, it is quite evident that the species is established as an inhabitant of the Rangely lakes.

Another instance from the same State may be adduced in the case of the Weld pond, which I will give in Mr. Stanley's language:

"The most reliable information I have in regard to growth of land-locked salmon or the time it takes to reach a certain size is what I get from the Weld pond in Franklin County. This pond is about five miles long and two miles wide; is fed by numerous large brooks which take their rise back in the wilderness among the mountains, to which the trout and salmon (the former

are plenty) have free access to their head waters. Also the outlet of the pond, Webb's river, about the size of the Presumpscot, is a rapid stream, five miles after it leaves the pond, with clean, gravelly bottom, and unobstructed by dams. This pond is famous for its trout and pickerel—the angler catching about as many brook trout as pickerel. It is plentifully stocked with smelts and minnows. * * * * I give you the number and dates of the plantings below:

1875,	2,000	Sebago	salmon.
1876,	3,000	"	"
1877,	10,000	"	"

The first 2,000 were put into the Bowley brook; the other two lots were turned into the river, with the exception of perhaps about 2,000 more, which were put into the above brook. A friend of mine who is reliable, told me he saw weighed one that was caught in this brook that tipped the scales at eleven pounds. Last fall they came into the brook and river also in considerable numbers, and of large size, some, undoubtedly, of ten or twelve pounds. Last summer the small salmon six to eight inches long were quite plenty in this brook, also some in the river. Parties fishing for brook trout, would in half a day's fishing catch fifteen or twenty of these little salmon, which, however, they put back. None have been taken in any of the streams except the river and Bowley brook, and the pond. Quite a number have been taken fishing through the ice this spring, but none over three and a half pounds.

Quite remarkable results have been observed in some of the waters of New Hampshire. I will quote Commissioner E. B. Hodge. Under date of April 25th, 1885, he writes as follows:

"In regard to the Schoodic salmon in this State, I am happy to state that they are doing well, and good reports are being received from various parts of the State. In some waters their growth has been remarkable, particularly in Squam lake. The first plant was made in this lake by Col. S. Webber, in 1877. In June, 1880, a land-locked salmon was taken in the outlet of the lake that weighed 6½ pounds, and one was killed by going through a mill-wheel that measured twenty-seven

inches; weight not taken, as it was decomposed when found. In November of 1883, six years after the lake was stocked, two salmon were speared on their spawning beds at the outlet, one of them weighed ten pounds, and the other fifteen pounds.

"In Lake Sunapee their growth has been greater than in Squam. First stocked in 1880, by Commissioner A. H. Powers. The largest fish taken in 1883, weighed 7½ pounds., and one reported to weigh 8¼. Several of five and six pounds were taken during the season, *and the large ones all got away.*

The figures I have given you are all from reliable persons and are authentic. Even in small ponds I have seen fish that weighed 2¼ pounds, when two years and two months of age. I could give you many other instances where large land-locked salmon have been reported to have been taken, but the above is enough to show that they are a success in this State, and to warrant the commissioners in following up the planting of them in such waters as are adapted to them."

Under date of April 28th, 1884, Mr. Hodge writes further:

"Since my letter to you of last week, there has been taken at the outlet of Squam lake, a land-locked salmon twenty-eight inches in length, and weighing nine pounds. This fish was measured and weighed in presence of several reliable persons."

REQUIREMENTS OF LANDLOCKED SALMON.

It is to be regretted that there are no adequate data at hand from which to discuss the question of the requirements of Schoodic salmon. We ought to know definitely the size and depth of all the lakes that they naturally inhabit; the quality of the water; its temperature at surface and bottom during the heated term; the quantity and variety of food afforded; what enemies they have successfully combatted, and to what ones they have succumbed; the character and extent of their spawning grounds, etc. The data at hand will enable us to lay down only general rules, which will, nevertheless, it is hoped, be of some service in directing future effort.

It does not appear that the matter of area is important. Land-locked salmon appear to thrive as well, other things being con-

sidered, and attain as large size in lakes of a few hundred acres area as in those covering thousands of acres. For instance, the largest salmon of the Grand lake region are found in West Musquash lake, whose area is less than a thousand acres; and among new localities we may instance Shrewsbury lake, in Vermont, only one mile long and one-half mile wide, where such signal success has attended the introduction of these fish.

The depth of water is apparently a more important matter. I think the rule will hold good that large fish of the salmon family generally inhabit deep lakes. Of the native haunts of the land-locked salmon, the deepest is Lake Sebago, where 410 feet of water have been found, and in this region we find the largest land-locked salmon in Maine; it must, however, be noted, as a possible exception to our rule, that the salmon of Long pond, a tributary of Lake Sebago of much smaller size, and, it is supposed, much shallower water, are not much, if any, inferior to those of Sebago itself, and have actually furnished the largest individuals on record. West Musquash lake, which produces the largest salmon of that region, is known to be in some places over 130 feet deep, while Grand lake is not known to be over 115 feet. Shrewsbury lake in Vermont, is 160 feet deep.

I am not, however, prepared to say that there can be no success in lakes of moderate depth. It is known that land-locked salmon were once abundant at Princeton, at the outlet of the lower lakes of the Schoodic chain. They must have inhabited Lewy's, Long or Big lakes, all of which are in general, shallow, and in which there is good reason to believe, though by no means certain, that a depth of more than sixty feet cannot anywhere be found.

As to temperature, I am only able to say that the phenomena observed indicate that on the approach of hot weather the salmon forsake the streams and surface waters, and retire to the depths, where it is always comparatively cool. It is likely that they will not permanently thrive in waters where they are compelled to endure through the summer a surface temperature, or say upwards of 70 degrees Fahrenheit. Very likely this limit will have to be moved a few degrees up or down, when data are obtained. The latitude in which nature has placed these fish,

indicates roughly the climatological conditions required. It is not likely that they will thrive much further south than their natural range, unless in elevated, and therefore cool regions.

As regards qualities of water other than temperature, I do not think land-locked salmon are specially fastidious. Muddy water is undoubtedly objectionable, but among their native haunts are many lakes whose water is strongly colored with peaty and earthen solutions.

Gravelly shores and bottom are not essential, except on the breeding grounds, which must be ample to insure a great degree of success. A good sized brook, abounding in gravelly rapids, will meet the requirements. Whether it should be an inlet or an outlet may be properly brought in question. It seems to me well proven, that these fish are endowed with instincts of locality that impel them to deposit their eggs in their native streams, to the extent of selecting one among several streams connected with the same lake. On no other supposition can we explain certain pnenomena at Grand lake. Junior stream, at the head of the lake, is a fine, gravelly stream, offering excellent locations for spawning beds, and more easily accessible from the lake than is Grand lake stream, and was formerly much resorted to by the salmon. Of late, however, it is almost entirely deserted, notwithstanding the salmon are abundant in the lake, and thousands of them yearly resort to Grand lake stream at the other extreme of the lake. Whether this instinct will interfere with the use of fry from Grand lake eggs for the stocking of waters whose only spawning grounds lie in their affluents is a question deserving consideration, but which we shall doubtless have to leave to the solution of experience. It is interesting to note that in many of the lakes where they have been introduced we hear of them first in the outlets. Such is the case at Woodhull lake in New York, and at Squam lake in New Hampshire. Some of the new inhabitants have made themselves known by running down into mill-wheels. At Woodhull lake, "from appearances," writes Gen. R. U. Sherman, "the whole stock went out of Woodhull dam through the open gates, and gathered in the stream below to spawn."

The question of enemies must be regarded as one of the first

importance. I am inclined to attribute the disappearance of land-locked salmon in recent times from some of their old haunts in different parts of the Schoodic lakes, to the attacks of pickerel which were introduced from the Penobscot waters. I think it is capable of demonstration that in each instance where this has occurred the existing conditions were more favorable to the growth of pickerel than of land-locked salmon. A case in point is that of Junior stream mentioned above. The lower course of this stream is a broad, weedy, semi-stagnant piece of water, full of aquatic weeds, a most admirable place for the reproduction and growth of pickerel, which could here lie in wait for the young parr, and down whose capacious throats the entire brood may have slipped. The presence of pickerel is not, however, necessarily fatal. If the conditions are sufficiently favorable the salmon will maintain themselves, as at Grand lake stream. In general any lake in which trout maintain themselves against pickerel may be considered suitable for land-locked salmon. It is quite possible that in some cases the salmon will succeed where trout have yielded to their foes, but there is nothing in experience to warrant the expectation.

The growth attained in some of the instances cited above, lead to the hope that introduced to conditions more favorable than those of their native haunts, they will become permanently increased in size and in importance. It is not too much to hope that in suitable tributaries of some of the great lakes, especially those of Lakes Superior, Michigan and Huron, they may even become what they have never yet been in their original homes in Maine, the objects of pursuit of an industrial fishery.

Prof. Goode: Mr. President, I am sure we have all listened with great interest to the paper read by Mr. Atkins. It certainly is a magazine of new facts concerning the land-locked salmon. I should like to take advantage of the presence of Mr. Atkins to ask one or two questions. The land-locked salmon is, I suppose, universally admitted to be a descendent, through modification in habit, of the sea-running salmon. (To Mr. Atkins) Have you in your studies of this fish been enabled to judge how long

it has been since the land-locking took place; or, rather, when the oldest and most recent land-lockings occurred? I would also ask whether, in your opinion, the land-locking has produced an hereditary tendency in the fish to remain in the head waters of streams, so that if obstructions are removed, fish descended from land-locked fish will also be likely to remain in the head waters. I would also ask in the special interest of the fish-culturists of England, who at the present time are doing a great deal of work in the way of hybridizing various species and races of salmonidæ, etc., whether our land-locked salmon could not be transported to England and crossed with the large brook trout or the char? It would be a great advantage, for they would thus secure a heavier and better fish than the trout which they now have; and, moreover, a fish which would be likely to remain in the head waters of the streams. Such is the theory of certain English experts, but it occurs to me that their theory is without very good foundation. If Mr. Atkins can throw any light on any of these questions, we shall all, I think, be greatly interested.

Mr. Atkins: I do not think we have any evidence that the land-locking of the species under consideration has occurred during recent geological periods. There is nothing at present to prevent any of these salmon from going out to sea from any of those waters where they are now found. There are obstructions to their coming back, if they once went to the sea, and these same obstructions would hinder the sea salmon having access to the upper waters where the land-locked salmon now live. It is possible that at some very remote period there were obstacles which prevented their descending to the sea. I think it possible, also, that the change in their habits and instincts occurred gradually. The male salmon will live in fresh water until their reproductive organs are developed, which occurs at an early stage of their existence. I do not know that it has been proved (excepting in the case of some other species than *Salmo salar*) that salmon can be kept from making migrations to the sea until the eggs of the female become pretty well developed; but I think it possible that such proof may be furnished. One salmon may have stayed over the proper time—perhaps

from compulsion—perhaps from some natural weakness of instinct—and she may have developed eggs without going to salt-water, and her descendants may have inherited the tendency to remain in fresh water. That is, of course, mere speculation, without any observation to base it upon, excepting the absence of obstructions at the present time. That the lack of instinct to migrate seawards is hereditary, is unquestionably true. The salmon have an opportunity to go to sea, and do sometimes run down as far as the mouths of weirs, but apparently not with the intention of going to sea. As to the hybridization suggested, I have never seen any evidence of its occurrence naturally among the salmon or any other species of fish. I have had no experience in the matter of artificially breeding hybrids, but the general testimony from those who have attempted to raise them, is that they grow well and probably make good fish.

The President: Is a great depth of water necessary to the welfare of the fish? I ask this because I have noticed that on Long Island in some small ponds they never came to anything.

Mr. Atkins: I think that probably the depth of water is the most important point to be considered. They will not thrive if compelled to sustain a high temperature of water. They must in the heated season be allowed to go into deep water where they can keep cool.

Prof. Goode: Mr. Atkins, have you ever seen any indications of hybridization under natural conditions between sea salmon and land-locked salmon?

Mr. Atkins: I never had an opportunity to observe anything of that kind. I have taken only four or five anadromous salmon in company with land-locked salmon. In Grand lake stream we have on several occasions taken sea salmon that ascended to the lake, and came to the same ground as the land-locked salmon for the purpose of spawning. Two of the above four or five were mated—male and female, and the others we took and made use of without waiting to see what the action of the fish would have been if left alone.

BLACK BASS IN MAINE.

BY GEORGE SHEPARD PAGE.

It is often difficult to determine the exact date, or obtain reliable information as to the original introduction of a new species of food fish into a river or lake, and particularly to ascertain the facts relative to the stocking of the water of a State for the first time. This is important, not only that the agents in the work shall be placed on record, but chiefly that we may know definitely the time required to disseminate fish over a large territory in such numbers that the people can rely upon them for food and sport. Experience with the black bass in Maine is one of the most pertinent and effective illustrations of the value of such labor.

In August, 1869, accompanied by four friends, I left New York by Hudson river afternoon steamer for Newburgh. Arriving there about 7 P.M., my transportation box was conveyed to the small private pond of Mr. Walter Brown. At daylight the next morning we literally surrounded the pond and began casting the fly. In an hour, thirty-five small-mouthed bass were placed in the box, and at 7 A.M. the steamer Mary Powell started with us for the metropolis. Arriving there at 11 A.M., the box containing forty gallons of water and thirty-five bass from one-quarter pound to a pound weight, was taken to the dock of the Fall River line, and a stream of croton water turned on until 5 P.M. Arrangements were made with the night watchman to work the air pump at intervals. Arriving in Boston an express wagon conveyed the box to the Eastern Railroad, and during the journey at intervals of fifteen minutes I ærated the water by the use of the air pump. At 3 P.M. the train reached Monmouth, in Maine, about fifty miles northeast of Portland. Very near the station is Cochnewagn pond. I selected twelve bass and quickly transferred them to the pond. The train moved on, and a few minutes later arrived at Winthrop. A wagon was hired and the box taken to East Winthrop, four miles distant, and twenty-one bass were liberated at the head water of the famous Cobosseecontee pond, the largest of a chain of lakes thirty miles in length. Placing

the remaining pair of bass in a three-gallon pail, I started by team for Phillips, Franklin County, forty miles away. On the route one of them died. The remarkable vitality of the bass is exhibited in a strong light in view of the mode of capture, long and difficult transportation and mid-summer temperature.

The following October, Mr. Charles G. Atkins, then Commissioner of Fisheries of Maine, procuring my transportation box, took thirty-nine bass from Mr. Brown's pond, which he placed in Duck pond, near Portland, Me. So far as I know these seventy-four were the first and only black bass deposited in Maine waters. Fourteen years have elapsed, mark the gratifying results: The report of Hon. Henry O. Stanley, Commissioner of Fisheries for Maine for 1881, contains the following: "The black Bass, owing to its very game qualities, continues to be a favorite fish with anglers, and applications for introduction are received beyond the powers of the commissioners to gratify. It should never be introduced into any waters where there are trout, or from whence it can gain access to trout streams. For ponds, whose stock of trout has been exhausted by poachers, who murder the fish in their spawning beds, and where only yellow perch, bream and pickerel are left, it is invaluable. Trip pond, in Minot, Gardiner's pond, in Wiscasset, Gun Point Ice Company pond, in Harpswell, Hosmer pond, in Rockport, Keazer's Heald and Cushman ponds, in Lovell, and Little Pushaw, in Corinth, have all been stocked with bass this past year."

Messrs. E. M. Stillwell and Hon. H. O. Stanley, in the report for 1883, report as follows: "The black bass is still growing in popular favor. We have had more orders this year for stocking ponds than in our power to fill. The great success met with at Pushaw lake; the number and size of the fish taken, some turning the scales at four and one-half pounds, tend to popularize fish protection and fish planting; the increase in the product of fish, the result of the suppression of netting, all tended to produce a great and beneficial change in the public mind, giving firm and even enthusiastic support, where hitherto we have been met by active opposition. Newport and Glenborn can now boast of two of the most beautiful and productive lakes in the State, destined in the future to become popular places of summer re-

sort for devotees of boating and angling, and where pretty cottage residences may be built for family homes at but trifling cost, and where easy access to telegraph and railroad would render their occupants scarcely conscious of absence from city comforts. Cobosseecontee, Snow and Belgrade lakes are places of marked beauty and healthfulness, easy of access and where facilities for boating and angling are unsurpassed. Homes for hundreds whose lives are dependent upon country air and exercise can be made in cottage and tent, while the expense of the more fashionable places of resort bars them from all but those of large means. We often wonder that our city residents do not appreciate at how small a cost a pretty summer cottage can be built upon the shore of any of these beautiful lakes, abounding in fish, with health and exercise, and freedom from all the cares of city life."

In a letter dated Dixfield, Me., April 27th, 1884, Mr. Stanley writes: "Yours of the 24th received. With regard to black bass, I know we have them here in great abundance, the number of ponds we have stocked (all pickerel ponds) I think will reach to the hundreds. Wherever you put half a dozen, they are sure to take and will be heard from in two or three years. I have taken bass of two and one-half pounds in a pond that had only been stocked two years, and with young fry, so they could not be over two and one-half years old. There has been a great demand for them in our State, and in many ponds there is good bass fishing where there was none whatever before. I think they are a fish that cannot be thinned out by fishing with hook and line. I have met with the best success with the fly, from dusk till ten at night, fishing close in shore in very shoal water, have caught large fish when it was so dark I could not tell, casting from a boat, whether my fly struck on shore or in the water, and only knew I struck a fish by feeling the tug or hearing the splash. The Winthrop ponds, Cobosseecontee, one of the ponds you stocked, Lake Maranocook and in all that chain of lakes, is good. I have taken in one afternoon in Cobosseecontee, sixty pounds of from two to three and a half pounds each. There is also fine fishing in Belgrade ponds, Pushaw pond, Bangor, and in scores of others. I mention these as they are easy of access

by rail, and good accommodation can be had at hotels and farm houses, and at low rates. Also pleasant places to camp. The inhabitants are always glad to welcome sportsmen and visitors, and accommodate them with boats and information at low rates. I think the black bass are a great benefit to Maine."

IS LEGISLATION NECESSARY FOR THE PROTECTION OF THE OCEAN FISHERIES?

BY EUGENE G. BLACKFORD.

Commissioner of Fisheries, State of New York.

One of the questions that frequently perplexes the mind of the fish-culturist and the legislator is, how to protect in the best manner the valuable food fisheries of the sea coast and ocean.

On the one hand, there are the market fishermen, who use sailing vessels, and work either in the deep outside waters, or with net and hook, gather their prey along the shores and in the bays of our coast. This industry gives employment to over 85,000 men, and a capital of over $30,000,000.

On the other hand we have the large fleet of steamers that patrol the ocean catching the menhaden, and from them manufacture oil and fertilizers. An occupation involving nearly $3,000,000, and giving employment to over 2,000 men. These facts give some idea of the magnitude of the interests involved, and of the importance of the question under discussion.

For the last five years a large number of the former class of fishermen have claimed that the steamers seriously affected their business, stating that many kinds of fish that were formerly abundant, are now scarce, and that, unless laws are passed, prohibiting the menhaden steamers from fishing within three miles of the shore, or in some way restricting their operations, many kinds of the valuable fishes will be exterminated or driven from our shores. In pursuance of this idea, they have petitioned both State and National legislatures to that effect.

The question has been largely discussed by the press, the State and National Fish Commissions, and in the United States Senate. The latter has appointed a Committee on Fisheries, with Hon. E. G. Lapham as chairman. This committee has for the past two years taken the testimony of all classes of fishermen, and obtained the views and theories of fish-culturists and ichthyologists. And, in addition to this, we have the valuable information and statistics gathered with great care by Prof. S. F. Baird, the eminent Commissioner of Fish and Fisheries of the United States.

It has been my privilege to assist in obtaining information on the subject for the Senate Committee, the United States Fish Commission, and the New York State Fishery Commission, and I have read with great interest all of the evidence that has been taken by them bearing on this subject. And now, in discussing the question as to the advisability of any legislation to protect the ocean or sea fisheries, it is best to look over the facts which have thus far been brought out and see what would be the best way to provide for the continuance of the abundant supply that we now enjoy.

The first thing that we want to ascertain is whether what we know as salt-water fish, are scarcer now than in former times, and I would say here, that the absence of statistics covering any considerable space of time, makes an answer to this question somewhat difficult, but, thanks to the New York Fishmongers' Association, and to the Boston Fish Bureau, a beginning has been made to supply this hiatus, and it is hoped that the National Government will very soon take definite measures for the purpose of getting, annually, correct statistics of the amount of fish caught in the waters and on the coast of the United States. Having been a dealer in fresh fish in Fulton Market, New York, for the past seventeen years, I have had the opportunity of noticing during this period, the varying supply of various kinds of fish, and I beg leave to submit my views as to the scarcity or plentifulness of some of these various species.

First and most important of all our fishes is the cod. I believe that there has been no considerable diminution in quantity in the last decade, judging from the quantity brought to market and

the prices obtained; and as some indication of the range of price, I may say that during the year 1883, cod sold as low as one dollar per hundred weight. In some years there has been a perceptible decrease in the catch, but it has been followed by such enormous catches that the markets have been glutted. The statistics of the Boston Fish Bureau show the catch of the New England fleet to be: for 1881, 775,027 quintals; for 1882, 898,904 quintals; for 1883, 1,061,698 quintals, showing an absolute increase in two years of nearly 300,000 quintals. Surely these figures need not occasion any alarm or fear that codfish cakes will be beyond the reach of the most impecunious fish-culturist.

Next, and hardly second in importance, is the bluefish. It is a matter of historical record that these fish disappeared entirely from our coast in the year 1764, and did not make their appearance again for several years, and then they were taken in vast numbers. Suppose such a disappearance should take place this summer. How quickly the fishermen would appeal to the legislatures to abolish the menhaden steamers, and the angler would cry out for the destruction of the pound and trap nets. Each would probably claim that the scarcity was owing to these instrumentalities. This one instance of the bluefish in 1764, should lead us to be careful and conservative in regard to legislation, and to carefully consider whether there are not some great natural laws that determine the appearance and disappearance of fish on our coast, rather than attribute it to the comparatively puny efforts of man to affect the supply.

But let us turn to the question as to their present apparent scarcity or plentifulness. During the year 1882, bluefish were scarcer than they had been for some years, and the wholesale price did not go below five cents. This scarcity was particularly noticeable on the New Jersey coast. But the season of 1883 was unusually productive, and bluefish sold as low as two and a half cents per pound, and, had it not been for the large quantities that were taken out of the market and stored in refrigerators for winter use, the price would have declined to one cent per pound.

It would seem to be a fair inference that the bluefish needs no protection at present.

The fresh mackerel is another important factor in the food supply of the people. It has attracted a great deal of the attention of fish economists, and it is one of the fishes in regard to which, through the statistics of the Boston Fish Bureau, we can speak somewhat intelligently.

In 1825, the New England catch was 260,000 bbls; in 1826, 160,000 bbls.; in 1827, 200,000 bbls.; in 1828, 240,000 bbls., and in 1831, the largest quantity on record was taken, amounting to 390,000 bbls. After this wonderful catch the number steadily declined until the year 1840, during which season only 55,000 bbls. were taken. In 1851, there was another wonderful catch of 330,000 bbls.; in 1859, only 100,000 bbls.; in 1863, 310,000 bbls ; in 1868, 180,000 bbls.; in 1870, 320,000 bbls.; 1877, 110,000 bbls.; in 1880, 245,000 bbls.; in 1881 and 1882, the number is the same—260,000 bbls.; in 1883, 160,000 bbls. These figures, covering a period of fifty-eight years, would seem to indicate that their plentifulness or scarcity is not governed materially by the purse seines of the Gloucester fleet.

In my own experience in the New York markets I have seen just such fluctuations in the quantities brought to that city, and whenever there occurs a bad season the fishermen and others interested, talk of the probability of the mackerel being all caught up, and of the necessity of some protection for the mackerel fisheries.

The opening of the present season has been a remarkable one. The first vessel arrived March 24th, and the mackerel were so small that the captain refused to take off his hatches to show the fish, and insisted on selling them "unsight unseen," and he was fortunate enough to find a purchaser on those terms, at two and a half cents each. There were something like 100,000 fish in the load, and they were so small that it took five of them to weigh a pound. The firm that bought them succeeded in selling a few hundred at four cents each, and then the price rapidly declined, until the larger portion of the cargo was sold at 50 cents per 100. About that time the unfortunate buyer called my attention to the fact that it was a great shame that such small mackerel were caught, and that Congress ought to pass a law to prohibit such a wicked waste.

The first load of mackerel was followed by several loads with fish a very little larger in size, but about the 20th of April a new school made its appearance, the average weight of the fish being about one pound each, and at least 1,500,000 of this size have, up to the present time, been marketed, and a large portion of them have been sold as low as two cents each.

The porgy, or, as it is sometimes called, the scup, is another important fish that furnishes abundant and cheap food, and about which considerable controversy has been had during the past few years, between the net men on one side and the hook and line men on the other, the latter claiming that the pounds and traps of the former were exterminating these fish, and efforts were put forth to have laws enacted that should restrict or abolish pound and trap fishing. But nothing came of such endeavors. This was in 1871, and fishing has been carried on in the same manner ever since, and in the New York market last week porgies sold as low as 75 cents per barrel, or about one-half a cent per pound.

I might continue on through the list of food fishes, and occupy your time, and possibly your attention, but I think I have said enough on this branch of the question.

Now, let us consider the menhaden fisheries, against which is brought the charge that they are prosecuted to such an extent, by both sail and steam vessels, that they have materially decreased the numbers of menhaden, and seriously impaired the catch of food fishes. You will find, by referring to the reports of the United States Menhaden Oil & Guano Association, that in 1875, with 283 sailing vessels, and 25 steamers, 492,878,000 fish were taken, that in 1881, with 286 sailing vessels, and 73 steamers, 454,192,000 fish were caught, and in 1882, with 83 steamers, and 212 sailing vessels, only 346,638,000 were caught, and last year, 1883, with 136 sail and 69 steamers, there was the enormous catch of 613,461,000 fish. These figures, taken in connection with the statements that have been made to me by captains of merchant vessels and fishing smacks, that during the fall of 1883, they sailed through miles of menhaden, would warrant the belief that this fish is very far from being exterminated, and that, with them as with the food fishes that are taken for market, there are seasons

of great abundance, and seasons of scarcity, and that up to the present time, these seasons have not been affected, either one way or the other, by human agency.

Another significant fact is, that during the early part of the menhaden season of 1883, and up to nearly its close, the fishing was so poor and unprofitable, that the fishermen themselves began to think they had "killed the goose that laid the golden egg," when all at once the fish appeared in countless numbers, and in a few days they had taken enough to turn what had promised to be a most disastrous season into one of large profit to all concerned.

Now, having presented these facts to you in a crude and disjointed form, permit me to say in closing, that although what are known as the hook and line fishermen, almost without exception, testify (and I believe truly) that they find their occupation and means of living seriously impaired, yet, from my experience and observation in the markets, I believe the facts to be that, with the exception of striped bass and lobsters, all kinds of sea food fishes are as abundant now as they were fifteen years ago, and, believing this, I am forced to the conviction that any legislation looking to the restriction of the fishing by the menhaden fishermen is unnecessary, and that any laws prohibiting pound and trap net fishing would cut off a large proportion of abundant and cheap food for the people, and nothing would be gained.

But I do hope that Congress will take some action that will provide for the collection of statistics as to the quantities of fish taken, so that in future, when questions affecting these vast industries come before them, they will then be able to frame legislation that will protect the fisheries, and not oppress the fishermen.

Mr. Endicott: I would like to ask Mr. Blackford to state whether in his opinion the pollution of the waters by gases and oils has a detrimental effect upon the fisheries.

Mr. Blackford: That is a question which, I believe, received some attention at the last meeting of the Association in the Cooper Institute, New York. On that occasion some action was taken, which looked towards a petition for legislation to

prevent the pollution of the water. I think it was admitted by all that it had been a source of great detriment to the fishing in our bays, and especially in New York harbor. I will quote from the Report of the Association for 1883, page 75:

"Mr. BENKARD: I would like to bring up the subject of the pollution of our waters, which brings many of our fish-cultural efforts to nought. I would respectfully offer the following:

"*Whereas*, It is the sense of this Association that the continual and increasing pollution of the waters of New York bay from the refuse of certain factories, threatens eventually to kill or drive away all fish, shellfish and bivalves natural to said waters:

"*Therefore*, Be it resolved that this Association beg to call the immediate attention of the Fish Commissioners of the States of New York and New Jersey, also of the members of their legislatures, to this impending calamity."

I seconded that resolution and made a few remarks to the effect that a great many fish, which had formerly been abundant in the bay, were no longer to be found there. Striped bass, and particularly lobsters, had been driven out entirely. These latter used to be taken abundantly on the Jersey flats. Shrimps, too, which were very numerous and formed food for larger fish, were almost exterminated, and what few remained were tainted with a flavor of kerosene. Oysters and clams have been killed by thousands in the vicinity of Rockaway. The water has been so polluted by the factories of Barren Island as to render a number of oyster beds, that used to be considered valuable, of no importance whatever. I think, though I am not certain, that the New Jersey legislature has taken some action, and I am of the decided opinion that if our Association moved in the matter, legislation could be brought about which would be able to control this matter at least in our own State of New York.

THE FLORIDA SPONGE FISHERY.

BY JOSEPH WILLCOX.

Mr. President: Professor Goode has asked me to say something about the resources of the coast of Florida, and I see that I am set down on the programme for a paper on the sponge fishery. I do not feel able to give an exhaustive paper on the sponge fishery, and not having expected to have been called upon until to-morrow, I am not well prepared, but I will do the best I can:

The geological formation of Florida, at least in the central and western portions, is lime-stone overlaid with sand. This limestone is tertiary; and judging from the fossils that have been collected by several, myself included, it is referred to the Oligocene age by Prof. Heilprin, of Philadelphia. The west coast at one time, not very remote, undoubtedly extended farther into the sea than it does at present. The rocky surface, under the water, not having been eroded to a great extent, now forms great shoals along the coast from Cedar Keys nearly to Tampa Bay. I know nothing of the coast north of Cedar Keys, but south of that place these shoals extend into the gulf many miles, interfering materially with the navigation of even small boats.

North of Tampa bay, for the distance of about thirty or forty miles, there is a series of long, narrow, low islands, two or three miles from the mainland, very similar to those on the coast of New Jersey. They enclose a shallow bay, the northern portion of which is called Clearwater harbor.

The same features may be seen south of Tampa bay, forming for a distance of about thirty miles, Sarasota bay. Still farther south, enclosed in the same manner, is the large expanse of water called Charlotte harbor. The same condition still exists farther south, but I have not seen them. The shoals on the west coast of Florida are admirably adapted for the existence of great varieties and quantities of forms of life suited for food of fish, which exist there in corresponding abundance. The enemies of these fish also occur there in vast quantities.

Presuming that all the living productions of the sea, of com-

mercial importance, might be classed within the legitimate province of the American Fish Cultural Association, I will relate some matters connected with the marine resources of the west coast of Florida, at the request of Mr. Goode.

A large portion of the gulf coast of Florida consists of shoal water, the bottom being limestome rock, which is usually covered with mud, a few inches deep. Upon the bottom many species of sea weed grow in great abundance, affording both food and shelter to a vast amount of animal life, such as molluscs, worms, crabs, and other crustaceans and fish.

The annual consumption of the latter especially, from natural causes alone, is very great, as vast numbers of aquatic birds may be seen there, attracted by the abundance of animal food existing in the shoal water.

The most numerous of these birds are cormorants, which live chiefly upon fish; though I have sometimes found shell fish in their stomachs. Being gregarious, they habitually roost at night in large colonies; selecting one or two islands for that purpose, from among a large cluster, without any apparent reason for such preference; and they do not abandon them unless greatly disturbed by man. I think two or three thousand cormorants would be a moderate estimate for the number resorting to one of those islands; and I consider a half pound of fish for each, per day, within the limits of their consumption, as they are very voracious.

I have frequently examined their stomachs, which were always found to be well supplied with fish. Near the mouth of Crystal river I have lately seen four of those island rookeries, and I believe the cormorants in that vicinity consume more than five thousand pounds of fish daily.

In addition to the cormorants great numbers of herons of several species resort to the same islands, presumably considering that there is increased safety in great numbers. These birds are also great consumers of fish.

While cruising lately along the coast between Cedar Keys and Punta Rassa, I hurriedly collected some specimens of sponges for the Museum of the Academy of Natural Sciences, in Philadelphia. Many of them were collected while living, in shoal

water in the bays. At low tide they could be seen spouting out water vigorously. When approached they became alarmed, and ceased spouting water; and when they were touched, they closed the orifices through which the water escaped, manifesting a surprising amount of activity of life. Though I collected more than fifty species of sponges, none of them possessed any commercial value. When I witnessed the great extent of the bays on the west coast of Florida, and saw on the bottom so many specimens of sponges, and so many species, I was forcibly impressed with the idea that these waters were capable of future possibilities of great commercial importance. If sponges of no market value can thrive there in abundance, there are reasonable grounds to expect that some of the desirable species may also grow there by cultivation. I was informed that the sponge crop in Florida is rapidly diminishing, and that their value is now much greater than in former times. If they can be cultivated artificially, a great industry might be established on that coast in the sponge trade, which does not appear to be capable of much extension in any other manner. It way be asserted that if valuable sponges could exist in the bays of Florida, they would be found there now. We should not be unmindful that, as a general rule, animals have a wonderful faculty for accommodating themselves to changed conditions in their life; not only when produced by the agency of man, but often by natural causes; or by voluntary altered conditions. I will give a few illustrations. We often find that oysters thrive well when transplanted upon new grounds, even where they do not subsequently multiply well, the conditions for spawning not being suitable.

I once saw a dog, in Nova Scotia, that refused to eat fresh meat which I offered to him. His master told me that he (the dog) never saw meat while he was young, and would not eat it. He ate fish only; chiefly dried codfish.

The sheephead fish, on the west coast of Florida, inhabit the fresh water streams in great abundance. There is practically little animal food there suitable to their tastes, such as molluscs and crustaceans, for eating which their mouths are specially adapted. So they accommodate themselves to their circumstances, and eat grass. Except in the rapid channels, the bottoms

of the rivers are covered with aquatic grass, every leaf and stem of which supports a growth of mosslike confervæ. The sheephead live upon this confervæ almost exclusively. I sent the contents of the stomach of one of these fish to Prof. Leidy, who said that in addition to the confervæ, he found multitudes of diatoms. In the case of the sheephead, the changed condition in their food is voluntary as, in the gulf of Mexico, into which they could go at any hour, abundance of molluscs and crustaceans may be seen in every handful of sea-weed taken from the bottom.

It is a surprising fact that many species of fish live in the fresh water in Florida, which inhabit salt water exclusively in the North. The sheephead, which are considered deep-water fish in the North, habitually feed with their dorsal fins out of the water, while in the fresh water rivers in Florida.

Mr. Willcox added: I lately witnessed the manner in which the saw-fish use their saws, while in Clearwater harbor. Several young saw-fish, not more than two and a half feet long, were observed in the water where it was only a few inches deep. When they saw me they ceased swimming, and remained on the bottom, where, by a gentle motion of their fins, they were nearly obscured by the sand which settled upon them. Imagining themselves secure, while thus covered, they permitted me to approach near enough to spear one. The wounded fish immediately elevated its head out of the water, thrusting the saw back, and moved it about, seeking for an enemy. Having felt the handle of wood, the saw-fish at once pulled its saw against it, using much force, and repeating the operation rapidly, always pulling, never pushing. It thus cut gashes in the handle. Two other saw-fishes performed the same operation when speared. None of them permitted an approach until it had partly concealed itself in the sand.

At the close of the morning session the members inspected some fine specimens of European trout, from the ponds of the New York Fish Commission at Cold Spring harbor, and then went in a body to view the national carp ponds, which have been greatly extended during the past year.

THE EVENING ADDRESSES.

In the evening at 8 o'clock, an address was delivered by Hon. Theodore Lyman, of Massachusetts. Hon. Elbridge G. Lapham occupied the chair. The hall was well filled by an appreciative audience, of which about one-fourth were ladies. Mr. Lapham, in introducing the orator of the evening, spoke as follows:

"LADIES AND GENTLEMEN: I am thankful for the honor of having been selected to preside over the ceremonies of this evening. The subject which has called us together is one of far greater importance than the mass of the public conceive it to be. The question of the propagation and preservation of the food fishes of our streams and along the ocean coasts, is second only in importance to the propagation and preservation of animal food. Indeed, the food which is furnished by the fish of our waters is free from many of the difficulties and dangers connected with the subject of animal food. We have in the former no trachinæ, pluro-pneumonia, foot-rot or mouth disease. Fish are not controlled in their habits by man as animals are. The demand for fish as an article of food has of late years been rapidly increasing. Indeed, such demand far exceeds the supply, and every year the interest taken in the subject is increasing, and this is the case not only in this country but in almost every civilized country of the earth. This subject has of late attracted special attention through the international exhibitions held at Berlin in 1880, and at London last year, where I am proud to say the United States bore off the honors for having the best and largest variety and most perfect exhibits which were made. It is a subject, I repeat, of vast and deep importance to everybody. A little more than two years ago the State of New Jersey undertook the passage of a law to regulate the fisheries in the waters of the ocean, over which she supposed she had control. The Attorney

General, however, decided that the State had no jurisdiction over the subject beyond low water mark on the ocean coast. A bill was introduced by Hon. Mr. Sewell, of New Jersey, looking to the passage of a national law regulating this subject. This was referred to the Committee on Foreign Relations, to consider whether such a law would interfere with our treaty obligations under the Treaty of Washington. For two seasons a sub-committee of that committee has been investigating the subject, and has visited many of the principal points along the ocean coast from Fortress Monroe, Virginia, to Portland, Maine. A volume of valuable testimony has been gathered on the subject, and I confess that I had no conception of the importance of this question until I entered upon that investigation. It is almost as fathomless as the ocean itself. We have met this evening to consider this grave and important subject, and I now take great pleasure in introducing to you the Hon. Theodore Lyman, of Massachusetts, who will deliver the annual address of the Association."

Speech of Hon. Theodore Lyman.

Old Rondelet wrote a great work at the beginning of the sixteenth century on sea fishes. His breadth of view included under the term "Fishes" almost every living thing that he found in salt water. It is in relation not to a fish, but to the radiated Medusa-head that he uses these fine words, more familiar, perhaps, to our older naturalists than to those of the rising generation: *Immensa et summe admirabilis dei potentia atque solertia in rebus cœlestibus iisque quœ in aere et terra fiunt, maxime vero in mari, in quo tam variœ et stupendœ rerum formœ conspiciuntur ut quœrendi et contemplandi nullus usquam futurus sit finis.*—"Vast and highly admirable are the power and skill of God in things heavenly and earthly, and in those of the air, but more especially in the sea, where are beheld shapes so various and stupendous that the study and contemplation of them shall never end."

He spoke thus in a spirit of prophesy. Three centuries have passed and we are still contemplating and investigating the things of the sea. We have skimmed its surface with muslin nets in search of its infusoria, and we have let down dredges and

scraped its valleys three miles deep, and still the shapes various and stupendous continue to multiply. The more workers there are, the more work remains to be done. Humble clams, worms and urchins take on great importance and become marine Sphinxes, asking riddles that no one can answer. Creatures that once were conveniently dismissed as gelatinous, or gristly, now advance claims to an intricate circulatory system, to muscular fibres and to nervous ganglia. Nay, they proudly look down on the vertebrates, in the matter of reproduction, as they pass gracefully through the varied stages of alternate generation and self-division.

Rondelet lived near a sea whose inhabitants were well calculated to excite his wonder and delight. He was professor of medicine at Montpellier, not many miles from Aigues-Mortes, the port whence St. Louis embarked for his crusade, and whose walls, now surrounded by dry land, were in the middle of the sixteenth century, still bathed by the waters of the Mediterranean. The shallows of the bay teemed with the smaller crustacea and shells, while the open sea beyond was then, as now, the home of many fishes, varied in form and brilliant in color —the whiting, the red mullet, and the tunny, celebrated by classic writers. There, too, were found the darting squids and the great-eyed octopus, while from its depths came the rosy coral.

In the ancient medical school of Montpellier, still hangs the portrait of Rondelet in his red gown. He has the grave and placid look of a man who was master of his studies, and who stood well with science and with the Church. For had he not as a patron, Bishop Pelicier? and was he not the first authority in zoology and medicine, at a time when a good scholar could acquire all that was known of these and many things besides?

Every gain in knowledge has a loss that balances it. As the current of human thought grows wider, it becomes also more shallow, and splits into that infinitude of little channels which now are called specialties. In each of these channels may be seen a diligent investigator urging forward his little skiff, and well content to be navigating what to him seems the great river of truth.

Learning has grown so great in our day that the genius of one man can grasp no more than a part of it; so that in proportion as learning becomes larger, generalization, which is the final end of learning, grows more difficult. Worse than this, the mind employed on particular investigations gets unsymmetrical. The side that is used is strengthened; the disused side fails. and there results a scholar who believes in one set of ideas only.

After all then, we must look with a certain envy at the state of mind of old Rondelet. Like most men of his age he had that richness of thought and expression which comes of many-sided culture, and a strong faith in things both material and immaterial. When he said "Dei potentia," he distinctly meant power of God, and not "potentialities" or "molecular environment" or "power that works for righteousness," or any of those modern euphuisms which taste in the mouth like weak boiled arrow-root. Nevertheless, if we look closely, we can find the beginnings of that skepticism which plays so great a part in our day. For both he and his Bishop Pelicier were strongly suspected of favoring the Reformation. As to his colleague, Rabelais, he was noted for his unorthodox opinions, and went so far as to describe the future life as a "great perhaps."

But it is high time to leave Rondelet, and turn our attention to his sea-fishes. Their importance was great then—it is greater now. We might know by analogy, did we not know by actual research, that fishes have ever been of the first importance for man's food. Their natural abundance and the easy capture of shallow species put them within the reach of the primitive savage. The skeleton of the pre-historic chief, found in the cave of Mentone had as a head ornament, a net strung with Trochus shells, showing that he had walked the beaches of the neighboring Mediterranean, whose waters doubtless furnished his food.

The shell heaps of Scandinavia and of America, contain abundant bones of fish. Morton, of Merry Mount (1628), gives us a good idea how these shell heaps were formed, when he tells how the Indians came each year to the shore near Quincy, in Massachusetts, and there camped for a long time, feasting on the plentiful clams and lobsters, and alewives and striped bass, whose

shells and bones combined with the camp offal to build those deposits that we call shell heaps.

In New England, it must have been the fish that furnished the surest support to the native savages. Even in the depths of its Arctic winter there was a chance to get eels, smelts and clams and at the first approach of mild weather the waters teemed with abundance. "It (Pawtucket Falls) is excellently accommodated with a fishing place," wrote good Mr. Gookin in 1674, "and there is taken a variety of fish in their seasons, such as salmon, shad, lamprey eels, sturgeon, bass, and divers others. And this place being an ancient and capital seat of the Indians, they came to fish; and this good man (Mr. Eliot) takes this opportunity to spread the net of the Gospel to fish for their souls."

That child of Belial, Morton, of Merry Mount, as keen a sportsman as any of our Bohemian backwoodsmen, gives enthusiastic accounts of the abundance and excellence of the fish which were in the sea convenient to his house. He is the first author that mentions cod-liver oil, which now plays so beneficent, though nauseous a part in medicine.

He writes: "The coast aboundeth with such multitude of codd that the inhabitants of New England doe dunge their grounds with codd, and it is a commodity better than the golden mines of the Spanish Indes. * * * Greate store of train oyle is mayd of the livers of the codd and is a commodity that without question will enrich the inhabitants of New England quickly."

Almost coincident with the establishment of Plymouth Colony, we find laws concerning the fisheries, proof positive of the esteem in which they were held.

In 1633, was passed what I take to be the first law for the encouragement of fish-culture, in these words: "It is enacted by the Court * * * but if any man desire to improve a place and stocke it with fish of any kind for his private use, it shal bee lawfull for the Court to make any such graunt and forbid all others to make use of it."

In 1637 the same court enacted, with the contrary-mindedness of our Puritan forefathers, that six score and twelve fishes shall be accounted to the hundred of all sort of fishes.

In 1670, it was set forth with pious teleology that "the provi-

dence of God hath made Cape Cod commodious for us, for fishing with seines"; implying that it might not be commodious for less religious persons. The act goes on to say that "careless persons" must not interfere with the said providence, "by leaving the garbage of fish to lie there."

The country had not been settled a half century before there was complaint of the diminution of fish. The act just quoted goes on to speak of the great inconvenience of taking mackerel at unseasonable times, whereby their increase is greatly diminished, and a law was passed prohibiting the catching of fish before they have "spaumed." This shows that our ancestors were not more logical than most of their descendants, who still hold, that to take a fish when ripe for spawning is in some peculiar way destructive to the species. It is almost needless to say that fishes taken at any time of the year are killed before they have "spaumed." The only reason that it is more destructive to take fish during the spawning season is because they are then tamer and are crowded together, so that greater numbers are likely to be captured.

The river fisheries, too, call aloud for protection. In 1709, it was enacted "That no weirs, hedges, fish garths, stakes, kiddles or other disturbance or encumbrance shall be set, erected or made on or across any river, to the stopping, obstructing or straightening of the natural or usual course and passage of fish in their seasons * * * without allowance first had, and obtained from the General Sessions of the Peace in the same county." This law especially applied to such fishes as run up the rivers to spawn, salmon, shad and alewives. The Indians, in their day, were wont to construct weirs and the like obstructions to capture these fishes. But the Indians were few and were idle and wandering. They took only what was necessary for their present use. Now, however, had come the white men, who put up permanent abodes and increased in numbers, year by year. They were money-makers, who worked every day and all the day. They would catch fish, not for themselves only, but to sell to strangers; and so they have gone on ever since. Pawtucket Falls, on the Merrimac, where the Apostle Eliot spread his net of the gospel, now furnishes the water power for the great man-

ufacturing city of Lowell. And Merry Mount, to-day the country seat of John Quincy Adams, is a suburb of the metropolis of New England. The inhabitants no longer "dunge their grounds with codd," but are fain to buy that fish in the market at a round price per pound.

The river fish whose protection has cost most law-making in the old commonwealth of Massachusetts, is the humble alewife. In contradiction of the proverb, "mute as a fish," this one may truly be said to have made a great deal of noise in the world. Like some men they are small and humble, but persistent and numerous. In the springtime the alewives stand in from the sea, and push up the smaller fresh-water streams, seeking ponds wherein to deposit their spawn. They come in great armies and insist on entering those ponds. Nothing less than a vertical wall six feet high will stop them. Amid the clatter of mill wheels, and in the very face of the sweeping scoop net, they force themselves through rapids, over falls, and by long underground drains, regardless of their perishing comrades, who by thousands fall a prey to the fishermen and to hawks and eagles; or who run themselves ashore in their frantic efforts to get on. It may be that only a few reach the spawning ground, and these are enough to keep up the race; for one female will lay a quarter of million of spawn. They are, therefore, *par excellence* domestic and cultivable fish, and have been so regarded in Massachusetts for generations. As early as 1741, there was passed "an act made to prevent the destruction of the fish called alewives," wherein it was provided that any owner of a dam "shall make a sufficient passageway, for the fish to pass up such river or stream, through or around such dam."

It is, however, not until 1790, that the alewife fishery of Taunton Great River, first appears on the statute books, whose pages it was destined to encumber. If very few of my hearers know anything of Taunton Great River, the fact proves how miserably our system of popular education fails to instruct people concerning the most remarkable geographical features of the land. Taunton Great River was doubtless named in the spirit of contrary-mindedness already referred to as a characteristic in our puritan ancestors. The unregenerate would be inclined to

call it Taunton Small River, for it is a small stream, which heads in some ponds in the town of Lakeville, and after a short and quiet course empties into the sea at Fall River. But not the mighty Mississippi itself bears on its bosom so great a mass of legislation. The great and general Court of Massachusetts invariably spends a portion of each session in trying to regulate the fisheries of this stream. The fishermen of the upper waters always complain that those of the lower waters get all the alewives, while those of the lower waters maintain that their rivals feloniously conspire to shut the fish off from their spawning grounds. And when by some special providence, both sets of fishermen are at peace with one another, they invariably make a combined attack upon the regulations of the State Fish Commissioners. The riparian inhabitants of other alewife streams, although not so combative, are quite as much interested as those of Taunton Great River. Indeed it was in such waters that a sort of fish-culture first grew up. In some cases, where a dam owner wished to save his water power by shutting up his fishway, he would agree to catch each year so many thousand alewives at the foot of the dam, and to convey them alive to the mill pond above, and thus to keep up the crop. And it has been the custom for more than a century to regulate these little streams by special acts which govern the public sale of the fish, the days on which they may be netted, and the fishways that are to be kept open for their passage. The law goes often so far into detail as to provide that each widow of the town shall have a barrel full for nothing. I have dwelt thus long on this humble fish, because its successful culture gives encouragement to attempt that of others more difficult.

I shall follow briefly the decline of the fisheries in New England, because it is there that an organized system of fish-culture first in this country took its origin. That region has two rivers of considerable size—the Connecticut and the Merrimac. Both rise in the cold streams of the White Mountains. The Connecticut, flowing south, empties into Long Island Sound, and the Merrimac, by a southeasterly course, reaches the Atlantic Ocean. A century ago both rivers abounded in shad, salmon and alewives, and would doubtless have continued for many years to

give a fair yield in spite of over-fishing, had it not been for the erection of impassible dams, which were intended to give water power to the manufacturers, or to furnish slack water navigation to lumber rafts. As early as 1798, the Connecticut river was thus barred at a point just within the northern limit of Massachusetts, but it was not until 1847 that the Merrimac was in a like manner shut off by the great dam at Lawrence. In both cases the salmon, stopped on their passage to the spawning grounds, became extinct after a few years, while the shad and alewives, which could be bred in the lower waters, continued annually to revisit these rivers.

What happened on the Merrimac and Connecticut happened equally on almost every lesser stream in that region. The people of New England, lacking advantages for farming, turned all their attention to manufacturing. Water power was then much cheaper than steam, so that before long there rose a dam wherever there was a fall great enough to turn a millwheel. Except some simple trenches for the passage of alewives, no fishways were then known. The complete ignorance of this subject may be illustrated by the great dam twenty-seven feet high at Lawrence. The charter of the company permitted the building of a dam, provided a pass were furnished for salmon, which should be satisfactory to the County Commissioners. Before the dam was finished, a solemn council of the best ichthyological and engineering talent was held to determine what kind of a pass would be suitable. The council based its judgment apparently on the cheap woodcut in the primary geographies of half a century ago, which represented a salmon briskly leaping over falls at least fifty feet high. At any rate, the salmon pass finally approved by the learned Commissioners consistedof a simple plank trough, sloping from the crest to the foot of the dam, at an angle somewhat steeper than forty-five degrees. It is needless to say that the salmon declined to exhibit any of the feats of agility portrayed in the wood-cut of the primary geography.

There soon came to be a general feeling, and one under the circumstances quite natural, that manufactures and fish mutually excluded each other, and so things were allowed to drift at their pleasure. The streams that emptied into salt water no longer

furnished such abundant swarms of small fry, as had in former days served to toll the sea fishes toward the land, while the passage of boats and steamers and the increase of population and of fishing tended to destroy or to scare away the fish of the small bays and coves. The balance of nature had thus been changed, and one part had reacted against another.

The steady diminuition would have gone uninterruptedly on but for the revival of fish-culture.

The discovery of artificial impregnation of eggs is such a simple one that the only wonder is that it was not practiced long ago. Country boys who watch the brooks in autumn, know how trout deposit their eggs; and fishermen, after hauling their seine ashore, are familiar with the spectacle of spawn and milt flowing from the ripe fishes. It is more than likely that many persons have in the past times practiced the artificial fecundation of ova. The process was described in 1420 by Dom Pinchon, a monk of the abbey of Réome. It was re-discovered by Jacobi, of Westphalia, in 1763, and several naturalists availed themselves of this method in their embryological researches. Among others, Louis Agassiz, who, in 1838, hatched the impregnated eggs of Swiss white-fish by tying them in a muslin bag, and sinking it on the margin of the lake of Neufchatel.

In 1843, two fishermen of the Vosges, Joseph Rémy and Antoine Géhin, not only hatched a large number of trout, but devised means of feeding them artificially. They succeeded in stocking several water courses in their neighborhood with these trout fry. Seven years later their results had become known to the scientific men in Paris. Napoleon the Third had already begun his elaborate measures for the material aggrandizement of France, and he took up fish-culture and the acclimatization of new animals among other schemes. He disliked the professors of the Garden of Plants, because of their Orleanist sentiments, and he set up a rival under the name of the Garden of Acclimatization, of which fish-culture was in some sort a branch. Its apostle was Professor Coste. With large appropriations from the central government he established at Huningue, near the Swiss frontier, a large and elaborate station for fish-culture. His enthusiasm was great. He estimated that the yield of fresh

water fishes in France was not worth more than $1,200,000 annually, which he was confident could be raised by artificial fecundation to $180,000,000. Like many another inventor, Professor Coste was doomed to opposition and disappointment. M. Rimbaud, Secretary of the Fishery Board of Marseilles, ridiculed what he called the unnatural water-culture. He said the machinery and labor for hatching and the artificial food would cost more than the fish would come to. He was not far from right. With plenty of money to work with, it was not difficult to build hatcheries, dig ponds, set up apparatus, and put in turbine wheels for pumping. The working of the establishment was more difficult. The spawn, collected at distant points and sometimes in a careless way, often failed to hatch. The fry, carefully placed in suitable pools, disappeared in a way considered mysterious, until it was discovered that several large pickerel had found their way into the pools. The eminent engineers of the *ponts et chaussées* contended in vain with the waters of the Rhine, which sometimes backed up and flooded the pools and tanks, and anon receded, leaving the turbine wheels high and dry. Years rolled on, and Professor Coste was still struggling to make fish plenty in France, when the Prussian armies crossed the Rhine and appropriated Huningue to the use of the German Empire.

All these disappointed hopes had not been quite in vain. Many valuable experiments had been tried and precious information published, and, above all, it had been discovered that certain things could not be done. Meanwhile, knowledge of these discoveries had crossed the Atlantic, and in 1853, Dr. Theodatus Garlick hatched the artificiallv-impregnated eggs of trout. Three years later commissioners appointed by Massachusetts published a valuable report on the general subject of fish-culture, and attempted uusuccessfully to hatch trout. In the same year an admirable report on fisheries was written by the eminent scholar, George P. Marsh, who had been appointed a commissioner by the State of New Hampshire.

The true beginning of fish-culture, however, under the auspices of State governments, was in July, 1864, when New Hampshire and Vermont passed legislative resolves calling on Massa-

chusetts to re-establish a free passage for migratory sea fish through the dams on the Connecticut and Merrimac rivers. To the late Judge Henry A. Bellows, of New Hampshire, this country owes the successful beginning of the undertaking. He was an advocate learned in the law and full of enthusiasm for the restoration of the former runs of salmon and shad in the cool waters of the Pemigewasset and the broad expanse of Lake Winnepiseogee. He appeared before a committee of the Massachusetts legislature, and by their recommendation two commissioners were appointed, of whom I had the honor to be one. This was in 1865. Within a year every New England State was represented by Fishery Commissioners. They were accustomed to assemble from time to time for the discussion of their mutual interests. These modest gatherings, whereat the assembled authorities failed not to test the excellence of their own fish, were the prototypes of the national gathering which we celebrate this evening.

The opening of the great dams by fishways led to several important results. In the first place the decision in the case of the Massachusetts Commissioners against the Holyoke Water Power Company, has settled the law in regard to the rights of migratory fishes in rivers. This decision, which was confirmed by the United States Supreme Court in 1872, sets forth that a river was a public way, and the passage of migratory fish in it a public right. Therefore,whoever builds a dam across a river must furnish a passage to its migratory fish unless expressly exempted by the legislature.

It thus became easy to open the streams, and hundreds of owners of dams, who, by adverse possession had considered themselves safe from intrusion, now found themselves obliged to construct fishways at their own expense.

The second important step was also a legal one. It was the passage in 1869, by Massachusetts, of an act to encourage the cultivation of useful fishes, which was intended to embody in one law all necessary regulations. Before that time the fishery laws of that State, to the number of nearly four hundred, were for the most part special enactments. The new statute substituted general provisions. It established a board of fish-

ery commissioners, and gave them suitable power; gave to the riparian proprietor the control of ponds not exceeding twenty acres in extent, and regulated the times and methods of taking fish.

In attempting to restock the Merrimac and Connecticut, the most difficult problem possible was the one first encountered, that of building a fishway which would carry salmon, shad and alewives over a vertical dam near thirty feet high. In this country we had nothing to go by save the salmon passes of Great Britain, or the little water-steps over the low continental dams. Through successive improvements we have now attained a fishway that will with certainty carry salmon, alewives and the common river fishes over the most difficult dams. But the shad, with his love of the broad, gentle stream, and his suspicion of artificial contrivances, still remains rebellious. There is, however, a strong belief that the ingenious Colonel McDonald will irresistibly inveigle the shad into his mysterious pass. It is, indeed, a truly Irish pass, in which more water runs in than runs out; and the steeper is the incline, the more rapidly the water runs up hill; so that a shad would think that he was swimming toward Fortress Monroe when he was in reality going over the falls of the Potomac. From the outset, the Massachusetts Commissioners had foreseen that the building of fishways on the Merrimac river was but a half remedy. It was further necessary to breed salmon and place them in the upper waters, that they might thence descend to the ocean, and return as marketable fish to their native river. To obtain impregnated eggs of salmon was at that time a work of great difficulty and expense. In the autumn of 1866, Dr. W. W. Fletcher, of New Hampshire, placed 15,000 New Brunswick salmon eggs in the Pemigewasset; but it was not until 1872, that 16,000 young fry were let loose in its waters; and in 1873, 185,000. Occasional captures of salmon in nets at various points on Massachusetts bay were soon after reported; and on the 31st of May, 1877, two full-grown salmon were discovered mounting the Lawrence fishway. Since that year, salmon have been artificially bred at the headwaters of the Merrimac, and the full-grown fish have annually ascended a river in which for twenty-five years they have become extinct.

The other chief river of New England, the Connecticut, was the scene of the first artificial hatching of the shad. With the encouragement of the Massachusetts Commissioners, Seth Green, of New York, began, in the summer of 1867, his experiments in shad hatching at Holyoke. His simple and ingenious invention of a hatching box, which kept up a constant current by floating, not horizontally but at an angle, has become a matter of familiar history. Great was the ridicule directed against Green, as he painfully waded about in the river under the hot June sun. But when, a few seasons later, the shad appeared in unusual numbers at the mouth of the river, ridicule was changed to admiration, and the great crop of that year was called "Green's shad."

In the following year, 1868, shad-hatching was established on the Merrimac and daily record was kept of the temperature of the air and water, of the number and sex of the fish taken, and the quantity of eggs hatched. These tables were the first of the kind published in this country.

The progress of this slight sketch has brought us to the question which underlies the subject of fish-culture in its broadest sense; it is the question of the possible exhaustion of great fisheries, and especially those of the sea.

We have seen that soon after the first settlement of the country, complaints of the decrease of fish began to arise. It is very likely that these complaints came rather from the accidental differences of seasons than from any real decrease. Nevertheless, they indicate that the relation between overfishing and decrease of the crop was one that was early suggested to our people. The entire subject was brought into prominence in our own day by the report of the English Commissioners to inquire into the sea fisheries of the United Kingdom in 1864. Of these Commissioners it has been said: "Their industry was so extraordinary, and the piles of evidence were such as to leave the impression that every fish-wife in the three kingdoms had had her say. The trawlers were vehement against the set-hook men, and the set-hook men were furious against the trawlers. The Commission decided that they all were right, and might fish when, how and where they pleased. But just then Mr. Bertram comes

out with his "Harvest of the Sea," in which by fact and figure he aims to show just the opposite, namely, that the open sea fish had decreased by overfishing.

The question of the progressive exhaustion of sea fisheries came up six years later in America, in the form of a monster petition presented to the Massachusetts legislature, which was asked to pass a law restricting fishing with weirs, seines and gill nets. The petitioners alleged that valuable fishes, such as the scup, the tautog and the striped bass, were taken by the above mentioned contrivances in so wholesale a way as to threaten their speedy extinction. The complaints applied chiefly to the southern waters, including those of Narragansett bay, where the inhabitants of Rhode Island were equally interested, and both States proceeded to investigate the subject. Their methods, however, were no better than had been those of the English Commissioners, and consisted chiefly in the examination of numerous witnesses. It was the same story over again. The weir men swore against the hook-and-line fishermen and the hook-and-line fishermen swore against the weir men. The moment had evidently arrived to abandon the methods of the court-room and to take up those of scientific investigation.

To this end the Massachusetts Commissioners, in the spring of 1881, hired a weir at Waquoit, on the south side of Cape Cod, and put it in charge of an observer, who kept a daily record of the fishes taken, of the wind and weather, and of the temperature of air and water. At the end of the season the results were embodied in a report, entitled "Third Notice upon the Possible Exhaustion of Sea Fisheries." It was shown by this investigation that the moment at which fishes leave the ocean to enter rivers is determined by the temperature of the water. It further appeared that these so-called anadromous fishes are usually caught in weirs and in similar traps when hurrying along the coast in their northward migrations, whereas those that arrive near or at the mouth of their native river slacken their pace and cautiously feel their way, like a ship standing into a harbor These last are more apt to avoid the nets ingeniously set for their capture.

Up to this time the movement in favor of fish-culture had been

confined to New York and New England, and chiefly to the State of Massachusetts. Dams hitherto impassible had been opened to the passage of anadromous fishes; fish-ways of an improved form had been built; a decision of the Supreme Court had given to fish the right of way in rivers; acts for the encouragement of the cultivation of useful fishes had been passed; the artificial hatching of shad and salmon had begun, and an investigation into the exhaustion of sea fisheries had been set on foot. All these measures were, however, partial and on a small scale. The moment had arrived for the interposition of a power stronger and more general in its character.

That democratic and gregarious fish, the scup, was the founder of the United States Commission of Fish and Fisheries. It is a fish coeval with the first white settlements. In 1621, on the shores of Buzzard's bay, the hungry Englishmen were entertained by Massasoit with "two fishes like bream, but twice as big and better meat," and Roger Williams says, in 1642, "Mishcup, the bream. Of this fish there is abundance, which the natives dry in the sun and smoke; and some English begin to salt." With the first warm days of spring, the scup were wont to push into the bays and fiords and salt ponds in great multitudes, standing in from the off shore depths which had sheltered them, and furnished them abundant food during the winter. Then followed a jubilee for poor and rich. Anybody who had a hook and line could catch a "mess of fish" before breakfast; scup, he was sure to get, and he was likely to get a fat tautog or a striped bass. But when did a Yankee ever allow any peace either to himself or to his neighbor, or when did his mind, sleeping or waking, ever cease to dwell on the invention of some labor-saving machine? Hook and line was too primitive a method to be permitted in this age of improvement. About the year 1846, one Benjamin Tallman, being doubtless moved and abetted by the evil one, conceived the idea of driving posts in a straight line running out to sea and stretching thereon netting so as to make a fence; and constructing at the end thereof a sort of enclosed yard. The schools of scup, as they coasted along the shore, ran against the fence, and turning their heads seaward, were captured in the said yard. The inventor, in the pride of

his heart, named this engine a "trap." He little knew that he had only made a small copy of a contrivance that was known to the Phœnicians, who used it along the shores of the Mediterranean and even on the coast of Spain. There, in later days, the Moors called it the *almadraba*, whence is derived the modern French word *madrague*. If the Moors created as much popular indignation with their *almadrabas* as Benjamin did with his "traps," the fact may account for their expulsion from Spain by the Gothic tribes. For twenty years, war and recrimination prevailed between the trappers and the hook-and-line men, until at length, both parties, like the Jewish factions, determined to appeal unto Cæsar, or as he is now called, Uncle Sam.

On the 19th of February, 1871, was passed a joint resolution of Congress, the preamble of which says: "*Whereas*, it is asserted that the most valuable food fishes of the coast and the lakes of the United States are rapidly diminishing in number, to the public injury, and so as materially to affect the interests of trade and commerce, *Therefore*, resolved, that the President be authorized to appoint a Commissioner of Fish and Fisheries."

It has been truly said that when the critical moment arrives, the man appears also; and this critical moment made no exception to the rule. A man—nay, *the* man, was at once found in the person of Professor Spencer F. Baird. The Cæsar to whom the warring factions had appealed could not have sent forth a more judicious prætor. Mercifully he was not one of those self-taught men (of whom, for some occult reason, we are so proud), but a man of careful scientific training; and one as industrious in collecting facts, as in arranging them. Also, was he a man of a pleasant countenance and conversation, and well calculated to assuage the irritated feelings of the hook-and liner, or to soothe the exasperated nerves of the trapper. Indeed, he seems to be the only individual in history who ever intervened between two combatants without receiving the blows of both.

Henceforth the history of American fish-culture is contained in that of the United States Fish Commission. Its work, widespread and pushed with extraordinary energy, attracted the attention of the whole country. A greater part of the States appointed fishery commissions, which co-operated with, and were

assisted by that of the general Government. Its rapidly increasing value and power culminated in the great fishery exhibitions of Berlin and London, where the United States exhibits gained the chief prizes.

The history of the movement for the restoration of our fishes may seem like a triumphal march; but in summing up its results we cannot in honesty avoid the cold question *cui bono?* of what good is all this?

Up to the year 1880, the fishery commissions of the States and of the general Government had had appropriated $1,306,378. Has the country got a return of a million dollars' worth of additional fish?

In 1880, the total value of the fishery products of the United States was $43,000,000, a less sum than that of the manufactures in a single Congressional district in the little State of Massachusetts. The two products show that real value is not always to be measured by money. The people of this country could have been deprived of the manufactures of that district, without recognizing their loss, but what an outcry would arise were they cut off, even for a month, from cod and white-fish, lobsters and oysters!

Did the expenditure of $1,300,000, since 1866, add anything to the $43,000,000 which our fisheries produced in 1880, or did it pave the way for an increase?

To answer these questions we must define what we mean by a decrease in fisheries.

When so many fish are annually taken from the waters, that the remainder are not numerous enough to produce a new crop equal in numbers to the old one, there must be a progressive decrease in the yield. It is a very simple matter to demonstrate such a decrease in ordinary rivers or in lakes of moderate size, where it is easy that spearing and netting of the trout on their spawning beds has diminished their numbers, or that the establishment of weirs has made white-fish scarce. In the bays and coves of the sea, also, where the waters are shallow, it is not difficult to show that the use of numerous fykes and trawl-lines destroy the local fish, like tautog, rock-bass and flounders. But, when we come to the schooling fishes of the open sea, it is very

difficult to tell how much effect the hand of man has in lessening them. If, for example, we argue that traps and purse seines diminish the crop of menhaden by capturing them in enormous numbers, we leave out of mind the fact that these same traps and purse-seines also capture blue-fish and small sharks, which are thus taken from their daily occupation of killing menhaden. Again, when menhaden entirely disappear from a long stretch of coast, they are, in reality, no scarcer than before. They refuse to come to their wonted waters either because the temperature is too low, or because their favorite food is not to be found. They are not destroyed, only absent. There are familiar instances of such disappearances. The scup was plentiful when the whites first landed in New England; they afterwards disappeared, and re-appeared about the beginning of the present century. The blue-fish was caught on the southern coast of New England from 1659, for more than a hundred years. In 1764 they disappeared, and after an absence of sixty-six years, they re-appeared about 1830.

Another element that must be borne in mind in estimating the total catch of fish is the number of men and the kind of engines employed. If, for example, the population of a coast is scanty, and only a dozen men go a fishing, each of them is likely to have a good catch; but when the coast becomes thickly settled, a hundred men will fish, and though each one may take but few, the catch of the hundred will be much greater than that of the twelve.

In the light of the patient investigations of the past dozen years, it is safe to assert, first, that our fresh water fisheries have in general, greatly diminished since early times, and have, in some cases, been destroyed. Secondly, that the local coast fisheries have also to a greater or less degree diminished.

What have our fishery commissions done to remedy or to palliate these evils? It is fair to say that they have done a good deal, and are in a way to do more.

Their first, and perhaps most valuable service has been to excite universal interest in our fisheries, and to draw general attention to their importance. The second great step in advance has been the accumulation of a vast amount of accurate inform-

ation concerning the numbers and variety of our fishes, their food, manner of breeding, condition of life, migrations and stages of growth. The third degree of progress has been fish-culture, which may be called negative and positive; negative when obstructions to the increase of fish, such as improper apparatus and impassible dams are removed; positive when fishes are artificially bred, or when new species are introduced from distant countries.

It may be fairly said that both forms of culture have already given considerable results. Of the success of negative culture, a familiar example is that of the smelt, which a few years ago had grown scanty in numbers and small in size on the Massachusetts coast, because the breeding fish were captured in the brooks, when crowded together on their spawning beds. The prohibition of this kind of fishing was followed within three years, by the restoration of the smelts to their former numbers and size.

The best instance of positive culture is that of the California salmon in the Sacramento river, where Livingston Stone, by annually turning into the river 2,000,000 young fry, artificially hatched, increased the yearly catch from 5,000,000 pounds to 9,500,000 pounds.

Wide experience in the hatching of shad and white-fish proves pretty clearly that a marked increase may be obtained, if the work be done on a scale large enough, and that an amount of work insufficient to produce a positive increase will, nevertheless, check the decrease of these species.

In a word, artificial breeding by greatly augmenting the proportion of eggs impregnated and by protecting them until hatched, presents a great advantage over the natural process, and gives us an available method of preserving many important fisheries. But to produce results of commercial value, this waters culture must be practiced as universally and methodically as is agriculture.

It is not the custom of Americans to stop half way in a profitable enterprise. Therefore I do not doubt that in the next generation some of our chief fisheries will be maintained by an established system of artificial culture.

Perhaps, in that day, the honorable guild of fish-mongers will erect a monument of their gratitude, and will inscribe on its tablets the names of scientific men, who have in our time labored to create a new industry.

Speech of Hon. S. S. Cox.

Ladies and Gentlemen: It is my pleasure and privilege this evening to move a vote of thanks to the Hon. Theodore Lyman, for his very felicitous and learned address upon this annual occasion. I am told that by a custom which now obtains in this museum, I am expected to speak to my own motion. If I were in another body I think I should rule it out of order, but I have a special gratification this evening in having a Congressman appear here so thoroughly learned in marine zoology. There is sitting before me, I notice, an ex-member of Congress, the Hon. Mr. Roosevelt (and I beg to say that in this particular province an x is not an unknown quantity), who has also devoted his services, his intellect, and sometimes his sportive nature to the same object as my distinguished friend from Massachusetts. But a New York man has not the same right to talk fish as a New England man. It is the privilege peculiar of the latter, as any one can see who will examine the last census, and you may have noticed all through the remarkable address of our friend that he is associated with the fish interest and with the dams of Massachusetts. I cannot say that I was shocked or astonished at his description, and at hearing the names of the various little streams of that State. We have always heard of them in the River and Harbor Bill. [Laughter.] But I was struck by one thing, namely, that he took very good care in his discussion to connect science with religion. And even at the falls of the Pawtucket, where he said the manufacturing interests did not harmonize with those of the fisheries, he associated the old Puritan doctrine with religion, revelation, science and fish-culture, which were almost one and the same thing. And it is simply true. If you look at the escutcheon of the State of Massachusetts you will find it to be a codfish, and nearly all the quarrels of that

Puritan State have arisen from the same question that vexed the old Hollanders in early days, as to whether the codfish took the hook or the hook took the codfish. [Laughter.] I do not know whether that point is settled yet. The State of Massachusetts should be proud of her fisheries. I remember having the honor of being arrested at 3 o'clock in the morning with General Butler, in the House of Representatives, in my attempt to break down the proposition to pay over to England the $5,500,000 growing out of the fishery award. I heard Mr. Rice, another member from Massachusetts, contend for the abrogation of the fishing treaty, which now allows fish to come in free from the Dominion of Canada. I sustained him in that, not because I was unwilling to have fish come in free to this country, but because I did not want fish to come free from Canada or Great Britain, who had cheated us out of $5,500,000. Throughout this whole subject Massachusetts has played a most prominent part. Why not? New England is the home, if not the mother, of invention. The feature which most interests us here to-night is the inventive faculty. It has been shown in such a remarkable degree in fishing, and chiefly in New England, in connection with improvements for the catching of fish. These were displayed on a magnificent scale at Berlin, in 1880, and in London in 1883.

You may remember that a certain weaver at Lyons invented his famous net, which revolutionized fishing. They arrested him, and the great War Minister Carnot, sent for him to come before the great Napoleon. The Minister said: "Are you the man that can do what God cannot?—tie a knot on a stretched string?" And they put him gently under arrest, for fear he would go to England and there introduce his net.

Since then we have made remarkable strides in the invention of fish apparatus. We now use steam as an adjunct and the great purse-seine. In the whale fisheries the harpoons are no longer of the old sort, but explosive. Not satisfied to blow up dynasties with dynamite, we blow up whales with it. [Laughter.]

But the great element of advancement was not discovered perhaps as early as some think—in Japan or China. Our learned friend fixed it at about 150 years ago, but I have data to show

that this discovery of fish-culture was made in *Ohio!* [Laughter.] I know the man! [Prolonged laughter.] His name was Dr. Garlick, of Cleveland. His discovery like others was not complete at first. It was necessary that New York should perfect what Ohio had begun, and with the aid of several New York men, prominent among whom was my honorable friend in front (Hon. R. B. Roosevelt), this science was brought to perfection. By aiding nature, and with the skill of such men, these investigations have been prosecuted. Congress has been enabled to see something of the inestimable value of food fishes. Out of these investigations came the United States Fish Commission in 1871, for the creation of which I had the honor to vote. We should in a body pass a vote of thanks to Congress. From it came the appropriations that warmed up the hatching places. They helped on the grand results. So that now we can send from one end of the country to the other over car-wheels, tanks of fish. We all have, I trust, or ought to have, a deep interest in the fisheries.

The fishery interest is one which the last census shows to be of immense importance. Perhaps it is most important to New England considered in its deep-sea bearings, and for purposes of commerce; but since the plans of the commission have been replenished and multiplied food fishes in our estuaries, bays and streams, it is of great importance to the inland as well as to the coastwise States.

THE GOOD PURITAN FOLK.

It was especially fitting that the sons of Massachusetts should have made a defense of our fishing interests upon that occasion. The early culture of her aristocracy was fish-culture. Indeed, her religion is allied with the piscatorial calling. Adventurers to New England of the "Northern Company" were not altogether inspired by the promised yield of gold and silver, though visions of bonanzas were not wanting. Their fancied treasures lay in the sea. Their divining rod held its hook, line, bob, and sinker. It is of record that when the Pilgrims went to King James for their charter, they said to him that they desired to go to the New World to worship God—and catch fish. "What

profits do you intend?" asked the king. On being told—"those from fishing," he replied ironically: "So God have my soul, 'tis an honest trade; 'twas the apostle's own calling." These good Puritan folk expected to find miraculous argentiferous draughts in the mouths of the fishes. They have ever since "sacrificed to their net and burned incense to their drag; because by them their portion is fatness and their meat plenteous." No wonder, then, that this godly class broke forth into hymning praise to the Creator for the blessings they received from the sea:

Ye monsters of the bubbling deep,
Your Maker's name upraise;
Up from the sands, ye codlings peep,
And wag your tails always.

SACRED ASSOCIATIONS.

However irrevelant to this discussion the connection between piety and angling, it does not detract from the dignity of this calling to know that it has high authority, great antiquity, and sacred associations. Was it not the Psalmist of Israel who said —"They that occupy themselves in deep waters see the wonderful works of God?" Did not our Saviour choose for the great work of the Gospel the prudent, peaceable and devout fishermen? Of the Twelve, were not four of this simple craft? While reproving the scribes and moneyed men for their peculiar employment, the Saviour gave to these simple disciples the power to speak all tongues, to persuade by their quiet manners and sincere eloquence, and to perform wonders unheard of before upon the chosen soil of Palestine. Peter, Andrew, James, and John, the four fishermen, as the good Izaak Walton has said with great felicity, were men of mild and sweet and peaceable spirits, as, indeed, most anglers are—

And it is observable that these our four fishermen should have a priority of numeration in the catalogue of the twelve apostles. And it is yet more observable that when our Saviour went up into the mount, when he left the rest of his disciples and chose only three to bear him company at his transfiguration, that these three were all fishermen. And it is believed that all the other apostles, after they betook themselves to follow Christ, betook themselves to be fishermen, too, for it is certain that the greater number of them were found to-

gether fishing, by Jesus after his resurrection, as it is recorded in the twenty-first chapter of St. John's Gospel.

The Bible has many references to this quiet, contemplative calling, to which it is not necessary here and now to refer.

Whatever may be the controversy between theology and science, or revelation and reason, it is certain that in early New England revelation and science met on common grounds—the fishing grounds! Practicalness went hand in hand with Science, and Science meekly worshipped at the shrine of Faith.

FISHING AN ANCIENT CALLING.

Fishing and fish-culture are not new discoveries; nor are the present modes, especially by line and spear, novel. Necessity was the mother of these as of other arts. It is said that Deucalion, just after the flood, invented angling for food to save his starving family. Seth taught it to his sons. It is believed by some that Japan and China early understood artificial propagation. Fishing runs into mythology; for, is not the trident of Neptune the fish spear, thrice armed? As an ancient and most fish-like muse sings:

> Then darts the trident, and the briny flood
> Is crimsoned with the incautious victim's blood.

Do we not read in the Bible about putting a hook into the jaws of Leviathan? Is this not a clear reference to angling on a large scale? The Ichthyophagi are as old as the Strabo who records them.

The fishermen of the past may have been poor, but they were never cowardly. They may have been ignorant, but they had an eye for beauty, which was improved by the iridescent hues of the finny tribes, and by the rare views of nature on sea and shore. They may have been simple, but it was from their humble guild that the grandeurs of the New Dispensation came to a sinful world, to improve and bless.

We may go back to Egypt—that ancient mother of spiritual and temporal empire, and read upon her monuments and paintings, the designs and modes by which fish were taken and preserved for the chief butlers and bakers of the Pharaohs. Worshipping, as they did, animals of various kinds, it was not infre-

quent that one tribe in Egypt declared war against another for eating up her deities! Even the fun on a fishing excursion which our urchins now enjoy, Cleopatra, herself, practiced on Antony in her frolicsome mood, when she ordered her divers to put a salted fish on his hook, whereat he pulled with vehement agitation.

> Thus she was used to take delight with her fair hand
> To angle in the Nile.

PISCINE LORE AND LUXURY.

I have made a pilgrimage to the tomb of Izaak Walton in Winchester Cathedral, and have made my homage to that "grand old man" and rare old fisher. I found that his remains were under a large black slab, in a chapel in the south aisle called Prior Silkstead's Chapel. It was evening when I endeavored to decipher the poetic tribute to the ancient angler—"crowned with eternal bliss."

The cheerfulness of his disposition and the serenity of his mind gave to him ninety years of felicity, in the midst of great and good and yet sportive scholars and churchmen. I honor him as well for his pen as for his hook and line; as well for his grace of diction and his genial muse as for his many-colored flies; and, above all, for that lesson of equipoise which he teaches in his rambles after his favorite recreation. He teaches the contemplative as well as the sportive quality of the art.

But if any one should think that the literature of fishing began with Izaak Walton let him read classic lore. It is as full of the details as it is of the fun and poetry of fishing. Arion rides upon a dolphin as easily as the bold Viking darts out of the Norse *fjords* in his war *jægt*. But neither the classic nor the romantic past has any history or fancy equal to the reality of our deep-sea fishing, or to our artificial reproduction from the *ova*. It is said by a clever writer on this theme, that the luxurious Romans achieved great wonders in the art of fish-breeding, that they were able to perform curious experiments with the piscine inhabitants of their aquariums, and that they were well versed in the arts of acclimatization. This writer alleges—that "the value of a Roman gentleman's fish-pond in the palmy days of

Italian banqueting, was represented by an enormous sum of money. The stock kept up by Lucullus was never valued at a sum less than £35,000! These classic lovers of good things had pet breeds of fish, as gentlemen in the present day have pet breeds of sheep or horned cattle. Lucullus, for instance—to have such a valuable stock—must have been in possession of unique varieties derived from curious crosses. Red mullet and fat carp, which sold for large prices, were not at all unusual. We can ascertain that £60 were given for a single mullet, and more than three times this sum for a single dish of that fish. Enormous sums of money were lavished in the buying, rearing, and taming of the mullet; so much, indeed, that some of those who devoted their time and money to this purpose, were satirized as "mullet millionaires." These old Romans are the archetypes of our cod-fish aristocracy. Social life repeats itself.

ICHTHYOLOGICAL MYTHOLOGY.

How fancy has sported with the fishes! Strange stories about sea-monsters fill the pages of ancient lore and modern fish-gossip. These stories culminate in the mysterious kraken, the apochryphal sea-serpent, and the real octopus. These narratives of sea-monsters are not surprising when we think of such oddities of the sea as the cuttle-fish and other armed brigands of the deep. The inhabitants of the sea are, perhaps, more curious, if not more numerous, than those upon the land. Our deep-sea dredging is bringing to the surface and light such *outre* forms of marine life as to make the prehistoric monsters respectable in fashion and form.

The heavens in their remote and strange phases declare the glory of the marine life. Are not the four principal constellations called after the marines? Does not the zodiac connect astronomy with sea-monsters? In one of the tractates of the London Exhibition, Mr. Phil Robinson thus revels in the imagery of sea-things as translated to the sky:

What antiquities, then, they are, these sea-myths of our stellar hemispheres! Tumbling in open space, the happy Dolphin, belted with stars, the gift of grateful Olympus; the luminous sea-lizard; Cetus, the shaggy whale, spangled from twinkling snout to twinkling tail,

that, but for the strong, bright-fronted Ram that intervenes, seems agape to swallow the suppliant Andromeda; Hydra, dripping stars as it goes, and trailing its gem-lit convolutions across the hemispheres; the Flying-fish, feathered and beaked, darting its brief flight from the pole of the southern ecliptic; the Austral-fish, with radiant eyes uplifted to the grateful flood that the Waterer forever pours upon it; the Sword-fish, cleaving its bright way to encounter in the ocean of the firmament its hereditary foe; the Tortoise, that in its starry concave holds the lyre whence Mercury first struck the music of the spheres.

And, above all, the fishes of the zodiac,

> "The double Pisces, from their shining scale,
> Spread wat'ry influence and incline to sail."

foster the sailor-spirit in men and teach navigators to be boldly self-reliant, preside over sea-fights, and are the patrons of fishermen.

But the children born under the sign are, by a poetical extension of the Venus tradition, hot-blooded, given to jealousies and strife; for the tradition is that "when the skies grew weak and the giants strove, and snaky typhon shook the throne of Jove," Venus fled the tumultuous scene, and hiding herself in the Euphrates as a fish, inspired the scaly tribes with new passions, "and with the ocean mixt her fire." So, too, the Southern fish claims Aphrodite's favor, for the legend says that it saved her daughter from drowning in the Lake Boethe; and yet another claims for it that it is the progenitor of all the fishes in the firmament. Next "glowing" Cancer,

> "As close in 's shell he lies, affords his aid
> To greedy merchants and inclines to trade."

But over births his influence is hardly more auspicious than the Fishes', though in omen it is happy—

> "The dream's good;
> The Crab is in conjunction with the sun."

These whimsies of astrology still keep their places in our astronomies. They show how the unknown has ever been regarded as the supernatural or marvellous.

From gems taken from the heads of fishes, rare wonders were worked by the Magi. Helen won suitors by a jewel out of the belly of a fish. Amphitrite rode about at her own sweet will in a sea-shell. And a thousand other figments indicate that in the twilight of history the unknown above the earth was in strange association with the marvels beneath the sea. As the gentle Elia says:

Gorgons, and Hydras, and Chimeras dire—stories of Celæno and the Harpies—may reproduce themselves in the brain of superstition, but they were there before. They are the transcripts, types—the archetypes are in us and eternal.

> ——Names, whose sense we see not,
> Fray us with things that be not.

Lamb's fancy ran strong on marine spectra:

Methought I was upon the ocean billows at some sea-nuptials, riding and mounting high with the customary train—of tritons and nereids gamboling around—sounding their conchs before me, and jollily we went careering over the main, till just where Ino Leucothea should have greeted me with a white embrace.

IMMENSITY OF THE NUMBERS OF FISH.

Figures of speech and arithmetic fail to show the immensity of the numbers which the sea gives us of its finny life. Juvenal said that the sea was over-fished. This may have been true of the Lavinian shores, as it is of some of our rivers, like the Potomac, when swept with destructive nets. But Juvenal had not seen or heard of the banks of Newfoundland and their opulence of fish, nor of the Lofoden Isles with their mountains of piscatorial wealth. The teeming Arctics were unknown to the Roman conquerors of the world. Could Juvenal have heard Professor Huxley dilate on the cod mountains—one hundred and twenty to one hundred and eighty feet in vertical thickness, in and around those waters, or the stroms of Norway which affrighted our youthful fancy, he would have modified his own poetic idea as to over-fishing the sea.

THE CENSUS OF THE SEA.

A shoal of codfish one mile in superficial extent contains 120,000,000 fish! Yet not more than half of that number of codfish are taken in one year on the coast of Norway. The cod lives on herring, hence such a shoal will eat 840,000,000 herring in a week! The idea that sea-fisheries are being overworked is almost a joke, when we remember what science reveals. Science tells us that our fixed fisheries contain only five per cent. of the fish of the sea.

Nor is this swarming of marine life a marvel, when we know

how fish yield their eggs by millions. The queen bee, it is said, has her 50,000 eggs a season. But the fecundity of fish might as well be expressed by some algebraic formula as this—$x \times y = \infty$ —. Bertram in his "Harvest of the Sea," say that he counted the separate eggs in the roes of some of our fish. He counted exactly 7,000,000 eggs in a sturgeon. In codfish he gives 3,400,000; in flounders, 1,250,000; in soles, 1,000,000; and in mackerel, 500,000.

We cannot too much admire the nice accuracy of scientific scrutiny and enumeration. Let us take a glance at these strictly accurate figures. We will estimate the value of herring—in the raw state—at one dollar a hundred. We have to pay at retail in the markets five or six cents each for the manufactured (smoked) article. At a dollar a hundred, a little school of codfish of the area of Rhode Island consumes, in one year, herring to the value of $473,928,000,000! Gentlemen can see at a glance that the annual appropriations made by the sub-marine directors of schools, must exceed this sum many thousand times for the codfish establishment alone! What has Congress done that is in any degree comparable with this encouragement of fish-culture? We call ourselves a wealthy nation; yet we spend less than $80,000,000 a year for our schools—while one little codfish school costs for its support every year, nearly thirty times the assessed valuation of all our real and personal property! But I will not mortify you with any more humiliating calculations. Let these give you some incentive towards the important work of fish-culture.

Where do the fish go? Comparatively few of them reach our tables as food. They have the delight of eating each other. The smaller pass their time in guarding against being eaten by the larger fish. If one-half survived there would be no need of restoring our shipping—navigation would cease.

FISH AS ICHTHYOPHAGI.

This reminds me that fish are cannibals, as my motto indicates. Fish prey on fish, and live fish like live fish; so that we need have no compunction when preying on them.

Professor Rice, of the New York Commission, has designated

the kind of fish on which different fish feed. Some are select, like the striped bass; others omniverous, like the bluefish; and all are enormous feeders. Eight alewives of three-quarters of a pound each, were found in a sixty-six pound striped bass! Forty mullets were found in a thirty-pounder! I have seen in the *fjords* above the Arctic Circle, in the swift tide-currents, endless flocks of birds, ready to devour the fish that congregate to destroy other fish. Sharks, porpoises, and other fish of prey know when and where to find the weak "Innocents Abroad."

SPORTIVE ELEMENT.

No Bergh has yet appeared to prohibit the fish in their gambols after other fish, or to enjoin men from gamboling after them. Indeed, a part of the sport of fishing consists in decoying the wriggling beauties upon the hook. In the North Sea they double the sport, for they have hook so shaped as to catch a small fish, whose wriggling and struggling attracts the larger fish. It is said that the first admirer of our American beauty, the traditionary husband of the original Mrs. John Smith—*nee* Pocahontas—who settled the earliest English colony on this continent, often fished in the waters of this District; and that he assisted greatly to develop the fishing industry of the rivers round about Jamestown. He fished along our sea-shore as far up as Maine, and gave to his occupation its useful and delightful harmony when he said:

> And is it not pretty sport, to hale up two pence, six pence, and twelve pence as fast as you can hale and veare a line?

The sportive element which comes out of the same game of chance, with which statesmen of former days pursued horse-racing or poker, gives to its uncertainty and luckiness to the toiler of the sea the charm with which no other laborious pursuit attracts. Is it not a sort of gratification to watch the unwary fish, to entrap and entice him, not merely by studying his habits and migrations, the weather influences, and the nature of the ground, but by copying the qualities of the fish, its courage, vigor, velocity, and cunning? Thus the sportsman may render

his pursuit exciting. With nicest skill and judgment he "tackles" the subtle salmon and the wary trout, whose pluck makes the sport so gameful and the flesh so toothsome.

THE GENTLE ART.

I have had some experience in fishing. May I be pardoned if I refer to the fact that I have fished under the shadows of our Sierras in Tahoe, lake and stream; that I have followed the mountain rivulet Restonica in Corsica, where the waters blanch the bowlders into dazzling whiteness, and the associations of the vendetta and the Bonapartes give a ruddy tinge to the adventure; that I have caught the cod in the Arctic around Cape Nord, under the majestic light of the midnight sun; that I have angled in the clear running Malaren Saltsjön, which circulates healthfully amid the splendid islets of stately Stockholm; that I have flecked the waters of the Bosphorus, in sight of the historic Euxine and the marble palaces and mosques of two continents; that I have been tossed in shallops along with the jolly fishers of the Bay of Biscay; that I have sauntered near the pillars of Iskanderoon which were erected by a grateful Mediterranean people on the spot where Jonah was thrown ashore by the whale; but where'er I wandered, whether I cast my line—

> —— under hanging mountains,
> Or by the fall of fountains,

my thoughts have always bounded o'er the main to ride the league-long rollers on the shores of New Jersey along with my favorite life-savers—to see and feel "the bluefish wriggling on the hooks." But, notwithstanding these widespread endeavors, I am not prepared to say there has been any perceptible diminution of the quantity of fishes in the waters of our planet!

ADVANCEMENT IN FISHING.

Marine fishing, from small beginnings in upon the rock-bound coast made its way down to the Chesapeake and James river, where the mollusk helped to swell the gains of our ancestors of eight generations ago. The ventures for cod, mackerel and

whale carried the pioneers of this trade far out upon the banks of Newfoundland, and into the waters around Nantucket.

But it was not until after our civil war that the fisheries began to grow with steady increment. Professor Goode estimates the value of our products now at more than $100,000,000. Our Census bulletins amplify and specify, by States and localities, the products of our fisheries. They show the capital invested in 1880 to be $37,955,349; and the number of persons employed at 131,426. For the variety of this and kindred industries I refer to the table prepared by Professor Goode, which I shall append to my remarks. Its figures are more significant for our legislative action than any ancient, classic or hallowed relations which the curiosities of profane or sacred literature may furnish.

NEW INVENTIONS.

Beyond all the dreams of poetry, the fables of mythology, or the enthusiasm of such dreamers as Izaak Walton, has been the progress of our fishing industry under the advanced conditions and inventions of our time.

It was a great step when Jacquard made his famous net. It astounded the dullards of the age, and made him for a time a demi-god among the astonished fishermen of France and England. But it was only a step compared with the strides now being made by the improved, and less expensive apparatus invented to capture, preserve, and transport fish. Our newly fashioned trawling nets, recently on exhibition in South Kensington, are marvels. Our unrivalled fishing-schooner, with its special advantages, captured the admiring thousands who gazed on her model in the British exhibition. The steam-vessels rigged for the whale fishing; the purse-seine and its machinery; the new and deadly explosive harpoon and bomb lance for the monsters of the deep and the deeps below the depths, which our scientific plummets are sounding—all these new modes of force, thus harnessed by mechanism, have received incentive, inspiration, and aid from the efforts of voluntary and State associations, as well as from home and foreign exhibitions under Federal patronage and appropriations.

MARVELS OF TRANSPORTATION.

We may not indulge in the dainties of the Roman epicure who displayed his many hued beauties alive to his guests, before cooking and serving; but for abundant food and plucky game, for marvellous breeding and wonderful distribution, no devices compare with those of our own time and country. By new modes of transit, frozen mullet are brought from New Zealand to be sold in old England, and live carp are sent in tanks over car-wheels from Washington to Dakota and Texas. Under the name of Kennebec salmon, large quantities of salmon from rivers of the Pacific slope are being sold at this moment in New York, and even by dealers in Washington markets. The little blue-back (*Oncorhynchus nerka*) and the quinnat (*Oncorhynchus chovicha*) are now sold in this city at the price of 50 cents per pound. These are brought in refrigerator cars from the Columbia river, Oregon, and are in such a good state of preservation as to pass readily for Maine salmon.

By telegraph to-day, we learn that a car-load of 20,000 salmon from the Dalles, Oregon, is *en route* for New York, and is to arrive in eight days. This is what may be called the fruit of an enterprise by means of water frozen and water vaporized,—ice and steam,—for the preservation and transportation of this rarest of fish, fresh from the grand river of our Pacific coast.

OTHER ELEMENTS OF ADVANCEMENT.

The demand for fish-food has been greatly increased by the enhancement in the minds of people of fish as a healthful diet, by the extension of railroads in our country, and by the utilization of ice in transportation and of cans for preservation. I need not refer to the manufactories for oil and guano, now grown into a great business on the Long Island and New England coasts. Even the skin of the fish taken is made into glue and isinglass, and has resulted in a large and valuable trade.

RANGE OF THE INTERESTS.

From Cape Hatteras to the Gulf of Saint Lawrence, where mackerel and menhaden are taken; from North Carolina to

Massachusetts, where the oyster and other mollusks abound; about the keys of Florida, where the red snapper is caught in abundance; from the fur-seal fishery of Alaska to the North Pacific, which our whalers penetrate; from the waters where rolls the Oregon that once heard no sound save its own dashing, but now hears the hum of men engaged in a great industry, to the great lakes, where white-fish play around the isles made memorable by Perry's victory; from one end of our land to the other, over one hundred thousand of hardy men pursue this interesting and adventurous industry. A million souls depend upon the pursuit. Their fleet is nearly 7,000 vessels and 45,000 boats. We may signal from this Capitol and District to these toilers of the sea our interest in their avocation, and elevate and protect it without detracting from or burdening other interests. Here there can be no "over-production."

POPULAR AND SCIENTIFIC NOMENCLATURE.

I sometimes wonder whether we would not popularize the interest in this industry more, if we could only interpret to the people the remarkable names of the fishes we catch and consume. The dead Latinity of their nomenclature is more terrific than some of the monsters of the deep of which poetry and fable are full. I hold in my hand a treatise by Professor Goode and Mr. Bean. It is a part of the proceedings of the United States National Museum. It says that in a paper on the fishes of Nova Scotia and Labrador, Mr. R. H. Storer described a species under the name of *Platessa rostrata.* "This species," it is said, "has been a puzzle to ichthyologists." Dr. Gunther, in 1862, ventured to remark that it appears to be allied to the *Pleuronectes rostrata.* Professor Gill, in 1861, referred it to his nominal genus *Myzopsetta*, and in 1864 to *Limanda.* All of which is quite puzzling to those who are not ichthyologists; but the classification appears clear when we find out that the fish thus clad in this bewildering Latinity is—a flounder! But it is none the less a delight to know that when one is tasting the luscious shad at this, its season, that it is of the *Anadromous* kind, of the herring family, known as *Clupea sapidississima;* or that we may alternate

our worship in Martha's Vineyard in midsummer with a quahaug bake of the *Venus mercenaria!* That's a clam! [Laughter.] What a joy to know, when meandering around Tom's river, in New Jersey, that we can perceive the backward movement and shadow in the water of the *Callenictes hastatus.* That's a crab! [Laughter.]

Perhaps this refinement in terminology is the rebound from the peculiar patois of the fishmonger from earliest times. In Greece and Rome, later in Italy and Spain, the fishermen or fish dealers—especially mongers of the gentler sex—were noted for their uncontrollable vivacity of tongue. Billingsgate has survived the demolition of other famous gateways into London It is to-day an illustration of a business that runs up to £120,000 and is growing beyond precedent. How picturesque is the description given of this famed locality:

If without the trouble of taking a long journey we desire to witness the results of the British fisheries, we have only to repair to Billingsgate to find this particular industry brought to a focus. At that piscatorial bourse we can see in the early morning the produce of our most distant seas brought to our greatest seat of population, sure of finding a ready and profitable market. The aldermanic turbot, the tempting sole, the gigantic codfish, the valuable salmon, the cheap sprat, and the universal herring, are all to be found during their different seasons in great plenty at Billingsgate; and in the lower depths of the market buildings countless qnantities of shell-fish of all kinds, stored in immense tubs, may be seen; while away in the adjacent lanes there are to be found gigantic boilers erected for the purpose of crab and lobster boiling. Some of the shops in the neighborhood have always on hand large stocks of all kinds of dried fish which are carried away in great wagons to the railway stations for country distribution. About four o'clock on a summer morning this grand piscatorial mart may be seen in its full excitement—the auctioneers bawling, the porters rushing madly about, the hawkers also rushing madly about seeking persons to join them in buying a lot, and so to divide their speculation; and all over is sprinkled the dripping sea-water, and all around we feel that "ancient and fish-like smell," which is the concomitant of such a place.

There has ever been a deal of satire against the frugal and hard-worked fish-wives; not merely those who congregate in Billingsgate, but in all fisherland, and in every market where

grotesque repartee, "shapely shanks," and dulcet voices are at a premium. We know how the humorous sally of Daniel O'Connell silenced the furious fish-hawker of Dublin. He called her a "parallelopipedon," a regular solid, a prism, whose base was a parallelogram! She succumbed before his transcendent power of vituperation. Had he been compelled to go through the ordeal of a whole fish market as I have seen it in France, where all—

> Were mad to speak, with none to hearken,—
> They set the very dogs to barking,

he would have prayed for the extension and advancement of a scientific nomenclature, rather than endure a jargon of Babel and Bedlam combined.

A NEW CLASSIFICATION.

It would seem a safe remark for a layman in this fishing business, to say that fish live in water. But when I meet with the fact that a species is found in Ceylon that lives in the earth or exists in mud, not to mention others that fly in the air and perch on trees, it will be confessed that a classification under the head of water-animals is less scientific and certain than under that of vertebrate. Perhaps I may say that fish are the only animals, except the rhetorical man, whose breathing apparatus requires to be kept moist by fluid saturation!

REASONS FOR LEGISLATION.

We find in Bertram's "Harvest of the Sea" this very pertinent question: "Why should not an acre of water become as productive as an acre of land?" If this is suggestive for Europe, how much more suggestive as applicable to our own country! The answer given on this point with reference to France, Germany, and England is—that fish-culture in those countries is essentially practical, hence, it is not much wonder that in France it has been taken under the protecting wing of the State.

But I forgot that I am speaking on a mere motion of thanks. Besides, I yesterday had occasion to speak at length in Congress in favor of Professor Baird's bill for the preservation of

the shad and herring of the Potomac. We carried it handsomely.

I have already spoken too long. I meant merely to refer to what my friend has stated so eloquently, and to make the motion which has already been made. I cannot, however, cease without referring to one matter, which is, that in our legislative action in Congress in connection with fishing and fish-culture, we have not been behind other nations, or rather legislative bodies. It is pleasing to know that we have furnished all the appropriations necessary to enable us to meet the nations of the world, both at Berlin and at London. I believe such appropriations should continue to be made. They will enable us to solve, as no other nation can, the problem which you fish-culturists are trying to solve here, and which France, Germany and England are now solving. With scientific applications to the multiplication of fishes, we shall always, with the aid of liberal appropriations from Federal and State governments, not only be able to increase our food supply, but also to meet the nations of the world in happy rivalry and successful competition. I will say in conclusion: All honor to men engaged in this work! All honor to the Congressmen who can elucidate its value to the satisfaction of the people. All honor to the men, nay to this chief of men, Professor Spencer F. Baird, who received the grand medal from the Emperor of Germany at Berlin, as the greatest of all living fish-culturists. All honor to Professor George Brown Goode and his associates at Berlin and London, who bore away the highest prizes given in Germany and England. I want these honors to come while they are full of life, faith and hope, and can enjoy them. They are worthy of the commendation of Professor Huxley, who said that Professor Baird, Professor Goode and his associates, by their energy, patience, and scientific research, have made the world more and more comfortable for mankind. By their exertions they have advanced into high favor, the doctrine of applying science to human ends. I, therefore, ask you, Mr. President, to put the question of thanks to Professor Lyman for his very able address. I wish I could add to it that emphatic sentiment of the people,

who in their homes all through the land gratefully commend the efforts of the United States Fish Commission.

The PRESIDENT of the meeting proposed a vote of thanks to Hon. Theodore Lyman, for his eloquent and instructive address.

HON. JAMES B. GROOME, referring to Hon. S. S. Cox's statement that Ohio had originated and New York perfected fish-culture, remarked: "I beg to say also that Ohio produced and New York perfected the model Congressman." [Applause.]

The CHAIRMAN proposed a vote of thanks to Hon. S. S. Cox, which was carried unanimously.

The meeting then adjourned to meet next day.

NOTES PERTAINING TO FISH-CULTURE.

BY JAMES ANNIN, JR.

Gentlemen and Members of the American Fish-Cultural Association:

It is with keen regret that I find at the last moment that I shall be unable to attend this, the thirteenth annual meeting, especially after such care and pains had been taken by the committees in charge to make it of great interest and profit. Business prevents my preparing an extended or elaborate paper, and I but briefly call your attention to one or two subjects.

The California, or rainbow trout, are they a success in waters of the Atlantic coast? In one stream in which they were planted some five or six years ago I consider that they are not. I have reference to Caledonia Spring Creek, Caledonia, Livingston County, N. Y. This stream has contained them longer than any others east of the Mississippi river, but to-day you can catch no more, and no larger ones than you could the second or third year after the first plant was made. Where have they gone? I

have not answered it satisfactorily to myself yet. They could not have been all caught out as the stream is preserved. From observations the writer thinks that many have gone down, finding their way into the Genesee river and Lake Ontario, just as the California salmon did several years ago; they have gone as suddenly as the salmon. Stories are afloat of large ones being caught miles below. As the spawning season approaches they also run up stream just as far as they possibly can, and as the stream is generally at its best at this season they cannot get back unless they do so before the water subsides. I have often found them in water holes that had no connection with the stream except during high water and where they would die in a short time. I heard of one found in a man's garden this spring that was nearly a mile away from the stream, the fish had gone up there in a little stream that was formed by melted snow and rain, and which run dry in a week. Brook trout generally find their way back and don't get stranded. You would suppose that the natural increase would keep the stock up in a preserved stream, but it does not in this case, and here I would call your attention to the fact that at the best not more than 50 or 60 per cent. of the many rainbow trout eggs taken at the hatcheries at Caledonia can be impregnated. There is no such percentage of empty eggs of others of the trout family that are handled here.

During the past winter I made an experiment with eggs taken from a fine healthy brook trout, impregnated by a number of good males of the same. First, I took 350 of her eggs, placed the milt with them and then washing it off as quickly as possible, and forty-five seconds after taking the eggs placed them on the screens in the hatching trough. Next, I took 350 more eggs from the same fish and let them stand three minutes before washing off the milt. Next, the remainder of the eggs the fish contained, 335 in number, I let remain in the spawning pan the usual length of time—about thirty minutes. The three lots I carefully placed on trays, picking out the bad ones every day, until they were old enough to plainly show the eye spots, when I counted what I had left of each of them:

First, which had an exposure of forty-five seconds, only 6 were impregnated.

Of the second, with exposure of three minutes, 31 were impregnated.

Of the last, thirty minutes exposed, 208 remained that were good.

This is only the result in the case of one fish, but if it should prove the same in all, is it any wonder that fish-culture is a grand success?

FISH AND FISHING AT POINT BARROW, ARCTIC ALASKA.

BY JOHN MURDOCH.

I have been spending the last two years among the Esquimaux of Northwestern Alaska, and it has occurred to me that a short account of the fishes that they use for food, and the methods they employ in capturing them, might be of interest to the Fish-Cultural Association.

Point Barrow, as you probably all know, is the northwestern extremity of the Continent of North America, the place where the coast line, after running nearly northeast from Behring's Strait, turns and runs in a direction a little south of east toward the Mackenzie river and the northwest passage. The point itself is a long, narrow sandspit, continuing the northeast direction of the coast line for five miles, and then bending to the east-southeast, running on for some three miles more, thus enclosing a sheet of water known as Elson bay. Just at the elbow of the point is a little knoll of land somewhat higher than the rest, and this is occupied by an Esquimaux village. There is another village about eleven miles down the coast to the southwest. The inhabitants of these two villages together number about three hundred men, women and children. Fish forms an important article of their diet, which consists, I may say, entirely of animal

substances, and occasionally becomes their chief dependence. East of Point Barrow, and the nearest about fifty miles off, are three large rivers running into the Arctic Ocean, and to these the Esquimaux resort for the purpose of catching the white-fish and burbot with which they abound.

Early in October, as soon as the rivers are well frozen and enough snow has fallen to make sliding practicable, a number of families start out from both villages, with all their hunting and fishing gear, and proceed to these rivers, where they camp in tents, or build snow huts when they can find snow enough, and remain till the daylight gets too short for hunting, which is about the middle of November. Those of the men who are well supplied with ammunition devote themselves to hunting reindeer, while the others and the women attend to the fishing. The white-fish are caught in gill nets made of reindeer sinew, which are set through holes in the ice and allowed to remain, being visited from time to time and the fish removed.

Three species of white-fish are caught; a small species belonging to the same group as the lake herring, which has been described by Dr. Bean with the name of *Coregonus laurettæ*, the large *Coregonus kennicotti*, found also in the Yukon, and another large species, also found in the Yukon, which Dr. Bean considers to be undiscribed, and which he proposes to call *Coregonus nelsonii*. The burbot, or *titta lu*, as the Esquimaux call it, is the ordinary species *Lota maculosa*, common to all our Northern waters, and is caught with hook and line, though one will occasionally try to swallow a small white-fish which is entangled in the gill net and become "meshed" himself in the attempt.

They use a large bone squid, about four or five inches long, having either a barbless hook of iron or copper, of their own manufacture, or a good-sized cod hook, bought from some whaleship. The bait is a large piece of white-fish, with the skin and scales left on, which is carefully wrapped and sewed around the squid, much in the same way as fishermen on our own coast make an eelskin drail for bluefish. With this they fish through a hole in the ice and take a good many fish. They consume a good many fish, of course, on the spot, but the rest are carefully stored away in a little house built of slabs of ice, and at that

season of the year immediately frozen solid. When they are ready to leave camp they break up this mass of frozen fish into lumps of a size convenient to load on their dog sleds, and bring them back to the village in this condition.

The season of no sun and short daylight is passed at the village. This lasts till about the end of January, and then many families again resort to the rivers, and stay, living in snow huts always at this season of the year, till the first or middle of April. Fish do not appear to be quite so plenty at this season as in the autumn, but they still catch a good many. In the meantime, those who have remained at home have not been without a supply of fish food. There is a small species of codfish, the Polar cod (*Boreogadus saida*), which appears along the coast in large schools about the end of January, or when the sun again begins to rise. We were unable to find out whether the fish really leaves the coast to return in January, but at all events the Esquimaux do not fish for them until then, and say there are none to be found. They would be likely to fish for them were any to be caught, because just at this season of the year they are apt to be pinched for food, as no deer are to be had, and if the ice happens to be unfavorable seals are very scarce.

Wherever there is a level field of this season's ice inclosed by lines of hummocks, the fish are sure to be plenty. Such a field as this, about half a mile long, practically afforded a living to most of the people in the village during the season of 1883, because that year the ice was very unfavorable for sealing, and food was pretty scarce in the village.

The fishing is carried on mostly by the women and children, though one or two old men generally go out, and one or two of the younger men, when they cannot go sealing and food is wanted at the house, will join the fishing party. Each fisherman is provided with a long-handled icepick, which he frequently leaves sticking in the snow near the fishing ground, a long line made of strips of whalebone, reeled lengthwise on a slender wooden shuttle about eighteen inches long and provided with a copper sinker and two pear-shaped "jigs" of walrus ivory armed with four barbless hooks of copper, and a scoop or dipper made of reindeer antler, with a wooden handle about two feet long.

Hardly an Esquimaux, and especially no Esquimaux boy, stirs out of the house in the winter without one of these scoops in his hand. To every party of two or three there will also be a good-sized bag of seal-skin, generally made of a piece of an old kayak cover, for bringing home the fish. Arriving at the fishing grounds, each proceeds to pick a hole through the ice, which is about four feet thick, clearing out the chips with the scoop. The "jigs" are then let down through the hole and enough line unreeled to keep them just clear of the bottom where the fish are playing about. The reel is held in the right hand and serves as a short rod, while the scoop is held in the left hand and used to keep the hole clear of the scum new of ice which, of course, is constantly forming. The line is kept in constant motion, jerked up quickly a short distance and then allowed to drop back, so that the little fish that are nosing about the white "jigs" after the manner of codfish, are hooked about the jaw or in the belly.

As soon as a fisherman feels a fish on his hook he catches up a bight of the line with his scoop and another below this with his reel, and thus reels up the line on these two sticks in loose coils till the fish is brought to the surface, when a skillful toss throws him off the barbless hook on the ice, where he gives one convulsive flap and instantly freezes solid. The elastic whalebone line is thrown off the sticks without tangling, and paid out through the hole again for another trial. If fish are not found plenty at the first hole the fisherman shifts his ground until he "strikes a school." They are sometimes so plenty that they may be caught as fast as they can be hauled up. One woman will frequently bring in upward of a bushel of the little fish—they are generally about five or six inches long—from a single day's fishing. This fishing lasts until about the middle of May, when the ice begins to soften. A good many are also caught along the shore in November in about a foot of water when there are tide cracks in the ice. At this season the Esquimaux use a little rod about two feet long with a short line and a little ivory squid at which the fish bite.

During the summer, many of the natives are encamped in tents at a place called Perginak, just at the bend of Elson bay,

and after the ice leaves the bay, gill nets are kept constantly set, and visited from time to time. In these they catch whitefish chiefly, *Coregonus laurettæ*, a few salmon, *Oncorhynchus gorbuscha*, and another undetermined species, and occasionally large individuals of a sea-run form of *Salvelinus malma*, the Pacific red-spotted trout.

This fishing lasts from the middle or end of July into September, but is never very productive. The trading parties that go east to the Colville river in the summer, also catch large quantities of fish. *Salvelinus malma* was so abundant in the summer of 1882, that the dogs were fed with it.

Another food fish appeared on the coast in the summer of 1882, which appears not to be utilized by the natives as they have not nets small enough to catch it. This is the caplin, *Mallotus villosus*, which we netted by the thousand in the outlet of the lagoon close to the station, and found most excellent eating. The natives who live on the river running into Wainwright's inlet, seventy miles down the coast, also catch through the ice a good many smelts, *Osmerus dentex*, which are as delicious as the smelt of our coast. Fish, when cooked at all, are always boiled; as, indeed, all Esquimaux food is, but many are consumed raw or frozen. Very little of a fish is wasted except the scales and perhaps the larger bones.

To close my account of the fish of this region, it may be well to say that the Esquimaux tell of a large lake between Point Barrow and the Colville, in which there are fish "as big as a kaiak." This certainly has the appearance of a "fish story."

COMPARATIVE EXCELLENCE OF FOOD FISHES.

BY DR. JAMES A. HENSHALL.

In this paper I design considering the relative merits of certain fishes as food, solely as to their comparative excellence of flavor, and not, in any sense, as to their nutritive qualities, as

commercial fishes, or as food for the masses. The inherent or innate excellence of flavor is alone considered; that is, the fish is supposed to be simply boiled, fried, broiled or baked, without the addition of extraneous substances, as sauces, condiments, etc., except the indispensable salt and perhaps a little black pepper. Moreover, I speak in the light of the ample personal experience of having eaten of all the fishes mentioned, from Montauk Point to Key West, and from Lake Superior to the Gulf of Mexico, and, with the sole exception of the salmon, of having eaten of them all perfectly fresh, or literally out of the water into the kettle, broiler or frying pan, which is the only true test of the peculiar flavor of each fish. Of course one is necessarily guided in such a matter by his own individual tastes and idiosyncracies, and due allowance must be made for this "personal equation," though I believe that most persons will agree with the conclusions drawn. But there is no accounting for gastronomic tastes likes and dislikes, which proverbially disagree, as evidenced by the old saying, "What is one man's meat is another man's poison," or to express it more appropriately in this connection, and to perpetrate an old Anglo-Gallic-ichthyc pun: What is one man's *poisson* is another man's poison. For the sake of convenience I will separate the different fishes into several groups: (1) fresh water, (2) anadromous, (3) estuary, and (4) marine. The various fishes in the several groups are arranged in their sequence according to their degree of merit.

FRESH-WATER FISHES.

The white-fish (*Coregonus clupeiformis*) is far ahead of all other fresh-water fishes in its exquisite delicacy and richness of flavor. Its flesh is pure white, firm, flaky and free from small bones; and while a "fat" fish, does not cloy the palate like the salmon, mackerel, and other "oily" fishes. But to realize the delicious savor and flavor of the white-fish, it is imperative that it be in its best condition, and that it be cooked as soon as possible after being taken from the water; for when in poor condition, or long out of the water, it loses entirely its characteristic excellence. The white-fish is essentially a broiler, being excessively fat in the fall before spawning, when it is in its best condition. Those

of Lake Superior and the Straits of Macinac are preferable to those of other waters of the United States. I have eaten broiled white-fish at the old Mission House, at Mackinac, for twenty-one meals a week and like Oliver Twist, asked for more. It resembles, more than any other fish, the pompano in flavor, and in my opinion is second only to that peerless fish in its excellence for the table.

The brook trout (*Salvelinus fontinalis*), when freshly caught, I consider, among the fresh-water fishes, next to the white-fish for the table; but as obtained at the restaurants, I prefer the black bass or pike-perch. When served up in camp beside a trout stream (the small ones fried, the large ones boiled), the flesh is pinkish, very firm, and of a delicate, delicious flavor, though rather too dry to suit some palates. It is a fish that will not bear transportation, however carefully packed, without losing its savor; and this is likewise true of all delicately-flavored fishes. Moreover, it will retain and absorb the "twang," and smack of the packing material or the container.

The black bass (*Micropterus*).—Next to the freshly caught and cooked brook trout, I rank the black bass of either species. Its flesh is pure white, firm, flaky, free from small bones and of a rich, sapid flavor when in proper condition. Just after the spawning period the flesh has a musky taste and odor, which is disagreeable to some persons. The character of the water has much to do with the excellence of the black bass for the table, and as it inhabits so many waters of different conditions of purity and temperature, there are as many opinions of its gustatory qualities. The small-mouthed bass is generally the best flavored, as it usually exists in the purest waters; but where both species co-exist in the same water there is no apparent difference in taste or flavor. I have eaten small-mouthed bass of some waters which were inferior to large-mouthed bass of others. Contrary to a popular impression, I will state that the finest-flavored black bass I ever ate, and even superior to any brook trout I ever tasted, were large-mouthed bass of certain streams in Florida, notably the upper waters of St. Lucie river, on the east coast, and the Weckawachee river, on the west coast. These are re-

markably clear and pure waters. Black bass should be fried or boiled, according to size.

The pike-perch (*Stizostedium vitreum*) is a staple fish during the early spring throughout the West, being shipped from the great lakes. It bears transportation well, the flesh being hard, white, flaky, and of good flavor; consequently it is much esteemed during the Lenten season. It is a very desirable fish for lakes and rivers which have a good depth of water, being very hardy and prolific, and one of the best percoid fishes. The smaller ones should be fried, those of six pounds and over should be boiled.

The mascalonge (*Esox nobilior*) may be classed as a good dinner fish in the fall and winter, when it is in its best condition; it has, however, been much overrated. It has yellowish or pinkish flesh, according to season, which is of good quality and fair flavor, with fewer small bones than any of the pike family. It is never a "fat" fish, and should be either boiled or cut in vertical slices and fried.

The Mackinaw trout (*Salvelinus namaycush*) varies greatly according to size, season and locality, as to its edible qualities. In the great lakes, where it is taken with the white-fish, it is lightly esteemed in comparison. In other waters, as in the lakes of the Eastern States, it is more highly prized. The flesh is yellowish white to red in different waters, and may be classed as rather good and well-flavored when in its best condition. In good condition it is a very fat or oily fish, and should be boiled or cut into vertical steaks and broiled.

Catfish (*Siluridæ*). The various species of catfish and bullheads are good, bad, and indifferent as articles of food. Some of them are really excellent when properly cooked, and would prove an agreeable surprise to most persons who are prejudiced against them. The fork-tailed cat of the lakes and the Mississippi (*A. nigricans*), and the channel cat (*I. punctatus*), when of suitable size, and when parboiled and baked brown, are not to be despised by an epicure, the flesh being rich and savory, though not very firm.

There are a number of fresh-water "pan fish," fair in quality, which I consider best in the order named, as white bass (*R.*

chrysops), croppies (*Pomoxys*), rock bass (*A. rupestris*), the sunfish (*Lepomis*), yellow perch (*P. americana*), etc. Last and least in point of merit among fresh-water fishes (and which are just better than "no fish") are the pike, pickerel, buffalo, suckers, etc.

ANADROMOUS FISHES.

The salmon (*Salmo salar*) stands at the head of this group when "fresh run" from the sea. Its excellence is so well known that it needs no further notice here, more than to observe that after spawning no fish is more sorry or ill-flavored. The comparative excellence or worthlessness of anadromous fishes, before or after the breeding season, is more strikingly exhibited in the salmon than any other of the group.

The shad (*Clupea sapidissima*). Of the anadromous fishes, none is so well known or so much appreciated as the shad, whose rich, delicate and luscious flavor is pronounced by many to be superior to that of any other fish. Suffice it to say that he who has never partaken of that Lenten luxury, "planked shad," has an epicurean revelation in store that will surprise and delight him. The shad should never be served in any other way than planked or boiled. It well merits its name, *sapidissima*, and one can tolerate its numerous bones in consideration of its fine flavor.

ESTUARY FISHES.

This group comprises so many species, and of so wide a range, and some vary so much in edible qualities in different waters, that it is difficult to institute a just comparison.

The pompano (*Trachynotus carolinus*). Although a fish of Southern waters, the excellence of the pompano for the table places it at the head, not only of the estuary fishes, but of all known members of the finny tribe. It is incomparable with any other. While in the restaurants of New Orleans and Mobile it is the fish beyond compare, it is worth a trip to Southern Florida to realize the delectable, luscious savor of a freshly caught and broiled pompano. The salmon, white-fish, and shad alike pale before its superexcellence. A broiled pompano's head is a *bonne-bouche* to eat and dream of for a life-time. See Rome and die,

eat pompano and live! The pompano has a creamy white flesh, of a gelatinous richness, without the oily taste of most broiling fishes. It must not be confounded with the dark-meated fish called pompano on the Carolina coast, which is a crevalle (*Caranx*). The bones of the pompano are few and soft, and one can eat them "bones and all."

The striped bass (*Roccus saxatilis*) enjoys a deserved reputation as a table fish. Its firm, white and delicious flesh is so well known that it needs no further comment. The memory of its savory flavor and odor, broiled at camp fires on the Chesapeake, steals over me as I write, with a conscious yearning for the flesh-pots of Egypt.

The sheepshead (*Diplodus probatocephalus*), while excellent in Northern waters is only tolerable in those of the extreme South. North of Cape Hatteras it is justly considered a great delicacy, broiled or baked; while in Florida it is not above mediocrity, having a piquant, pungent flavor that is decidedly unpleasant.

The bluefish (*Pomatomus saltatrix*) is another fish that varies in its eatable qualities in different waters, and which, perhaps, depends on the nature of its food. North of Cape Hatteras, it is well-flavored, of good quality and much esteemed, though inclined to be too oily; while in Florida waters it is excellent, far exceeding in richness and flavor those of the North. Its flesh is firm and white, and it should always be boiled or planked.

The whiting (*Menticirrus nebulosus*) is a small, but good fish, one of the best for chowders. It has a fine, white, flaky flesh of rich flavor, and is much esteemed as a breakfast fish, broiled or fried.

The weakfish (*Cynoscion regale*) is worthless, unless absolutely fresh, when it is peculiarly sweet and gelatinous, fried or boiled. The Southern species, the salt-water trout (*C. maculatum*), is equally as good a fish for the table.

The red snapper (*Lutjanus blackfordii*) has become a popular hotel and restaurant fish throughout the South and West, where it is shipped from the Gulf of Mexico. It is also extensively shipped to Havana. Being of large size it is a good dinner fish,

its flesh being rather coarse, but very white, firm, flaky, juicy, and of good flavor. It should be either boiled or baked.

The tautog (*Hiatula onitis*) has fine white flesh, and broiled or or fried is quite toothsome, with a rich lobster flavor. It does not lose its good qualities when out of water, so soon as most fishes.

The redfish (*Sciæna ocellata*) is essentially a Southern fish, though during the summer it ranges as far north as Cape Cod, when it is in its best condition. It grows to a large size, with firm white flesh, of no decided flavor. It is a tolerable dinner fish, and should always be boiled. It is also a fair chowder. fish.

Crevallé (*Caranx*). There are several species of crevallé, the *C. hippos* being the most common in Southern waters. They are dark-meated fishes, firm and flaky, with a sharp, strong flavor (similar to the bonito), which is relished by some but disliked by others. It is an oily fish and should always be broiled. It is easily cured by smoking, when it forms an appetizing dish, far better when fresh, and superior, I think, to smoked halibut. There are quite a number of good estuary "pan-fish," among the best being the Lafayette (*L. xanthurus*) and white perch (*R. americanus*.

MARINE FISHES.

The Spanish mackerel (*Scomberomorus maculatus*) stands at the head and front of the pelagic or marine fishes. It is second as a table luxury only to the pompano and white-fish. It is a creamy, white-meated fish of great delicacy and richness of flavor when broiled. By many it is thought to be the best fish that swims.

The common mackerel (*S. scombrus*), when fresh and fat, as in the early fall, is one of the best fishes for broiling. As a breakfast fish it is greatly and justly prized, and is too well known to need further notice here.

The codfish (*Gadus callarias*). I mention the codfish out of respect and sympathy for my fellow man, and not for any love that I bear for it myself. It is, perhaps, only necessary to say that at the last annual meeting of your Association, your worthy

recording secretary declared that he preferred a fresh codfish to the brook trout or black bass.*

WEDNESDAY, MAY 14TH.

At half-past ten the President called the Association to order, and announced that the election of officers would take place at the afternoon session. The following Committee on Nominations was then appointed to propose officers for the ensuing year: Messrs. G. Brown Goode, R. E. Earll, C. A. Kingsbury, C. G. Atkins, and Tarleton H. Bean. The President further stated that all names proposed for membership in the Association would be voted upon during the afternoon session.

Mr. BLACKFORD: I beg to state that there is one name which I feel that we should add to the list of honorary members, viz.: Professor Spencer F. Baird. I think that this action would be no more than a fitting appreciation of his great work, and I therefore name Professor Spencer F. Baird as an honorary member of this Association.

The PRESIDENT: Professor Baird is nominated as an honorary member of this Association. All those in favor say "Aye." (There being no dissenting voices, the nomination was carried.)

The RECORDING SECRETARY: Mr. President, I have received a telegram from Mr. W. F. Witcher, formerly Commissioner of Canada, in which he expresses his inability to attend this meeting, on account of family sickness. I have here many letters from members and others who regret their inability to be present. To read them all would consume the morning. I would, however, ask your attention to three of them. The first is from the father of American fish-culture, who writes:

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*Being a prominent member of the Ichthyophagus Club, any statement of his regarding the flavor of fishes should be be received with due caution, inasmuch as by virtue of the onerous duties of his office—"head taster"—his sense of taste has presumably become perverted or impaired.

BEDFORD, Ohio, April 25th, 1884.

DEAR SIR:—I am in receipt of the announcement for the Washington meeting of the American Fish-Cultural Association to be held in May. My health is such that it is impossible for me to be there. I feel as much interest as ever in this important industry.

What a great debt our country and the world owe to Prof. Spencer F. Baird for what he has accomplished in promoting this industry.

I have no paper to be read on that subject at the meeting. I would be glad however if a correction is made in the report of the proceedings of the meeting of 1881. On page 42, under the head of Fish-Culture in America, it is stated that my experiments were made in 1853, and that I read a paper before the Cleveland Academy of Natural Sciences, detailing my experiments, February 14th, 1854, which is correct. But it is further stated in the report, that my paper was not printed until 1857, which is incorrect, and does me great injustice, as it gives Dr. Bachman four years of priority of publication (or record). My paper was published the month and year that it was read before the Academy, in the "Annals of Science," edited by Prof. Hamilton Smith.

I am writing, or trying to write, lying on my lounge, and fear you will find some difficulty in reading my letter.

Hoping you may have an interesting meeting, I am, dear sir, very truly yours,

T. GARLICK.

P. S.—The first edition of my book on Fish-Culture was run through the *Ohio Farmer* in 1857. Prof. Ackley, my partner in the practice of surgery, never wrote nor published a line on the subject of Fish-Culture.

The next letter comes from across the water, and asks that our notices of meetings be issued earlier. It is as follows:

BERGEN-OP-ZOOM, 9th of May, 1884.

To the American Fish-Cultural Association:

MR. CHAIRMAN:—Marshall McDonald's letter came yesterday to hand, not leaving a ghost of a chance to get a hearing for what I might have to say in the meeting, either by mouth or by paper.

Please send in future communications for meeting, if possible, sooner, to this side of the great fish-pond, to give us time to prepare if we have something to say.

I remain, dear sir, yours truly,

C. J. BOTTEMANNE,

Government Inspector of Fisheries, Netherlands.

The third relates to the lobster question. It says:

BOSTON, April 25th, 1884.

DEAR SIR:—I would say in reply to the circular received this morning that I regret that I shall be unable to attend the meeting of the American Fish-Cultural Association, which promises to be so interesting and instructive. And I earnestly hope the matter in which I am particularly interested (the best method for the preservation of lobsters), may be discussed and bring out the views of those familiar with fish-culture and protection in its broadest meaning, for I am confident of its importance as compared with other branches of fish-culture, and protection and its intelligent consideration will in the end be of great benefit to the people, for whose good the efforts of this Association are directed. With best wishes for a successful and profitable meeting, I remain,

Yours respectfully,

S. M. JOHNSON.

The President then declared the reading of papers to be in order.

THE SHELL FISHERIES OF CONNECTICUT.

BY DR. WILLIAM M. HUDSON.

Before beginning to read my paper I think it is fair to state that, in view of the papers in regard to the special matter of the propagation of oysters, etc., which we shall have from experts, I have thought it best to confine myself entirely to the relations existing between the State of Connecticut and the shell fisheries of that State, especially the oyster.

The especial object of this essay will be to consider the relations existing between the State of Connecticut and the public and private oyster beds in Long Island Sound, within the boundaries of the State. Until 1855, all the oyster grounds of the State were treated as common land, open to every one, and no one having any exclusive right to any portion of them. In 1855, the legislature enacted a law providing for the appointment of committees in towns adjoining the shore, who should have the right, for a given consideration, to designate and allot to private indi-

viduals, plots of ground not exceeding two acres in extent, for the sole purpose of cultivating oysters. Numerous applications were made to these committees, and many acres of ground, mostly in the shallow waters of the bays and coves, were designated for this purpose. The State then passed laws recognizing the right of property in these lots, and punishing depredators and thieves for stealing from them. The business of raising oysters gradually increased in magnitude, new laws were enacted for the regulation of the industry, and finally some of the more adventurous of the cultivators conceived the idea that oysters might be successfully raised in deeper water than had yet been tried. Their efforts were successful and a new impetus was given to the business. An interesting account of the industry up to and including 1880, may be found in the article contributed by Mr. Ernest Ingersoll to the tenth census of the United States. During all these years a dispute had existed between the States of New York and Connecticut in reference to the respective boundaries of the two States in Long Island Sound, and also as to that of Connecticut on the west end, and New York on the east; in the former case New York claiming to low water mark on the northern shore of Long Island Sound, and in the latter about 2,600 acres more than Connecticut was willing to concede. Commissioners were appointed by the two States to take the matter into consideration, and after due consultation they reported in favor of Connecticut conceding the 2,600 acres in dispute on her western boundary to New York, and New York giving to Connecticut about one-half of Long Island Sound, the line running practically through the center. An act carrying out the recommendation of the commissioners was passed by the legislatures of New York and Connecticut, and finally approved by Congress, February 26th, 1881, and the new boundary was finally fixed.

On the 14th of April, 1881, the legislature of Connecticut passed an Act Establishing a State Commission for the Designation of Oyster Grounds, a copy of which is here inserted:

CHAPTER CLX.

An Act Establishing a State Commission for the Designation of Oyster Grounds.

Be it enacted by the Senate and House of Representatives in General Assembly convened:

SECTION 1. The State shall exercise exclusive jurisdiction and control over all shell-fisheries which are located in that area of the State which is within that part of Long Island Sound and its tributaries bounded westerly and southerly by the State of New York, easterly by the State of Rhode Island, and northerly by a line following the coasts of the State at high water, which shall cross all its bays, rivers, creeks, and inlets at such places nearest Long Island Sound as are within and between points on opposite shores from one of which objects and what is done on the opposite shore can be reasonably discerned with the naked eye, or could be discerned but for intervening islands. And all shell-fisheries not within said area shall be and remain within the jurisdiction and control of the towns in which they are located, under the same laws and regulations and through the same selectmen and oyster committees as heretofore. If a difference shall arise between any town and the commissioners as hereinafter provided for, as to the boundary line between said town and the area so to be mapped, said town, by its selectmen, may bring its petition to the Superior Court for the county within which said town is situated, to determine said boundary line, and said court upon reasonable notice to the parties shall hear said petition and appoint a committee to ascertain the facts in such case and report the same to said court, and said court shall thereupon make such order as may be proper in the premises.

SEC. 2. The three fish commissioners of the State now in office, and their successors, shall also be and constitute a board of commissioners of shell-fisheries, and be empowered to make or cause to be made a survey and map of all the grounds within the said area in Long Island Sound which have been or may be designated for the planting or cultivation of shell-fish; shall ascertain the ownership thereof, and how much of the same is actually in use for said purposes; they shall also cause a survey of all the natural oyster beds in said area, and shall locate and delineate the same on said map, which survey and map when completed shall not cost a sum exceeding twenty-five hundred dollars, and shall report to the next session of the legislature a plan for an equitable taxation of the property in said fisheries, and make an an-

nual report of the state and condition of said fisheries to the legislature, and the said commissioners shall be empowered to appoint and employ a clerk of and for said board, and they shall each give a bond to the State with sufficient surety for the faithful performance of their duties, and for the payment to the State treasurer of all money that may come into their hands under this act in the sum of two thousand dollars.

SEC. 3. The said commissioners shall also be empowered, in the name and in behalf of the State, to grant by written instruments, for the purpose of planting and cultivating shell-fish, perpetual franchises in such undesignated grounds within said area as are not and for ten years have not been natural clam or oyster beds, whenever application in writing is made to them through their clerk by any person or persons who have resided in the State not less than one year next preceding the date of said application. The said application and the said grant shall be in manner and form as shall be approved by the chief justice of the State, and all such grants may be assigned to any person or persons who are or have been residents of the State for not less than one year next preceding such assignment, by a written assignment, in manner and form approved by said chief justice; and the said commissioners shall keep books of record and record all such grants and assignments therein, and the same shall also be recorded in the town clerk's office in the town bounded on Long Island Sound within the meridian boundary lines of which said grounds are located.

SEC. 4. When any such application is filed with the clerk of said commissioners, he shall note on the same the date of its reception and shall cause a written notice, stating the name and residence of the applicant, the date of filing the application, the location, area, and description of the grounds applied for, to be posted in the office of the town clerk of the town bounded on the said Long Island Sound within the meridian boundary lines of which said grounds are located, where such notice shall remain posted for twenty days. Any person or persons objecting to the granting of the grounds applied for, as aforesaid, may file a written notice with the town clerk, stating the grounds of his or their objections, upon the payment to said town clerk of the sum of twenty-five cents, and at the end of said twenty days the said town clerk shall forward all such written objections to the clerk of said commission; and in case such objections are so filed and forwarded the said commissioners, or a majority, shall upon ten days' notice in writing, mailed or personally delivered to all the parties in interest, hear and pass upon such objections at the town in which such grounds are located as aforesaid, and if such objections are not sustained and

the area of ground is not, in the opinion of the commissioners, of unreasonable extent, they may for the actual costs of surveying and mapping of such grounds, and the further consideration of one dollar per acre, paid to the said commissioners to be by them paid over to the treasurer of the State, grant a perpetual franchise for the planting and cultivating shell-fish in such ground or in any part of the same in the manner aforesaid, and where no such objections are made such grants may be made for the considerations hereinbefore named. At all hearings authorized by this act the said commissioners may, by themselves or their clerk, subpœna witnesses and administer oaths as in courts of law.

SEC. 5. The said commissioners shall, previous to the delivery of any instrument conveying the right to plant or cultivate shell-fish on any of said grounds, make or cause to be made a survey of the same, and shall locate and delineate the same, or cause it to be located and delineated upon the map aforesaid, and upon receipt of said instrument of conveyance the grantee shall at once cause the grounds therein conveyed to be plainly marked out by stakes, buoys, ranges, or monuments, which stakes and buoys shall be continued by the said grantee and his legal representatives, and the right to use and occupy said grounds for said purposes shall be and remain in said grantee and his legal representatives; *provided*, that if the grantee or holder of said grounds does not actually use and occupy the same for the purposes named, in good faith, within five years after the time of receiving such grant, the said commissioners shall petition the Superior Court of the county having jurisdiction over the said grounds to appoint a committee to inquire and report to said court as to the use and occupancy of such grounds in good faith, and said court shall in such case appoint such committee, who, after twelve days' notice to the petitioners and respondents, shall hear such petition and report the facts thereon to said court, and if it shall appear that said grounds are not used and occupied in good faith for the purpose of planting or cultivating shell-fish, the said court may order that said grounds revert to the State, and that all stakes and buoys marking the same be removed, the costs in said petition to be paid at the discretion of the court.

SEC. 6. When, after the occupancy and cultivation of any grounds designated as aforesaid by the grantee or his legal representatives, it shall appear to said commissioners that said grounds are not suited for the planting or cultivation of oysters, said grantee, upon receiving a certificate to that effect from said commissioners, may surrender the same or any part thereof, not less than one hundred acres, to the State, by an instrument of release of all his rights and title thereto, and shall

on delivery of such instrument to the said commissioners receive their certificate of said release of said grounds, the location and number of acres described therein, which shall be filed with the State treasurer, who shall pay to the holder the sum of one dollar for every acre of ground described in said release, where said sum has been paid therefor to the State. And the said release shall be recorded by the said commissioners in their record books, and in the town clerk's office in the town adjacent to and within the meridian boundary lines of which said grounds are located. For all purposes relating to judicial proceedings in criminal matters, the jurisdiction of justices of the peace of the several towns bordering on Long Island Sound shall extend southerly by lines running due south by true meridian from the southern termini of the boundary lines between said towns to the boundary line between the States of Connecticut and New York.

SEC. 7. Said commissioners shall provide, in addition to the general map of said grounds, sectional maps, comprising all grounds located within the meridian boundary lines of the several towns on the shores of the State, which maps shall be lodged in the town clerk's office of the said respective towns, and said commissioners shall also provide and lodge with said town clerks blank applications for such grounds and record-books for recording conveyances of the same, and all conveyances of such grounds and assignments, reversion, and releases of the same shall be recorded in the books of said commissioners, and in the town clerks' offices of the towns adjacent to and within the meridian boundary of which said grounds are located, in such books as are provided by said commissioners, subject to legal fees for such recording, and the cost of all such maps, blank books, surveys, and all other expenses necessary for the carrying out the provisions of this act, shall be audited by the comptroller and paid for by the treasurer of the State, and the said commissioners shall each receive for their services five dollars per day for the time they are actually employed, as provided for in this act; their accounts for such service to be audited by the comptroller and paid by the treasurer of the State.

SEC. 8. All designations and transfers of oyster, clam, or mussel grounds within the waters of Long Island Sound heretofore made (except designations made of natural oyster, clam, or mussel beds), are hereby validated and confirmed.

SEC. 9. All the provisions of the statutes of this State relating to the planting, cultivating, working, and protecting shell-fisheries upon grounds heretofore designated under said laws, except as provided for in section eight of this act and as are inconsistent with this act, are

hereby continued and made applicable to such designations as may be made under the provisions of this act.

SEC. 10. When it shall be shown to the satisfaction of the said commissioners that any natural oyster or clam bed has been designated by them to any person or persons, the said commissioners shall petition the Superior Court of the county having jurisdiction over the said grounds to appoint a committee to inquire and report to the said court the facts as to such grounds, and the said court shall in such case appoint such committee, who after twelve days' notice to the petitioners and respondents shall hear such petition and report the facts thereon to said court; and if it shall appear that any natural oyster or clam beds, or any part thereof, have been so designated, the said court may order that said grounds may revert to the State, after a reasonable time for the claimant of the same to remove any shell-fish he may have planted or cultivated thereon in good faith, and said court may further order that all stakes and buoys marking the same be removed, the costs in said petition to be taxed at the discretion of the court.

SEC. 11. Any commissioner who shall knowingly grant to any person or persons a franchise as hereinbefore provided in any natural oyster or clam bed, shall be subject to a fine of not less than one hundred dollars nor more than five hundred dollars, and if such franchise is granted the grant shall be void, and all moneys paid thereon shall be forfeited to the State; and the said commissioners shall in no case grant to any person or persons a right to plant or cultivate shell-fish which shall interfere with any established right of fishing, and if any such grant is made the same shall be void.

SEC. 12. The Superior Court of New Haven county, on the application of the selectmen of the town of Orange, and the Superior Court of any county, on the application of the oyster-ground committee of any town in said county, shall appoint a committee of three disinterested persons of the town within the boundaries of which any natural oyster, clam, or mussel beds exist, to ascertain, locate, and describe by proper boundaries, all the natural oyster, clam, or mussel beds within the boundaries of such town. Said committee so appointed shall first give three weeks' notice, by advertising in a newspaper published in or nearest to said town, the time and place of their first meeting for such purpose; they shall hear parties who appear before them, and may take evidence from such other sources as they may in their discretion deem proper, and they shall make written designations by ranges, bounds, and areas of all the natural oyster, clam, and mussel beds within the boundaries of the town they are appointed for, and shall make a report of their doings to the Superior Court, and such re-

port, when made to and accepted by said court, and recorded in the records thereof, shall be a final and conclusive determination of the extent, boundaries, and location of such natural beds at the date of such report. It shall be the duty of the clerk of the court to transmit to the town clerk of each of said towns a certified copy of said report so accepted and recorded, in relation to the beds of such town, which shall be recorded by said town clerk in the book kept by him for the record of applications, designations, and conveyance of designated grounds. Such public notice of said application to the Superior Court, and of the time and place of the return of the same, shall be given by said selectmen or oyster-ground committee as any judge of the Superior Court may order. It shall be the duty of the selectmen of the town of Orange, and of the oyster committees of other towns, upon a written request so to do, signed by twenty electors of their respective towns, to make such application to the Superior Court within thirty days after receiving a copy of such written request, and said applications shall be privileged and shall be heard and disposed of at the term of said court to which said application is returned, in preference to other causes. All expenses properly incurred by such selectmen and oyster-ground committees in said applications, and the doings thereunder, and the fees of said committees so appointed by court, shall be taxed by the clerk of said court and paid by the State upon his order. Any designation of ground for the planting or cultivation of shell-fish, within the areas so established by such report of said committee, shall be void.

SEC. 13. The selectmen of the town of Orange and the committees of other towns shall, at the expense of their respective towns, procure and cause to be lodged and kept in the office of the town clerk of each town respectively, accurate maps showing the boundary lines of their said towns in the navigable waters of the State, and all designations of ground for the cultivation of shell-fish heretofore made and that shall hereafter be made within such boundaries, and shall number said designations on said maps, and shall cause to be designated on said maps all natural oyster, clam and mussel beds lying within their several towns respectively, as the same shall be ascertained by said report of said committee recorded in said towns as hereinbefore provided.

SEC. 14. All acts and parts of acts inconsistent herewith are hereby repealed, but this act shall not affect any suit now pending.

Approved April 14th, 1881.

It will be important to recollect hereafter that while this act

was approved April 14th, 1881, yet by a general act of the same legislature, it did not take effect until May 1st, 1881, and as there was on the part of a portion of the oystermen a bitter opposition to the new commission, a grand scramble commenced to secure from the town committees all the good grounds possible, before the act should take effect. In this way, about 40,000 acres were designated by town committees before May 1st, and as this was necessarily done in the most hurried manner, great confusion arose as to the titles of many of the designations. The newly appointed commissioners immediately established an office in the city of New Haven, secured a clerk, and soon after an engineer, who, with his two assistants does all the surveying required by the commission. The first work of the commission was to establish the line known as the eye-sight line, which is demanded by the first section of the act, and which extends from headland to headland along the whole shore of the State. All the ground lying north of this line remains as formerly in the jurisdiction of the towns, and all south of it to the New York line is under State jurisdiction. The line as established with one or two amendments in certain localities, was ratified and confirmed by the legislature April 26th, 1882.

Section 3 of the act authorized the commissioners, in behalf of the State, to grant perpetual franchises for the planting and cultivation of shell-fish, in any undesignated grounds within the jurisdiction of the State, which were not and had not for ten years been natural clam or oyster beds, to any person who had lived in the State one year next preceding the date of application. The application and grant were required to be in a form approved by the chief justice of the State, and all grants were to be recorded in books kept for the purpose. Notices of applications were to be sent to the town clerk of the town within the meridian lines of which the grounds were located, and if after twenty days' posting, no objections were made, the application was returned to the office, and the commissioners for $1.10 per acre granted a deed to the applicant. If, on the other hand, objections were made, the party objecting paid to the town clerk twenty-five cents, filed his written objections, and, at the end of twenty days, the application and objections were returned to

the commissioners, who then gave all parties interested ten days' notice of a hearing in the matter. If the objections were sustained nothing further was done, but if not the grant was made as before.

By section 5, the commissioners are required to have all designations mapped and surveyed, and the grantee is required to have the ground at once plainly marked out by "stakes, buoys, ranges or monuments." The same section provides that if the grantee does not use and occupy the grounds for the cultivation of oysters within five years, the commissioners shall apply to the Superior Court to appoint a committee to examine and report, and if said committee after twelve days' notice to petitioners and respondents, on a hearing of the case, finds that the grounds have not been used in good faith for the purpose of cultivating or planting shell-fish, the court may order that said grounds revert to the State, and that all stakes, and buoys marking the same be removed, the costs in said petition to be paid at the discretion of the court. On the other hand, section 6 provides that if after occupancy and cultivation of any gounds designated, it shall appear that said grounds are not suited for the planting or cultivation of oysters, the grantee, upon receiving a certificate to that effect from the commissioners, may surrender to the State the same or any part thereof, not less than one hundred acres, and receive one dollar for each acre from the treasurer.

Section 8 provides that all designations and transfers of oyster, clam or mussel grounds within the waters of Long Island Sound heretofore made (except designations made of natural oyster, clam, or mussel beds) are hereby validated and confirmed. It is under the authority of this section that so many designations were made by town committees between April 14th and May 1st, 1881.

Section 10 provides that if the commissioners unintentionally designate a natural clam or oyster bed, they shall apply to the Superior Court of the county having jurisdiction over said grounds to appoint a committee of investigation, and if said committee find that any natural oyster bed has been so designated, the court may order said grounds to revert to the State,

after the claimant has had a reasonable time to remove any shell-fish he may have planted or cultivated thereon in good faith.

Section 11 provides that, "Any commissioner who shall knowingly grant to any person a franchise in a natural clam or oyster bed, shall be subject to a fine of not less than one hundred nor more than five hundred dollars, the grant shall be void, and all moneys paid thereon shall be forfeited to the State." Section 2 provides that the commissioners shall make or cause to be made a survey and map of all the grounds within the jurisdiction of the State in Long Island Sound, which have been or may be designated for the planting or cultivation of shell-fish, and also cause a survey of all the natural oyster beds in said area, and shall locate and delineate the same on a map. The same section provides that the commissioners shall report to the next session of the legislature a plan for an equitable taxation of the property in said fisheries, make an annual report and give a bond for the faithful performance of their duties. One of the first things to be done under the law was to designate the natural oyster beds of the State, and after long and patient hearings and consultation with the oystermen, all of the natural oyster beds have been mapped, except one about which there has been much litigation, and as one question in reference to its location is now in the hands of the Supreme Court of the State for decision, the mapping has been delayed until this question shall be decided. Eight in all have been described to the satisfaction of everyone, and they comprise 5,498 acres. Surveying and mapping the designations made by the town committees has been exceedingly difficult, caused by the fact that in many cases the survey was done hurriedly, and in many more by incompetent persons who seem never to have pretended to do more than guess at the work. The consequence is that frequently a person has a deed described in words, an accompanying map of the ground, and is in occupation of a plot of ground which corresponds with neither; the map and description also being found utterly irreconcilable. Now as his next neighbor is in a similar predicament, and the ground has become valuable, it is easy to see that ill feeling and prolonged litigation are almost inevitable.

In order to meet this difficulty the legislature April 26th, 1882,

enacted a law relating to disputes about boundaries, which is here inserted:

CHAPTER CXXIV.

An Act Pertaining to Shell Fishery Grounds within the Exclusive Jurisdiction of the State.

Be it enacted by the Senate and House of Representatives in General Assembly convened:

SECTION 1. All questions and disputes touching the ownership, titles, buoys, boundaries, ranges, extent, or location of any shell fishery grounds within the exclusive jurisdiction of the State may be referred to and settled by the Commissioners of Shell Fisheries, who are hereby empowered, on petition of any person interested therein, to summon all the parties in interest, so far as such parties may be made known to them, to appear before them at a time and place in the summons named, such summons to be signed by the clerk of said commissioners, and served by him or such other person as the commissioners may direct; whereupon, at such time and place named, or any other time and place to which the hearing may from time to time be adjourned, the party petitioner shall file a sworn statement of the facts as claimed by him, to which any interested party may respond by filing a sworn counter statement of the facts as claimed by him; and after hearing all the parties interested with their witnesses and counsel, the commissioners shall make their decision in writing as soon as convenient thereafter, which decision shall be recorded in the books of record in their office, and the same shall be binding on all the parties in interest so summoned or appearing, unless an appeal shall be taken from such decision to the Superior Court in and for the county where the town is situated, between whose meridian lines any portion of said grounds may be, within ten days after such decision shall be filed by said commissioners with their clerk aforesaid, and unless such appeal shall be prosecuted to judgment, and said decision reversed by said Superior Court. Said appeal may be taken in the same manner as appeals in civil cases from justice courts.

SEC. 2. Every person filing a petition, statement, or counter statement, as in the foregoing section provided, shall, at the time of such filing, deposit ten dollars with the Commissioners of Shell Fisheries, who shall return to the prevailing party the sum so deposited by him, and shall retain the money so deposited by the defeated party as a forfeit to pay the expenses of the investigation, which money so retained shall be accounted for and paid to the State treasurer for the benefit of the State.

SEC. 3. All applications, designations, papers and maps pertaining to any allotment or designations of shell fishery grounds within the area of the exclusive jurisdiction of the State, heretofore made by town officers, and all assignments of such grounds or of parts thereof which have not been recorded in the office of the town clerk or of the shell-fish commissioners, shall be left by the owner or owners, claimant or claimants thereof for record, and shall be recorded in the office of the shell-fish commissioners, or in the office of the town clerk of the town between whose meridian lines said grounds or any part thereof are situated, and they shall be so left within three months after a copy of this section shall be posted in the town clerk's office of the town where such grounds are situated; and upon failure to leave such evidences of title within such time, for record, the Commissioners of Shell Fisheries may order the alleged owner or owners, claimant or claimants, to appear before them at a time and place in such order named and show cause why said grounds should not be deemed as property of the State; and if such parties or any of them fail to appear as ordered, or, on appearing, shall refuse to produce any evidences of the title which they may have or claim to have, or shall refuse to permit the same to be recorded, or if they shall fail to produce any evidence of title, or shall fail to show any reason for such failure to produce the same, the grounds shall be treated, as against such alleged owner or owners, claimant or claimants, as undesignated grounds belonging to the State, and said commissioners may thereupon designate the same or any part thereof as provided by statute.

SEC. 4. The same fees shall be paid for recording or copying papers and maps in the office of the Commissioners of Shell Fisheries as are charged by town clerks for like services; and all fees so paid shall be accounted for and paid to the treasurer of the State for the benefit of the State; and one of said commissioners, or their clerk, shall have power to sign and issue subpœnas in all matters of inquiry before them.

SEC. 5. Sections one and two of chapter seventy of the Public Acts of 1879, are hereby repealed, so far as they may apply to shell-fish grounds within the exclusive jurisdiction of the State; and section three of said chapter is hereby amended, so far as it applies to such grounds, so as to read as follows, viz.: When any designation of shell-fish grounds which are wholly or partially within the exclusive jurisdiction of the State, contains therein a map thereof, or refers therein to such map lodged on file in the town clerk's office, and the owner or owners of the adjoining grounds, so far as they lie within the exclusive jurisdiction of the State, do not agree as to the location of the

line fixed by such map, or if the boundary between such owners is a town boundary and they disagree as to the same, one or more of such owners may apply to the Commissioners of Shell Fisheries who shall thereupon notify all parties in interest to file sworn statements of facts and copies of maps as claimed by them respectively, and said commissioners shall thereupon appoint a surveyor who shall take such maps and statements and lay out and survey the grounds in the various ways claimed, and if any town boundary comes into question he shall ascertain and report upon such boundary as it appears from the maps and records in the custody of the respective town clerks of such towns. Thereupon he shall report his doings, accompanied with the maps or copies of maps found by him touching the dispute to the dispute to the Commissioners of Fisheries, who shall thereupon summon all parties in interest before them at a time and place to be named in the summons, and after a full hearing of said parties, with their witnesses and counsel, the commissioners shall establish the line in dispute, and cause the same to be located and marked by ranges and buoys; and the line so established shall be the true dividing line between such grounds, unless an appeal is taken to the Superior Court, as provided for in section two of this act, and said decision shall be there reversed; and the costs and expenses of such proceedings shall be equally divided between the adjoining owners, who shall pay the same to the commissioners upon the filing of their decision, and the same shall be accounted for and paid to the State treasurer for the benefit of the State; and the cases provided for by this section shall not be deemed included under section one of this act.

SEC. 6. All expenses necessarily incurred in carrying out the provisions of this act shall be audited by the comptroller, and paid by the treasurer of the State.

SEC. 7. All acts and parts of acts inconsistent with the provisions of this act are hereby repealed.

SEC. 8. This act shall take effect from its passage.

Approved April 26th, 1882.

This act provides that all questions and disputes touching the ownership, titles, buoys, boundaries, ranges, extent or location of any shell fishery grounds within the exclusive jurisdiction of the State, may be referred to and settled by the commissioners upon the petition of any person interested therein, after due hearing of all persons interested, and their decision shall be final, unless an appeal be taken to the Superior Court of the county, within ten days after the decision has been filed with

the clerk, and said decision be reversed by the court. Practically the law has been very successful in its operations. Parties in dispute have generally agreed to submit their differences to the commissioners for adjustment, all persons interested have been summoned to appear, the facts have been investigated and patiently considered in all their aspects, and in every case thus far tried the parties concerned have submitted to the decision of the commissioners. A plan of taxation was also recommended in accordance with the requirements of the original law, and the result was the passage of an act providing for the taxation of oyster grounds, a copy of which is here inserted.

CHAPTER CXXV.

An Act providing for the Taxation of Oyster Grounds.

Be it enacted by the Senate and House of Representatives in General Assembly convened:

SECTION 1. All owners of shell-fish grounds lying within the exclusive jurisdiction of the State shall, on or before the first day of November, annually, deliver to the Commissioners of Shell Fisheries a statement under oath specifying the number of lots owned by them, the location and number of acres in each lot, the number of acres in each lot cultivated, and the value thereof per acre, the number of acres in each lot uncultivated, and the value thereof per acre; and printed blanks for such statements shall be prepared by the commissioners and furnished to such owners upon application to them or at their office; and upon the failure of any owner to deliver such sworn statement to said commissioners at their office within the time above specified, said commissioners shall make up such statement from the best information they may obtain, and shall add for such default ten per cent. to the valuation so made.

SEC. 2. All statements or delivered so made shall be alphabetically arranged, and said commissioners shall equalize, if necessary, and determine the value of all the property so returned and described in said statements, which property shall be liable to taxation at the valuation so determined, including the ten per cent. for defauft as aforesaid; and said commissioners are authorized and empowered to declare and lay a tax thereon, annually, at the rate of one per cent. upon such valuation, which shall be payable at the office of said commissioners on and after the first Monday in May, annually; and said tax shall be a lien upon the grounds so taxed from the time it is so laid by

said commissioners, until paid, and shall be in lieu of all other taxes on said grounds.

SEC. 3. If any tax so laid shall not be paid on or before the first Monday in July, the said commissioners shall make and issue their warrant for the collection thereof, with interest thereon, at one per cent. per month from the day such tax became due and payable until paid, together with the expenses of such collection, which warrant shall authorize any reputable person named therein, to seize such grounds and any oysters or other shell-fish thereon. or any other property of the owner or owners thereof not exempt from execution, and to sell the same, or so much thereof as he may find necessary, at such time and place, and in such manner, and by such person as said commissioners may direct, whereupon such sale shall be so made, and such warrant shall be immediately returned to said commissioners by such person with all his doings endorsed thereon, and he shall pay over to said commissioners the money received upon said sale, and they shall apply the same to the payment of such tax and all the expenses thereon, including the expenses of such sale, returning any balance that may remain to such owner or owners; and all moneys received by said commissioners in payment of taxes and interest thereon shall be accounted for and paid to the State treasurer for the benefit of the State, within thirty days from its receipt. Said commissioners shall each, in addition to the bond now required by law, give a bond with surety in the sum of one thousand dollars to the State, conditioned for the performance of the duties imposed upon them by this act.

SEC. 4. All other shell-fish grounds lying within the waters of this State shall be taxed in the same manner in all respects as real estate in the several towns within the meridian lines of which such shell-fish grounds are situated, and no other tax or rental shall be laid or collected on said grounds. or the franchise of any person therein.

SEC. 5. All expenses necessarily incurred in carrying out the provisions of this act shall be audited by the comptroller and paid by the treasurer of the State.

Approved, April 26, 1882.

It provides that all owners of shell-fish grounds shall on or before the first day of November, annually, deliver to the commissioners a sworn statement of their property, the number of acres cultivated, the number uncultivated, and their estimate of the value of each. In case of a failure to make a statement, the commissioners are empowered to make one from the best infor-

mation they can obtain, and add ten per cent. for the default. The commissioners are authorized to "equalize if necessary, and determine the value of all the property so returned and described," and to lay a tax of one per cent. thereon, and said tax is a lien upon the grounds so taxed from the time it is so laid by the commissioners until paid. If the tax is not paid by the first day of July, the commissioners are required to make and issue their warrant for the collection thereof, with interest at one per cent. per month from the time the tax became due until paid. The commissioners are further empowered to enforce such warrant by the seizure of any taxable property which the party in default may own.

Under this law the commissioners collected in 1883, $3,681.47, the entire tax laid. Of course there are difficulties in estimating the value of oyster grounds, and the commissioners were obliged in many cases to equalize and determine the value of the grounds returned. The general plan of valuation adopted was the following. The commissioners assumed that the very all best grounds should be assessed at a given figure, and then were graded with reference to their proportionate value compared with the best. This subject is one requiring careful consideration, and the system may doubtless be improved by further experience. As no appeal can be taken from the assessment of the commissioners, they have themselves acted as a board of relief for the present year. In other words, after the valuations of the grounds had been fixed according the best information obtainable by the commissioners, appointments were made of certain days on which they would be present with the lists at each of the principal towns along the shore, and listen to any parties who might wish to present reasons why the assessment of their grounds should be reduced. This proved to be a very popular move, and when the assessment was finally fixed, the only person seriously dissatisfied with the result was the one owning the largest acreage of oyster grounds in the State. The oystermen of this State are divided into two principal classes, namely, those who own and cultivate grounds of their own, and those who gain a subsistence by work upon the natural or public beds. The former are generally men of some means, and work with steam-

ers, the latter are poor men, who use sailing vessels. The public beds have been raked so constantly for a number of years that very few large oysters can be found upon them. Most of the "stuff" as it is called, taken from them is used for the planting of other beds more or less remote.

A few years ago a serious controversy arose as to the effect of steamer work upon the natural beds. The steamer owners claimed that their work tended to improve the bed by preparing the bottom for a better set of the spat in the breeding season. The owners of sailing vessels on the contrary claimed that the heavy dredges of the steamers plowed up the ground to such an extent as to ruin it. The result of the discussion of the subject was that in 1881, the legislature passed an act forbidding the use of steamers upon any of the natural beds of the State, and that law still remains in effect to-day. While most of the natural beds are in comparatively shallow water, the cultivators of oysters do not deem it safe to plant oysters in less than twenty-four feet of water, and many of their productive beds are in water from thirty to sixty feet deep. They claim that in less than twenty-four feet of water, the crop is liable to be destroyed by heavy storms, the oysters being either covered up and smothered with mud or sand, or washed ashore by the action of the waves.

The hydrographic work of the engineer of the commission is so accurate that confidence has been given to cultivators to take up claims in deep water, with a certainty that if they secure valuable ground and their stakes or buoys are removed or carried away by storms or steamboats, they can be replaced. The system adopted in this respect is the following: When an applicant has secured a grant of a plot of ground from the commissioners, on an appointed day, the engineer with an assistant proceeds to the locality with the applicant, and having fixed the precise situation with their instruments, the buoys are placed in position, and a record is made of the spot, which is transferred to the books of the office, each buoy being numbered. If at any future time, the buoys are misplaced, all that is needed to correct the error is to consult the number of buoys in the records, and they can be replaced without difficulty. The amount of

ground lying within the exclusive jurisdiction of the State returned to the commissioners for taxation, in 1883, was 74,930 acres, of which 13,008 acres were described as cultivated and 61,922 as uncultivated. In 1882 the returns were 9,007 acres cultivated, and 46,316 uncultivated. The gain therefore for 1883 over 1882, was 4,001 acres cultivated and 15,606 uncultivated. New applications are constantly being made, and more acres are annually put under cultivation.

The usual method of planting new ground is to strew about three hundred bushels of oyster shells, and thirty bushels of spawning oysters to each acre. In some cases where the new ground is in the vicinity of a natural bed or other ground on which are spawning oysters, a good set is obtained without the deposit of any mature oysters. The time of planting is from June 15th to September 1st, the deeper the water the later is the "set," and the cultivators govern themselves accordingly in their work, the great requisite being that the "cultch" shall be clean and fresh at the time of the floating spat. All kinds of business have their drawbacks, and the cultivation of oysters is no exception. In Connecticut the two principal enemies of the oyster cultivators are the star-fish (*Asterias rubens*), and oyster thieves of the human species. The oyster growers sometimes say that it is questionable which is the greater pest, the "five fingers" or the "ten fingers." The star-fish are much more destructive in some years than others, and during the same season inflict great injury upon the beds in one portion of the State, while in others they do not appear at all, or in such insignificant numbers as to do no appreciable harm. Until recently the only remedy has been to remove the oysters and star-fish together, the star-fish being destroyed, and the oysters either sold or removed to some locality where no star-fish were to be found. Mr. J. F Homan, of New Haven, in this State, has invented a dredge which, it is claimed, will remove the star-fish without taking the oysters. Its construction is based upon the fact that the star-fish is of lighter specific gravity than the oyster. The bag of the dredge is located about six inches behind the bar or rake, and a few inches higher.

The practical effect is that the oysters and star-fish being stir-

red up together, the oysters drop back to the ground, and the star-fish fall into the open mouth of the bag. When this pest makes its appearance upon the oyster grounds, great vigilence is needed to prevent the loss of the crop. The owners of private beds watch their grounds carefully, with a view to prompt action in case of necessity, but the public beds being open to every one, no one takes special pains to remove the star-fish, and it has been claimed that some of the oystermen have thrown them overboard after being taken. A stringent law to prevent this was passed at the last session of the legislature, and the owners of private grounds introduced an act to enable the commissioners to remove star-fish from the public beds at the expense of the State, but as some of the sections of the bill were deemed objectionable, the act was defeated.

Another effort will be made next year to accomplish the same end, and uncomplicated with other measures, will probably be successful. The whole area of ground in the exclusive jurisdiction of the State is about 300,000 acres. Of this about 45,000 acres were designated by the town committees before the appointment of the commission. The aggregate area designated by the commission during the last three years has been 38,548 acres, making in all 83,548 acres under their supervision. In addition to this, applications for 15,714 acres are now awaiting action, and this number will be increased as fast as parties discover what they consider to be advantageous locations. The oyster cultivators seem to be generally thriving, are eager to acquire larger areas of suitable grounds, and new steamers and sailing vessels are constantly being added to the fleet. New purchasers are coming into the field, more capital is being invested, and under the fostering care of the State the industry bids fair, at no distant day, to be one of the largest and most important in the entire commonwealth.

Lieut. Winslow: I would like to ask if, at the last session of the Connecticut State legislature, any act was passed which would facilitate the detection and punishment of theft from the oyster-beds. As I understand the law, as it existed a year or so

ago, a designation of a natural oyster-bed could not be made. Therefore, when the thief wanted an oyster he assumed all beds to be natural, and took what he wanted. He did not care whether it was a natural bed or not. The burden of the proof did not rest upon him, but upon the owner of the area. Any bed was assumed to be natural until the owner could prove to the contrary. Such a state of affairs surely militates very seriously against the owner. It has seemed to me that, after an area has once been designated, the owner should not be called upon to prove that it was not a natural bed. I would like to know if any measures have been adopted looking towards a remedy for that evil.

Dr. WILLIAM M. HUDSON: Such a bill was introduced in the legislature, but owing to the unfortunate fact that our oystermen in the western part of the State were in opposition to those in the eastern part, the bill fell to the ground. Earnest efforts have been made by our State Fish Commission to bring about that bill, and yet the only act passed in reference to the oyster interest, was one that simply prevented, under heavy penalties, any of the oyster dredges from throwing back into the water any star-fish they might catch. But the attempt to pass an effectual bill failed on account of this opposition between the east and west sections of the State. I think that possibly during the next twelve months a suitable bill will be passed.

Lieut. WINSLOW: Another question occurs to me. After having once adopted the system of proprietary ownership, the greatest difficulty was experienced in detecting a theft. You cannot prevent a man from traveling over the ground, and although you can readily see his appliances, dredge, etc., for taking the oyster, you have to prove that the man has actually taken the oyster: in other words, you must catch him in the very act, and prove that they are your oysters before you can really accomplish anything towards punishing him. Now, that is a very difficult thing to do, and it seem to me that there should be incorporated in the laws a provision for the punishment of a man found on a area with implements for taking oysters. His presence under such circumstances should be sufficient ground for his arrest, be-

cause evidently his intention is to take oysters. The excuse cannot be made that he mistook the ground, for each area is marked plainly. When you see the dredge-line going, it is pretty good proof that oysters are being taken. Public opinion is now very strong against the stealing of oysters, and it certainly seems to me that a provision should be made, which would assist the oyster grower in bringing an offender to justice.

Dr. HUDSON: I think that what Lieut. Winslow has said would be readily acknowledged by any who have looked into the matter. The Connecticut commissioners are anxious for favorable legislative action on this matter; but, as I have stated, there is unfortunately this controversial feeling which has arisen between the natural growers and the cultivators, which has thus far been the means of preventing the enactment of such laws as Lieut. Winslow has referred to. I have no doubt, however, that perhaps in the immediate future suitable laws will be passed.

Lieut. WINSLOW: I would like to say in addition that I do not know of any State that has made so great an advance in this matter as Connecticut. By examining the legislation on the subject for the last four or five years, it may easily be seen that it is of the most practical nature, and it is based on sound business principles. The people of Connecticut, proverbially shrewd, have certainly managed to get all the milk out of this particular cocoanut.

Prof. GOODE: I think that there can hardly be too much stress laid upon the importance of the work which Dr. Hudson and his colleagues are carrying on, the results of which have been described by him this morning. I have been looking into the history of the oyster industry of Europe lately, and am convinced that Connecticut is putting into practice the best system of oyster-culture in the world. The manner in which that State is dealing with the questions of fishery legislation, is certainly extremely interesting and worthy of commendation. The eyes of the world are upon Connecticut at the present time. I can appreciate this fact perhaps better than most of us here, having heard the eager questions and seen the intense interest of the fish-culturists and

oyster-raisers of Europe last summer in London, and having heard what was said concerning the action of Connecticut. Every country which has any oyster-fisheries is trying to solve the same problem, viz: how to protect the beds and give oyster-culturists right of property by the fruit of their labors. It really appears to me that this subject—the progress of the work in Connecticut—is one of the most interesting that could be brought before this society.

THE OYSTER INDUSTRY OF THE WORLD.

BY G. BROWN GOODE.

The oyster industry of the world is seated chiefly in the United States and France. Great Britain has still a few natural beds remaining, and a number of well conducted establishments for oyster culture. Canada, Holland, Italy, Germany, Belgium, Spain, Portugal, Denmark, Norway and Russia have also oyster industries, which are comparatively insignificant, and, in the case of the last two countries, hardly worthy of consideration in a statistical statement. Recent and accurate statistics, Mr. Goode said, were lacking except in two or three instances. A brief review by countries in the order of their importance was presented. The oyster industry of the United States was shown to employ 52,805 persons and to yield 22,195,370 bushels, worth $30,438,852, and that of France in 1881, employed 29,431 persons, producing oysters valued at $3,464,565. The industry of Great Britain yielded a product valued at from two to four million pounds sterling. Holland was shown to have a considerable industry in the Province of Zeeland, and to have produced native and cultivated oysters to the value of $200,000. Germany has an industry on the Schleswig coast valued at about $400,000; while the products of other European countries mentioned were too insignificant to deserve a place in this brief abstract. An

estimate of the total product of the world was presented as follows; the figures being given in the number of individual oysters produced.

COUNTRIES.	NUMBER OF OYSTERS.
United States	5,550,000,000.
Canada	22,000,000.
Total for North America	5,572,000,000.
France	680,400,000.
Great Britain	1,600,000,000.
Holland	21,800,000.
Italy	20,000,000.
Germany	4,000,000.
Belgium	2,500,000.
Spain	1,000,000.
Portugal	800,000.
Denmark	200,000.
Russia	250,000.
Norway	250,000.
Total for Europe	2,331,200,000.

The oyster industry is rapidly passing from the hands of the fishermen into those of oyster-culturists. The oyster being sedentary, except for a few days in the earliest stages of its existence, is easily exterminated in any given locality, since, although it may not be possible for the fisherman to rake up from the bottom every individual, wholesale methods of capture soon result in covering up or otherwise destroying the oyster banks or reefs, as the communities of oysters are technically termed. The main difference between the oyster industry of America and that of Europe, lies in the fact that in Europe the native beds have long since been practically destroyed, perhaps not more than six or seven per cent. of the oysters of Europe passing from the native beds directly into the hands of the consumer. It is probable that sixty to seventy-five per cent. are reared from the seed in artificial parks, the remainder having been laid down for a time to increase in size and flavor in the shoal waters along the coasts. In the United States, on the other hand, from thirty to forty per cent. are carried from the native beds directly to mar-

ket. The oyster fishery is everywhere carried on in the most reckless manner, and in all directions oyster grounds are becoming deteriorated, and in some cases have been entirely destroyed. It remains to be seen whether the governments of the States will regulate the oyster-fisheries before it is too late, or will permit the destruction of these vast reservoirs of food. At present the oyster is one of the cheapest articles of diet in the United States, while in England, as has been well said, an oyster is usually worth as much as or more than a new laid egg. It can hardly be expected that the price of American oysters will always remain so low; but, taking into consideration the great wealth of the natural beds along the entire Atlantic coast, it seems certain that a moderate amount of protection will keep the price of seed oysters far below the European rates, and that the immense stretches of submerged land, especially suited for oyster planting, may be utilized and made to produce an abundant harvest, at a much less cost than that which accompanies the complicated system of culture in France and Holland.

PRESENT CONDITION AND FUTURE PROSPECTS OF THE OYSTER INDUSTRY.

BY LIEUT. FRANCIS WINSLOW, U. S. N.

I beg that you will bear in mind that in a consideration of the oyster industry, present or future, there is opened to us so wide a field for investigation that it is hardly possible in a few minutes to treat the subjeet fully or thoroughly. I shall not attempt to go into minute details, but confine myself to the general principles which, in my opinion, govern successful oyster-culture.

At the last census, the oyster industry of the United States employed nearly 53,000 persons and over $10,500,000 of capital. Its production amounted to more than 22,000,000 bushels of oysters,

valued at about $13,000,000. While these figures are not of astonishing magnitude when compared with those of many of the industries of the country, they indicate, nevertheless, a gratifying volume of business, and when compared with the returns from the other fisheries they show the oyster industry to be of more importance than any.

I learn from Professor Goode's paper read at one of the conferences held in connection with the late London Exhibition, that the entire fishing interest of the country employs 131,426 persons and nearly $38,000,000 of capital, and produces $43,000,000 of products. Thus it is seen that the oyster industry employs nearly one-third of the persons, more than one-fourth of the capital, and produces over one-third of the income. Its product is about six times as great as that of the whale, seal, or menhaden fisheries, and considerably more than one-half of the product of all the other fisheries put together. Surely such an industry is well worth care and preservation. The question is, what degree of care does it receive; is its preservation in any way endangered?

The subject is of considerable moment, but that I need not impress upon you. Its full discussion would occupy more time than either you or I have just now to spare for it. I shall, therefore, only touch upon a few of the more important points, and salient features.

Oysters are found along the whole coast of the United States from Maine to the Rio Grande, and a species also exists on the north-west coast. But notwithstanding this wide distribution, pointing out the possibilities of the future, the greater part of the fishery and business is confined to the Chesapeake region; that is, to the States of Maryland and Virginia.

Of the 53,000 persons employed, nearly 40,000 belong to those States; and of the $10,500,000 of capital, over $7,000,000 is credited to them, while of the 22,000,000 bushels of oysters, more than 17,000,000 come from Chesapeake bay and its tributaries.

That is four-fifths of the laborers, seven-tenths of the capital, and considerably more than three-fourths of the product should properly be assigned to the Chesapeake region. Evidently, then, any consideration of the oyster industry must be to a great ex-

tent a consideration of the industry as it exists in the bay. Whatever other localities may produce; however valuable systems and methods in use in other States may be, whatever superiority of means or intelligence other fishermen may possess, they have not yet succeeded in wresting the trade from the Maryland and Virginia people. Superiority in intelligence, means, systems and crops, are but as so many drops in the bucket when compared with the natural advantages offered by the Chesapeake and enjoyed by those who fish in her waters.

The present condition of the Chesapeake fishery is, then, practically the condition of the whole industry, and the future prospects of the whole may be largely predicated upon the prospect in Maryland and Virginia. What is that condition? What are those prospects? Generally speaking, the condition is bad; the prospect worse. It is stated by many persons of good judgment and sufficient knowledge to enable them to speak with authority, that not only has the number of oysters on the great natural beds diminished very much of late, especially during the last five years, but it is stated by one of the most eminent and experienced observers and students of this question, Dr. William K. Brooks, of the Johns Hopkins University, chairman of the Maryland Oyster Commission and a member of the National Academy of Sciences, that the oyster property of the State is in imminent danger of complete destruction. From time to time during the last decade notes of warning have been sounded, but unfortunately, have not been heeded. Only within the last few years has the public awakened to the gravity of the situation and the necessity of taking steps to avert the threatened evil. The vague feeling of alarm which seized the oystermen as they discovered that the apparently exhaustless beds were no longer yielding their former returns, became sufficiently concentrated two years ago to cause the appointment, by the State of Maryland, of a commission to investigate the condition of the whole oyster industry. The rapid deterioration, both in size and quality of the oysters offered in the Baltimore markets, together with the frequent failure of the supply altogether, roused the packers of the city to set in motion under their own auspices, an entirely separate investigation. The expansion of the guerilla-

like depredations of the dredging vessels upon the beds reserved to the tongers, into first, a systematic onslaught of periodic occurrence; and second, into open, defiant and serious warfare with, not only the tongers, but also the civil, military and naval forces of Virginia and Maryland, lead to a more thorough and thoughtful discussion of the whole oyster subject, by both press and people. The results of the discussions and investigations are now before the public. It is not necessary that I should review them in detail. It will suffice if I mention but a few of the many indications of deterioration.

The report of the commission created by Maryland and Virginia in 1868, shows that the production of the Chesapeake was, in that year, 21,500,000 bushels. Possibly, says a writer in *Lippincott's Magazine*, it went as high as 25,000,000,000 bushels. If these figures are trustworthy, in spite of the improvements in implements, boats and general apparatus of the fishery, the production has fallen off rather than increased during the last fifteen years. Indeed, the testimony of all the oystermen is to the same effect. According to them, from three to seven times as many oysters could have been taken twenty years ago as at present, and a larger number actually were taken, some five years back. I am inclined to doubt the accuracy of the figures quoted for 1868. I am rather of the impression that the yield at that time was considerably less than it is now. Possibly not half so great. But there are very safe indications of a decrease within the last few years, even if the yield was an absolutely essential factor in determining the condition of the beds. But it is not essential by any means. An abnormally large production is quite as alarming, if not more so, than an abnormally small one, paradoxical as the statement may seem.

According to Mr. Edmunds, the gentleman who investigated the condition of the Chesapeake beds for the census, not only has the trade in raw oysters been greatly hampered, but, during the year of 1882, the packers were frequently compelled to quit steaming oysters on account of a deficiency in the supply. My own investigations in 1883 confirm this statement. One of the most prominent and well known Baltimore packers stated to me that he was compelled to take stock at 25 cents per bushel, which

three years back he could have purchased at 5 or 10 cents per bushel, and five years back would not have had at any price at at all.

I might continue quoting opinions indefinitely with the same result, but the decision of the matter is based upon sounder postulates than opinions.

In 1878-79 I made an examination of certain beds of the Chesapeake, and found them to be in a much impaired condition. Comparing my results with the results obtained by himself in 1883, Dr. Brooks states that the beds have decreased in value more than 39 per cent. This statement is based upon the following data: My examination in 1878-9, showed that in Tangier sound there was about one oyster to every 2.3 square yards. Dr. Brooks after examining the whole of the Maryland beds, states that in 1883, there was only one oyster to each 4.2 square yards. That is, the deterioration equalled nearly 40 per cent.

In 1876, Mr. Otto Lugger visited most of the Chesapeake beds and measured the quantity of shells and oysters obtained by dredging. He found 3.7 bushels of oysters for each bushel of shells.

In 1879, I made an examination of seventeen beds and found 1.9 bushels of oysters for each bushel of shells. A decrease of 1.8 bushels in three years.

In 1882, Dr. Brooks found 1.3 bushels to each bushel of shells, a decrease of 0.5 bushels in three years, showing that the deterioration was continuous. It is quite evident that an increase in the number of shells and a decrease in the number of oysters obtained at each haul of the dredge, is an indication of impairment, and combining that indication with the decrease in the number to the square yard, as shown by my own and Dr. Brooks' measurements, the impoverishment of the beds is apparent to the most superficial observer. But other evidence is not wanting. The principal test of the decrease of a commodity is the increase in its price; and it is well known among all oyster dealers of this region that oysters have been not only much more difficult to obtain, but much more expensive than they were a few years back. Fully twice and three times as much are now paid per bushel as was customary ten and fifteen years ago.

In 1861, oysters in the Chesapeake were worth, according to the writer in *Lippincott's* whom I have already quoted, 15 and 20 cents per bushel. In 1868, they had advanced to 25 and 30 cents. In 1879, the average price of the crop of 17,000,000 from Maryland and Virginia was over 40 cents per bushel; and at the present time it is nearer 50 cents than 40, and occasionally is much higher. And this increase in price is not wholly due to increase in demand. There has been an actual diminution in the number of oysters produced. The number of oysters passing through the Chesapeake and Delaware canal, the connecting link between Chesapeake and Delaware bays, is a pretty fair indication of the production of the Chesapeake beds. In 1879, in round numbers, 940,000 bushels passed through. In 1883, only 550,000. That is, the reduction was about forty per cent. of the amount in 1879. And it is worthy of notice how close this result agrees with Dr. Brooks' statement that the oyster beds had fallen off thirty-nine per cent. in value, since the examination made by myself in 1879.

The facts I have recited certainly should be sufficient to convince any one that the oyster industry in the Chesapeake is in a very bad way; and, as I have explained, the condition of the Chesapeake fishery is virtually the condition of the whole. In other words, the present offers but little encouragement. Does the future offer more?

A correct answer to the question necessitates the examination of the several causes which may have operated in bringing about the present state of things. We must decide upon the agency which has been at work and having discovered it, consider how it can be precluded from further operation. It may be confidently asserted that no natural cause has had any considerable deleterious influence.

The natural influences and conditions to which the oysters were exposed in the past and under which they increased and multiplied so greatly, have in no way changed. Temperature and density of the water have been no more various than in the past. Channels and bottoms have remained stable. Factories and mills with their polluting excrement have not been erected. Organic life of any kind has neither increased or diminished to

any noticeable extent. In fact, the environment has remained exactly as it has always been—with one exception. Continuous and exhaustive fishery has sprung up with all its attendant evils. To that and to that alone is the condition of the beds due. The prophecy so often made is at last coming true. The demand has outgrown the supply and in the effort towards equalization the beds, the source of wealth, are fast becoming a total sacrifice.

All the facts, all the opinions, all the evidence, was before the legislatures of the two States, and they did nothing beyond building a few more police boats. The influence of the oyster men was too strong to be overcome. They either would not or could not submit to any restriction of their privileges, and the influence so strong in the present is not likely to be diminished in the future, unless it is shown that it is for the best interest of the fishermen that a change of policy, radical and entire, is absolutely necessary for the preservation of the industry.

Look at the facts. The natural beds in the Chesapeake like the natural beds in the Northern States, are no longer capable of returning an adequate supply. What has been done to remedy the evil? An increase of the police force! In other words, a more perfect restriction of the fishery—a more extensive diminuition of the supply. Surely, that is not what we want! We do not care to have a valuable food product diminished. That is no real remedy. What should be done is to follow the course of the Northern States and endeavor, by artificial means, to cultivate the oyster and increase the productive area and supply.

I ask you but to look at the charts of the oyster beds exhibited in the fisheries, section and you will see a marked difference between the region north and south of the old Mason and Dixon line. In the northern portion the preponderance of the artificial over the natural beds is as marked as the reverse in the southern portion. Years ago the natural beds of Long Island Sound returned a sufficient supply to satisfy the demands of the consumers. Gradually those demands increased and with them the disposition towards the inordinate fishing of the beds. The natural consequence followed. The beds were over worked, became depleted, were exhausted. But the demand still existed and had to be satisfied. New beds were created; new methods intro-

duced; and to-day Rhode Island has some 10,000, and Connecticut some 100,000 acres of oyster ground over and above the allowance originally made by nature.

If the industry in the Chesapeake is to follow the same course as in the Northern States, then the establishment of artificial beds, and artificial extension of the oyster area with its consequent increase of the supply, will take place only upon the destruction of the present natural beds. Indeed a prominent and intelligent oyster planter testified before the Virginia legislature that he was half inclined to hope for just such a consumation, so little had he to expect from the present condition of things. But a careful study of the Northern fishery and the laws, statutory and natural, which govern it, will show quite plainly, the steps necessary to be taken in order to accomplish the desired end. And if history and experience are to have any influence in forming men's opinions and guiding their actions, the measures indicated by the study should surely be adopted. So far as I am able to see, the recuperation of an oyster industry is entirely dependent upon the recognition and adoption of one great principle as the foundation of the work. That principle is, the right of the State to cede and the individual to hold, tracts of bottom under a tenure similiar to that governing uplands. In other words the practice of holding the oyster area open to any and all as common property, necessarily prevents in practice the adoption of conservative measures, or a policy of comprehensive and systematic improvement. On the other hand, no sooner is an individual and proprietary right affected than that powerful lever—self-interest—is brought into play, and progress becomes assured.

Evidently cultivation of the common property will never be undertaken by the individual. Yet it must be undertaken by some one. It is impossible for the State to assume work. The Chesapeake oyster area equals some 400,000 acres. If the cost of cultivation did not exceed $10 per acre, and it is much nearer $30 than $10, the expense would be $4,000,000 every three years. If the State of Connecticut undertook to cultivate her artificial beds, it would cost her from one to three millions per annum. If Rhode Island entered the field it would be at an expense of

from $100,000 to $300,000 per annum. Evidently the expenditure of such sums for the benefit of a portion of the population is out of the question, even was it necessary. But it is not necessary. Oyster-cultivation can be carried on by individuals just as well as the cultivation of potatoes or rearing of live stock. That this is not understood is the principal difficulty met by those who desire the advancement of the fishery, and the first condition I would make with a fish-culturist in discussing this question, is that he should dismiss from his mind all impressions he may have which are based upon the supposed analogy between oyster and fish-culture. It is true that we can impregnate the eggs of an oyster in virtually the same way we impregnate the eggs of a fish. It is true we can keep the young oysters alive for some time in practically the same manner it is accomplished with a fish. But there the similarity ends.

Whoever may hatch the fish egg, the general public only can reap the benefit. Fish are migratory. Fisheries cannot be preserved. But the oyster is not migratory. It is an animal of domestic instincts and strong local attachments. Where it is placed it stays. Consequently, its cultivation is eminently a proper field for the employment of individual exertion. I would not be understood to mean by the term "cultivation" in this relation, the artificial impregnation of the eggs. That has not yet been made of practical importance. I refer, principally, to the cultivation of oyster ground rather than oysters. To the improvement of areas and beds rather than of stock. To increasing the facilities for natural expansion, rather than the exercise of natural function.

It is quite possible to take a totally barren tract of bottom and seed it with mature oysters, fertilize it with shells, and in a few years reap from it an abundant crop. But evidently no one will undertake this trouble or expense unless he is reasonably certain of gathering the harvest. Equally evident is it that the State cannot sow the ground for the fishermen. Naturally, but one conclusion can be reached. The harvest must be made sure to the individual, and it can only be made sure by the possession of indefeasible proprietary rights. How soon the industry revives under such conditions is proved by the history of every

Northern fishery, but I have not time to quote them in detail. Rhode Island offers perhaps the most instructive instance. In 1865 there was only some 60 or 70 acres of bottom under cultivation. The product was only some 71,000 bushels. The price was $1.75 per gallon.

In that year the law was passed which gave individual and proprietary rights to oyster ground, and an advance began which has never since been checked. In 1883, 11,000 acres were under cultivation; the product was in the neighborhood of 1,000,000 bushels, and the price per gallon had fallen to less than a dollar.

The fishery in Connecticut will be, I understand, the subject of a subsequent paper by a member of the Association, and I will not therefore do more than touch upon it. It will suffice for my purpose to state that since the operation of the law giving proprietary interest in defined tracts of bottom, an enormous area of what was entirely barren ground has been turned into productive oyster beds, and the crop of native oysters increased from insignificance to millions of bushels. Indeed, so great has been the success and so encouraging the prospect, that the most prominent planter in the State has said that the Connecticut people could easily afford a subsidy of $50,000 per annum to keep in existence the present Chesapeake policy.

These facts appear so overwhelmingly conclusive that it is a matter of astonishment that the course indicated by them has not been immediately adopted. Yet, though it has been urged with great persistency for several years, advocates and adherents have gathered but very slowly. The most important work to be done is, therefore, that of proselyting. But to accomplish this, methods differing from the usual ones must be adopted.

Experience shows that the class which it is desirable to convert cannot be reached by mere arguments, no matter how sound the postulates upon which they are based may be. It is useless to apply reason to prejudice. Only actual, tangible evidence can have any effect; and such evidence can only be given by what is practically a system of "object lessons." An excellent illustration of the value of such examples is given by the success of oyster-culture in France. There the individual oyster-culturist has been educated by the observation of the model govern-

ment *parcs*, until perceiving all the advantages which would accrue from systematic and intelligent effort in this field, he has engaged in the pursuit with wonderful success and credit. Some such system, it seems to me, must be adopted in the Chesapeake region, if we wish to secure sensible legislation and actual advance prior to the destruction of the great natural beds. The people must be educated—must be made to see the folly of their ways and the wisdom of those of others. And, though I am utterly opposed to the entrance of the State into the oyster business, yet if the establishment of a few model oyster farms can teach the people of Maryland and Virginia how to husband and increase the wealth nature has given them, I should regard the money expended in such establishment well spent.

But I have detained you far longer than I intended when I first thought of addressing you, and must bring this paper to a close. The range of my subject and the importance of the principle I have been most desirous of urging upon your consideration, have precluded discussion of many minor points of great interest to oyster-culturists, and possibly to the general public. It has also necessitated a more general and superficial treatment of the question, than I would desire. But if I have succeeded in impressing the need for some more efficacious measures than have yet been adopted my end has been accomplished. Certainly something should be done. Glance at the census tables and you will find that, with the exception of Virginia, Maryland employs ten times as many persons, and produces ten times as many oysters as any other State. The gross value of her product is two to four times as large, and her capital five times as great. She has at work two and three times as many vessels, and produces nine and ten times as many oysters. In every respect upon a superficial examination, Maryland's oyster trade appears head and shoulders above that of any other locality.

But when a comparison is made of the percentage of capital returned as income, instead of Maryland's heading the list as would be supposed, she actually brings up at the bottom, her industry returning a smaller income than any other State in the Union. Though the area of the oyster ground is about 400,000 acres, the yield per acre is only 40 bushels, while at the North

it is fully three times as much. Such a condition of affairs appears bad enough; but unless some such measures as I have suggested are undertaken matters will soon be worse. If the people are left to themselves, they will, in their ignorance, give us only another instance of exhausted beds and destroyed industry.

Unless they can be convinced of the folly of their present course we will have but a repetition in the Chesapeake of the experience in Long Island Sound.

The natural oyster of marketable size will disappear, and only a small "seed" oyster will be left. The goose will be killed; the golden eggs will be laid no more. And the vast fleet of pungies and canoes, and multitudes of men and women will have no employment beyond picking out the pin feathers of the inanimate carcass.

In the examination of one of the largest beds in Pocomoke Sound, I found that the shells represented 97 of the product; in other words, I had to get about fifty bushels of shells before I could get one bushel of oysters.

Prof. Ryder. I have listened to Dr. Hudson, Prof. Goode, and Lieut. Winslow with a great deal of interest, and it seems to me that all the data furnished in their papers point in the same direction, but I cannot but believe that artificial oyster-culture still holds out to us some little hope of success. I have lately read a recent paper by M. Bouchon-Brandely in which he makes the following remarkable statement: "It is to the French investigators that we are indebted for the first advances and experiments in artificial oyster-culture." That includes, I presume, the development of the methods of artificial oyster-culture, or rather of artificial fertilization as applied to oyster-culture. And I take this occasion before the American Fish Cultural Association to make a reclamation in favor of American investigators, and especially Prof. Brooks, of Johns Hopkins University, in whose footsteps I and several others have trodden, and particularly in our work along the Chesapeake bay. We have succeeded in confining the spawn of the American oyster in arti-

ficial ponds, so as to develop the fry to that point in their life-history at which they can be transferred from the fertilizing pans or dishes to parks, and there placed under such conditions as will enable them to grow into adult oysters. I do not mean to insist that the American methods of confining the oyster spat are of paramount importance, but I do assert that we were the first to practically apply any methods, or to devise suitable apparatus for such experiments. In the pamphlet to which I have referred, there is described a machine in which the embryo are confined and in which the water is kept in continuous circulation. That machine was devised and operated by Colonel McDonald in 1882. I believe that Lieutenant Winslow, in association with Professor Brooks operated a similar machine about the same time. Both of these experiments were successful, I think, in getting the fry attached within about twenty-four hours after artificial fertilization. So much for the facts. Subsequently, or about a year later, I carried on some experiments at Stockton, Maryland, following out on a larger scale the methods which I had devised in 1880, in order to confine the artificially fertilized eggs with the result of getting spat from artificially fertilized eggs. The method of confining the fry is simple, and merely involves the use of a diaphragm of sand through which the tide may ebb and flow automatically, and thus renew the water in the inclosure. It is evident that such a diaphragm might be utilized to confine the larvæ which are thrown off from the beds, and which are confined to coves or areas with restricted months: in other words, that there are a great many places (as indicated on the maps in this hall, prepared by Lieut. Winslow) in which diaphragms might be constructed on a very simple plan, but upon a larger scale, and by means of which we could actually confine the spawn and prevent it from escaping from the areas, whilst we would provide in those same waters clean "cultch" to which the spat could adhere.

The history of the attachment of the spat has been worked out very carefully by Professor Huxley and myself, for both the American and European species. The papers in which these matters have been discussed may be found in the *English Illustrated Magazine* for 1883, and in the Bulletins and Reports of the

United States Fish Commission for 1881 and 1882. So that I think that purely artificial methods, as applied to the cultivation of oysters in this country, are not altogether without indications of success in the near future.

Lieut. WINSLOW: I did not mean that the artificial propagation of the oyster might not in the future be brought to some practical issue. I only stated that it had not yet been. But while the process of raising oysters by artificially fecundating the eggs of the female, will not, probably, soon be made a matter of economic importance, the study of the embryonic life of the oyster will certainly be of great value to oyster-culturists in the future. For instance, the usual method of the oyster farmer is to deposit in the spring or late winter months, a certain number of "spawners" or mature oysters. After those oysters have lain on the ground three or four months and the spawning season has approached, vast quantities of shells or other suitable "cultch" are scattered in the vicinity, for the young fry to fasten to. Now it is of the utmost importance that this "cultch" should be clean, and consequently the later it is thrown overboard the better, as the deposit of sediment is thus avoided. But care must be used not to wait too long, else the time when the fry attach will be passed. Now as every oyster-man knows where an oyster is spawning, if, through the study of the embryological life of the animal, we could tell him just how much time elapses between the spawning and the attachment, we would provide him with information of great practical value. For reasons such as I have just recited, I think embryological work in this direction desirable. Possibly we may also make oyster raising through the artificial impregnation of eggs a matter of practical importance, but so far as my experience goes, I am inclined to doubt any such consummation, desirable though it may be.

Prof. RYDER: The results of my own experiments and observations in this matter are I think of some value. I have found by more recent study of spat which I obtained in vast abundance at Buzzard's bay that after the fry-shell had grown to the dimensions of 1-90 inch or about four times the size of the fry-shell

when it first affixes itself, there was proof that the fry-shell had been attached to the surface of fixation for a considerable time before the spat-shell was formed, and that the fixation of the fry-shell was continuous with the fixation of the spat-shell, which may last until the diameter of the lower valve is nearly two inches. I take it that the fixation occurs in from 24 to 72 hours. There is, however, this fact opposed to it. I have found embryo oysters not larger than 1-250 inch, still free; that is about twice the size of the larvæ oysters ordinarily observed in our waters or obtained by artificial fertilization. These large free oyster larvæ were obtained from the stomach of adult oysters.

Prof. GOODE: It seems to me that, from what we have to-day heard from Dr. Hudson, Lieut. Winslow, and Professor Ryder, we cannot fail to see what no doubt we have all partially realized before, namely, that there is a great cause for alarm as to the future of the oyster fisheries. I have already stated that the natural oyster-beds of Europe have become almost extinct, except as a source of seed for private cultivation, and it seems as if our own beds were becoming similarly destroyed. I think that Professor Ryder has not in the least overstated the importance of the artificial culture of the oyster, as developed by himself and others. One of the most striking events connected with the participation of the United States in the fishery exhibition at London last summer, was the receipt of a telegram from Professor Baird, stating the results of Professor Ryder's work at Stockton, Maryland. The substance of the telegram was printed in one of the English papers, and in less than a week it had been reprinted in at least 5,000 papers. Letters began pouring in from Russia, Denmark, Holland and Scotland, asking for details, and the general enthusiasm over the matter was indeed astounding.

Some of the recommendations which Lieut. Winslow has made with reference to the encouragement on the part of the Government by the establishment of model farms, are of great importance, as also are many of the other suggestions which he made. It seems desirable that the United States should carry out that system, as has been done at St. Jerome, Maryland. I think that a

special obligation of this Association is to utter a word of warning to this country that unless something is done very soon, a portion, at least, of the oyster grounds in some of our States will be as worthless as some of those of the European countries have already become. And it appears to me that we ought to put forth some official utterance in the matter, which shall be quoted in legislative houses as the deliberate opinion of this body of men, which includes all who have given any attention to the subject of fish-culture. I therefore move that a committee be appointed by the president of the Association to report before the close of the session, some resolution which shall express the opinion of the Society as to the necessity of protecting our oyster-fisheries by legislation by artificial propagation, and by all other possible means.

Mr. Blackford: I second the motion, and believe this matter to be one of the most important that could come before this meeting. I am of the opinion that such a resolution, going out at this time from the Association, would have a great effect upon the action of the State legislatures, some of which are now considering the propriety of taking some measures for the protection of the oyster industry—especially New York.

The President: It is moved and seconded that a committee be appointed by the president, to report as soon as possible, as to what steps shall be taken by this Association to warn the different States in regard to the oyster depletion. I will appoint for that committee, Messrs. Goode, Winslow and Ryder.

NATURAL CAUSES INFLUENCING THE MOVEMENTS OF FISH IN RIVERS.

BY MARSHALL MC'DONALD.

If we will consider for a moment the varieties of conditions that concur in and modify agricultural production, we will be better prepared to appreciate the multiple influences that enter into the question of maintaining and increasing the production of our fisheries.

The farmer of to-day has a guide in the conduct of the practical operations of agriculture, the collective experience of all who have preceded him. The observations of many generations condensed in proverb and apothegm, and handed down from father to son, gives to the unlettered peasant the interpretation of natural signs, the forecast of seasons and the empirical rules by which he tills and sows and garners the unequal harvests, which the unequal seasons bring.

Less than a century ago, chemistry allying herself with agriculture, laid the foundation of rational methods, and since then chemists and botanists, physicists and physiologists, have been busy with their investigations, each contributing in some essential particular to the solution of the important problem of increasing and maintaining the fertility of the soil.

In those countries, like England for example, where the results of scientific investigations have been formulated into rules of practice, the average production of cereals per acre now exceeds two-fold, and often three-fold, the average production per acre two hundred years ago.

This result has been accomplished in the face of an intensive system of cropping, which long ago would have rendered the fertile fields of England unproductive moorlands, or barren wastes, but for the lessons taught by chemists in its application to agriculture, and appropriated and applied in practice.

Just in proportion as man has learned to dominate the conditions which influence agricultural production, he has been enabled to raise the average yield per acre ; but, unequalities of

production from year to year, resulting from the influence of natural conditions beyond his control, still persist.

Confronted with those adverse influences, all the toil of the husbandman, all his stores of experience, all the resources of science, are powerless to avert scanty harvests, or absolute failure of crops.

What is true of agriculture is equally true of aquiculture, and more particularly of pisciculture in rivers.

The restoration and maintenance of our river fisheries depends upon our ability to promote conditions favorable to production, and exclude those which are adverse.

First—The seed of the future harvest must be sown. Where, in consequence of the interference of man by excessive fishing, or by the destruction of spawning grounds, natural agencies are inadequate to produce the young fish in numbers sufficient to repair the inroads made by capture or by natural casualties, we must supply the deficiency by artificial propagation.

But the breeding and planting of shad or herring by the million or tens of millions, in an area like the Potomac or the James, or the Susquehannah rivers, cannot carry the annual product of the fisheries in these rivers beyond a certain maximum limit, which is defined, first by the extent of the breeding and feeding area acceptable to the fish, and second by the abundance of food for the fry which is to be found in this area.

Second—The extension of the breeding and feeding areas to their natural limits, by providing practical passes for our anadromous fishes over the artificial or natural obstructions which have contracted these areas, is a second essential condition to be fulfilled, and is one of equal or even greater importance than the artificial propagation and planting of the fry, because it is possible by this means to secure the permanent restoration of our river fisheries under natural conditions.

A third condition, exercising an important influence upon the permanence of our river fisheries, has only recently attracted attention, and offers an inviting and important field of investigation.

We may plant the young of shad or herring in our rivers in countless millions, we may extend the breeding and feeding

areas to their natural limits, but if the agency of man has so modified the natural conditions that the proper food of the young fish during their river life is no longer found, or occurs in much less than the necessary abundance, then the effort to increase the supply by artificial propagation and planting will prove a dismal failure.

How far the pollution of our rivers by sewerage, gas tar, refuse chemical products, etc., has changed the original conditions of our rivers, is a matter inviting exhaustive and critical investigation.

Fourth—A rational code of laws, relating to the fisheries, may exert an important conservative influence, by imposing such restrictions upon the time and methods of capture, as will permit some considerable portion of the shad and herring which enter our rivers, to reach their spawning grounds and deposit their eggs without molestation.

By the observance and enforcement of the conditions above indicated, we may reasonably expect to greatly increase the average annual production of our river fisheries, but we can never hope to eliminate great unequalities in the product of the fisheries in different seasons.

Natural conditions, apparently beyond the control of man, will determine disastrous and discouraging failures one season, and the next a teeming abundance in the same river.

The influence of water temperatures, in determining the presence or absence of certain species of fish in certain areas of water, has been observed both in regard to the ocean and the river species which are the object of commercial fisheries. Observation of water temperature and its relations to the migrations of fish, have not been continued long enough to justify us in formulating conclusions, but the drift of investigation and observations goes to show that there is for each species a normal temperature in which it prerers to be, and that its migrations are determined by the shifting of these areas of congenial temperature under the influence of the seasons.

Observations, now continued for several years, have led to the conclusion that, in the case of the shad, the normal temperature, toward which it is ever moving, is about 60 degrees, Fahr.

The data upon which this conclusion is based are as follows:

First—The shad make their appearance in the St. Johns river, Florida, as soon as the temperature of the river falls to 60 degrees, or thereabouts, which takes place from the middle of November to the 1st of December. At this time the river is colder than the ocean plateau outside, and the movements or migration is from warmer to cooler areas in the direction of the normal temperature of 60 degrees.

Second—The shad which are spawned in the Potomac in April, May and June, remain in the river all summer. Schools of them may be frequently seen in the river in front of Washington. They continue abundant until the latter part of October or 1st of November. When the temperature falls below 60 degrees, they begin to drop down the river in their migrations seaward. In this case they are moving from cooler to warmer waters and toward the normal temperature of 60 degrees.

Third—The beginning of the spring run of shad into the Potomac river is about coincident with the date when the river temperature rises above that of Chesapeake bay. In this case, too, the shad are moving from cooler to warmer waters, and in the direction of the normal temperature of 60 degrees, for the temperature of both bay and river is at the beginning of the season always below 60 degrees.

It will be seen, therefore, that wherever we have been able to intercept the shad in its migrations and place it under observation, it is always moving in the direction of the normal temperature of 60 degrees.

Assuming it to be true as a general fact that the shad in their ordinary migrations are ever traveling on temperature paths which lead to the normal temperature of 60 degrees, it becomes possible to determine the law, the rate, and the limit of their movements in a certain area, by tracing the shifting of the areas of congenial temperature under the influence of the seasons.

The data for the discussion are furnished by the records of observations of water temperatures, made at the lighthouses by the direction of the Lighthouse Board, and at Washington by an employee of the United States Fish Commission.

The three stations selected for comparison of ocean, bay and

river temperature are (1) Winter Quarter Shoals for the ocean plateau, (2) Wolf-trap Light for Chesapeake Bay, and (3) Washington, D. C., for the Potomac River.

The station at Winter Quarter Shoals is up the coast about forty miles north of Cape Charles, and is about eight miles from shore. It is close to the edge of that cold Arctic current which wedges itself down between the Gulf Stream and the shore, and, bringing with it the temperature of Arctic latitudes, builds a wall of minimum temperature beyond which the shad probably never pass in their migrations.

The only records of bay temperature available for the season of 1881 were the signal service observations in Norfolk Harbor. These records, which give the temperature of Elizabeth river rather than the bay, indicate more rapid fluctuations than is possible in the general temperature of the bay, and give a daily range of temperature several degrees higher than that of the bay.

This correction I have approximately applied in the discussion of the temperature observations of 1881, in order to bring them into harmony with the observations of bay temperature for 1882 and 1883, which were made by observers at Wolf-trap Light.

This locality is on the west shore of the bay, half way between the Rappahannock and York rivers, and being well off from the shore, little influenced by local variations, the temperatures taken here may therefore be taken to represent the general temperature of the bay waters for corresponding dates.

The result of the study of the data above indicated are graphically presented in the three outline maps of the Chesapeake and Delaware basins, illustrating the movements of the areas of congenial temperatures under the influence of the seasons, and in the chart showing the relations between the temperatures of the Potomac river during the fishing seasons of 1881, 1882 and 1883, and the fluctuations in the shad fisheries of the rivers for the same period.

(The rest of Col. McDonald's remarks were oral and with reference to the maps and charts exhibited.)

The conclusions deducted by him from the discussion of the data presented were as follows:

The temperature records of 1881, '82 and '83 indicate that for the winter months the area of maximum temperature is not in the rivers or in the bay, but on that ocean plateau outside, extending from the capes of the Chesapeake to the Delaware breakwater. The presumption, therefore, is that the schools of shad belonging to both the Chesapeake and the Delaware, have their common winter quarters on this plateau. When under the influence of the advancing seasons the waters of the Chesapeake and the Delaware bays become warmer than on this plateau, the migrations into continental waters begin. The proportion of the entire run that will be directed to the Delaware or the Chesapeake, will be determined at this time. If the northern end of the area warms up more rapidly than the southern, then an unusual proportion of the shad will be thrown into the Delaware. On the other hand, cold waters coming down the Delaware, may effect a contrary movement, and throw the schools of shad almost entirely into the Chesapeake; thus leading to a partial or total failure of the the shad fisheries of the Delaware for the season.

When the schools of shad have entered the Chesapeake, their distribution to the rivers will be determined in the same way by temperature influences operating. If the season is backward, so as to keep down the temperature of the larger rivers which head back in the mountains, then the run of shad will be mainly into the shorter tributaries of the bay, which have their rise in the tide-water belt, and which, of course, are warmer at this season than the main rivers.

Again, warm rains at the beginning of the fishing season in our large rivers, and the absence of snow in the mountains, will determine the main movement of the shad into the larger rivers of the basin; and if, when the schools enter the estuaries of these rivers, they encounter a temperature considerably higher than that in the bay itself, the movement up the river will be tumultuous; the schools of shad and herring all entering and ascending at once, producing a glut in the fisheries such as we sometimes have recorded.

It follows, therefore, in the light of these facts, that we may have a successful fishing on the Delaware, accompanied by a total or partial failure in the Chesapeake area, and *vice versa;* and considering the Chesapeake area alone, we may have a very successful fishery in the aggregate, yet accompanied by partial or total failure in particular streams under the influence of temperature conditions, as above indicated. Statistics of the shad fishery, if they are to furnish a measure of increase or decrease, must include the aggregate catch of the Chesapeake and Delaware rivers and indeed of the rivers much further to the north. Statistics based upon a comparison of the catch in the same river in different seasons, are of no value as serving to give a measure of the results of artificial propagation.

THE AFTERNOON SESSION.

At the afternoon session the President asked if the Committee on Nominations was ready to report.

Professor GOODE: Your committee has nominated:

For President, Hon. THEODORE LYMAN, M. C., Massachusetts.
For Vice-President, Colonel MARSHALL MCDONALD, Virginia.
For Treasurer, Hon. E. G. BLACKFORD, New York.
For Corresponding Secretary, Mr. R. E. EARLL, Illinois.
For Recording Secretary, Mr. FRED MATHER, New York.

As members of the Executive Committee:

Mr. JAMES BENKARD, New York.
Mr. GEORGE SHEPARD PAGE, New Jersey.
Mr. BARNET PHILLIPS, New York.
Prof. G. BROWN GOODE, Connecticut.
Dr. WILLIAM M. HUDSON, Connecticut.
Mr. S. G. WORTH, North Carolina.

These nominations were formally carried.

The PRESIDENT: I would like to suggest to the gentlemen of the Executive Committee, and also to the officers for the ensuing year, that during the present meeting there be held a conference for consultation. We are sadly in need of rules and regulations, and have no order of business, and I think it desirable to move in this matter as our Association is rapidly growing in size and importance.

THE CHEMICAL COMPOSITION AND NUTRITIVE VALUE OF OUR AMERICAN FOOD FISHES AND INVERTEBRATES.

BY W. O. ATWATER.

At the meetings of the American Fish-Cultural Association in 1880 and 1881, I had the pleasure of presenting some brief statements of the results of an investigation of the chemistry of fish and marine invertebrates, which has been going on for some years past in the chemical laboratory of Wesleyan University, under the auspices of the United States Fish Commission and the Smithsonian Institution.

Since the papers referred to were presented to the Association, the investigation has been continued so as to include chemical analyses of the flesh of some one hundred specimens of food-fishes, embracing fifty-one species, and sixty-four specimens of invertebrates, oysters, lobsters, etc., embracing eleven species, making in all one hundred and eighty-two specimens of sixty-two species.

Besides the analyses, the range of the investigation has been extended so as to include two other, but closely related, topics. One of these is the digestibility of the flesh of fish as compared with that of mammals used for food, *e. g.*, beef, mutton, etc. The other line of research is more purely chemical, and consists in the study of the constitution of the compounds of which the tissues of the fish are composed.

Along with the analyses of food-fishes and invertebrates, a parallel series of analyses of other food materials, animal and vegetable, has been undertaken at the instance of the United States National Museum, to furnish data for illustrating its food collection. The results are, of course, valuable in connection with our present subject, as we need to know not only the composition and nutritive value of fish, but, also, how they compare in these respects with other materials used for food.

The report of the United States Fish Commission for 1880, contained accounts of some of the earlier portions of the investigation. I hope a detailed account of the work up to the present may be printed soon. Meanwhile I desire to lay before the Fish-Cultural Association some of the more important results, in so far as they bear upon the nutritive values of the food-fishes and invertebrates that have been studied.

Inasmuch as these statements may come under the notice of some who are not entirely familiar with the later results of the investigation of the laws of nutritive values of food materials, and how they are most economically utilized, a few explanations may be in place. These will be the more appropriate, because late investigation is tending to decide some disputed questions regarding the ways in which food is used in the body, and because many of the statements which go the rounds of the papers and still linger even in current works on physiology and chemistry, are shown by the researches of a few years past to be misleading, and in too many cases, decidedly incorrect. I may, perhaps, be pardoned therefore if the statements which follow contain some slight repetition of those made in papers previously presented to the Association.

THE NUTRITIVE VALUES OF FOODS.

It is a striking fact that while the chief item of the living expenses of the majority of civilized men is the cost of their food, even the most intelligent know less of the actual value of their food than of any other of the important articles they buy. It makes but little difference to the man with $5,000 per annum, whether he pays fifteen cents or five dollars per pound for the

protein of his food, provided it pleases his palate. But to the humble housewife whose husband earns but $500 a year, it is a matter of great importance, and she is very apt, after hesitating at the dry-goods store between two pieces of calico for her daughter's dress, and taking one at ten cents a yard for economy's sake, though the one at eleven was prettier, to go to the grocer's, the butchers, or the fish-dealer's, and pay a dollar a pound for the nutrients of her children's food, when she might have obtained the same ingredients, in forms equally wholesome and nutritious, for fifty or even twenty cents. She will continue this bad economy until she obtains a general idea of the actual cheapness and dearness of foods, as distinguished from their price.

A pound of lean beef and a quart of milk both contain about the same quantity, say a quarter of a pound, of actually nutritive material. But the pound of beef costs more than the quart of milk and it is worth more as a part of a day's supply of food.

The nutritive materials or nutrients, as we call them, in the lean meat, though the same in quantity as in the milk, are different in quality, and of greater nutritive value. Among the numerous branches of biological research, one, and by no means the least interesting and important, is the study of foods and nutrition. Within the past fifteen years especially, a very large amount of scientific labor has been devoted to the investigation of the composition of foods and the function of their ingredients in the animal economy. Indeed, very few persons this side of the Atlantic have any just conception of the magnitude of this work and its results. And, though the most important problems are still unsolved, and must, because of their complexity, long remain so, yet enough has been done to give us a tolerably clear insight into the processes by which the food we eat supplies our bodily wants.

The bulk of our best definite knowledge of these matters comes from direct experiments, in which animals are supplied with food of various kinds, and the effects noted. The food, the excrement, solid and liquid, and in some cases the inhaled and exhaled air, are measured, weighed and analyzed. Many trials have been made with domestic animals—horses, oxen

cows, sheep, goats and swine—with dogs, rabbits, birds and the like, and a large number also with human beings of both sexes and different ages. In the philosophical planning of the researches, in the ingenuity manifested in devising apparatus, in accuracy, thoroughness, patience, and long continuance in the work, as well as in the distinguished genius of many of the workers, chemico-physiological science has assumed the highest rank among the sciences of our time; with the rest it has brought us where we can estimate the nutritive values of foods from their chemical composition, with so near an approach to accuracy that in Germany, where the best research is done, tables, giving in figures, the composition and nutritive valuations of foods, have been prepared by eminent chemists and physiologists, and are coming into general use among the people.

We eat meat and fish, potatoes and bread, to build up our bodies, to repair their wastes, and to supply them with fuel for the production of heat and muscular force.

Of the meat my butcher sends me, the fish I find in the market, the bread and the other food upon my table, only a part serves to fulfill these purposes. The bone of our roast beef we do not use for food at all, and that of shad is worse than useless because of the bother it makes us to get rid of it; it is only the edible portion that is of actual value to us as food, the rest being merely refuse. And when we come to consider the edible portion, the meat freed from bone and gristle, the flesh of the fish, or the flour as it is baked in bread, we find that these consist largely of water. And although water is indispensable, that in the meat or the potatoes on my table is of no more valuable for the support of my body, than the same amount in milk or in the glass of water by my plate.

Leaving out of account, then, the refuse and the water, we have remaining the nutritive material of our food. This consists of different materials which we may call nutrients. We may divide them into four classes: protein, fats, carbo-hydrates and mineral matter, or ash. Let me speak briefly of some of the characteristics of these classes of nutrients.

Protein.—The terms protein, proteids, and albuminoids, are applied somewhat indiscriminately, in ordinary usage, to several

or all of certain classes of compounds charcterized by containing carbon, oxygen, hydrogen, and with them, nitrogen. The most important are the proteids or albuminoids, of which albumen, the white of egg, fibrin of blood, casein of milk, myosin, the basis of muscle, and gluten of wheat, are examples. Allied to these, but occurring in smaller proportions in animal tissues and foods, are the nitrogenous compounds that make the basis of connective and other tissues. Gelatin is derived from some of these tissues, and may be taken as a type of the compound of this class. As these constituents are of similar constitution and have similar or nearly similar uses in nutrition, it is customary to group them together as protein.* What we should especially bear in mind, then, is that protein is a term applied to the nitrogenous constituents of our foods, and we shall see these are, in general, the most important, as they are most costly, of the nutrients.

Fats.—We have familiar examples of these in the fat of meat, (tallow, lard,) in the fat of milk which makes butter, and in olive, cotton seed, and other animal and vegetable oils. The fats consist of carbon oxygen and hydrogen and contain no nitrogen. In nutritive value, as in cost, they rank next to the protein compounds. For some of the nutritive functions, indeed, the fats equal or exceed protein in importance.

Carbo-hydrates—Starch, cellulose, (woody fiber) sugar, and inoosite, ("Muscle sugar") and other similar substances are called carbo-hydrates. Like the fats, they consist of carbon, oxygen and hydrogen, but they have less carbon and hydrogen, and more oxygen than the fats.

Mineral matters or Ash.—When vegetable or animal matters are burned, more or less incombustible material remains as ash. The ingredients which make the ash are called mineral matters, or sometimes, salts. They are for the most part compounds of the elements, potassium, sodium, calcium and iron with chlorine, sulphuric acid and phosperic acid. Sodium combined with chlor-

* The muscular tissues of animals, and hence the lean portions of meat, fish, etc., contain small qualities of so-called nitrogenous extractives—creatin, carnin, etc., contained in extract of meat, etc., which contribute materially to the flavor, and somewhat to the nutritive effect of the foods containing them. They are not usually deemed of sufficient importance, however, to be grouped as a distinct class in tabular statements of the composition of foods.

ine forms sodium chloride, common salt. Calcium with phosphoric acid forms calcium phosphate or phosphate of lime, the mineral basis of bones.

Our bodies contain scores of compounds, many of which can not be included in either of the above four classes. But the bulk of the compounds in the bodies of animals, as well as in the food by which they are nourished, are either water or some material which we may call protein, fats, carbo-hydrates, or mineral matters.

Animal foods, as meats, fish, etc., contain but little of carbo-hydrates, their chief nutrients being protein and fats. Milk, however, and some shell fish, as oysters, scallops, etc., contain more or less of carbo-hydrates. Vegetable foods, as wheat, potatoes, etc., contain less protein and consist largely of starch, sugar, cellulose, and other carbo-hydrates, though nearly all contain more or less of fats.

THE FUNCTIONS OF THE NUTRIENTS.

These different nutrients as we have seen, have different offices in nourishing the body, in building up its tissues, repairing its wastes, and serving as fuel to produce animal heat, and muscular and intellectual energy. Just what is done by each class, exactly how they are transformed and used in the body, is not yet fully known. Still we have to-day a tolerably fair idea of the principal parts played by each class of nutrients.

According to views formerly held and frequently met with, still, the protein compounds were regarded as the "flesh-formers" and the sources of muscular energy, while the carbo-hydrates and fat were looked upon as "fat-formers" and "heat-producers." A vast deal of painstaking research, however, has shown that these distinctions were not correctly drawn. The albuminoids are flesh-formers, it is true; indeed, according to the nearly unanimous testimony of the most trustworthy experiments, flesh, *i. e.*, muscular and other nitrogenous tissue, is made from the nitrogenous constituents of the food exclusively. But the balance of testimony is decidedly against the production of muscular energy exclusively or mainly, by nitrogenous com-

pounds. Each of the three groups of nutrients probably shares, directly or indirectly, in the production of muscular force. So, too, it appears that the combustion which produces animal heat is not confined to the carbo-hydrates and fats, but the protein compounds, or the products of their decomposition, are also used for this purpose. Again, the production of fat in the body was formerly ascribed to the fats and carbo-hydrates alone. On the other hand some physiologists maintain that the carbo-hydrates cannot be transformed into fats, and that a very large part of the fat of the body is formed from the disintegration of the albuminoids. The weight of evidence to-day is decidedly in favor of the assumption that all three of the great classes of nutrients in our foods—the albuminoids, the carbo-hydrates, and the fats—are transformed into fat, and that the fat thus formed is consumed, either before or after being stored as body-fat.

It appears, then, that protein is the most important constituent of our food, because, while it performs the functions of each of the other two chief nutrients in being transformed into fat and in being consumed for fuel, it has a most weighty office of its own in forming the basis of the blood and in building up the muscular and other nitrogenous tissues, an office which no other nutrient can perform at all. And, as we shall see further, in examining the pecuniary cost, protein is the dearest as well as the most important of the ingredients of foods.

Next in physiological importance to protein come the fats. They lack the nitrogen of the protein and cannot do the work of protein in forming nitrogenous tissue, making blood, muscle, etc. But they are very rich in carbon and hydrogen, more so than either protein or carbo-hydrates, and hence they have a very high value for fuel, to supply heat and probably muscular force. And in pecuniary cost as well as in physiological importance they rank between protein and carbo-hydrates.

The carbo-hydrates stand lowest in the scale of physiological importance and are pecuniarily the least expensive. Nevertheless it would be wrong to class the carbo-hydrates of food as on the whole of minor importance. They have a most important use in taking the place of protein and fats and protecting them from being consumed, just as the fats replace and thus save the

protein. The materials used for food by man contain, taken all together, more carbo-hydrates than fats or protein. The carbo-hydrates have their normal place in our food and we could not dispense with them. They are of inferior value to the protein and fats, in the sense that there is much of the work of food in the body which they cannot do as well as the protein and fats, and much more which they cannot do at all. But they do work which the scarcer and dearer protein and fats would otherwise have to do, and, furthermore, they occur in such large proportions, especially in vegetable materials which make the larger part of the food of man, that their actual importance is very great.

AMOUNTS OF NUTRIENTS REQUIRED FOR A DAY'S RATIONS.

Numerous attempts have been made to determine how much of each of the three principal classes of nutrients, protein, fats, and carbo-hydrates, is needed for a day's food for an individual, an adult or a child, at work or at rest. We know, in general, a man when hard at work requires more, because more is consumed in his body than the same man would when doing no work. But different men have different requirements, due to individual peculiarities, so that the best we can do is to take an average amount as expressing the need of an average man. By comparing the amounts of carbon, oxygen, hydrogen, and nitrogen, actually found by experiments to be consumed by different individuals, and also noting the amount and composition of the food consumed by different persons, estimates have been made of the quantities of the several nutrients by individuals of different classes under various conditions. Prof. von Voit, of the University of Munich, for instance, who has made more extensive researches upon this subject, perhaps, than any one else, computes that a fair daily ration for a laboring man of average weight, at moderate work, would need to supply: 4.2 ounces of protein; 2 ounces of fats; and 17.6 ounces of carbo-hydrates. Of course he may get on with less of either one, provided he has more of the others. But there is a minimum below which he cannot go without injury, and especially he must not have too little protein. He may have more protein and less carbo-hy-

drates or fats with no great harm, but with too little protein he will suffer, no matter how much carbo-hydrates his food may furnish.

If I have dwelt at some length upon this matter of the nutrients of foods and the ways they are used in our bodies, it is because it is extremely important to a proper understanding of our subject. And perhaps I can do no better than to recapitulate what I have said in the following tabular form.

NUTRIENTS OF FOODS.

1. *Protein Compounds:*—Contain Carbon, Oxygen, Hydrogen and Nitrogen.
2. *Fats:*—Consist of Carbon, Oxygen and Hydrogen.
3. *Carbo-hydrates:*—Consist of Carbon, Oxygen and Hydrogen.
4. *Mineral matters or Ash:*—e. g. Calcium, Potassium and Sodium, Phosphates and Chlorides.

Protein
- A. *Albuminoids or Proteids:* e. g. Albumen of Egg, Myosin of muscle (Lean of Meat), Casein of Milk, Gluten of Wheat.
- B. *Gelatinoids:* e. g. Collagen (which boiled, yields Gelatin).

Fats: e. g. Fats of Meat, Butter, Olive Oil, Oil of Maize and Wheat.
Carbo-hydrates: e. g. Starch, Sugar, Cellulose.

MEAN PERCENTAGE COMPOSITION.

	Protein Compounds.	*Fats.*	*Carbo-hydrates.*
Carbon	53.5 per cent.	76.5 per cent.	44.0 per cent.
Oxygen	22.5 " "	11.6 " "	49.6 " "
Hydrogen	7.0 " "	11.9 " "	6.4 " "
Nitrogen	16.0 " "		
Sulphur	1.0 " "		
	100.0	100.0	100.0

FUNCTIONS OF NUTRIENTS:

ie. Ways in which the nutrients are used in the body.

The Protein of food	forms the (nitrogenous) basis of blood, muscle, connective tissue, etc. is transformed into fats and carbo-hydrates. is consumed for fuel.
The Fats of food	are stored as fat. are consumed for fuel.
The Carbo-hydrates of food	are transformed into fat. are consumed for fuel.

AMOUNTS OF NUTRIENTS REQUIRED IN A DAY'S FOOD.

Minimum daily ration for laboring men at ordinary work.

Protein	*Fats*	*Carbo-hydrates*
118 grams (4,2 ounces).	56 grams (2 ounces).	500 grams (17,6 ounces).

The same experimental research which has revealed to us the ways in which our food supplies our bodily wants, has shown us how to estimate the relative nutritive values of different foods from their chemical composition. The estimates are only approximate, because the nutritive effects are influenced by various conditions, some of which research has not yet been definitely explained, while others vary with the nature of the food or the user, so that the value of a given food in a given case may vary from the standard set by the analysis. These sources of uncertainty are nevertheless so narrowed down by late investigation, and the errors confined within such limits, that by intelligent use of the facts at our disposal, we may judge very closely from the chemical composition of a food, what is its value as compared with others of the same class, at any rate, for our nourishment.

CHEMICAL ANALYSIS OF FOODS.

We are now ready to consider the amounts of the different ingredients, nutrients and non-nutrients, in fish and other foods. Perhaps I can illustrate this in no better way than by an actual example. A sample of beef, sirloin, of medium fatness, was found by analysis in our laboratory, to consist of about one-fourth bone and three-fourths flesh, edible substance. The flesh was analyzed and found to contain, nearly: water, 60 per cent.; protein, 19 per cent.; fats, 20 per cent.; mineral matter, 1 per cent. Calculating upon the whole sample of meat, which one-fourth, or twenty-five per cent., was bone and other refuse, and 75 per cent. flesh, the analysis would stand as in the following table, in which the composition of the flesh by itself and that of the meat, bone, and all, are both given:—

	In flesh, edible portion.	In meat as bought including refuse.
	Per cent.	Per cent.
Refuse, bone, etc.	None.	25
Water	60	45
Protein	19	14¼
Fat	20	15
Mineral matters	1	¾
Total	100	100

This very imperfect analysis may be stated in the following form, as is done in the tables beyond:

The tables beyond contain also columns for carbohydrates, etc., which occur in milk and in some shell-fish, but are not found in ordinary meats in sufficient amount to warrant their insertion in such tables as these.

CONSTITUENTS OF SAMPLE OF BEEF—SIRLOIN.

FOOD-MATERIAL.	In Edible Portion— i.e., flesh freed from bone and other refuse					In Meats as purchased— including both edible portion and refuse.					
	Water.	Nutrients.	Nutrients.			Refuse: Bones, etc.	Edible portion.				
			Protein.	Fats.	Mineral matters		Water.	Nutrients.	Nutrients.		
									Protein.	Fats.	Mineral matters
	Per ct	Per ct	Per ct	Per ct	Per ct	Per ct	Per ct	Per ct	Per ct	Per ct	Per ct
Beef, sirloin, medium fatness	60	40	19	20	1	25	45	30	14.3	15	0.7

I think that with the above illustrations the following tables, illustrating the composition of fish and other animal and vegetable foods will be plain.

Table I gives the composition of a number of specimens of the flesh of fish and invertebrates, *i. e.*, the edible portion freed from bone, skin and other refuse.

Table II gives the composition of the specimens as actually found in the markets including both refuse and edible portion.

Table I is the more interesting from the chemical and physiological standpoint, but Table II is more useful, practically, since it shows how much of the several nutrients we actually get in the materials as we buy them.

Table III gives the composition of a number of our more common vegetable food materials.

Table IV includes a smaller number of the analyses of fish, but gives other animal foods, meats, dairy products, etc., for comparison. The composition of edible portions and of the materials as found in the markets are both given together.

I ought to say with regard to all the figures in the tables, that they are based upon too few analysis to allow them to be entirely satisfactory. It is only a short time since analysis of American meats, fish, etc., have been undertaken in any considerable number, and those as yet accomplished are far from

sufficient for a complete survey of the subject. Indeed, the work already done can be regarded only as a beginning. Still, the figures will give a tolerably fair idea of the composition of the articles named.

The analysis of animal food, the tables with the exception of a few from European sources and indicated by italics, are selected from the results of the investigation of which I have spoken as conducted under the auspices of the Smithsonian Institution and the United States Fish Commission, and are almost the only ones as yet attempted in this country. Those of vegetable foods are in part from the investigation, and in part from other sources.

TABLE I.

Percentages of Water and Nutritive Ingredients in Flesh, Edible Portion.

(Freed from Bone, Shells and other Refuse Matters)
OF FOOD FISHES AND INVERTEBRATES.

Specimens of flesh of Fish and of edible portion, (flesh and liquids) of Oysters, etc., were found to contain water and nutritive substances, as below. The figures represent parts in 100 by weight. Protein x Fats x Carbo-hydrates, etc. x Mineral Matters = Nutrients. Nutrients x Water =100.

KINDS OF FOOD FISHES AND INVERTEBRATES.	WATER.	NUTRIENTS.	NUTRIENTS.			
			PROTEIN.	FATS.	CARBO-HYDRATES, ETC.	MINERAL MATTERS.
FRESH FISH.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Alewife	73.0	27.0	19.5	6.0	.....	1.5
Black Bass	76.7	23.3	20.4	1.7	.....	1.2
Bluefish	78.5	21.5	19.0	1.2	.....	1.3
Cod	82.6	17.4	15.8	0 4	.....	1.2
Eel	71.6	28.4	18.3	9.1	.....	1.0
Lamprey Eel	71.1	28.9	14.9	13 3	.....	0.7
Flounder	84.2	15.8	13.8	0.7	.....	1.3
Haddock	81.7	18.3	16.8	0.3	.....	1.2
Halibut	75.4	24.6	18.3	5.2	.....	1.1
Herring	69.0	31.0	18.5	11.0	.....	1.5
Mackerel, rather lean	78.7	21.3	18.1	2.2	.....	1.0
" fat	64.0	36.0	18.2	16.3	.....	1.5
" average	73.4	26.6	18.2	7.1	.....	1.3
Yellow Perch	79.2	20.8	18.7	0.8	.....	1.3
Pike Perch	79.7	20.3	18.4	0.5	.....	1.4
Pickerel. (Pike)	79.7	20.3	18.6	0.5	.....	1.2
Salmon. In season, fat	61.4	38.6	24.2	13.0	.....	1 4
" "Spent" lean	79.2	20.8	17.6	2.0	.....	1 2
Shad	70.6	29.4	18.5	9.5	.....	1.4
Smelt	79.2	20.8	17.3	1.8	.....	1.7
Brook Trout	77.7	22.3	19.0	2.1	.....	1.2
Salmon Trout	69.1	30.9	18.3	11.3	.....	1.3
Whitefish	69.8	30.2	22.1	6.5	.....	1.6
PREPARED FISH.	Salt per cent					
Dried Cod. Boned and dried artificially	2.9	15.2	81.9	74.6	1.9	.....	5.4
Salt Cod. Salted and Dried	20.6	53.6	25.8	21.4	0.3	.....	4.1
Salt Mackerel. "No. 1 Mackerel" Salted	10.6	42.2	47.2	22.6	22.9	.....	2.6
Smoked Haddock. Salted, Smoked and Dried	2.1	72.6	25.3	23.6	0.2	.....	1.5
Smoked Herring. Salted. Smoked and Dried	11.7	34 5	53.8	36.4	15.8	.....	1.6
Canned Salmon. California (Oregon)	1.3	59.9	38.8	19.4	18.0	.....	1.4
Canned Fresh Mackerel	1.9	68.2	29.9	19.9	8.7	.....	1.3
Canned Salt Mackerel. "No. 2 Mackerel" Salted	10.3	43.4	46.3	17.3	26.4	.....	2.6
INVERTEBRATES. SHELL FISH, Etc.						
Oysters. Shell contents. Best (1)		83.4	16.6	6.4	1.7	6.5	2.0
" " " Inferior (1)		91.4	8.6	4.5	0.6	1.8	1.7
" " " Average (1). 34 samples		87.3	12.7	6.0	1.2	3.5	2.0
Oysters. Solids (2) Edible portion. Av'ge		87.2	12.8	6.3	1.6	4.0	0 9
Long Clams. Shell contents		85.9	14.1	8.2	1.0	2.3	2.6
Round Clams. " "		86.2	13.8	6.6	0.4	4.2	2.6
Mussels. " "		84.2	15.8	8.7	1.1	4.1	1.9
Scallops. Edible portion (Muscle)		80.3	19.7	14.7	0.2	3.4	1.4
Lobsters. " "		81.8	18.2	14.5	1.8	0.2	1.7
Crabs. " "		77.1	22.9	16.6	2.0	1.2	3.1
Cray Fish " "		81.2	18.8	16.0	0.5	1.0	1.3
Canned Oysters		85.2	14.8	7.4	2.1	4.0	1.3
Canned Lobsters		77.7	22.4	18.1	1.1	0.6	2.5

(1) In respect to quantity of nutrients.

(2) Shell contents as commonly sold, including whole of "solid" and most of liquid portion.

TABLE II.

Percentages of Refuse, Water and Nutritive Ingredients in specimens of Food Fishes and Invertebrates as found in the markets.

Samples of Fish—whole or dressed—and of Oysters, etc., including or freed from the shell, a ordiarily sold in the New York or Middletown, Conn. markets, were found to contain

1. Refuse—Bone. Shells, and other Inedible Matters.
2. Edible Portion—Water and Nutritive Substances.
3. Ingredients of Nutritive Substance, Nutrients—Protein, Fats, Carbohydrates, etc. ("Non-nitrogeneous Extractive Matters") and Mineral Matters in parts in 100 by weight, as below. (Nutrients x Water x Refuse = 100.)

Kinds of Food Fishes and Invertebrates, and Portions Taken for Analysis.	Refuse. Bone, Skin, Shells, etc.	Edible Portion.					
		Water	Nutrients.	Nutrients.			
				Protein.	Fats.	Carbohydrates, etc.	Mineral Matters.
Fresh Fish.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Alewife. Whole	49.4	36.9	13.7	9.9	3.0	.....	0.8
Black Bass. Whole	54.8	34.6	10.6	9.2	0.8	.....	0.6
Bluefish, Entrails removed	48.6	40.3	11.1	9.8	0.6	.....	0.7
Cod. Head and entrails removed	29.9	57.9	12.2	11.0	0.3	.....	0.9
Eel. Skin, head and entrails removed	20.2	57.1	22.7	14.6	7.3	.....	0.8
Lamprey Eel. Whole	45.8	38.5	15.7	8.1	7.2	.....	0.4
Flounder	66.8	27.2	6.0	5.2	0.3	.....	0.5
Haddock. Entrails removed	51.0	40.0	9.0	8.3	0.1	.....	0.6
Halibut. Sections of body	17.7	62.1	20.2	15.1	4.2	.....	0.9
Herring. Whole	46.0	37.3	16.7	10.0	5.9	.....	0.8
Mackerel. Rather lean. Whole	38.3	48.5	13.2	11.2	1.4	.....	0.6
Mackerel. Fat	33.8	42.4	23.8	12.1	10.7	.....	1.0
Mackerel. Average	44.6	40.7	14.7	10.1	3.9	.....	0.7
Yellow Perch. Whole	62.7	30.0	7.3	6.7	0.2	.....	0.4
Pike Perch. Whole	57.2	34.1	8.7	7.8	0.2	.....	0.6
Pickerel (Pike). Whole	47.0	42.2	10.8	9.9	0.2	.....	0.7
Salmon. In season, fat. Whole	38.5	37.6	23.9	15.0	8.0	.....	0.9
" "Spent" lean. Whole	46.2	42.6	11.2	9.5	1.0	.....	0.7
Shad. Whole	50.1	35.2	14.7	9.3	4.7	.....	0.7
Smelt. Whole	41.9	46.1	12.0	10.0	1.0	.....	1.0
Brook Trout. Whole	48.1	40.3	11.6	9.9	1.1	.....	0.6
Salmon Trout. Entrails removed	35.2	45.0	19.8	12.4	6.6	.....	0.8
Whitefish	53.5	32.5	14.0	10.3	3.0	.....	0.7
Prepared Fish.	Salt per cent						
Dried Cod. Boned and dried	2.9	.....	15.2	81.9	74.6	1.9	.....	5.4
Salt Cod. Salted and dried	15.4	24.9	40.3	19.4	16.0	0.4	.....	3.0
Salt Mackerel. "No. 1 Mackerel" salted	8.2	22.9	32.5	36.4	17.0	17.4	.....	2.0
Smoked Haddock. Salted, smoked and dried	1.4	32.2	49.2	17.2	16.1	0.1	.....	1.0
Smoked Herring. Salted, smoked and dried	6.5	44.4	19.2	29.9	20.2	8.8	.....	0.9
Canned Salmon. California (Oregon)	1.3	.....	59.9	38.8	19.4	18.8	.....	1.3
Canned Fresh Mackerel	1.9	.....	68.2	29.9	19.9	8.7	.....	1.3
Canned Salt Mackerel. "No. 2 Mackerel" salted	8.3	19.7	34.8	37.2	13.8	21.3	.....	2.1
Invertebrates, Shell Fish, Etc.							
Oysters. In shell. Inferior (1)	88.8	10.2	1.0	0.5	0.1	0.2	0.2
" " Best (1)	81.4	15.2	3.4	1.5	0.2	1.3	0.4
" " Average	82.3	15.4	2.3	1.0	0.2	0.6	0.5
" Solids. In shell. (2) Edible portion. Average	.....	87.2	12.8	6.2	1.5	4.1	1.0
Long Clams. In shell	43.8	48.3	7.9	4.3	0.5	1.3	1.8
Round Clams. "	68.3	27.3	4.4	2.1	0.1	1.3	0.9
Mussels. In shell	49.3	42.7	8.0	3.9	0.5	2.1	1.5
Scallops. Edible portion. (Muscle)	.....	80.3	19.7	14.7	0.2	3.4	1.4
Lobsters. In shell	60.2	33.0	6.8	5.4	0.5	0.2	0.7
Crabs. "	55.8	34.1	10.1	7.3	0.9	0.5	1.4
Crayfish. "	87.7	10.0	2.3	1.9	0.1	0.1	0.2
Canned Oysters	.....	85.4	14.6	6.4	1.6	5.1	1.5
Canned Lobsters	.....	77.7	22.3	18.1	1.1	0.6	2.5

(1) In respect to quantity of nutrients.

(2) Including solid and most of liquid shell contents as commonly sold.

TABLE III.

Constituents of Vegetable Foods and Beverages.

Kinds of Foods and Beverages.	Water.	Nutrients. Protein (Albuminoids).	Fats.	Carbo-hydrates etc.	Woody Fiber.	Mineral Matters.
FOODS.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Wheat-flour, average*	11.6	11.1	1.1	75.4	0.2	0.6
Wheat-flour, maximum*	13.5	13.6	2.0	78.5	1.2	1.5
Wheat-flour, minimum*	8.3	8.6	0.6	68.3	0.1	0.3
Graham-flour (wheat)	13.0	11.7	1.7	69.9	1.9	1.8
Cracked wheat	10.4	11.9	1.7	74.6		1.1
Rye-flour	13.1	6.7	0.8	78.3	0.4	0.7
Pearled barley	11.8	8.4	0.7	77.8	0.3	1.0
Buckwheat-flour	13.5	6.5	1.3	77.3	0.3	1.1
Buckwheat "farina"	11.2	3.3	0.3	84.7	0.1	0.4
Buckwheat "groats"	10.6	4 8	0.6	83.1	0.3	0.6
Oatmeal	7.7	15.1	7.1	67.2	0.9	2.0
Cornmeal	14.3	8.4	3.5	70.9	1.6	1.3
Hominy	13.5	8.3	0.4	77.1	0.3	0.4
Rice	12.4	7.4	0.4	79.2	0.2	0.4
Beans	13.7	23.2	2.1	53.7	3.7	3.6
Peas	15.0	22.9	1.8	52.4	5.4	2.5
Potatoes	75.5	2.0	0.2	20.7	0.8	1.0
Sweet Potatoes	75.8	1.5	0.4	20.0	1.1	1.2
Turnips	91.2	1.0	0.2	6.0	0.9	0.7
Carrots	87.9	1.0	0.2	8.9	1.2	0.8
Cabbage	90.0	1.9	0.2	4.9	1.8	1.2
Cauliflower	90.4	2.5	0.4	5.0	0.9	0.8
Melons	95.2	1.1	0.6	1.4	1.1	0.6
Pumpkins	90.0	0.7	0.1	7.3	1.3	0.6
Apples	84.8	0.4	.....	12.8	1.5	0.5
Pears	83.0	0.4	.....	12.0	4.3	0.3
Starch	15.1	1.2	.....	83.3	. .	0.4
Cane Sugar	2.2	0.3	.....	96.7	...	0.8
Wheat Bread†	32.7	8.9	1.9	55.5		1.0
Graham Bread	34.2	9.5	1.4	53.3		1.6
Rye Bread	30.0	8.4	0.5	59.7		1.4
Soda Crackers	8.0	10.3	9.4	70.5		1.8
"Boston" Crackers	8.3	10.7	9.9	68.7		2.4
"Oyster" Crackers	3.9	12.3	4.8	76.5		2.5
Oatmeal Crackers	4.9	10.4	13.7	69.6		1.4
Pilot (bread) Crackers	7.9	12.4	4.4	74.2		1.1
Macaroni	13.1	9.0	0.3	76.8		0.8
BEVERAGES.			Alcohol.		Free acid.	
Lager Beer	90.3	0.5	4.0	6.6	.....	0.2
Porter and Ale	88.5	0.7	5.2	7.2	.....	0.3
Rhenish Wine, white	86.3	.....	10.5	2.6	0.4	0.2
Rhenish Wine, red	86.9	.....	8.9	3.4	0.5	0.3
French Wine, Claret	88.4	.....	8.1	3.7	0.6	0.2

* Of forty-nine analysis.

† From flour of about average composition.

The analysis of foods in Roman letters are American, those of food and beverages in italics, are European.

TABLE IV.

CONSTITUENTS OF ANIMAL FOODS.

KINDS OF FOOD MATERIALS. (Italics indicate European Analysis, the rest denote American.)	In Edible Portions, *i.e.: Flesh, etc., freed from Bone, Shells and other Refuse.*						In Specimens as Purchased in the Markets. *Including both Edible Portions and Refuse.*						
			Nutrients.				Refuse.—Bones, Skins, Shells, etc.	Edible Portion.					
	Water.	Nutrients.	Protein (Albuminoids.)	Fats.	Carbohydrates, etc.	Mineral Matters.		Water.	Nutrients.	Nutrients. Protein (Albuminoids.)	Fats.	Carbohydrates, etc.	Mineral Matters.
MEATS—FRESH.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Beef, side, well fattened	54.6	45.4	17.9	26.5	.....	1.0	19.7	43.8	36.5	14.4	21.3	.....	0.8
Beef, lean, nearly freed from fat	76.0	24.0	21.8	0.9	.....	1.3	.....	76.0	24.0	21.8	0.9	.....	1.3
Beef, round, rather lean (1)	66.7	33.3	23.0	9.0	.....	1.3	10.0	60.0	30.0	20.7	8.1	.....	1.2
Beef, sirloin, rather fat (1)	60.0	40.0	19.0	20.0	.....	1.0	25.0	45.0	30.0	14.3	15.0	.....	0.7
Beef, flank, very fat (1)	27.3	72.7	12.4	59.6	.....	0.7	12.5	23.9	63.6	10.8	52.2	.....	0.6
Beef, liver	69.5	30.5	20.1	5.4	3.5	1.5	.....	69.5	30.5	20.1	5.4	3.5	1.5
Beef, tongue	63.8	36.2	17.1	18.1	.....	1.0	15.3	54.0	30.7	14.5	15.3	.....	0.9
Beef, heart	56.8	43.2	15.8	26.3	.....	1.1	6.0	53.4	40.6	14.9	24.8	.....	0.9
Veal, lean	79.8	21.2	19.9	0.8	.....	(0.5)	?	.....	.....	.....	.....	.....	.....
Veal, rather fat	72.3	27.7	18.9	7.5	.....	(1.3)	?	.....	.....	.....	.....	.....	.....
Mutton, side, well fattened	53.6	46.4	16.5	29.0	.....	0.9	20.0	42.9	37.1	13.2	23.2	.....	0.7
Mutton, leg (1)	61.9	38.1	18.2	19.0	.....	0.9	18.4	40.2	41.4	12.2	28.6	.....	0.6
Mutton, shoulder (1)	58.6	41.4	18.0	22.4	.....	1.0	16.9	48.7	34.4	15.0	18.6	.....	0.8
Mutton, loin (chops)	49.3	50.7	14.9	35.1	.....	0.7	16.3	41.3	42.4	12.5	29.3	.....	0.6
MEATS PREPARED.													
Dried beef	59.5	40.5	29.2	4.5	.....	6.8	6.5	55.5	38.0	27.4	4.2	.....	6.4
Corned beef, rather lean	58.1	41.9	21.4	17.4	.....	3.1	6.2	54.5	39.3	20.1	16.3	.....	2.9
Smoked ham	41.5	58.5	24.0	30.6	.....	3.9	12.4	36.4	51.2	21.0	26.8	.....	3.4
Pork, bacon, salted	10.0	90.0	3.0	80.5	.....	6.5	5.0	9.5	85.5	2.8	76.5	.....	6.2
FOWL.													
Chicken, rather lean	71 5	28.5	25.1	2.0	.....	1.4	41.6	41.8	16.6	14.6	1.2	.....	0.8
Turkey, medium fatness	65.6	34.4	24.7	8.5	.....	1.2	35.4	42.4	22.2	16.0	5.5	.....	0.7
Goose, fat	38.0	62.0	15.9	45.6	.....	0.5	?	.....	.....	.....	.....	.....	.....
DAIRY PRODUCTS, EGGS, Etc.													
Cows' milk	87.4	12.6	3.4	3.8	4.8	0.7	.....	87.4	12.6	3.4	3.7	4.8	0.7
Cows' milk, skimmed	90.7	9.3	3.1	0.7	4.8	0.7	.....	90.7	9.3	3.1	0.7	4.8	0.7
Cows' milk, buttermilk	90.3	9.7	4.1	0.9	4.0	0.7	.....	90.3	9.7	4.1	0.9	4.0	0.7
Cows' milk, whey	93.2	6.8	0.9	0.2	5.0	0.7	.....	93.2	6.8	0.9	0.2	5.0	0.7
Cheese, whole milk (2)	31.2	68.8	27.1	35.4	2.4	3.9	.....	31.2	68.8	27.1	35.4	2.4	3.9
Cheese, skimmed milk	41.3	58.7	38.3	6.8	9.0	4.6	.....	41.3	58.7	38.3	6.8	9.0	4.6
Butter	7.0	93.0	1.0	89.0	.....	3.0	.....	7.0	93.0	1.0	89.0	.....	3.0
Butter	4.5	85.5	0.7	83.3	0.6	0.9	.....	14.5	85.5	0.7	83.3	0.6	0.9
Hens' Eggs	73.7	26.3	12.5	12.1	0.6	1.1	11.0	65.6	23.4	11.1	10.8	0.5	1.0
FISH, Etc.													
Flounder, whole	84.2	15.8	13.8	0.7	.....	1.3	66.8	27.2	6.0	5.2	0.3	.....	0.5
Haddock, dressed	81.7	18.3	16.8	0.3	.....	1.2	51.0	40.0	9.0	8.3	0.1	.....	0.6
Bluefish, dressed	78.5	21.5	19.0	1.2	.....	1.3	48.6	40.3	11.1	9.8	0.6	.....	0.7
Cod, dressed	82.6	17.4	15.8	0.4	.....	1.2	29.9	57.9	12.2	11.0	0.3	.....	0.9
Whitefish, whole	69.8	30.2	22.1	6.5	.....	1.6	53.5	32.5	14.0	10.3	3.0	.....	0.7
Shad, whole	70.6	29.4	18.5	9.5	.....	1.4	50.1	35.2	14.7	9.3	4.7	.....	0.7
Mackerel, average, whole	73.4	26.6	18.2	7.1	.....	1.3	44.6	40.7	14.7	10.1	3.9	.....	0.7
Salt Cod	53.6	25.8	21.4	0.3	.....	4.1	SALT 20.6	24.9	SALT 15.4	40.3	19.4	16.0	0.4	.....	3.0
Smoked Herring	34.5	53.8	36.4	15.8	.....	1.6	11.7	44.4	6.5	19.2	29.9	20.2	8.8	.....	0.9
Salt Mackerel	42.2	47.2	22.0	22.6	.....	2.6	10.6	22.9	8.2	32.5	36.4	17.0	17.4	.....	2.0
Oysters, average (3)	87.3	12.7	6.0	1.2	3.5	2.0	82.3	15.4	2.3	1.0	0.2	0.6	0.5
Scallops, edible portion	80.3	19.7	14.7	0.2	3.4	1.4	.....	80.3	19.7	14.7	0.2	3.4	1.4

(1) Portions of the side of which analysis is given above. (2) New York Factory Cheese. (3) *i.e.:* The edible portion as ordinarily purchased in the markets, including the "meats" and most of the liquid portion of the shell contents.

I have said so much by way of introduction to the tables, that it may be hardly advisable to discuss their contents at much length. Nor will this be necessary for the figures themselves tell their own stories and very plainly. Only a glance is needed to show that fish as found in the markets generally contain more refuse bone, skin, etc., than meats, as is illustrated in Tables I, II and III. With the larger proportions of both refuse and water, the proportions of nutrients, though variable, are usually much less than meats. Thus a sample of flounder contained 67 per cent. of refuse, 28 of water, and only 5 per cent. of nutritive substance, while the salmon averaged 23, the salt cod 22, and the salt mackerel 36 per cent. of nutrients. The nutrients in meats ranged from 30 per cent. in beef to 46 in mutton, and 87½ in very fat pork (bacon). The canned fish compare very favorably with the meats. It is worth noting, that the nutrients in fresh codfish, dressed, in oysters, edible portion, and in milk, all were nearly the same in amount—about 12½ per cent., though differing in kind and proportions.

Vegetable foods have generally less water and more nutrients than animal foods. Ordinary flour, meal, etc., contain from 85 to 90 per cent. or more of nutritive material. But the nutritive value is not proportional to the quantity of nutrients, because the vegetable foods consist mostly of carbo-hydrates, starch, sugar, cellulose, etc., of inferior nutritive effect, and because their protein is less digestible than that of animal foods. Potatoes contain a large amount of water, and extremely little protein or fats.

There are two things concerning the composition of fish to be particularly noticed:

1st. The chief difference between the flesh of fish and ordinary meats is, that the fish generally contains less fat and more water. The fat of meats is in the fish, to a considerable extent, replaced by water. On this account the flesh of fish has, generally, a lower nutritive value, pound for pound, than ordinary meats. Fish, as we buy them, have the further disadvantage in comparison with meats, that they contain larger percentages of refuse bone, skin, entrails, etc., than meats.

2nd. On the other hand, the flesh of most fish, the nutritive

material is nearly all protein. That is to say, fish supply the nutrient that is at once the most important and the most costly of all.

DIGESTIBILITY OF FISH.

Regarding the ease and rapidity of the digestion of fish, the experimental evidence is as yet insufficient for exact conclusions. The investigations thus far made upon the constitution of the ingredients of the flesh, as well as those upon artificial digestion, indicate no great difference between the fish and the leaner meats, as lean beef, and imply that both would be very readily digested. The actual amounts of nutritive ingredients digested from fish can be only told by actual experiment. The only attempts to test this question, of which I am aware, were made in connection with the investigation the results of which I am alluding to, and are very few in number. It was my fortune sometime since to spend some months in Munich, Germany, where through the kindness of Prof. Voit, I was enabled to make some experiments in the physiological laboratory of the university in that city. The proportions of the nutrients digested were tested in a series of experiments with a healthy man and with a dog. The man digested some 95–97 per cent. of the protein of the fish, and nearly the same proportion from meat (lean beef). That is to say, the digestion of the protein of both meat and fish was nearly complete. The experiments with the dog also gave essentially the same results with both kinds of food. In brief, the experimental facts at hand do not indicate any decided difference in digestibility between fish and the leaner meats. Both belong to the more readily and completely digestible foods.

To get a fully satisfactory knowledge of the digestibility and nutritive values of fish compared with other foods, it will be necessary to make detailed studies of the nature of the chemical compounds contained in them. During a late residence in Heidelberg, I was enabled through the courtesy of Prof. Kuhne, who kindly gave me all needed opportunities in his laboratory, to commence some studies in this direction. Though far from complete, they indicate a very great similarity in the constituents of the flesh of fish and mammals used for food.

In brief, while fish contain somewhat less percentages of nutrients than ordinary meats, they have more waste, more water, and less fat. The nutrients they do contain seem to be very similar in constitution, and in nutritive value to those of other animal foods.

COMPARATIVE EXPENSIVENESS OF ACTUAL NUTRIENTS IN FISH AND OTHER FOODS.

The relative physiological values of the nutrients in different foods depends upon (1) their digestibility and (2) their functions and the proportions in which they can replace each other in nutrition. An accurate physiological valuation is, in the present state of our knowledge, at least, impracticable. The pecuniary costs of the nutrients are, however, more nearly capable of approximation.

From extended comparisons of the composition and market prices of the more important animal and vegetable food-materials, such as meats, fish, flour, etc., those which serve for nourishment and not as luxuries, and form the bulk of the food of the people, it has been estimated that a pound of protein costs, on the average, five times as much, and a pound of fats, three times as much as a pound of carbo-hydrates; that in other words, these three classes of nutrients stand related to each other in respect to cost, in the proportion:

Assumed ratios of costs in staple foods:	Protein . . .	5
	Fats . . .	3
	Carbo-hydrates	1

Suppose a pound of beef of average fatness to cost 25 cents, and to contain 25 per cent of inedible matters, bone, etc., 45 per cent. of water, and 30 per cent of nutritive substance, upon which latter—the bone and water being assumed to be without nutritive value—the whole cost comes. The 30 per cent. or $\frac{30}{100}$ pounds of nutritive substance thus costs 25 cents, or at the rate of $83\frac{1}{2}$ cents per pound. If now we leave out of account the minute quantities of carbo-hydrates and the mineral matters, the whole cost will fall upon the protein and fats. Assuming these to cost in the ratio of 5:3 and the amounts in the meats to be: protein $14\frac{1}{4}$ per cent., and the fats 15 per cent., an easy computation

will show the protein to cost 107,7 cents and the fats 64,6 cents per pound.—Proof: $14\frac{1}{4}_{100}$ pound of protein at 107,7 cents=15,3 cents. $\frac{15}{100}$ pounds of fats at 64,6 cents=9,7 cents. 15,3 cents × 9,7 cents=25 cents; the cost of the pound of meat which contained the given amounts of protein and fats. The above ratios, protein: fats: carbo-hydrates=5: 3: 1 represent at best only general averages, and may in given cases be more or less incorrect. A method free from these objections consists in simply comput-

COMPARATIVE COSTS OF PROTEIN IN FISH AND OTHER ANIMAL AND VEGETABLE FOODS.

FOODS.	Ordinary prices per pound.	Cost of protein per pound
	Cents.	Cents.
Beef: Sirloin, medium fatness	25	108
" Same, at lower price	20	86
" Round, rather lean	18	70
" Round, rather lean, lower price	16	62
" Corned, lean	18	56
" Flank,* very fat	15	36
Mutton: Leg	22	107
" Side, medium fatness	20	59
Pork,* very fat	16	30
Smoked ham	18	48
Milk, 8 cents per quart	4	61
Cheese: Whole milk	18	38
" Skimmed milk	8	19
Salmon: Early in season	100	572
" When plenty	30	172
Shad	12	98
" When abundant	8	65
Bluefish	10	98
Haddock	7	94
Halibut	15	87
Mackerel	10	80
" When abundant	5	40
Cod	8	67
" When plenty	6	50
Alewife	3	19
Canned salmon	20	70
Salt mackerel	12.5	46
Salt cod	7	38
" Lower	6	33
Oysters;† 25 cents per quart	12½	156
" 35 cents per quart	17.5	220
" 50 cents per quart, choice	25	312
Lobsters	12	209
Wheat flour, best	5	19
Indian corn (maize) meal	3	12
Oatmeal	5	15
Beans	5	14
Potatoes:* 50 cents per bushel	0.8	14
" 100 cents per bushel	1.7	28

* Contains very little protein. † Shell contents.

ing the amounts of nutrients that may be bought for the same price in different food materials. At the same time the method above detailed is doubtless accurate enough for a general comparison of the relative cheapness and dearness of ordinary foods, and is used in calculating the costs of protein below.

Of the different nutrients, protein is physiologically the most important as it is pecuniarily the most expensive. In fish, furthermore, as in the leaner kinds of meat, it is the predominant nutritive ingredient. For these reasons the cost of protein in fish and other foods may be used as a means of comparing their relative cheapness or dearness, as is done in the preceding table. The figures represent the ordinary prices per pound and the corresponding costs of protein, in specimens of food-materials obtained in New York and Middletown, Conn., markets. Though the number of specimens is too small for reliable averages, the figures, taken together, doubtless give a tolerably fair idea of the relative costliness of the nutrients in the different classes of food.

Thus the nutrients of vegetable foods are, in general, much less costly than in animal feeds. The animal foods have, however, the advantage of containing a larger proportion of protein and fats, and the protein, at least, in more digestible forms. And further, the so-called "nitrogenous extractives" of kreatin, carnin, etc., of meats, which contribute so much to their agreable flavor, exert a nutritive effect which, though not yet explained, is nevertheless important. It is these which give to "extract of meat" its peculiar flavor and stimulating effect.

Among the animal foods, those which rank as delicacies are the costliest. By the above calculations, the protein in oysters costs from two to three dollars, and in salmon rises to nearly six dollars per pound. In beef, mutton and pork, it varies from 108 to 48 cents; in shad, bluefish, haddock, and halibut, the range is about the same; while in cod and mackerel, fresh and salted, it ranges from 67 to as low as 33 cents per pound. Salt cod and salt mackerel are nearly always—fresh cod and mackerel oftener, and even the choicer fish, as bluefish and shad, when abundant, furnish cheaper sources of protein than any but the inferior kinds of meat.

In short, we pay for many of our foods according to their agreeableness to our palates rather than their values for nourishing our bodies. At the same time it is interesting to note that the prices of the materials that make up the bulk of the food of the people seem to run more or less parallel with their actual nutritive values. Here, as elsewhere, the resultant of the general experience of mankind has led slowly and blindly, but none the less surely, to the same general result to which accurate research more understandingly and quickly guides us.

USE OF FISH AS FOOD. ITS PLACE IN DIETARIES.

The chief uses of fish as food are (1) as an economical source of nutriment, and (2) to supply the demand for variety in diet, which increases with the advance of civilization and culture.

As nutriment, its place is that of a supplement to vegetable foods, the most of which, as wheat, rye, maize, rice, potatoes, etc., are deficient in protein, the chief nutrient of fish.

The so-called "nitrogenous extractives," contained in small quantities in fish as in other animal foods, are doubtless useful in nutrition. The theory that fish is especially valuable for brain-food on account of an assumed richness in phosphorus is not sustained by the facts of either chemistry or physiology.

It is an interesting fact, that the poorer classes of people and communities almost universally select those foods which chemical analysis shows to supply the actual nutrients at the lowest cost. But, unfortunately the proportions of the nutrients in their dietaries are often very defective.

Thus, in portions of India and China, rice; in Northern Italy, maize meal; in certain districts of Germany, and in some regions and seasons in Ireland, potatoes; and among the poor whites of the Southern United States, maize meal and bacon, make a large part, and in some cases almost the sole food of the people. These foods supply the nutrients in the cheapest forms but are all deficient in protein. The people who live upon them, are ill nourished, and suffer physically, intellectually and morally thereby.

On the other hand the Scotchman, shrewd in his diet as his

dealings, finds a most economical supply of protein in oatmeal, haddock and herring, and the rural inhabitants of New England supplement the fat of their pork with protein of beans and the carbo-hydrates of potatoes; maize and wheat flour with the protein of codfish and mackerel, and while subsisting largely upon such frugal but rational diets, are well nourished, physically strong, and distinguished for their intellectual and moral force.

In conclusion I have two more things to speak of:

The first is to repeat, but more emphatically, what I have already said, that the work of which I have been speaking is only the tentative beginning of an investigation which, if rightly prosecuted, may, I believe, develop into one of great importance.

The second, a very pleasant subject to refer to, is the assistance which has been given to the investigation thus far. Besides pecuniary and other aid which has been granted by the United States Fish Commission through Prof. Baird, one of the most efficient promoters of the Fish Cultural Association, Mr. E. G. Blackford, Fish Commissioner of New York, has donated $100 in money, and a large number of specimens of fish. Mr. A. R. Crittenden of Middletown, has also contributed $100 toward the expenses of the investigation of the chemistry of fish. Thanks are likewise due to Mr. G. H. Shaffer of the well-known firm of Dorlon & Shaffer, of New York, for a considerable number of specimen of invertebrates. As I have stated, the investigation of fish has been supplemented by one of other food materials

A considerable portion of the expense of these, also, has been met by private generosity. Mr. F. B. Thurber, of the firm of H. K. & F. B. Thurber of New York, having donated $500 for this purpose, while Hon. J. W. Alsop, M. D., of Middletown, has contributed a considerable sum in aid of researches carried on in the chemieal laboratory of Wesleyan University, in which, with more abstract investigation, the studies of fish and other foods have been included. These gifts of gentlemen interested in science, have covered a not inconsiderable part of the total expenses of the investigations whose results I have thus briefly detailed. Without such aid they would have been, in their present form at least, impracticable.

The PRESIDENT: Although this paper has been quite exhaustive, I have no doubt that some members would like to ask questions.

Mr. WILLCOX: We have, I am sure, been greatly interested in Professor Atwater's paper, and I would like to ask whether one animal by eating the flesh of another can transform that food into fats.

Prof. ATWATER: A great deal of experimental study has been devoted to the precise question to which you refer, during the past thirty years, and it may be thirty years more before it is fully answered. We have, however, a great deal of information already; enough to prove that the protein of one animal may be transformed into fat in the body of another. Dogs fed on lean meat have been proven to grow fat upon it in the limited sense that some of the protein of which the lean meat was composed was changed into fat and stored as fat in the bodies of the dogs. It is quite possible that a portion of the protein of the beef steak which you and I may have eaten for breakfast this morning, is during the course of the day, being changed into fat and carbo-hydrates. But how much of the protein of our food is transformed into fats, or how much of the fats in our bodies comes from the protein we eat, are matters which cannot, in the present state of our knowledge, be answered exactly.

The members of the Association then visited the Central Hatching Station of the United States Fish Commission in the armory building, east of the Smithsonian grounds, where they saw a model of the McDonald fishway in operation, and the hatching of shad in the McDonald hatching jars.

ON THE FORCES WHICH DETERMINE THE SURVIVAL OF FISH EMBRYOS.

BY JOHN A. RYDER.

Mr. President: Unfortunately the programme announces the title of my communication in a form somewhat different from the one actually chosen for my paper, although in reality there is no great difference between the two. I propose to-day to discuss some of the causes which limit the survival of fish embryos. It is well known to fish-culturists and naturalists that there is a great amount of variation in the number of ova produced by different species of fishes. This great variation is significant and can be accounted for on no other ground than this: that it must be supposed that there is a great over-production of eggs in order to make up for the losses in the struggle for existence, as indicated in the first place by Malthus and afterwards elaborately worked out by Mr. Darwin. This disparity in the number of germs produced by different species is so great as to astound us at first. There are species, for instance, in which the number of germs produced by the female fish would not exceed twenty. There are some, indeed, that only produce five or six. Again, there are species which produce as many as 10,000,000. Now, how is this difference to be explained? It is a singular fact that the greatest number of eggs appear to be produced by those fishes that take the least care of their progeny, viz., those species which discharge their eggs into the open sea and commit them to the mercy of the winds and waves, such as the codfish and flounders and many of the *Clupeoids*. Whereas the reverse seems to be true, in the case of those fish which studiously take care of their eggs, or incubate them inside of their ovaries —as for instance the *Embiotocoid* fishes of the west coast—or as in another case (*Gameusia*) within the ovarian follicle, modified into a quasi-placental structure; or, as in the case of the catfish, where the male hovers over the adherent mass of ova and forces the water through them, or yet again where the eggs are retained in a pouch underneath the abdomen, as in the pipe-fishes, or are

kept in a similar pouch under the tail, as in the male sea-horse (*Hippocampus*). It seems as if the number of eggs was diminished just in proportion to the amount of care taken—usually by the male—of the embryos. This, of course, indicates that in the case of eggs which are not protected in the way mentioned, millions of surplus ova are destroyed in the struggle for existence, whereas with the species which protect their ova, the struggle for existence at the commencement of development must be much less severe.

There are other points to be noticed. Some species have very small ova. Such are usually hatched in a condition in which the little fish is much feebler than in those cases in which the ova are large, and in which the young fish leave the egg in a much more vigorous conditon—in a condition, in short, in which they are able to contend with the environment more effectually. That is an important fact to be considered. Again, there are some species which leave the egg with the throat perforated, and other forms which do not. In the case of the shad, for instance, the young fish cannot swallow at the time of hatching, but in other forms the young can swallow as soon as they leave the egg membrane. There are still other causes which would affect the percentage of survivals, such as changes in their habitat produced by man, or the pollution of a river by substances which sink into its ooze, and so vitiate the water and thus render incubation on the bottom impossible.

There are also forms in which there are protective contrivances developed on the eggs themselves. We are all familiar with gelatinous strings that we find in stagnant ponds and which enclose the eggs of the toad, for example. Most of the various kinds of frogs have a different kind of spawn, adhering together in masses instead of in strings. Certain fish-ova, again, have long thread-like appendages, by which they are suspended on weeds and grass, so that the currents of sea-water can pass backward and forward among them, ærating them and preventing them from being smothered. This is the case with a number of marine, and some few fresh-water forms of fishes. There are cases where mimicry doubtless plays a part in preventing the capture of young fish, as in the case of the young of the stickle-

back, where the young fish seem to undergo a sudden change of coloration, rendering them much more difficult of detection in the water. A certain writer, speaking of sticklebacks, asserts that the male will acutally catch and return the young fish to the nest during the first day or two after hatching. This change of coloration may possibly be dependent upon the action of light. Regarding the survival of fish embyos, the specific gravity of the eggs of different species, is another point to be considered. Thus, the eggs of the cod, mackerel and crab-eater, are buoyant and tend to come to the surface of the water. Others as persistently sink. In other fish ova the oil drops are so arranged as to persistently turn the germinal disc to the top, as is the case with the salmonoids; this relation is reversed in the case of floating eggs, in which the vitellus is on the top and the germinal disc underneath.

Judging from the attempts made to rear and multiply certain feral mammalia, we know that confinement tends to produce sterility. I believe that under such conditions certain changes are effected in the ovaries of fishes in their efforts to free themselves from the bondage imposed by man, and that the physiological organization of the eggs is destroyed.

The distribution of food—especially articulate food—is also an element to be considered with respect to the survival of young embryos. In various regions of the globe certain living aquatic food seems to swarm at particular times and in fixed localities. I know this to be so from my own observations in the vicinity of Philadelphia, and especially in the swamps and low grounds of New Jersey. It is impossible to predicate from outward appearances what particular forms of articulates will be encountered until you are on the ground and make a careful examination, and there is no doubt in my mind that the absence from streams of certain small forms of articulates, such as Daphnids and *Copepoda*, have a great deal to do with the survival of the young fish. As this kind of food is absent or abundantly present, so will the young fishes perish or survive.

There is another cause to which may be attributed the destruction of the fish embryos, and that may be embraced under the head of "shocks" which pervert development. We know, for

instance, that shocks given to fish eggs during the time that they are in process of incubation, will often produce monstrosities, and if very violent will produce death. Shocks may be exerted as the result of natural causes, or may be brought about in the course of the application of artificial methods in the incubation of fish ova. The ordinary mode of formation of any fish embryos is around a globular vitellus. There is a dome-shaped cap of plastic material formed over the yelk in which nuclear matter is imbedded immediately after fertilization. Segmentation proceeds step by step, and in the course of this process shocks may produce aberration of development. The germinal matter at first covers, or is partially scattered through the vitellus and connected with the surface, migrating toward that surface and to one point so as to form a discoidal germinal mass at one side of the egg. That, of course, is not the first step in development. Now it is easy to understand that the shocks would impair the delicate processes of development going on within, especially when we remember that during this time the nuclear matter is arranged in a certain peculiar way, and that as cleavage proceeds, this nuclear body elongates and throws out rays through the enveloping protoplasmic matter. If at this stage of development I should shake the eggs violently, a second embryonic axis may be formed which soon fuses with the axis of the originally formed embryo, and the result would be a double-headed fish. Thus you can readily see that certain forces tend to diminish the number of normally developed embryos, malforming them and producing irregularities which cannot become adult or perfect fishes like the parents.

I have only mentioned some of the forces which are operative in diminishing the chances of survival of young fishes, but I trust that enough has been said to indicate to some extent, the nature of the ploblem still to be solved by those who are interested in the breeding, protection and multiplication of food fishes.

The first and most important principle which I would especially commend to the thoughtful attention of the Association is the general law already hinted at, namely: that just in proportion as the individuals of a species are prolific in respect to the

number of their germs, just in that proportion do the chances of survival of the individual germs seem to be diminished, and *vice versa*, and that this natural fecundity, or the want of it, is dependent upon the amount of protection received by the eggs in the course of development.

Prof. GILL: The observations of Mr. Ryder are very interesting, and it is one of those strange cases that we so often meet in nature—the accommodation and correlation of different things. In this case we have the number of eggs in a certain ratio to the capability of the young fish to take care of themselves. We have it now established on a large basis that there is generally a close correlation between the two, and that the number of eggs is in inverse ratio to the capability of the young to protect themselves. Besides the cases alluded to by Mr. Ryder, we have an interesting instance of the female of one type of catfish found in South America, *Aspredinidæ*, in which there occur periodically swellings of the skin of the abdomen in which the eggs are received, and therein they are nourished for some time. Again in the same group, or order of catfishes, but in another family, we have the *Arii*, in which the male parent takes care of the eggs by holding them in his mouth, and so preserving them from danger very skillfully. Care is taken of the young by other species of the family. It was with great interest, that some months ago Mr. Ryder and myself observed the habits of our common catfish. The male hovered over the young, and when feeding frequently took the young into his mouth, but always ejected them again, thus discriminating accurately between the objects taken as food and the young fish incidentally transferred to his mouth. This same habit of taking care of the young in the mouth is exhibited by certain *Cichlids*, forms somewhat like, and perhaps akin to, our common sunfishes. One of these is a fish found in the Holy Land, a species of *Chromis*. And the same peculiar habit is likewise manifested by species of the same family living in South America, the *Geophagi*. The belief was also long current, and found expression in most of the old books, that fishes not only did not take care of their young, but were invariably

oviparous. We all know how false such a statement is. In one class, the *Selachians*, the larger proportion of forms are viviparous. For example, of the sharks proper, three-fourths, or more, are viviparous, and the same statement holds good with respect to the rays or skates. Thus, out of 150 species of rays, over 100 are viviparous, and another noteworthy fact is that the oviparous rays are nearly all included in one family—the common skates or rays brought to our markets. This feature of viviparity was known to the ancient naturalist, Aristotle, who even went so far as to say that the *Selachians* were viviparous, while all scaly fishes were oviparous. There, however, he erred, for there is no such limitation. Many of the *Selachians* are oviparous, and, on the other hand, many of the scaly fishes are viviparous. For instance, all the *Embiotocoids* are viviparous; and of these the common perch of the Pacific is an example; also viviparous are the eelpout of our markets, and species of the *Cyprinodont* family among others. Viviparity is, indeed, largely manifested among fishes. The only reason why reverse statements are found in the old books is that in Europe these cases were almost unknown.

I agree with the statement of Mr. Ryder that confinement frequently affects the power of procreation, either directly or indirectly, and this does not apply to fishes alone, as is evident from the experience of those in charge of menageries and zoological gardens. It is known that many animals and birds which are confined seem to live with perfect freedom in zoological collections, but they do not bring forth young, or their eggs are sterile. There are many exceptions to this rule, but many cases of sterility for which we can assign no other cause. Somewhat anologous is the peculiar pathological condition of animals living in confinement, in which the bones become softened or rickety.

THURSDAY, MAY 15TH.

The President called the meeting to order at 10 o'clock A. M., and declared the reading of papers to be in order.

NOTES ON THE DECREASE OF LOBSTERS.

BY RICHARD RATHBUN.

One of the most important of our seacoast fisheries is that afforded by the American lobster, the *Homarus americanus* of naturalists. This interesting crustacean, the largest of its kind in North American waters, ranges from Labrador in the North to Delaware in the South; but is most abundant and most sought for along New England and the southernmost of the British coast provinces.

Its great abundance and rare flavor are not unfrequently mentioned in the early annals of New England, and it probably formed an important element in the food supply of the seacoast inhabitants of colonial times. As a separate and distinct industry, however, the lobster fishery does not date back much, if any, beyond the beginning of the present century, and it appears to have been first developed on the Massachusetts coast, in the region of Cape Cod and Boston, although some fishing was done as early as 1810 among the Elizabeth Islands and on the coast of Connecticut. Strangely enough, this industry was not extended to the coast of Maine, where it subsequently attained its greatest proportions, until about 1840. Concerning the history of this unique fishery, but few authentic records of any kind exist, nor was any attempt ever made to estimate its

extent and value prior to the census investigations of 1880. We are, therefore, left without much reliable data for comparing its past and present conditions, and for solving the many problems which now, in the minds of many, seem to threaten its continued prosperity.

The great question at issue, and one which demands the earnest attention of every lobster fisherman and dealer, is whether lobsters are decreasing in abundance, and will eventually become rare and difficult to obtain, or whether they are still as plentiful as ever and show no indications of approaching extinction. While we hope for the latter, we are forced to acknowledge that a carefuf study of all the materials at our command inclines us to the belief that the abundance, of lobsters has very perceptibly diminished within comparatively recent times, and that, unless some active measures are instituted to prevent continued decrease in the future, a great and irreparable injury to the fishery will ensue.

Although, as we have just said, the lobster fishery is without a carefully recorded history, we have been enabled, through the assistance of many intelligent fishermen and dealers, some of whom have shown themselves to be very capable observers, to trace back the conditions of the fishery through a number of years. The results so obtained have been embodied in a report prepared for publication by the United States Fish Commission. It has been suggested that a short statement of some of the facts bearing upon the supposed decrease might be of interest to the members of this Association, and it is for that purpose that the following brief notes have been prepared:

Concerning the distribution of lobsters it may be stated that a few stray individuals have been occasionally recorded from the extreme northeastern corner of Virginia, but the Delaware Breakwater may more properly be regarded as the southern limit of their range. On the New Jersey coast they are somewhat more abundant, and give rise to a limited fishery in the neighborhood of Atlantic City and Long Branch. Though formerly quite plentiful and extensively fished for in New York bay and Hell Gate, they are now nearty exterminated from that region, due to overfishing combined with the pollution of the

waters by the refuse from large factories. Along the Connecticut shores they are moderately common, while at the eastern end of Long Island and in the region of Block Island, the outer Elizabeth Islands and Marthas Vineyard they afford a very profitable industry.

The entire coast line of Massachusetts abounds in lobsters, wherever the character of the bottom is suited to them; but overfishing has nearly depleted some of the shallow-water areas which were once prolific, as at Provincetown. The sandy shores of New Hampshire furnish only a moderate supply, but on the Maine coast they are much more abundant than anywhere to the southward, and the yearly fishery greatly exceeds in quantity and value those of all the other States combined. This State is in fact the main source of supply for all the principal markets of the United States. Contrary to the belief of many persons the lobster is not a migratory animal in the common acceptation of that term as applied to fishes. On the approach of cold weather it leaves the shallow areas near shore, and retreats into somewhat deeper water, where the temperature remains milder and more uniform during the winter. As the spring advances it returns to its summer haunts. These spring and fall migrations vary as to time and extent on different portions of the coast, occurring earlier in the spring and later in the fall at the South than at the North. During the summer they often approach very close to the beaches, and in some favorable localities, especially on the coast of Maine, the traps set for their capture become partially uncovered at low water. The more usual depths for the summer fishery are, however, those of a few fathoms. The winter grounds are in depths of twenty to fifty or sixty fathoms, and generally not far from those of the summer, especially in regions where the water deepens rapidly.

In so far as it has been possible to make the observations, it is supposed that the different schools of lobsters, if we can so define them, return to about the same shallow places every spring, and do not journey northward or southward along the coast to any very great extent, although there may be a gradual interchange of ground in the course of time.* If this supposition be correct, as appears most natural, and there are many

facts to substantiate it, each geographical region is more or less independent of all others, and not influenced by large and frequent migrations from them. This division into distinct schools, and defined geographical regions, while an arbitrary one, not strictly existing in nature, serves to simplify the argument which we desire to make, and which is to this effect: That continued overfishing in any one region will tend to eventually reduce the stock of lobsters in that region, without the hope of its being replenished by early accessions from neighboring regions, and that the almost total depletion of that region is, therefore, quite within the bounds of possibility. This is not the case with such truly migratory fishes as the mackerel, menhaden and herring, and the laws which govern the movements of the latter cannot be applied to the lobster. In support of this proposition there are several well-authenticated instances of the almost entire extinction of lobsters in what were formerly regarded as exceedingly rich regions, and since lobster-fishing has been more or less abandoned in those regions, the abundance of lobsters has never perceptibly increased.

Another strong proof of the continued decrease in abundance of lobsters has been the gradual decrease in the average size of those brought to market. It is not rational to suppose that lobsters grow less rapidly now than in former years, or have in any way become dwarfed in size. On the contrary, it has been overfishing, restricted by legislation which protects the young, and influenced by the higher prices paid for the larger individuals in the fish markets which has caused the greater diminution in the supply of large lobsters. A strict observance of existing laws may prevent the total extinction of the species, but it cannot maintain the average size of those taken for market much, if any above the limit prescribed by those laws. This limit in nearly every instance is, moreover, about the size of the young female just beginning to spawn, and, therefore, with absolutely no protection for the spawning female, excepting in the close season, during which there is but little spawning, it is doubtful whether existing legislation is of much avail. A careful consideration of all the facts available certainly indicates

that a marked decrease in the size of lobsters is proof of an equally great, if not a greater diminution in the supply.

It is not possible within the scope of this short paper to strengthen our conclusions with a long array of facts, but the brief statement of some of our evidence must here suffice.

One of the best illustrations of the great decrease in the abundance of lobsters is furnished by the once famous fishing-grounds of Cape Cod. The lobster fishery was first started in this region about the year 1800, by Connecticut lobstermen, who carried nearly their entire catch to New York city. As early as 1812, the citizens of Provincetown began to entertain fears that unless some restrictions were placed upon the fishery, the extermination of the species would be speedily effected. Protective laws were at once passed by the legislature of Massachusetts, and from that time to the present they have been continued in one form or another, but all without avail unless it may have been to somewhat prolong the fishery which might otherwise have been much earlier destroyed. The fishermen of Provincetown did not themselves engage in lobstering until about 1845, but between then and 1850 the fishery was greatly expanded and a large trade started with New York city. In fact about this time the latter market received nearly its entire supplies from the vicinity of Provincetown. A great many men engaged in the fishery, using the old style of hoop-net pots, and catching from 100 to 200 lobsters each every night. These were prosperous times, and yielded the inhabitants of the town a profitable income. The carrying smacks obtained large fares and were kept busy. No marked diminution in the supply was noticed until about 1865, since which date there has been a rapid decrease in abundance from year to year, obliging the lobstermen to resort to other occupations for a living. In 1880 there were only eight men engaged in lobstering, and although they used the most improved appliances, their annual gross earnings were only about $60 each.

On the cost of Maine, although the fishery is of much more recent date, it has already exhibited many unfortunate changes, and in numerous places there has been a marked decrease in the average size of individuals caught. The shore fisheries have

also, in some cases, been well nigh exhausted, and the fishermen forced to resort to more distant grounds. When the fishery first began hoop-net traps were in general use, but soon after the introduction of lath-traps competition caused them to be universally employed. From year to year the fishermen increased the number of traps they used, and the custom of setting them, trawl fashion, rapidly came into vogue. These changes were due to the competitions of trade, the desire to obtain larger catches and for one man to perform the work of two. The fishing grounds were strained to their utmost, and there was no fear of an overstock, as the canneries were ready to buy all that were not taken by the market smacks. More recently the fishermen have begun to return to the old method of setting their traps singly, and why? Because they say the lobsters are more scattered over the bottom, and that by altering the position of the traps every time they are set, they fish better. But why should they be more scattered now than formerly unless they are more rare? In 1864 lobsters were so abundant at Muscle Ridges that three men tending forty to fifty traps each, caught all the count lobsters which one smack could carry to market, making a trip once in eight days. In 1879 the same smack was obliged to buy the entire catch of fifteen men in order to obtain full fares, and at times required to visit other localities to complete the load.

Regarding the Booth bay region, very nearly the same may be said. As late as 1856, lobsters were very abundant about the islands of Booth bay harbor, and the fishery was carried on close to the shore in slight depths of water. The season lasted about six months, and each man setting fifty traps could make about $500 during the season. By 1869, the number of fishermen having increased, however, the season's stock was reduced to about $175 per man, and the average size of lobsters had greatly diminished. This caused the fishermen to try further out from shore, and the fishery is mainly carried on in depths of twenty-five to thirty-five fathoms. The facts of these changes were furnished from many places in this section, between Cape Small Point and Pemaquid Point.

The canneries have undoubtedly largely influenced this result on the coast of Maine, as all sizes of lobsters large enough to

pay for the handling are consumed, and the ready market thus afforded has tempted the fishermen to save every specimen that enters their traps. It is unquestionably this extensive destruction of the young that has hastened the decrease; but that the decrease is not solely due to the presence of canneries is evidenced by the statements we have already made regarding other sections of the coast.

In the Saco district, although there are no canneries located nearer than Portland, a smack trade between the fishing grounds and the canneries to the eastward has recently been started, and several witnesses have testified to a marked falling off in the proportionate catch since it began. The average catch per man is now about one-third what it was twenty years ago, and while, in 1876, a barrel of lobsters averaged 65 by count, an average of 80 lobsters is now required to fill a barrel.

On the New Hampshire coast the decrease for twenty years is stated to have been from 50 to 75 per cent.

From Rhode Island and Connecticut we have complaints regarding a decrease in abundance and size of lobsters, similar to those already noted from the more northern States; but the statements we have given constitute but a small proportion of the evidence that we have obtained.

That this evidence is unimpeachable as to a general and lasting decrease, we would not now affirm, but to our minds it has been conclusive. To press a definite and unfavorable opinion, however, regarding so extensive and valuable a fishery, after the meager returns of a single investigation extending through only one or two years, would scarcely be justifiable, but it has seemed to us that public attention should be now attracted to the subject, as it appears in the light of the tenth census.

The fishery has had such a rapid growth, and the demands upon it have so exceeded its capacity, that the problem of weighing evidence has been somewhat difficult. The total catch of lobsters has increased from year to year, but so has the number of fishermen, and the number of traps used, even in greater proportion; and the grounds have been enlarged until they now cover an exceedingly broad area, and extend into deeper water than was ever dreamed of formerly in connection with this fish-

ery. The decrease in the average catch per trap and man, in the yearly earnings, and in the average size of lobsters has kept pace with the increase of the fishery; the inshore grounds in many places have been nearly depleted, and in some of the deeper areas the lobsters are so much scattered that it is no longer profitable to set the traps in trawls. If a continuous and rapid decrease should be proved, what can be done to stop it and insure the future prosperity of the fishery? The task of remedying the evil will be much more difficult than the proof of its existence, and the question is one regarding which we have as yet no definite ideas.

Past legislation has certainly not been very effective, nor can any laws avail much until the true character and extent of the evil has been determined. Neither are laws beneficial unless they can be enforced—an exceedingly difficult task in the case of any fishery.

The question of artificial propagation has been raised, and a few unsuccessful attempts have already been made to carry it on. But the failures have not been without cause, as we do not yet even know the rate of growth of lobsters, or whether they require six or a dozen years to attain the adult size, which is about ten or twelve inches. Immediately after hatching they swim freely about at the surface of the water, and continue their erratic ways of life during most of the first season, after which they settle down upon the bottom and assume their future habits.

The first task, therefore, which we suggest for the would-be benefactor of the lobster fishery, is a most thorough investigation of all points bearing upon the natural history of the species, upon the changes which have occurred in the fishery grounds, and upon the relations of the total catch for each section to the number of fishermen and traps set, and the average size of the lobsters taken.

With the census returns, soon to be published, as a starting point, a plan of the work can easily be sketched out, and the figures there given may serve as a basis for future calculations.

THE PROPAGATION OF THE STRIPED BASS.

BY S. G. WORTH.

The propagation of the striped bass, by artificial methods, appears to be as easy of accomplishment as that of the shad, and there are greater opportunities probably of doing a large work with less money than is necessary in the propagation of shad.

It is much to say that the striped bass can be as economically hatched as the white shad, for the expense of shad hatching is very small. From the observations upon the shipment of rock fry, it would seem that there is no difficulty whatever in successfully depositing the fry in rivers at points distant from the hatcheries.

It is not known at what points ripe fish of this species can be found in greatest abundance, but in our present state of knowledge, Weldon, North Carolina, presents the greatest number. This town is at the head of navigation on Roanoke river near the North Carolina and Virginia line, and is more than one hundred miles above the head of the tide. The Roanoke river, at this point, is a large stream, which would be navigable many miles further up except on account of the abrupt falls existing above a distance of a few miles.

It is a muddy stream a great portion of the year, having its source about two hundred miles in the tributaries of the Dan and Staunton.

However muddy its waters may be at times, a great portion of the volume is from pure mountain springs.

Although large quantities of striped bass are taken during the several months by the large seines and pound nets seaward, there appears to be no one point where the eggs in a condition proper for fecundation can be found so abundantly. At the particular point named, the fall is so great that ordinarily, owing to a lack of a great volume of water to smooth over the falls, the fish are unable to pass directly over, and in consequence are detained at the foot of the falls.

Here more than a hundred canoes are used each spring in the capture of the striped bass.

Bow nets are used in water ten or more feet deep, two men occupying the boat, one using the paddle, the other holding the net.

At times great numbers of fish collect here, and within fifteen years past as many as three hundred of these fish, weighing upward of thirty pounds, some reaching seventy, have been taken on a slide or trap (another minor fishing contrivance used there), in a single day.

The quantity, however, has greatly fallen off of late years, owing to the greatly increased fishing operations below.

It is stated on good authority that on many occasions, when these fish were very numerous at this point, that in their spawning movements they have been so abundant that great quantities of blood were extracted, owing to the contact with each other, conveying the idea that the water was literally overcrowded with them, causing them to come into abnormal conflict with their sharp spines, owing to the lack of space.

The bloody appearance of the water has been popularly considered the bleeding consequent upon an actual fight between those fishes, but was probably only the result of overcrowding where dorsal fins were frequent.

Some few thousand of striped bass are still taken at this place.

The place has appeared favorable for the work of collecting eggs for artificial propagation, and after investigation of its capabilities the following results may be enumerated:

In the year 1882, in the month of May, I sent an expert among the fishermen by way of investigation, and had reported back from him the sale during his stay of something less than a dozen spawning fish.

He was there but a few days, and made no attempt to fecundate or hatch the ova. Previous experience in the propagation of the striped bass at Avoca, in 188–, led to the inference that the discovery of this many fish in a ripe condition at Weldon, would ordinarily afford material for a limited hatchery.

Consequently, I established at Weldon, quite late in the season of 1883, an exceedingly crude establishment, containing sixty-five McDonald jars, equipped as if for very rude shad or whitefish hatching.

The station was provided with five experts, a force rather too small, though efficient. During a period of ten days from May 14th to 24th, nine rock-fish in spawning condition were secured.

Four of these were sold on the market before the hatchery was ready, and the eggs were lost. They were observed, however, to contain ripe eggs. Five others were captured and handled by my force subsequent to the establishment of the hatchery.

One of these weighed thirty-four pounds twelve ounces, but being dead and stiff before it was found, the eggs were not available for impregnation, so I used it for the purpose of determining as near as possible the relative number of eggs contained in this species. A fraction of an ounce was carefully weighed out on apothecary's scales by a young druggist who chanced to be in my corps, and a computation was made of the number of eggs, and 3,194,000 were found. The two ovaries were packed in ice and sent to Prof. Baird for more careful calculation. They are in his possession and are preserved in alcohol. The total weight of these ovaries at the time the calculation was made was seven pounds nine ounces.

However many the exact number may be, it is evident that the average rockfish produces upward of 1,000,000 of eggs.

Four other fishes in spawning condition were taken, one on the 17th, weighing 12 pounds, two-thirds spent, yielded 250,000 eggs, another taken on the 18th, weighing 8 pounds, two-thirds spent, contained 280,000 eggs. The eggs from the last named fish, when impregnated, measured 14 U. S. standard liquid quarts, and in the ovaries which I dissected afterward, were remaining 4 ounces unimpregnated eggs. These latter I considered about 100,000 in number, showing that this fish of 8 pounds weight, contained upward of 1,200,000 eggs.

The result of the crude operations at Weldon, produced something like 1,000,000 of eggs from the four fish stripped (these being mostly spent), from which a very moderate number of fish —50,000—were hatched and turned into Roanoke river; specimens being sent to Prof. Baird in glycerine.

The only difficulties encountered were two, the one consisting

in the great delicacy of the egg shells in the latter stages, which caused the fish to hatch prematurely by concussion, and the other consisting of the difficulty of securing fine enough screens to hold the fish when hatched.

Now since I found that the eggs would stand a great while in water without a change, even twelve hours, it is apparent that they may be hatched without motion, and thus prevent premature hatching, and as to the difficulty of confining the young fish by proper screens, all that seems necessary, is the substitution of clear water for that muddy water which I used. Not only do the rock spawn at Weldon, but incidentally at several points below, and with the system of impounding, there seems scarcely a doubt of securing a great supply of eggs, thus opening a means of propagating the choice, valuable striped bass.

RESULT OF THE INTRODUCTION OF GILL-NETS INTO THE AMERICAN COD-FISHERIES.

BY CAPT. J. W. COLLINS.

The United States Fish Commission, though it has in so many ways done a useful and important work in the artificial propagation of food-fishes, has not confined itself solely to fish-culture as a means for improving the American fisheries. It has accomplished quite as important objects by disseminating among our fishermen knowledge of methods of fishing, etc., to which they were previously strangers, and which has been of the utmost advantage to them for the successful prosecution of their work. The introduction of the use of gill-nets in the cod fisheries may be mentioned as an instance in point, and viewed in the light of results already attained (though we may yet consider this method of fishing only fairly begun), it seems not too much to claim that the bringing about of such an innovation in the

ocean fisheries, is entitled to rank among the most important works of the Commission. The change that has been made in the method of taking cod and other species of the *Gadidæ*, has proved of such immense advantage to the New England fishermen that an entire revolution has been created in the winter shore cod fishery, and it is difficult to predict to how great an extent the gill-net fishery for cod may be prosecuted in the future. It is not possible now to say with any degree of certainty whether or not gill-nets may be successfully employed in the cod fisheries of the outer banks, since a thorough and careful trial needs to be made to settle that question. A few unsatisfactory attempts have already been made by the fishermen to use gill-nets on the outer banks, but in no case have these trials been so extensive and thorough as to fully demonstrate what might or might not be done. In consideration of the results which have already been attained, it seems desirable that a brief historical sketch should be given here of the introduction of gill-nets into the cod fisheries of the United States, and also of the varying success which has attended their use since they were first adopted by American fishermen.

Though gill-nets have been long used in Northern Europe, more especially in Norway, as an apparatus for the capture of cod, and are considered by the Norwegians as quite indispensable, they have not, until recently, been employed by American fishermen. In 1878, Professor Spencer F. Baird, United States Commissioner of Fish and Fisheries, knowing how profitably these nets were employed by the Norwegian fishermen, decided to make experiments with them at Cape Ann, with a view to their introduction among the fishermen of this country. He accordingly secured a number of the Norwegian nets, which were forwarded to Gloucester, and there tested by the employees of the Commission.

Experiments were made when the winter school of cod were on the shore grounds in Massachusetts bay, but the results obtained were not satisfactory, owing chiefly to the fact that the nets were found far too frail for the large cod which frequent our coast in winter. This was apparent from the numerous holes in the nets, which indicated plainly that large fish had torn their

way through, none being retained excepting those that had become completely rolled up in the twine. The current also swept the nets afoul of the rocky bottom, which injured them still more, so that they were soon rendered nearly unfit for use. They were invariably in bad order when hauled from the water, but even under such unfavorable circumstances nearly a thousand pounds of fish were caught on one occasion. This seemed to indicate that nets of sufficient strength might be used to good advantage, at least on some of the smoother fishing grounds along the coast.

These preliminary trials, therefore, having demonstrated that nets could be employed advantageously in the American cod fisheries, Professor Baird availed himself of the first chance that offered, for obtaining definite knowledge of the methods of netting cod in Norway, with the intention of disseminating this information among the American cod fishermen.

The opening of the International Fishery Exhibition at Berlin, Germany, in the spring of 1880, presented a favorable opportunity for accomplishing this purpose. Professor Baird having appointed me as one of the commission to attend the exhibition on the staff of Professor G. Brown Goode, desired that I should make a careful study of the foreign methods of deep-sea fishery as represented at the exhibition. The method of capturing cod with gill-nets, as practiced by the Norwegian fishermen, was mentioned as a subject which should receive especial consideration.

In the meantime, Professor Baird offered to lend the nets to any responsible fisherman who would give them a fair and thorough test. But the fishermen were conservative and hesitated to adopt any "new-fangled notions" for catching fish. This disinclination to try the new method was due chiefly to the fact that fishermen cannot usually afford to spend any time in making experiments, especially when they feel fairly confident of good returns by continuiug in their old ways of fishing.

Mention has been made of the introduction and trial of cod gill-nets by the United States Fish Commission in 1878, but no attempt was made by the fishermen to use them until the fall of

1880, when Captain George H. Martin, of Gloucester, Mass., master of the schooner "Northern Eagle," fitted out with them for the winter cod fisheries off Cape Ann and in Ipswich bay The immediate cause which led to this trial was the difficulty of getting a supply of bait, the procuring of which is a source of considerable trouble to our shore-fishermen, and its cost, even when obtainable, is such a heavy tax on this branch of the fishing industry, that often the fishermen hesitate to engage in it, fearing that the result may be a loss rather than a gain. It was to obviate this difficulty about bait, and to render our cod fisheries more valuable in consequence, that led Professor Baird to bring the cod gill-nets to the notice of the American fishermen. The bait principally depended upon by the shore fishermen in the vicinity of Cape Ann, during the fall and early winter, is young herring (*Clupea harengus*), known as the "spirling." The appearance of these fish about the cape is somewhat uncertain; sometimes large schools remain for several weeks, and at other times but a few can be taken. There was so little prospect of getting a supply of bait in the season of 1880, that Captain Martin hesitated about fitting out for trawling, fearing that the cost and difficulty of securing a supply of this article, which is indispensable to the trawl-line fishery, would render the undertaking unprofitable. While the matter of fitting out in the old way was under consideration, gill-nets were suggested by the father of Captain Martin, an employee of the Fish Commission, as a means of solving the perplexities of the bait question. He thought the idea a good one, and, together with several of his crew, visited the station of the Commission at Gloucester, looked at the Norwegian nets that were there, and consulted with the agent in charge as to the probabilities of success. The result of this interview was that Captain Martin decided to fit out and give the new method a thorough trial, and nets were therefore obtained for this purpose, part of them being supplied by the Fish Commission.

Before the trial trip was made Captain Martin had an interview with me at Gloucester, to get some additional information as to the management of the nets. I briefly explained to him the methods adopted by the Norwegians. He thought, however

that the nets might be "underrun," as trawls sometimes are, which would enable one man to handle a gang of nets for which an entire boat's crew, six to eight men, is required in Norway. I could see no reason, myself, why the nets could not be underrun, providing the current was not too strong and the water not to deep. It may be explained here that the Norwegians set their nets late in the day and take them up on the following morning, the apparatus being carried to the land, the fish removed from the meshes, and the gear prepared for setting again. This involves a large amount of labor and much loss of time, as compared with the method of underrunning, which may be considered "another yankee invention."

When the nets are set for underrunning, the anchor is first thrown over, and 25 fathoms of line paid out, when the buoy-line is bent to it. The buoy and line are then thrown over, and the remainder of the anchor line, the end of the latter being made fast to the nets, which are the next to follow. A middle buoy is attached to the center of the gang. When the nets are all out, the other anchor line, with the buoy-line attached, is veered out, and last of all the anchor is thrown over, which finishes the work. The nets are usually set in the afternoon, and allowed to remain in the water for several days, unless for some reason the vessel leaves the fishing ground. Even then, when the vessels have been forced to seek the shelter of a harbor during a storm, the nets have frequently been left out. Fish are caught only at night, and, consequently, the nets are underrun only in the morning, unless the men are detained by unfavorable weather until later in the day. In underrunning, the fisherman goes to one of the buoys on the end of his gang of nets, takes it in the dory, and hauls away on the buoy-line, the buoy being thrown out on the other side and the line allowed to run out on one side as fast as it is hauled in on the other. When the anchor-line (or underrunning line, as it is sometimes called) is up, it is taken across the dory, and the fisherman hauls along towards the nets. The gear is underrun by pulling the nets in on one side of the dory, and, as fast as the fish are removed, allowing the apparatus to pass over the other side into the water, the anchors which remain firmly fixed in the bottom, holding

the nets in position until the work is accomplished. When the end of the gang is reached, it is thrown off the dory, and the nets remain setting as before, needing no further attention until the next day.

As will be readily understood, this method of fishing can be carried on with the minimum of labor, and it has also this additional advantage, namely: while the gear is still out, the vessel may take her morning's catch to the market, or, if the weather is threatening, she may quietly remain at anchor over night in the nearest harbor, though, in the meantime, her nets are fishing.

Ipswich bay, where the nets have been chiefly used, more particularly in the winters of 1880-'81 and 1881-'82, lies north of the prominent headland of Cape Ann, which divides it from the waters of Massachusetts bay on the south. A sandy beach extends along the northern and western sides of the bay, and the bottom sinks gradually from this, only reaching a depth of 25 to 30 fathoms at a distance of several miles from the land. The bottom of the bay is a sloping and sandy plateau, with only here and there small patches of rocks or clay, supporting but a small amount of animal life that may serve as food for the cod. It is, therefore, a spawning rather than a feeding ground for these fish, and large schools visit the bay during the winter for the purpose of reproduction, and generally remain until late in the spring. The nets are usually set along the northern portion of the bay, only a few miles from the shore, in about fifteen fathoms of water, where there is less current than at many other points along the coast.

In this connection may be mentioned a curious fact which has been observed concerning the fish that have been taken in Ipswich bay during the past two or three winters. It is stated that a large portion of the fish caught in this bay have been netted on a small area not exceeding three-fourths of a mile in diameter. This piece of ground, I have been told by the fishermen, for a considerable portion of the season seems to be swarming with cod, while the adjacent bottom appears to be quite barren of fish. According to Captain S. J. Martin, the center of this area bears south by west from Whales-back light, Portsmouth,

and southwest by west from the light-house on the Isle of Shoals. It is somewhat irregular in outline, the fishermen say, judging from where the fish are taken, but so far as anything can be told of its physical conformation, it does not differ at all from the rest of the sandy slope immediately surrounding it. It is said that there is no "feed" on the bottom. The fishermen have a curious theory that there are fresh water springs in this particular locality, around which the cod love to gather; nor, indeed, can they assign any other reason, since there appears to be no special feature in the character of the bottom to attract the fish. So persistent are the cod in clinging to this locality, that it almost invariably follows, that nets placed within its limits come up well filled with fish, while gear that is set a dozen or twenty fathoms outside, get very few, if any, cod. The fishermen confess that it is a mystery to them, and they are exceedingly puzzled to know how the fish get there and escape the walls of netting which surround this spot in all directions. They do not believe it possible that enough cod could be there at once to fill the nets night after night for months, and they arrive at the conclusion that the fish must reach the place during the day, at which time they are supposed to rise above and swim over the nets that bar their progress near the bottom, and which of course can be seen by daylight.*

The results that were obtained from the use of nets by the "Northern Eagle" during the winter of 1880'-81 were considered very remarkable. The amount of codfish taken in the first three trials (which were made in Massachusetts bay) in unfavorable weather and with inferior nets, was 4,000, 6,000 and 7,000 pounds, respectively. On a trip ending January 11th, 35,000 pounds of cod were taken by the "Northern Eagle," 8,000 pounds of which were caught in a single morning. Two other vessels, which were absent the same length of time, fishing at the same place

* Captain S. J. Martin, writing from Gloucester to Professor Baird under date of January 7th, 1884, says: "In Ipswich bay the fish are in one place. Four hundred nets are set in a place one-half mile wide by one-half mile long. The nets are across one another. The vessels have set their nets all over the bay, but find only a few scattering fish except in that one spot. There they get good hauls every morning when there is a chance to haul the nets. * * * The fishermen think strangely of the fish being in one place. They can find nothing (there) to keep them alive.

with trawls, got only 4,000 and 8,000 pounds respectively. After that time she made another trip, taking the same amount 35,000 pounds, in four days' fishing, 18,000 pounds of which were caught in one day. On this day the schooner "Christie Campbell," of Portsmouth, set ten trawls (each trawl having 1,000 hooks) close to the nets. The 10,000 hooks caught 2,000 pounds of fish to the 10,000 taken in the nets.

The "Northern Eagle" began fishing with nets on November 27th, 1880, and as early as January 20th, 1881, she had taken 111,000 pounds of cod. None of the trawlers during that time caught more than one-third of that amount, though they were fishing at the same place. The netted fish were much larger than those taken on the trawls, averaging during the first six weeks' fishing twenty-three pounds each. Among these were individuals which weighed seventy-five and eighty pounds a piece, but there were no small fish, such as are frequently taken on trawls, and which can be sold only at reduced prices. This, it may be stated, has invariably been the case when gill-nets have been used. No immature fish or what is termed as "trash" by the fishermen, have been taken. At first the nets met with the same opposition from the trawl line fishermen that trawls did—when first introduced—from the hand-liners some thirty years ago. Notwithstanding, however, that many of the fishermen were inclined at the start to inveigh against "building a fence" to prevent the fish from moving about on the bottom, it was not long before they all began to realize the advantages of using gill-nets. It is said that whenever in port, the deck of the "Northern Eagle" was crowded with fishermen, anxious to learn about the method of capture which she had adopted. Before the close of the first winter several vessels, both from Gloucester and other ports, fitted out, to a greater or less extent, with nets. As a rule these schooners commenced their operations so late in the season that they could not make a fair test of the gill-nets, for the schools of spawning fish that had been in Ipswich bay began to leave the shore-grounds soon after the vessels began operations.

Gill-net fishing for cod and pollock opened favorably in the winter of 1882, but the shore codfish were much less abundant

during the greater part of that winter than in the previous year; and consequently the success of this branch of the fisheries was not so pronounced as has generally been the case.

Writing under date of November 15th, 1881, Captain Martin says: "I find that pollock will mesh as well as codfish. The first night the schooner "Maud Gertrude" set her nets, twelve in number, they caught 3,000 pounds of pollock and 2,000 pounds of cod. The nets were set on "Brown's" [This is a small rocky shoal lying off to the southward of Eastern point, at the entrance to Gloucester harbor]. * * * Captain Gill told me that if the nets had eight-inch meshes, they could get them full of pollock. The ten-inch mesh catches large pollock, some of them weighing 20, 21 and 21½ pounds." The nets are often very badly torn by the pollock, which is well known to be a remarkably strong and active fish.

It does not seem necessary that I should go into detailed statements of statistics of the amount taken each season, since the following instances that are given of catches made on various occasions will, I think, serve to convey a fair idea of the results obtained.

Although the winter of 1881-'82 was unquestionably the least productive of any season since the introduction of gill-nets into the shore cod fishery, we find that the catches were often of considerable magnitude. For instance, Captain Martin mentions the following facts: Early in November twelve nets set in Ipswich bay caught 12,000 pounds of cod in two nights' fishing. A little later the "Northern Eagle" landed 33,000 pounds of large cod from an eight days' trip, stocking $800, and each of her crew sharing $63. Captain Martin, writing under date of December 6th, said that during the previous week there were 145,000 pounds of codfish caught in gill-nets, and he makes this remark: "If it were not for the gill-nets we could not get fish enough to eat." He also says: "All the vessels that were fishing with trawls are getting nets."

Again on December 22nd, he states: "There were 165,000 pounds of codfish caught in gill-nets last week." This, too, was when codfish were remarkably scarce upon the shore grounds,

and when there was only a small fleet of about 25 or 30 vessels engaged in the net fishery.

The importance of the introduction of the method of catching codfish with gill-nets was more fully demonstrated than ever before in the winter of 1882-'83, and the operations carried on during that season in the inshore fisheries may be considered as having first fairly established this method of fishing in New England; since, previous to that time, there had been many persons rather skeptical as to the benefits that might be derived from the use of nets for catching cod.

Owing to the almost total failure of the bait supply in the latter part of 1882 and the beginning of 1883, it was found impracticable to carry on the shore cod fishery by the old method of hook-and-line fishing. Such a scarcity of bait had never been previously known, and if the fishermen had been ignorant of the use of gill-nets for the capture of cod, a valuable and important industry must have been almost abandoned, for that season at least, while it may be considered probable that the scarcity of fresh cod, which would have resulted, must have increased the price in our markets very materially, possibly, in some cases, to such an extent as practically to place this desirable article of food beyond the reach of the masses. But during the two previous years the New England fishermen had learned a great deal about catching codfish in nets, not only by practical experience but also from an illustrated pamphlet, containing descriptions of all the methods, which had been freely circulated by Professor Baird. The fishermen were, therefore, prepared to meet this unforseen emergency—an almost entire absence of bait. Instead of being compelled to give up the shore cod fishery, as they otherwise must have done, they met with a success which had seldom or never before been equalled. Such results were obtained by the use of gill-nets, that the local papers in the fishing ports contained frequent notices of successful catches. As an instance may be mentioned the following from the *Cape Ann Advertiser*, December 8th, entitled "The Good Results of Net Cod Fishing. On Tuesday, December 4th, boat "Equal," with two men, took 5,000 pounds of large codfish in seven nets off shore, sharing $40 each. The "Rising Star" has stocked

$1,200 the past fortnight fishing in Ipswich bay. The "Morrill Boy" has shared $101 to a man net fishing off this shore the past three weeks.

The "Morrill Boy" met with unexampled success, her crew of five men having shared $320 apiece, clear of all expenses, by the last of December, the time employed being less than six weeks.

From the port of Gloucester alone, according to Capt. Martin, there were employed in the gill-net cod fishery during December, 1882, twenty vessels, carrying 124 men and 176 nets. In the period between November 19th and the last of December, 600,000 pounds of large shore cod were landed in Gloucester, while 150,000 pounds were marketed at Rockport and Portsmouth, making a grand total of 750,000 pounds. When to this is added the amount which was probably taken by the vessels from other ports, it is perhaps safe to say that no less than 2,000,000 pounds of this highly valued and most excellent food-fish were caught in nets during the month of December and the latter part of November.

In the early part of the winter of 1882-'3 codfish were taken in nets in great abundance on the rocky shoals of Massachusetts bay. After the beginning of January, however, the fish were found to be most abundant in Ipswich bay; and, in consequence of this, the fleet of shore cod fishermen resorted to that locality, where they met with the most remarkable success, the catch during the first month of 1883 being, it is said, much larger than at any previous time. According to Captain Martin's report for January, 1883, 121,000 pounds of netted cod were landed in Gloucester during the month. Writing to Professor Baird under date of February 6th, he made the statement that "ten sail of small vessels which had been fishing in Ipswich bay, had landed at Rockport, Mass., and Portsmouth, N. H., during the previous twenty days, 230,000 pounds of large codfish." Calculating on this basis, the total catch of the whole fleet during the month of January, 1883, must have been very large.

It was not, however, until the winter of 1883-'4, that the real value and importance of the introduction of gill-nets into our cod fisheries could be fully and fairly estimated. The results

obtained during the winter of 1882-'3 had inspired the fishermen with more confidence to engage in the net fishing in the succeeding fall. Consequently, we find that the shore fishermen were prosecuting this method of fishing earlier in the season than ever before, even employing it for the capture of pollock before the winter school of cod had reached the shore grounds. This method of fishing was found especially well adapted for taking the large pollock, which generally visit, in the fall, the inshore fishing grounds in Massachusetts bay. The singular fact was also discovered that many of the finest pollock, like the cod, may be taken with nets when they utterly refuse to bite a hook, and consequently cannot be captured by the old methods.

Writing under date of October 28th, 1883, Captain Martin says: "Pollock and cod have been scarce this fall. Forty sail of small craft, which were out two days on the pollock grounds, came in with 2,000 pounds. Captain Gill, of the boat 'Gracie,' had four cod nets given him that were worn out in catching codfish last winter. He set them, together with two new ones, and the first night he caught 5,500 pounds of pollock and 400 pounds of codfish. The pollock averaged 21½ pounds apiece, while those caught on hand-lines averaged 13 pounds a piece. * * * * There are three boats which have nets set. They catch three times as much pollock and three times as much codfish as they do on hand-lines. There will be more cod gill-nets used this winter than there have been since they began to use them. * * * There are no sperling this fall, so that the most of the boats will use nets." Under date of October 31st, 1883, he gives the following statement, which shows in a most striking manner the advantages that are sometimes derived from the use of gill-nets, and, at the same time, affords us an insight into the way in which the fishermen are often induced to adopt this method of fishing. "The schooner 'S. W. Craig,' of Portland, one of the high-line pollock catchers," says Captain Martin, "was in here last Wednesday. I went aboard to see the skipper and to gain what information I could concerning the pollock fishery. The conversation ran thus: 'How do you find the pollock, Captain?' 'Pollock! there ain't none. I have been out two days with twelve men and got 2,000 pounds—that is bad enough.' I said:

'They are catching a good many pollock in nets. Do you see that small boat coming? That is Horace Wiley's; he caught 3,000 pounds the night before last, and caught as many last night. He has got nets.' 'Where does he catch them?' 'Off on a spot of rocks called Brown's.' The Captain said: 'I will get some new sperling to-night, and go off where they have got their nets set. We will give them fits, if we can get some new sperling.' I answered: 'Cap., it is no use to go where they have got their nets set. If you do, you will get no fish.' He replied: 'That be hanged for a yarn. I think you can catch fish with sperling as well as you can with nets.' I said: 'No sir, you can't do it.'

The next day he went out with some new sperling to where Wiley was hauling his nets. (The latter had picked out a dory full of cod and pollock, about 2,000 pounds). He let go his anchor close to the nets and gave the order, "all hands over lines." He lay there two hours, but did not catch a fish.

"I was aboard again yesterday and said: 'Captain, how did they bite where the nets were?' 'That beats all,' he replied; 'we never felt a bite. I am going to Boston to order twenty-five nets.'"

The boat "Gracie," which began fishing with nets the middle of October, did remarkably well; her crew made $145 a piece up to November 11th. According to Captain Martin she had landed 15,000 pounds of large cod and 30,000 pounds of large pollock, and he writes: "Some of the line fishermen have not caught as much as 10,000 pounds in the same time. * * * All the shore fishing will be done with nets this winter, as the sperling are scarce." This success had the effect to induce others to engage in this fishery, and at the date just given (November 11th) there were ten boats using nets. Each one was provided with fifteen nets, each fifty fathoms long, 2½ fathoms deep, with a 9½ inch mesh.

The first vessel to go to Ipswich bay began fishing there early in November, and on her first trip, with only five nets, she caught 6,000 pounds. By November 18th, there were 26 boats setting 390 nets in Massachusetts bay. This would make 39,000 yards of netting. Besides this there were two or three ves-

sels in Ipswich bay, and the schooner "Onward," which left Gloucester that day to go round the cape, had a gang of thirty-five nets. The little schooner "Morrill Boy," previously alluded to, set her nets for the first time on the Sunday preceding November 18th, and at the last mentioned date she had landed 43,000 pounds of cod and pollock, stocking $1,066.75. There were seven men in the crew, who shared $124 for their week's work, and this, too, when two days of the time were lost on account of high winds. On one day (Wednesday) they made $50 to a man. At the same time bait was so scarce and difficult to obtain that the hook and line fishermen could do almost nothing. Sperling, when obtainable at all, brought the high price of fifty cents a bucket-full, which was a very heavy tax on the cod fishermen. On the six days ending November 25th, 487,000 pounds of cod and pollock were taken in gill-nets set in Massachusetts bay, and during the same time four small gill-netting vessels caught 55,000 pounds of fish in Ipswich bay. Writing under the last mentioned date, Capt. Martin says that "about all the fish caught in-shore is by nets," and he also remarks that "if they could be knit fast enough the whole fleet would have nets." So urgent was the demand for cod nets at that time that many of the women at Gloucester were employed in making them. Capt. Martin tells us that "every body is at work," and he continues: "A great winter's work is anticipated." By the latter part of November the fleet of netters had increased to 35 vessels, and it is probable that a larger number might have been engaged in this fishery at that date if they could have obtained gear. The fishermen were often bothered to get nets, and on one occasion several boats had to wait four days to get a supply of glass floats which are so essential in this fishery. By the last of January the fleet numbered fifty-two vessels, which appears to be the maximum; for about the middle of March only forty-two schooners were engaged in netting, a few of the boats having probably worn out their nets, and not caring to refit so late in the season, left shore fishing to go to the outer banks, or else, perhaps, to fit out for the spring mackerel fishery. In addition to the vessels a few open boats engaged in the gill-net cod fishery last winter, and as early as December, according to Captain

Martin, five dories were thus employed from Salisbury, each having three nets.

The gill-net fishery has not been exempt from loss of gear, though, perhaps, this loss is much less than it would be if trawls only were used. In a gale that occurred January 4th, 1884, considerable property was destroyed or injured. Captain Martin reports that thirty-five nets were lost and many others badly damaged. "No fish," he says, "were caught for four days after the storm." Curiously enough, the fishermen say that they never get many fish just previous to a heavy storm, and the netters have learned by experience that a sudden falling off in the catch is generally an indication of the near approach of bad weather. Another feature of the net fishing is that, in addition to various species of the *Gadidæ* which have been taken, porpoises (locally called "puffers"), monk-fish or fishing frogs, and dogfish (*Squalus*) have been caught, though, fortunately, the latter, which are considered especially obnoxious by net fishermen, are not on the coast during the coldest weather.

In addition to the instances already given of catches made last winter, the following have been recorded. For the week ending December 9th, 1883 there were landed at Gloucester 590,000 pounds of netted fish, while 84,000 pounds were marketed at the two ports of Rockport and Portsmouth, the week's catch amounting to the total of 674,000 pounds. The following week Gloucester received 430,000 pounds, Rockport and Portsmouth a total of 81,000, and Swampscott 48,000, making a total of 559,000 pounds. This large amount was taken, too, when the weather was so unfavorable that nothing could be done for three nights and days of the week. For the week ending March 23rd, 1884, 530,000 pounds of cod that had been caught in gill-nets were landed. For the week ending March 30th, 1884, 18 vessels landed 483,000 pounds. The following statement of the total amount of fish captured by the use of gill-nets during the past winter, has been compiled for me by Mr. C. W. Smiley from the notes of Captain Martin, who has made it a special object to collect all possible statistics and information, relative to this important branch of the fisheries.

TOTAL AMOUNT OF FISH LANDED FROM GILL-NETS DURING THE MONTHS OCTOBER, NOVEMBER, AND DECEMBER, 1883, AND JANUARY, FEBRUARY, MARCH, AND APRIL, 1884, FROM THE NOTE BOOKS OF CAPT. S. J. MARTIN, GLOUCESTER, MASS.

MONTH.	COD. No. of lbs.	POLLOCK. No. of lbs.	HADDOCK No. of lbs.	HAKE. No. of lbs.	CUSK. No. of lbs.	GRAND TOTAL.
October, 1883,	35,500	573,000	45,000	36,000	30,000	719.500
November, "	1,275,500	185,000	249,000	20,300	9,000	1,738,800
December, "	1,373.000	3,000	264,000		15,000	1,655,000
January, 1884,	932.000		40.000			972.000
February, "	923,000		75,000			998,000
March, "	1.248,000					1,248,000
April, "	705.000					705,000
Total,	6,492 000	761,000	673,000	56,300	54,000	8,036,300

An important matter for consideration in connection with the cod gill-net fishery, is that not only can fishing be successfully carried on even when bait is not obtainable (for of course no bait is required when nets are used), but there is a very great saving of money and time that must be expended in procuring the bait and baiting the lines when hook and line fishing is followed. As an instance of the expense involved, it may be stated that the average bait bill of a shore trawler is not, under ordinary circumstances, less than from $150 to $250 per month, when herring are as high as they usually are in winter. It is therefore, safe to estimate that when as many vessels are employed in gill-netting as there has been during the past two winters, the money saved to the fishermen, which otherwise must have been paid for bait, could not be less than from $30,000 to $70,000 each season. Besides this, a very large percentage of the time is saved, as has been stated, that otherwise must have been lost in seeking for bait.

In pursuing the cod gill-net fishery, fishermen have been to some extent, handicapped by the rotting of their nets, and in some cases—more especially in the fall when the waters are filled with animal life—the nets have decayed very rapidly so that they have been found quite unfitted for use after being in the water for five or six weeks. While at Gloucester, last fall, I had this matter brought to my attention by fishermen, who were anxious to obtain some preservative which would prevent their nets from rotting. I addressed a letter to Professor Baird on the subject, and the result was that the matter having been

brought to the notice of Messrs. Horner and Hyde, of Baltimore, by Major T. B. Ferguson, Deputy United States Fish Commissioner, those gentlemen forwarded to Gloucester a barrel of their net preservative for the purpose of having its merits tested on the cod gill-nets. It was applied to a portion of the nets of several small vessels in January last, and after the apparatus had been in use from that time to the middle of April, sections of the net so prepared were forwarded to me at Washington, together with a statement by Captain Martin as to what the fishermen said regarding its use. Previous to this, however, I had talked with some of the fishermen concerning the nets treated with Horner and Hyde's preservative, and they asserted very positively that not only did it prevent the nets from rotting, but that they were fully impressed with the idea that a great many more fish were caught in nets so treated than in others prepared in the ordinary way. The sample of netting sent me by Captain Martin shows little sign of deterioration, notwithstanding the fact that the net from which it was taken had been in constant use for upwards of three months.

Whether future trials of this material will sustain the statements made by the fishermen who have already experimented with it, I am unable to say; but, if such should be the case, there can be no question but that a very important step has been attained through the efforts of the Commission in perfecting the work of cod gill-netting, which it commenced in American waters five years ago.*

* It is, perhaps, proper to state here that some of the North Carolina fishermen who have tried Horner and Hyde's treatment on their nets, have complained most bitterly that their gear was much injured if not almost ruined by it. I have seen copies of two letters from fishermen of the South containing such complaints. This being the case, it will, perhaps, require a longer test to settle definitely whether or not this treatment has all the merit that the Gloucester fishermen say it has, though it is altogether possible—the conditions being so very different—that what might give excellent satisfaction when properly applied and used in the ocean fisheries might prove a failure under other conditions.

In this connection it may be well to say that last winter nets cost $14.25 a piece, and that glass floats could not be obtained cheaper than 22 cents each. It will therefore be seen that a "set of gear" for a vessel carrying thirty to thirty-five nets costs a considerable sum, and if these had to be renewed every few weeks it was a material drawback to the prosperity of the fishery.

The SECRETARY then read the following letter:

WASHINGTON OFFICE
WORLD'S INDUSTRIAL COTTON CENTENNIAL EXPOSITION,
515 Fourteenth Street.

WASHINGTON, D. C., *May 13th*, 1884.

Mr. MARSHALL MCDONALD,
Chairman Local Executive Committee:

DEAR SIR:—Permit me through you to extend to the American Fish Cultural Association, an invitation to hold its next annual meeting on the grounds and in one of the buildings of the World's Industrial Cotton Centennial Exposition, to be held at New Orleans, beginning December 1st, 1884, and continuing for six months. Any time that your Association may designate for said meeting will be acceptable to the Directory, which I have the honor to represent. As there will undoubtedly be large displays of fish-culture made by both the United States Fish Commission, and by the several States interested in this great food industry, I think your Association will derive both pleasure and profit by accepting this invitation. Be assured that the Executive Managers of the Exposition will do all that in them lies to make your annual meeting next year—if held at the Exposition—a great success.

Very respectfully yours,

E. A. BURKE, *Director General.*

Mr. WORTH offered a resolution as follows:

Resolved, That if the United States Fish Commissioner makes a fishery display at the World's Exposition, that the fishermen of the country be requested to meet in convention the American Fish- Cultural Association there at its next annual meeting.

Dr. HUDSON then offered:

Resolved, That the thanks of the visiting members of the American Fish-Cultural Association are hereby tendered to the various local committees for their cordial reception, and take this opportunity to express their appreciation of the efforts which have been made to render this fourteenth annual reunion the most successful since the organization of the Association.

The PRESIDENT announced that after adjournment the Association would call upon the President of the United States, as had been arranged.

On motion the Association adjourned to meet at the call of the Executive Committee.

At 11 o'clock A.M. the members were introduced to President Arthur by Professor Baird.

At noon Professor Baird convened a meeting of the State Fish Commissioners in the office of the Assistant-director of the Museum.

THE RIVER EXCURSION.

At 1 o'clock P.M. the members of the Fish-Cultural Association proceeded in carriages to the Lower Cedar Point wharf, where they embarked on board the "Fish Hawk," one of the Fish Commission steamers, which had been tendered for the occasion by Professor Baird.

In the course of the afternoon the committee, appointed on Tuesday by the President of the Association to draw up a resolution looking to the interests of oyster cultivators, prepared their report, and shortly afterwards a meeting of the Association was called to order in the saloon of the vessel by the President.

The PRESIDENT: This meeting is called for the purpose of considering the desirability of changing the name of the Association. The present name is not considered comprehensive enough by a number of its members. After this point has been settled, we will consider any other business that may be brought forward.

Prof. GOODE: I beg to propose that the name of the "American Fish-Cultural Association" be changed to the "American Fisheries Association." I have conferred with several of the members present in order to get an idea as to what the general feeling might be in the matter. I should not have brought up this question on the present occasion but for the fact that every one with whom I have spoken, seems to be in favor of the change. I think it hardly necessary, therefore, to present all the reasons

for the proposed change. I will, in brief, say that in most of the European countries,—Norway, England, Holland, Germany and Spain,—there are "fisheries associations," "fisheries societies," and "fischerei vereins," which in scope correspond precisely to this one, and I believe that by changing its name, we shall be brought into a more appropriate relation with those sister societies, and that thereby the limitations of the Society will be more exactly represented. Of course the greater includes the less, and the change of the words "Fish-Cultural" to "Fisheries" will in no way diminish the importance of fish-culture, or of the work of those members of the Association who are more particularly interested in that special branch of the fisheries.

The President submitted a general request for the opinions of the members.

Mr. Roosevelt: I confess that the proposition to change the name of this Association has surprised me somewhat. I am not quite satisfied that the proposed name conveys to our English-speaking and American-thinking men precisely the purpose of the organization. Our Association is in reality a Fish-Cultural Association. The name "Fisheries Association" is open to various interpretations. At this moment I am hardly prepared to define distinctly what would be precisely conveyed by that expression. We certainly do not meet for the purpose of catching fish but for the purpose of creating fish. I do not think that to the English mind the word "fishery" or "fischerei" conveys the purpose of this Association at all, and it seems to me that "Fish-Cultural" is the better term. The name of this Association originally was "Fish-Culturists' Association," but that was not broad enough. Fish-culturists confine themselves exclusively to raising fish, involving practical and not scientific research. It has been suggested that many of the papers that have been read before the Association have been only indirectly connected with fish-cultural matters; but it seems to me that all of them have had a direct bearing on fish-culture. The food of fish is necessary to their cultivation and a knowledge of their uses, character and nature is also essential. I cannot see how anything that is connected with the study of fish would not come within the

limits of a Fish-Cultural Association; and when I heard of the name proposed, it occurred to me that the term "Fisheries Association" would not definitely interpret the aims of this society.

Dr. HUDSON: I have been reflecting upon this matter and would say that my thoughts in the main coincide with those of Mr. Roosevelt, although my conclusions are somewhat different. I am inclined to the opinion that the word "Fisheries Association" is rather broader than "Fish-Cultural Association," and would be more acceptable. Many men when asked to join our Association, say "I am not a fish-culturist. I do not feel as if I had any special interest in the subject," although, if they attended its meetings, they would soon discover that all kinds of fish, lobsters and oysters are described; their anatomy and physiology discussed; their food investigated; their flesh analyzed, and their organizations compared with others. It seems really as though in the term "Fish-Cultural" all the matters just alluded to cannot be strictly included, and for that reason I believe that "Fisheries Association" would be more suitable. It is the term most generally employed in Europe, and I think it is the best for us to adopt.

Mr. PIKE: I think the proposed change of name is one which should commend itself to this Association. According to my view, the Association has outgrown its original purposes. Its primary object was to bring into closer relations those who were immediately engaged in the artificial breeding of fish; and when the fish commissioners of the several States were invited to join, some, I know, declined, because they were not fish-culturists or fish growers for gain. But all this is changed now; the aims of this Association have gradually become more expanded and elevated—embracing everything that pertains to food fishes in all their manifold relations. This is seen in the great variety of topics which were presented for discussion during the session of the Association. Strictly speaking, Professor Atwater's excellent paper would not have been an appropriate one before an association of persons devoted simply to the best method of cultivating and increasing food fishes. And yet it was one of the most acceptable papers presented; and it was acceptable because

the members of the Association have learned to take broader and more comprehensive views of the subject of fisheries. In a word, this Association has outgrown its name—and it needs to adopt a name that will more truly, more significantly, indicate its present commendable objects and studies. I think the term "Fisheries Association" would accomplish this. It may be adopted with or without the definite article "the;" but I would prefer to call it "The American Fisheries Association."

Mr. WORTH: Mr. Chairman and gentlemen: I have felt in my work that I needed the hearty co-operation of the fishermen, and I have endeavored to bring about a more intimate relationship between them and fish-culturists. I have found in North Carolina that the fishermen were fighting the work, and at the Exposition which we propose to hold there this fall, I have already organized in the State a movement which will bring about a "fisherman's convention," which will hold its sessions in October, at which time I hope to display the fishery industries of North Carolina. With regard to the change of name, I think that the term at present in use is rather narrow. Several special subjects have been taken up at our recent sessions which are not fish-cultural, and yet if we call it "The American Fisheries Association" we drop rather beyond the line where we want to go. As Colonel McDonald said to me, we are a kind of protective association of the fisheries. We not only want to propagate fish, but to perfect the system of fishing, and the methods of preparing and marketing them; all of which considerations have direct bearing upon the name by which our Association should be known. While it is desirable that these various questions should have their place with us, it seems to me that the proposed name is rather a broad departure from its present anchorage. I think the name should be broader and more comprehensive than at present, but I am rather opposed to calling it "The American Fisheries Association." I can suggest nothing better, I admit, but it seems as if there must be some intermediate and appropriate name. The term "Society" strikes me as more suitable than "Association." If manufacturers and fishermen be allowed to come in, I am somewhat afraid that they will overbalance en-

tirely the fish-cultural element. I am opposed to changing the name to "The American Fisheries Association," but there is an intermediate name if we could just hit on it.

Col. McDonald: I have no opinion to express beyond what has already been expressed by Mr. Pike. I agree with him fully.

Mr. Evarts: I somewhat disagree with my friend Mr. Roosevelt. I would suggest something covering the same idea, but how it will sound I cannot say—"The Fish Interests Association"—I don't know whether that would be intelligible or not.

Mr. Willcox: I feel as if it were desirable to change the name, judging by what my feelings were when I was asked to become a member. I said: "I am not a fish-culturist, although I am interested in its scientific relations." I thought I would be "out of my latitude" in the territory of this Association. But judging from what I have seen and heard since I have been a member, I now believe that the Association has outgrown the purpose of its original organization. I think the time has come when the name should be changed; but I am not prepared to suggest a substitute, as I have not considered the matter sufficiently.

Mr. Stone: I do not know that I have much to say. I think the considerations on both sides are of about equal weight. When Professor Goode asked me if I objected to the change being made, I said I had no objection, but since Mr. Roosevelt has spoken on the other side, I can say that the change of name would I believe, radically change the purpose of the Association. I think it would be rather a pity to do that. Perhaps I am more sensitive on the subject than some of the others, because I happen to be the one who drew up the constitution under the old name. If, however, the change is thought to be for the interests of the Society, I don't think I should offer any objection, but I think it would be a good plan to let the matter lie over for a year, until we have given it more thought.

Mr. Mather: I feel like saying a few words. I think with

Mr. Stone that if we could offer a name that would embrace the whole purpose of the Association—perhaps "The American Fish, Fisheries, Oyster, Lobster, and Fish-Cultural Association"—it would be well, but it would take a great deal of ink. I should prefer to call it a "society," because there are fewer letters in it than in "association," and the Secretary has less writing to do. As a fish-culturist, I do not like to see the idea of fish-culture lost sight of or made to take a second place. That was the main purpose of the Association at its birth, and I believe that Mr. Stone and I are the only two original members left. I agree with Mr. Stone's suggestion that the matter lie over for a year. I object to any change whatever, because we are well known by our old name and under it, have taken in all questions which we can under the proposed new one. If at a future meeting there should be a majority of net-makers, they might wish to again change the name to include their business. I have grown up with the Association under its old names, and it seems to me suicidal to make a change. It is like exchanging a tattered flag that we have fought under for one just out of the shop. I can readily see how new members may desire a change, but I cannot approve it.

Prof. GILL: Although I may not be a member of this Association, I have no objection to speak, as I am requested. I am rather inclined to disagree with that old proverb that a rose under any other name smells equally sweet. I think Mr. Roosevelt has given a good argument for changing rather than keeping the name. He has well remarked that the Association has developed from a fish-culturists' association into a fish-cultural association, and that it is still in progress of further development; and it seems as though it would be merely following a natural sequence to enlarge it still further and call it "The American Fisheries Association." As regards the preference of the word "association" or "society," I should be disposed to retain the old name, because we are apt to recognize a "society" as a local organization, while this is rather a peripatetic body. It would then be on a footing with the "American Association for the Advancement of Science," and others which are also peripatetic

in their habits. I should, therefore, be in favor simply of changing the name to "American Fisheries Association."

Dr. H. H. Cary: It occurs to me that the name might be made a little more comprehensive, and it seems to me that a change is desirable. In that view, I venture to throw out a suggestion, and ask how it would do to call it "The American Fish-Cultural and Protective Association." We need protection as much as anything else. There are as many poachers of fish as of game.

Mr. Endicott: I have listened to the interesting papers that have been read at many annual meetings of this Association, and have as yet seen nothing to prevent a member from introducing any matter that pertains even in the remotest degree to fish or fisheries. Nor do I suppose we shall ever have any difficulty in that particular. Consequently I see no reason for changing the name. I do not think that we have grown so large that we should be ashamed of the old colors. I am in favor of retaining the old name.

Mr. Roosevelt: I propose to let the matter lie over for a year. If you change the name to "Association of Fisheries," people would regard it as composed of fishermen. It would narrow our aims instead of broadening them. If we could agree on an accurate and satisfactory substitution, I would not object. I move that the subject lie over for a year, or until the next meeting of the Association.

Prof. Goode: Mr. President: I have no personal feeling in the matter, but it seems to me that there has been a little misapprehension of the significance of the term "fisheries" as used in the literature of the present time. We have had last year in London the International Fisheries Exhibition, the classification of which corresponded to some extent with the scope of this society, and was much broader than this institution at the present promises to be. The word "fisheries" is used in the broadest sense by a great many writers upon fishing topics. "Fishery" is a very different word. The word "fisheries," as in Germany and France, takes in the whole subject of economy in fishing, and

includes protection, propagation, proper methods of carrying on the fisheries, and embraces all the subjects that have been discussed by this Association during the past two or three years of its history, in which interval the scope of the Association has been much wider than in previous years. I have not the slightest objection to voting for a deferment of the consideration of the subject, but fail to see what can be gained. I think such action will retard the Association in its march of progress just twelve months.

Prof. GILL: I would suggest that the furtherance of the fisheries is the object of this Association, as I understand it, and fish-culture is simply a means by which this objective can be obtained. Now I think that the work of this Association naturally includes a very wide field of investigation, and therefore am of the opinion that the term "fish-culture" is decidedly too narrow in its meaning. If fish-culture is its limit, then to be logical we would have to eliminate a good deal that has been done by this Association; in other words, we should have to call a halt, put down the brakes, and put back the work of the Association a good deal behind that point which it has already reached. This organization began in a small way—as a fish-culturists' association;—it became naturally developed in the course of time into an association that took cognizance of all that related to fish-culture, and it has now developed beyond that point, embracing in its aim all that is useful for the fisheries. It seems to me consequently that, if it be desired to have a name which is expressive of its present aims such a change as is proposed, namely, to call it the "American Fisheries Association," is decidedly preferable.

The PRESIDENT: Gentlemen: Are you ready for the question? The first vote will be on Mr. Roosevelt's amendment.

This was taken and lost.

Mr. ROOSEVELT: I recommend the word "society" instead of "association."

Prof. GOODE: I accept this amendment, and am willing that it should be called "The American Fisheries Society."

Mr. MATHER: I would really like to ask whether it is parliamentary, after this Association has adjourned, and some of its members have gone home, to hold this meeting here. I object to all the proceedings of this meeting as being irregular.

The PRESIDENT: I shall rule it in order, as the Association has no order of business. Besides, Mr. Mather has taken part in the discussion, and therefore has no right to object to the meeting as an irregular one.

Col. MCDONALD: It is the largest attendance we have had throughout the whole meeting.

Mr. MATHER: But the regular meeting adjourned this morning.

The PRESIDENT: The last amendment has been accepted that the name shall be changed to "The American Fisheries Society."

Prof. GOODE: I would like to ask one question. Supposing the wish of the majority be to retain the old name, "Association?'

The PRESIDENT: The amendment has already been accepted. We will now vote upon it.

This was taken and carried.

The PRESIDENT: The future name of this Association is "The American Fisheries Society."

Mr. MATHER: It has been suggested that, in order to put ourselves on an equality with similar bodies in other countries, and carry on an exchange of publications, this Society should have, in addition to its regular members and honorary members, one or two of the leading men connected with the fisheries and fish-culture in each foreign land as corresponding members, to whom our reports shall be sent. It was complained to Professor Goode, while in Europe last summer, that our publications were not to be had. Several people wanted to know what we were doing, and we want to know what they are doing. Therefore, at the suggestion of Professor Goode, I make a motion that this Society add to its list of members and honorary members, certain

corresponding members to be elected from among men who are prominent abroad in connection with fisheries and fish-culture.

The PRESIDENT: Is that motion seconded?

Mr. ROOSEVELT: I second it, but would put it in a different form—That the Executive Committee be empowered to select correspondents abroad in connection with foreign societies.

Mr. MATHER: I withdraw my motion.

Col. McDONALD: Before the motion is put I beg to say, that the object to be attained in the election of corresponding members is that the Association may be promptly informed of the progress of fish-culture abroad, and be kept in close relations and correspondence with societies whose aims are similar to ours.

An election as corresponding member is, moreover, a compliment to the distinguished gentleman who may be selected, inasmuch as it is a recognition of eminent services rendered to fish-culture, or important investigations germane to it.

The compliment of election will in my opinion be more distinguishing if made by a vote of the Society, rather than by designation of the Executive Committee, and I propose therefore, to amend this resolution of the honorable commissioner from New York by requiring the election of corresponding members to be by vote in open meeting.

Neither resolution or amendment, however, are in order until we by resolution provide for a class of corresponding members.

Under our present organization, only two classes of members are specified, viz.: honorary members and ordinary members.

I beg therefore to submit the following resolution, viz.:

Resolved, That persons in foreign countries who have made themselves conspicuous by services to fish-culture or by investigation of questions relating to fish-culture and the fisheries, may, upon nomination duly made, be elected corresponding members of the American Fisheries Society, with all the privileges of members, but without liability for initiation fee or annual dues.

Prof. GOODE: I second the proposition.

The PRESIDENT: If there is no objection to Colonel McDonald's motion we will proceed to vote on it.

This was taken and carried.

Mr. MATHER: The following names have been suggested, on consultation, as persons who should be elected as corresponding members of this Society.

Capt. N. Juel, Norwegian Royal Navy, President of the Society for the Development of Norwegian Fisheries, Bergen.

S. Landmark, Inspector of Norwegian Fresh-water Fisheries, Bergen.

Dr. S. A. Buch, Christiana, Norway, Government Inspector of Fisheries.

Prof. G. O. Sars, Christiana, Norway, Government Inspector of Fisheries.

Dr. Oscar Lundberg, Stockholm, Sweden, Inspector of Fisheries.

Baron N. de Solsky, Director of the Imperial Agricultural Museum, St. Petersburg, Russia.

Prof. B. Beneke, Commissioner of Fisheries, Konigsberg, Pomerania.

Prof. T. H. Huxley, H. M. Inspector of Fisheries for Great Britain.

Edward Birbeck, Esq., M. P., President National Fisheries Association of Great Britain.

Sir James Gibson, Maitland, Bart., Sterling, Scotland.

R. B. Marston, Esq., Editor of the *Fishing Gazette*, London.

Dr. Francis Day, F. L. S., late Inspector General of Fisheries for India.

Thomas Brady, Esq., Dublin Castle, Inspector of Fisheries for Ireland.

Archibald Young, Esq., Edinburgh, H. M. Inspector of Salmon Fisheries for Scotland.

Arthur Fedderson, Viborg, Denmark.

Prof. A. A. W. Hubretcht, Member of the Dutch Fisheries Commission and Director of the Netherlands Zoological Station.

M. Raveret Wattel, Secretary of the Societe d'Acclimatation, Paris.

Don Francisco Garcia Sola, Secretary of the Spanish Fisheries Society, Madrid.

Prof. E. H. Giglioli, Florence, Italy.

M. A. Apostolides, Athens, Greece.

William Maclean, Sydney, President of the Fisheries Commission of New South Wales.

The PRESIDENT: You have heard the names which have just been read. We will now vote on them.

This was taken and carried.

The PRESIDENT: The Committee on the Oyster Resolution will please report.

The COMMITTEE has the honor to report:

WHEREAS; The oyster industry of the United States exceeds all other fisheries in the number of its employees, capital invested, and value of its products, which are not articles of luxury but a veritable food supply; and it having been shown that this important industry is in danger of extinction; and it being the opinion of this Association and of all competent persons, that the preservation of the industry and the increase of the supply of oysters is dependent upon artificial extension of the present oyster-area, which extension can only be achieved through private ownership and cultivation of oyster ground, therefore be it

Resolved, That this Association most earnestly recommends the adoption of the principle of individual ownership of oyster grounds, that the oyster culturist may possess the surety of gathering the results of his labors. And it is likewise the opinion of this Association that an investigation of all the conditions affecting the life of the oyster is eminently desirable and should be immediately undertaken. And furthermore be it

Resolved, That a copy of this preamble and the resolution be forwarded to the Governors and legislative assemblies of the oyster producing States, and that copies also be transmitted to the President and Senate and the House of Representatives of the United States.

Lieut. WINSLOW added: I am also instructed to move the immediate adoption of the preamble and resolution.

Mr. ROOSEVELT: I question the propriety of the resolution that has just been read. I beg that it may be read again.

WHEREAS, The oyster industry of the United States exceeds all other fisheries in the number of its employees, capital invested, and value of its products, which are not articles of luxury but a veritable food supply, and it having been shown that this important industry is in danger of extinction; and it being the opinion of this Association and of all competent persons, that the preservation of the industry

and the increase of the supply of oysters is dependent upon artificial extension of the present oyster-area, which extension can only be achieved through private ownership and cultivation of oyster ground, therefore be it resolved, etc.

Lieut. WINSLOW reads preamble, and adds: The demand for oysters has far outgrown the supply. No remedy is likely to be of any practical value which does not have in view an increase of the supply, and upon that principle the preamble is drawn. It sets forth that an extension of the oyster area is necessary, and it has been proved by the experience of every oyster community and country in the world, that an extension of the area and increase of the industry has resulted only when private individuals have taken it into their hands. The only government that ever attempted it was the French government, and if you look at the translations on this subject by the Fish Commission, you will see that one of the most eminent of authorities says that the failure of Coste's efforts was due to the fact that the government attempted to go into the oyster business, and that oyster culture was made a success only when private individuals undertook it. A private oyster area is certain of a most conservative treatment, for it can be handed down to the descendants of the owner. Ownership begets that most powerful influence, self-interest, upon which success depends. If money is needed for its cultivation, money can be raised on it by mortgage. I am not alone in this opinion. It is supported by the experience of all other fisheries, and by gentlemen who have had greater experience in the elaboration of details than I. That being, then, the essential principle upon which depends the extension of the oyster areas, the committee thought it more advisable to deal with that alone, and leave the details to be decided by the legislatures of the different States. I do not think that this Society wishes to commit itself in this matter, other than to advise the adoption of a principle, as I have already explained.

Mr. WILLCOX: I favor the resolution; but, if I were participating in the legislation concerning the subject, I should provide that the owners should only have the exclusive use of the areas for the cultivation of oysters; and only as long as they use them for that purpose. I shall vote for the resolution.

Mr. EARLL: It is not my purpose, in calling out a discussion of this resolution, to oppose any legislation that may prove beneficial to our oyster interests as a whole. It should, however, be remembered that this Society is national in its scope, and that any resolutions tending to affect legislation without limit as to locality, should not receive its sanction until it is clearly proven that such resolutions are for the best interests of the industry when taken as a whole. Several gentlemen familiar with the oyster interests of the New England and Middle States are present, and, as I understand, heartily approve of the adoption of the resolution for these regions.

But the oyster interests vary greatly with the locality, and laws of unquestionable benefit for one portion of the coast might work disastrously in another.

As one who has given considerable attention to the oyster interests of our South Atlantic and Gulf States, I cannot believe that the adoption of the resolutions proposed would be a benefit to that region. On the contrary, I am strongly of the opinion that they would have an injurious effect.

Our entire coast between Cape Henry and Mexico, including the thousands of miles of coast line along the numerous sounds, bays, and tide creeks, are literally alive with oysters, and yet, in all this region, the oyster interests are absolutely undeveloped. There are not half a dozen places along this entire coast that have a shipping trade in oysters of any importance, and yet the oysters are so abundant that men can wade about in the shoal waters, and pick up boat loads of them in a few hours, often finding them in bunches larger than they can lift. In North Carolina, for example, oysters are so abundant that some of the fishermen find profitable employment in securing vessel loads of them, and carrying them to the river landings in the agricultural regions and selling them for fertilizing at three to four cents a bushel. I feel safe in the statement that there is not one city between North Carolina and Mexico, where, with proper attention, the oyster interests could not be increased fifty-fold without endangering the natural supply.

What we most need in this region is more encouragement of

the oyster interests, rather than legislation having a contrary effect.

Lieut. WINSLOW: Please explain how a resolution which is an incentive to individual cultivation of oyster area or propagation of oysters, and to an increase of the oyster supply of the market, is likely to result disastrously.

Mr. EARLL: The resolution urges the principle of private ownership of oyster beds, and does not exclude the natural beds from such control. The natural beds in the South are capable of furnishing many more oysters than are now taken. If the principle of private ownership were adopted here, the best beds would naturally come under the control of individuals, who could neither utilize them, nor allow their less fortunate neighbors to do so without charge. Many of the poorer fishermen would be thus shut out from the best localities, and would be put to inconvenience in being obliged to go further from home to obtain a supply. In addition, many of the farmers living five to twenty miles from the shore, who now make occasional visits to the coast to gather a supply of oysters for distribution among their neighbors, would meet with opposition from the oyster monopolists, and a large quantity of food would thus be lost to the country.

I believe that, as a rule, it is not best to introduce the principle of private ownership until the national supply of oysters is endangered; and even then it would seem unwise to give a man control over more ground than he is willing to keep up to its full limit of production, and work regularly.

Mr. PIKE: I heartily concur in both the preamble and the resolution. I do this not alone theoretically, but from practical experience.

As I understand the resolution, it is not designed to exclude those who get their living from the natural beds; but simply to encourage private enterprise and systematic effort to develop the growth of oysters where they are obviously disappearing. This can be done without interfering with the natural beds to any serious extent. There is room enough for both classes of oystermen to work, and work profitably. The States of Mary-

land, Delaware and Virginia are suffering from a rapid depletion of their oyster beds. Something must be done to stay the waste, and this Society believes that this resolution embodies a method which will meet the difficulty. The poor man will continue his wasteful ways of gathering oysters from the natural beds; while those who wish to pursue the better ways of private cultivation will have an opportunity to do so, and will be protected by the law in the product of their labor. We have adopted this plan in Connecticut, and we find that both classes of oystermen get along together harmoniously and prosperously. Indeed the poor oysterman finds his best customers in the cultivators. The result is that the oyster industry of Connecticut has grown beyond all anticipation, and we have ten-fold more oyster cultivators to-day than we had ten years ago. This is the direct result of the system set forth in the resolution. Why; our Connecticut growers are now shipping thousands of bushels of oysters every week to Baltimore. This may be exceptional. We do not expect to compete with the Southern growers, but we can see that our system is greatly improving our industry, and giving us unusual advantages in the market. This Society can safely recommend such a system to the States named. I advocate this on theoretical and on practical grounds. I hope the resolution will be adopted. The poor men are not to be driven off the natural beds. They can gather the products of the natural beds as heretofore. The resolution simply proposes to encourage another class of oystermen who will cultivate private tracts. They will occupy but a very small part of the oyster grounds of these States—so small a part, indeed, that there can be no interference with the poor men, and there is not the slightest danger that they will be excluded from the natural beds.

Mr. Roosevelt: A year ago I sailed from Charleston, S. C., through the inland waters to Florida, and was astonished at the oyster resources of that part of the country. For a thousand miles I sailed between masses of natural oyster beds that at low tide were six feet high. In our localities at the North we have to bear in mind that in establishing oyster beds it is necessary to supply them with seed, which can only be obtained from pub-

lic beds, or by importation. Shut up the public beds or make them private, and you shut them out of competition. So I suggest these words as an amendment to the resolution: "That in approving private ownership in oyster lots, we do not recommend that the natural beds should be so appropriated."

Lieut. WINSLOW: I object to the amendment. I think it would be unwise to embarass the enunciation of the general principle with any particular applications of it. That is a province which perhaps we have no right to enter. I should, therefore, speaking for the committee, prefer to see the resolution adopted as it stands, thinking it would better accomplish our end—that is an extension of the oyster area and an increase of the supply of oysters.

Mr. EARLL: I second Mr. Roosevelt's amendment.

Lieut. WINSLOW: I move to strike out the amendment made by Mr. Roosevelt. This preamble and resolution have been very carefully drawn, and are simply the enunciation of a general principle. As I explained, we want the supply of oysters increased, and that can be done only by an extension of the area. The extension can only be accomplished through the efforts of private individuals, which efforts will be exerted only when those individuals have a proprietary interest in the beds. We should not in the same resolution enunciate a principle and recommend only its partial application. Let others decide that.

The motion to strike out Mr. Roosevelt's amendment was put, resulting in a tie.

The PRESIDENT: I move to strike it out.

The amendment was therefore cancelled.

Mr. PIKE: I beg to offer this amendment.

[This amendment was never delivered to me, and a letter to Mr. Pike asking for a copy of it has never been replied to.]

RECORDING SECRETARY.

Lieut. WINSLOW: I object to this amendment on the general principle already stated.

Mr. Earll: I think that the resolution will tend towards the monopolizing of individual beds.

Prof. Gill: I think it is unnecessary to add anything whatever to, or make any change in the resolution.

The President: We will now vote on Mr. Pike's amendment.

This was taken and lost.

The President: We will now vote on the original motion.

This was taken and carried.

The meeting then adjourned.

TREASURER'S REPORT.

DR. AMERICAN FISH CULTURAL ASSOCIATION in acct. with E. G. BLACKFORD, Treas. CR.

1884.			
To balance due Treasurer as per last report, - - - -	$89 55	By amount received for dues since last report	$393 00
Jan. 11th, To cash paid for stamped wrappers,	4 20	Balance in Treasury. - - - -	205 75
22nd, " " J. M. Davis, for printing reports, etc. - - -	91 80		
May 9th, To cash paid for postage to date,	1 70		
New York, May 18th, 1884.	$187 25		$187 25

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