PROCEEDINGS

OF THE

American Fish Culturists' Association

AT ITS THIRD ANNUAL MEETING,

FEBRUARY 10. 1874.

ROCHESTER, N. Y.
EVENING EXPRESS PRINTING AND ENGRAVING COMPANY.
1874.

OFFICERS.

R. B. ROOSEVELT, - - - - - President.
160 Broadway, New York City.

GEO. S. PAGE, - - - - - Vice-President.
10 Warren Street, New York City.

A. S. COLLINS, - - - - - - Secretary.
Caledonia, Livingston Co., N. Y.

B. F. BOWLES, - - - - - - Treasurer.
Springfield, Mass.

EXECUTIVE COMMITTEE.

H. J. REEDER, - - - - - - Easton, Pa.

M. C. EDMUNDS, - - - - - Weston, Vt.

ALEX. KENT, - - - - - Baltimore, Md.

W. F. WHITCHER, - - - Ottawa, Ontario, Canada.

SETH GREEN, - - - - Rochester, N. Y.

REPORT.

TUESDAY, FEB. 10, 1874.

The third annual meeting of the American Fish Culturists' Association was held on Tuesday, February 10th, 1874, at the office of George Shepard Page, No. 10 Warren street, New York City.

The Association was called to order at 11 o'clock, A. M.

The President of the Association being absent, on motion of A. S. Collins, Hon. Robert B. Roosevelt was called to the chair. Mr. Roosevelt gave thanks for the honor, and made some interesting statements about the operations of the N. Y. State Fish Commissioners, especially with regard to the shad and the whitefish.

The record of the last meeting was read and approved.

The report of the Treasurer was read and accepted. (The papers read at the meeting are printed with this report.)

The Secretary read a paper by Mr. Charles G. Atkins, on Salmon Breeding, at Bucksport, Maine.

All those present interested in Fish Culture were invited to participate freely in the discussions.

On motion of Mr. George Shepard Page, the "Forest and Stream," of New York, was made the official paper of the Association.

Hon. Spencer F. Baird, U. S. Commissioner of Fisheries, gave a general description of his work for the year.

Mr. J. W. Milnor read a paper by Nicholas Pike, on the Gourami.

Mr. Livingston Stone read a paper on his recent experiments in collecting salmon eggs in California, and on the food fishes of the Pacific coast.

On motion of Mr. F. Mather, the constitution was so amended that the list of officers should include a Vice-President.

Messrs. Green, Porter and Kent were appointed a committee to make nominations for the ensuing year.

Recess—One half hour.

Mr. B. F. Bowles gave some description of Mr. Stone's Aquarium Car.

Mr. James D. Brewer laid before the meeting a description of a new fishway.

Col. James Worrall, of Pennsylvania, read a paper on Fishways, &c.

The committee on nominations reported the following:

For President—R. B. Roosevelt.

" Vice-President—George Shepard Page.

" Secretary—A. S. Collins.

" Treasurer—B. F. Bowles.

" Executive Committee—H. J. Reeder, M. C. Edmunds, Alexander Kent.

The report was adopted.

Mr. Seth Green read a paper on Fish Culture.

Mr. Samuel Wilmot, of Newcastle, Canada, made an address on the artificial hatching of the commercial fish of this continent.

Mr. Seth Green made some remarks on carrying live fish.

Mr. Alexander Kent gave a narrative of his experience in the transportation of fish.

Hon. W. F. Whitcher, of Ottawa, Canada, spoke of fish progress in Canada.

On motion of Mr. Stone, all those who had paid $5.00, and signed the Constitution, were made members of the Association without further action.

Adjourned till 10 A. M., Wednesday.

WEDNESDAY, FEB. 11, 1874.

Association called to order at 11 A. M.

Mr. F. Mather spoke of the safe transportation of fish, and gave his personal experience.

Mr. A. B. Lamberton spoke of his observations of the undeveloped eggs of birds.

Mr. H. J. Reeder reviewed the operations of the Pennsylvania Fish Commissioners, with some very interesting remarks on the Bass.

Mr. Charles Hallock, editor of "Forest and Stream," spoke of the necessity for some uniform protection law for game and fish.

An interesting discussion followed about Bass, in which Messrs. Green, Reeder, Wilmot and Roosevelt took part.

Mr. Goldsmith, chairman of the Fish Division of the Centennial Exhibition at Philadelphia, made a request that this association should co-operate with his committee.

An article on Frog Culture, by Seth Green, was read by the secretary.

Recess—one half hour.

On reassembling, Mr. B. F. Bowles offered the following resolution:

"Recognising the importance of co-operation between the different states to secure laws for the better preservation of useful food fishes and birds,

Resolved, That this association use its influence to procure the passage of laws in the several states that shall be identical in their objects and purposes, to better preserve and promote the increase of all the game birds and useful food fishes." Adopted.

Dr. Edmunds, of Vermont, spoke of the introduction of salmon into Lake Champlain, &c.

A discussion on food for fish followed, in which Prof. Baird, A. S. Collins, Alexander Kent and others took part.

Mr. E. Blackford, of Fulton market, New York, spoke of the demand for trout, and gave statistics of prices and supply of trout and other fish. He said that the demand was greatest for cultivated trout, and that they brought the highest price in the market.

Mr. S. Wilmot spoke of the increase of the salmon in the Miramichi.

Hon. W. F. Whitcher explained the fact more fully, and gave some very interesting statistics of the Salmon Fisheries of Canada.

Mr. H. J. Reeder moved that the Constitution be amended by striking out the last paragraph of Article II. Carried.

The President, Vice-President, and a third to be selected by them, were appointed a committee on programme for next meeting.

On motion of Mr. G. S. Page, the executive committee was made to consist of five, and Messrs. Whitcher and Green were elected to fill vacancies. Moved that the Secretary and Treasurer be authorized to have the report of the Convention printed. Carried.

Mr. George S. Page moved to amend Article II by striking out the words "All Fish Culturists," and inserting the words "any person." Carried.

Moved and carried that the Secretary be instructed to ask the Fish Commissioners of the various states to send to the next annual meeting a number of their reports for distribution.

On motion, the convention adjourned, to meet in New York on the second Tuesday in February, 1875.

A. S. Collins,
Secretary.

TREASURER'S REPORT.

DR.

Balance on hand Feb. 11th, 1873	$29 08
Eleven Memberships	55 00
	$84 08

CR.

Paid Argus Company for printing Report for 1873	$57 50
Printing programme and receipts	4 75
Postage and Stationery	3 00
Balance on hand Feb. 10th, 1874	18 83
	$84 08

B. F. BOWLES,
Treasurer.

CONSTITUTION.

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.

Any person shall, upon a two-thirds vote of the society, and a payment of five dollars, be considered a member of the Association, after signing the Constitution.

ARTICLE II. OFFICERS.

The officers of the Association shall be a President, a Vice-President, a Secretary and a Treasurer, 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 as any regular meeting.

REMARKS OF HON. ROBERT B. ROOSEVELT.

In thanking you for the honor you have done me in asking me to preside over the deliberations of the Fish Cultural Association, I cannot do better than explain what has been done by the Fishery Commission of the State of New York. I do this with no purpose of arrogating praise to myself and with no expectation of giving instruction to gentlemen as experienced as yourselves in this special line of knowledge, but with the intention of informing the public of what has been effected, and encouraging the skeptical to go and do likewise.

The New York Fishery Commission was created by an act of the Legislature, passed April 22, 1868. Its first duty was to examine the condition of the fisheries of the State; these were found to be much run down, and in some cases practically exhausted. Salmon no longer entered the streams that flow northward into Lake Ontario on the St. Lawrence, and which once abounded with them: white-fish, salmon-trout, pike-perch and the other fish of Lake Ontario were much less abundant than they had been, while even the shad fisheries of the Hudson were so greatly deteriorated that the fishermen were in many instances abandoning them, and allowing their nets to remain idle.

I think it may safely be asserted that but for the efforts of the Commissioners in restoring the supply and in restocking the river, the shad fisheries would have been wholly abandoned before this. As it is, the dearth of fish has been so great that the Commissioners have never been able to obtain one quarter as many mature fish on the spawning beds as they desired, and hence have effected much less good than they would have done if a sufficient number of eggs could have been procured.

In the spring of 1868 preliminary operations were commenced for shad-hatching on the Hudson, but preparations were necessarily delayed till so late that little was achieved beyond making a commencement. It may be said that about one million of young shad were hatched that year and safely turned loose in the upper waters of the river. Not enough to produce any perceptible effect. In 1869 about fifteen million shad were hatched on the same stream, and from 8,000,000 to 10,000,000 have been hatched yearly since; very much less than the Commissioners would have raised if the proper number of spawners were to be had, but as many as can be promised until the Legislature shall see fit to pass a law as requested by the Commissioner, to establish a weekly close time and forbid all shad fishing from Saturday night till Monday morning. In all some 50,000,000 of shad have been deposited in the Hudson and the yield of fish has been greatly increased in consequence. The price has fallen in our markets to a marked degree, and this valuable species of

food has been brought within the reach of a large class of our people whose poverty previously prevented them from purchasing it.

The New York Commissioners claim the credit to have been the first to cultivate white-fish artificially. In 1868 Mr. Seth Green, then one of the Commission, obtained a number of white-fish eggs and experimented upon them in various ways and subjected them to various conditions of water, manipulation, and so forth. He then established the fact that they could be hatched in substantially the same manner as trout. The eggs were smaller and more delicate, as were the fry also when brought into existence, but otherwise there was no important difference. As the white-fish of the great lakes had been almost exterminated by indefatigable pound fishing, the importance of this discovery was appreciated and it was determined to utilize it as far as possible.

The following year large quantities of the ova were taken and distributed throughout the State to all persons who would hatch them, as there was at that time no State hatching house. Some however remained and these were matured under the care of the Commissioners. In the following year about one million of eggs were obtained and distributed in the same way, but it was not till 1871, when the State Hatching House was completed, that any great strides were made in the increase of this fish. Then some two million white-fish and about an equal number of salmon-trout were hatched and distributed, and from that time to this from two to five millions of each of these varieties have been hatched regularly every year.

The Commissioners also distributed a large number of black bass, pike-perch, rock-bass and other valuable fish and restocked many of the lakes in this State. They have sent one or more of these varieties wherever they were wanted and in sufficient numbers to meet all demands. I may safely say that the rivers, lakes, ponds and streams in this State are in a fair way of being all thoroughly restocked, and I take pride in saying that this has been done at a cost which is absolutely trifling. The Commissioners receive no salary, and their expenditures have scarcely, if at all, exceeded $5,000 a year, while the amount of fish-food produced must have been worth millions of dollars. They have sought to perform these duties in a thoroughly practical, business-like way and show a substantial balance to the credit side of their account.

In conclusion, there is one matter which I wish to submit to you, gentlemen, as practical fish culturists, that is, the advisibility of a rotation of crops in fish as in agriculture. We all of us know that when a pond is first built it is remarkably productive and the fish grow rapidly. This has been frequently remarked on Long Island in the building of trout preserves. It has also been noticed in many instances where new varie-

ties have been introduced into waters only partially filled by common sorts and where they have propagated surprisingly. If it is universally true, it is due, I think, to the fact that the enemies of the new species do not exist, while their food, if the locality is adapted to them, is abundant. Subsequently the enemies increase, by which the food is consumed, and so in time the general equipoise of nature is established. I make this suggestion, as, if it is well founded, it is of importance in increasing the supply of fish food, and may either be confirmed or disproved by your experience.

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SALMON BREEDING.

The Introduction of Eastern Fish into the Waters of the Pacific Slope, together with an Account of Operations at the United States Salmon Breeding Establishments on the McCloud River, California.

BY LIVINGSTON STONE.

Mr. President, and members of the American Fish Culturists' Association:

GENTLEMEN:—With your permission I will make a slight deviation from the terms of the subject which has been assigned me, and will endeavor to give an account both of my operations in California in procuring salmon ova, and also of the attempt to introduce other varieties of fish into the waters of the Pacific slope.

SEASON OF 1872.

As many of you are aware, I arrived at the spawning grounds of the Sacramento salmon too late year before last to obtain more than a few thousand eggs, which were duly shipped eastward, and have since been hatched and placed in the Susquehanna River, where I am informed they thrive remarkably well.

After the spawning season of 1872 was over I intended to go to Oregon and examine portions of the Columbia River, with a view to learning what were the facilities there for procuring salmon eggs.

INTRODUCING WHITE FISH (*Coregonus albus*) INTO CALIFORNIA.

I had previously suggested the idea of introducing white fish into California by shipping the eggs across the Continent, and postponed the trip to Oregon on receiving a request from Mr. S. R. Throckmorton, of the California Fish Commission, to look up a suitable place for the hatching of a shipment of white fish eggs, which Professor Baird had promised

to send as a present to the Californians, and which were already on the way.

In accordance with Mr. Throckmorton's request, I went in January, 1873, to Clear Lake, in Lake County, California, in company with Mr. John G. Woodbury, my assistant on the McCloud River, and afterwards superintendent of the California State Hatching Works, and we finally selected a place for the white fish eggs on Kelsey Creek, near Clear Lake, where Mr. Woodbury put up suitable hatching works, and where he hatched out 25,000 white fish, which he afterwards placed in good condition in various portions of Clear Lake. This is the first introduction of white fish (*Coregonus albus*) into the waters of the Pacific slope.

CALIFORNIA AQUARIUM CAR.

During the latter part of March I came east with instructions from the California Commissioners to bring to California a car load of the best varieties of the fishes of the Atlantic slope, the kinds and numbers being left to my discretion. This was the beginning of the California aquarium car expedition, which came to so unfortunate an end. My plan was to take twelve varieties of living fish in the car, and as many of each variety as the space at my command in the car would permit. This plan was actually carried into practice, and the fish were gathered from the Raritan River, Buzzard's Bay, Massachusetts Bay, the Hudson River, Lake Champlain, the Connecticut River, and other points on the eastern coast, to the number of twelve varieties, and started on their way across the Continent. It was a terrible undertaking. I cannot find words to express the care, anxiety, the risks, the labors, and the hardships that it involved. Only those who have travelled with living fish can ever know what incessant vigilance, what untiring labor, and what constant care was required to get together this car load of fish and to keep them alive till the time for starting, and to carry them alive, as we did with few exceptions, for over five days and nights of consecutive railroad travel. I will only say that every one on the car worked actively twenty-one hours out of the twenty-four during the whole five days, and had, of course, during that time only three hours a day of such rest as he could get with the car in motion, and when we came into Omaha the night after the accident we all looked as if we had been through a week's serious illness. We were successful, however, to a wholly unexpected degree. The large spawning bass and catfish, about 200 in all, were living and in good order. The full grown yellow perch, glass eyed pike, and horn pouts did nearly as well. The young perch and glass eyed pike had hardly met with any loss. Only seven out of the thousand brook trout had died, and what were left were in excellent condition. Not one of the

tautogs had died. We had 30,000 silver eels, and over a thousand salt water eels living and doing well, and a barrel of oysters in perfect condition. There were forty-one spawning lobsters left, half of which at least were likely to survive the rest of the journey, and of all the varieties taken into the car not one had entirely given out, nor was there any serious loss with any except the lobsters, and of these forty-one, as just mentioned, were still living. I ought to add here that it was my intention to take out some shad, and I did actually send for some, but none reached the car alive; so of course there were none lost on the car.

We were on our sixth day out when the accident happened. The whole trip by passenger train time takes but seven days, and we should have been in Utah instead of Nebraska, but the arrangements not having been perfected for travelling all the way with passenger trains we had in consequence met with delays which had made this difference. But the circumstance that the fishes were doing so well on the sixth day speaks well for their chances of surviving the balance of the journey.

The accident occurred at the Elkhorn river, thirty miles beyond Omaha. The engine, tender and aquarium car went through the treacherous trestle work into about twenty feet of water, with a swift current running. The engineer, brakeman, roadmaster, and the three occupants of the aquarium car went down with the wreck. The roadmaster, Mr. Carey, was killed; the rest of us escaped with bruises. The contents of the aquarium car were a total loss to California, every fish escaping into the Elkhorn river. The accident took place on Sunday afternoon about three o'clock. The next morning just after breakfast I received a dispatch from Prof. Baird (a circumstance which shows with what promptness our national commissioner is in the habit of acting), to return east with my men and make a second attempt to cross the continent with shad.

CROSSING THE CONTINENT WITH SHAD.

I accordingly returned, and on the night of Wednesday, the 25th of June, 1873, left the Hudson river with 40,000 live shad, and reached the junction of the Utah railroad on the afternoon of Monday, June 30th, with the fish in perfect order. Here I left 5,000 shad for Great Salt Lake, and proceeded to California with the remaining 35,000. We reached Sacramento City at half-past one on the afternoon of Wednesday, July 2d, with the shad in first rate condition. At ten minutes past nine on the evening of the same day we deposited them safely in the the Sacramento river at Tehama, the whole expedition, from beginning to end, having been a perfect success.

SALMON BREEDING ON THE McCLOUD—SEASON OF 1873.

We began our work on the McCloud river in 1873, on the 18th day of July. The year before, our dwelling house, hatching works, and in fact everything appertaining to our camp were located at a considerable distance from the river, in order that we might avail ourselves of the use of the water from a brook, which at that time, in our inexperience, we considered the only safe water we could employ for hatching purposes. The disadvantages of this location were very great. The brook water had a very fluctuating temperature, besides being limited and insufficient in its supply, and sometimes roily. The distance from the river caused a great waste of time and labor in going to and from the fishing grounds, which was an inconvenience particularly irksome when we had salmon eggs to bring to the hatching works; and, to add to the discomforts of the place, it was often intolerably hot where our house stood, the mercury frequently rising as high as 110 degrees in the shade, and standing for days together through the afternoon at 105 degrees. This last year (1873) I resolved to use the river water if possible, so as to bring the fishing grounds and hatching works together, and also to obtain a larger and more trustworthy supply of hatching water. Accordingly, on arriving at the river last summer we moved our house and hatching works from their former location down to the bank of the McCloud, and immediately began digging a ditch from a higher point of the river to a spot which we had previously selected for the hatching house. Although we had before this surveyed the ground, and thought the attempt practicable, we found so many obstacles to its successful prosecution that we changed base once more, and determined to put a large wheel into the river current at one of its most rapid portions, and to pump up from the river the water intended for the maturing of the salmon eggs. The wheel, which was furnished with a series of buckets around its circumference for lifting the water, was a perfect success in every respect, and worked the whole season to our entire satisfaction. It raised over 6,000 gallons of river water an hour, and to such a height that we could have our hatching troughs as far from the ground as we pleased, which alone was a great convenience. While the wheel was being built, work was pushed with all possible dispatch in other departments, so that on the 19th of August our dwelling house was finished, the water was running merrily through the troughs of the hatching house, several corrals and ponds had been built three or four hundred salmon had been caught and corralled in them, and we were ready for the first instalment of salmon eggs.

OUR CAMP.

At this point a few words about our camp and work and surroundings may perhaps be not inappropriate. The McCloud river, on which the

United States salmon breeding camp is situated, rises in Mt. Shasta and flows through deep and rocky canons for nearly seventy miles to where it empties into the Pit river, a tributary of the Sacramento. At our fishing grounds it averages from forty to fifty yards in width. It is a rapid, foaming stream, and is considered one of the most, if not the most, beautiful of the rivers in California. Wherever it is known it is famed for its bright sparkling waters, the loveliness of its verdure-covered banks, and its wild and magnificent scenery. It is formed by the melting snows of Mount Shasta, is clear as crystal, and even under the scorching atmosphere of a California summer, at noon, always seems icily cold to the taste and touch. Opposite our camp, steep pinnacled rocks of gray limestone rise nearly 2,000 feet almost perpendicularly from the further edge of the river. In all other directions are hills and bluffs of various heights, covered with live oaks, manzinita bushes and other California vegetation.

Along the banks of this sparkling river the different points of our salmon breeding camp were strung at various intervals. Our house, where we lived and ate and slept, and which formed the central point of the camp, was a plain wooden structure of one story and twenty-eight feet in length, fronting the river. It consisted of a living room, with several bunks for beds, a kitchen and an office, each room opening on the river side out on a broad piazza, which almost projected over the water's edge. About sixty rods above the house was the mouth of the abandoned ditch. Fifty rods further down or ten rods above the house, was an Indian rancherie, where some of the Indians lived who worked for us. Just below the rancherie were two small tents occupied by some of our party or by Indians working for us. Then came the house itself. Just below the house was a large tent, sixty by thirty feet, enclosing and covering the hatching works. Next came the flume which brought the water from the wheel; then a pond for confining the parent salmon; then the wheel itself, always moving night and day, with a heavy creaking motion, and lifting its eight buckets of water at each revolution. Below the wheel, and about twenty rods further down the river bank, was a brush camp belonging to two of our fishermen, two corrals for salmon, and the lower fishing grounds, which terminated our settlement in that direction. On the other side of the river we had nothing but a fishing ground and corral, which were just opposite the hatching house. Behind our dwelling was an Indian cemetery, and just above the cemetery was our American flag floating at the peak of a fifty feet staff. The whole camp as it could be seen in one view from the hills on the opposite bank, formed a very pretty and interesting picture.

HATCHING APPARATUS AND HATCHING HOUSE.

Our hatching apparatus was simple but very satisfactory. The wheel, which was twelve feet in diameter, with an eleven feet shaft, took the water from the river into the flume. The flume carried the water about fifty yards to the filtering tanks. The filtering tanks conveyed the water in the distributing spout. The distributing spout discharged it into the hatching troughs.

The hatching troughs were placed parallel with each other, at right angles with the distributing spout, as is the usual custom in hatching houses. There were ten rows of troughs placed in pairs with a passage way between each pair, and in each row were three troughs, each sixteen feet long, placed end to end, one a little lower than the other, so as to give a fall from the first to the second, and from the second to the third, of a few inches. The troughs were on an average about breast high, and were furnished with covers made by stretching white cotton cloth on a light frame of wood. The whole, excluding of course the flume and wheel, was surmounted by a large and substantial tent, sixty by thirty feet. Most of the eggs rested on the charcoal bottom of the troughs, but I used trays to a considerable extent, formed of iron wire netting coated with asphaltum, and found them perfectly satisfactory. I also used by way of experiment and with Seth Green's permission, half a dozen of his shad hatching boxes, anchoring them in the river current. They worked so well that I have no doubt that in a warm climate like that of California, salmon eggs could be hatched in these boxes with perfectly satisfactory results, which adds another merit to this very simple but wonderfully effective invention. The only difficulty which we experienced in their use was the inconvenience of getting at them and of picking out the dead eggs. On account of this inconvenience I would prefer the stationary hatching troughs, if I had my choice, but I should feel perfectly confident of hatching successfully any number of salmon eggs with nothing but the shad boxes.

The hatching house, or more properly the hatching tent, contained our work bench and tools, and was the place where all the carpenters' work was done. It was always in the day time the most bright and cheerful, as it was the busiest spot about our pleasant camp. The happy murmur of the rippling water, the busy sounds of the workmen's tools, the bright, soft light diffused through the canvas covering of the tent, the cool river breeze gently pouring in through the raised walls of the tent, the active forms of the workmen, the thought that millions of tiny creatures were coming into being under the white covers of the troughs, all these things lent a charm to this spot, which made it very attractive and an extremely

pleasant place to be in; and the effect was not lessened by the exhilarating reflection that every shovel full of sand which formed the whole floor of the tent was mixed with gold dust, so that every step we took, we were literally treading on golden sands.

OUR HOUSEHOLD AND WORK.

Our household consisted permanently of Mr. John G. Woodbury, foreman; Mr. Myron Green, head fisherman; Mr. Oliver Anderson, man-of-all-work, and myself in charge. Our fluctuating force consisted of a carpenter, a cook, several fishermen and men-of-all-work, together with more or less Indians, making our total number average during the fishing season, when I kept on a force every night hauling the seine, about a dozen or fifteen hands.

As it may perhaps seem surprising to some that we could find work for so many persons, I will say that on the 18th of July not a shovel full of earth had been moved, nor a stick cut on the site of our future camp, and by the first of October, seventy-four days after, we had erected our dwelling house, hatching works, and other structures belonging to the camp, we had caught and confined a thousand salmon, had taken and laid down two million eggs, and already packed and shipped eastward nearly a million. This we had done in a wild and almost uninhabited country, where we had to rely wholly upon ourselves, and either do ourselves what was to be done or leave it undone. We could not send out for a blacksmith or plumber or engineer when we wanted one, as if we were living in a town, but had to rely on our own resources for what we wanted or go without. This, of course, complicated and extended our work very much.

At all events there was something for all to do every moment, and from beginning to end it was as busy a camp as one could wish to see. There was not a game of cards or chess or checkers played all the time I was there, and every one seemed to realize that the business of the place was work, and every one worked accordingly.

PRESENCE OF INDIANS.

The presence of the Indians formed a peculiar feature of our camp life on the McCloud. We were in an Indian country, on a river which had never been opened up or inhabited by white men, and which the Indians regarded as their own by rights which had descended to them undisturbed through their ancestors for centuries back. Indians swarmed about our camp all the time. There was hardly a moment in the day when there were not more or less of them lounging on or under the piazza or about the tent.

Occasionally a white horseman or a white straggler on foot, or a newspaper reporter from the Modoc country just above us, stopped at our door, or stayed over night; but usually we saw twenty Indians to one white man. Red faces became more familiar, as they were much more common than white ones. Indian words and phrases crept into our vocabularies, and became part of our every day language. As a rule the Indians were friendly and civil. They had been, however, the last of the Californian tribes to yield to the white man's sway, and the hardest to subjugate. They had also succeeded thus far in one way or another in keeping white men away from their country. At one time a party of miners came down across the Sacramento hills to their river to look for gold, but they were waited upon in the morning by three chiefs and three hundred warriors, and summarily escorted out of the country. This sort of thing was repeated several times. Still later a party of two Americans and eleven Chinamen came up from the Sacramento river to dig for gold, and camped a short distance above the present location of our camp, but before morning the McCloud Indians murdered every one of them, not leaving one to tell the story.

A year ago a Mr. Crooks came to the river, and settled a mile or two above us, but the Indians murdered him as late as last September, while I was there. Thus by one means or another they have kept the whites out, so that even now, there is not a single white man living on the McCloud river.

When we came to the river to erect our house and hatching works, a large number of Indians assembled on the opposite bank and spent the whole afternoon endeavoring by threats and furious gesticulations to drive us away, and afterwards several of them waited on me and told me in their dialect, of which I had learned a little, that this was their river and their land, and these were their salmon, and that I was stealing their land and salmon; that they had never stolen any thing from the white man nor taken his land, and that I ought to go away. Some of them were very much excited and very angry while talking. Others went so far as to give out threats about my being killed. When I thought of the fate of all my predecessors on the McCloud, I did sometimes feel slight misgivings, but I adopted a firm and and conciliatory policy with them which worked so satisfactorily that I am now perfectly satisfied that none of us are in any danger there. I ought also to add that they stand in too much fear of the white man to do any open injury.

I gave the Indians all the salmon which we caught after we had got through with them, and I treated them well always, being particularly careful to be thoughtful of and attentive to their sick, so that we got along with them very well, and I think really made friends of some of

them. We found them very serviceable in assisting about our work, although they were provokingly freakish. When they worked they worked well, but when they did not want to work, they were as obstinate as mules or as alevins—those who are accustomed to hatching fish will appreciate this last allusion, I know—and then they would not lift a hand to help us, however urgent the circumstances might be. I employed them to help run the seine, to chop wood, to cook, to build dams, to work in the water, to pick out dead eggs, and to do various odd jobs. They were especially dexterous and nimble in picking over the eggs. Their slender fingers and delicate touch seemed particularly adapted to this light work. They could not always resist the temptation to pilfer such little things as needles and soap, and sometimes a shirt, but considering the constant opportunities they had for stealing on a larger scale, I think they deserve a good deal of credit for not taking more than they did. I am of the opinion that we should have lost more things in an average white community, under the same circumstances.

INTERESTING CHARACTER OF CAMP LIFE.

Our life at the camp was exceedingly interesting and pleasant. We had a harmonious household, the work progressed satisfactorily, the mountain air was invigorating, and the landscapes were beautiful, or magnificent, according to the direction in which one looked. Every morning we were sure of a cloudless sky and a pleasant day, and although a quarter of a mile away the heat was intolerable; nearer the river side where we were, it was so tempered by the icy water of the McCloud that we knew nothing about it. Every morning also it was a matter of new interest to know what luck the seine had had the night before, or how many eggs had been taken.

Almost every day the Indians would bring in a coon or a mink or deer or bear skin or at least some bit of news that interested us. The salmon were jumping in the river in front of our house, at the rate of a thousand an hour, and occasionally we would see an otter playing in the water opposite. We frequently saw emigrant wagons dragging wearily along, some going from California to Oregon, and some the reverse, both hoping to make a change for the better. Twice every twenty-four hours the Oregon stage with its six galloping horses made its fast time over the stage road on the hills above us, carrying the mail from San Francisco, California, to Portland, Oregon, and back. Altogether our life at the camp, in spite of hard and persistent work, was interesting and pleasant.

Our table was usually supplied with venison, trout and salmon grilse; the small grilse of the fall run generally being good eating. We also had occasionally quails, squirrels, rabbits and fresh vegetables. Our staples

to fall back upon when in want of something better were bacon, potatoes and baked beans. We had no fresh domestic meat whatever.

GAME.

The McCloud region is a good game country. Deer are very abundant, especially after the snow on the mountains had driven them down into the valleys. Black and cinnamon bears are quite common, and it was not unusual to see the track of a grizzly bear, though we did not encounter one. California lions are occasionally seen. Quails, gray squirrels and jack rabbits were quite common and not very timid. Indeed, a bevy of thirty or forty quails, and often more, used to feed around the house every day, and several gray squirrels came regularly to our table at every meal to be fed. Our Indians could almost always go out and get a deer of a morning or afternoon, and any one is sure to get a bear or two who makes a day's regular hunt for one ten miles up the McCloud river in October.

FROM THE 19TH OF AUGUST TILL THE EGGS WERE SHIPPED.

To resume the thread of my story, by the 19th of August we turned the water through the hatching house, and had the pleasure of seeing what I had long looked forward to, a successful hatching apparatus in perfect working order in the salmon breeding regions of the Pacific slope. There seemed to be something in the very sound of the rippling and plashing water to exhilarate our spirits, as it leaped through the troughs for the first time. I celebrated the day by collecting our whole force of whites and Indians at sunset and raising a large American flag over the camp.

We continued to catch more salmon, and to build more corrals for them, and to extend the operations for hatching the eggs. The female salmon now begins to show every sign of being nearly ready to spawn, and we were daily expecting to find some ripe eggs. We remained, however, in this not unpleasant state of excitement and anticipation until the 26th of August, when we took the first ripe salmon eggs of the season, numbering 23,000.

Now came a new and unexpected drawback. The salmon confined in the corrals had been literally wearing themselves out in their frantic endeavors to ascend the river. Every moment, day and night, impelled by their irrepressible instinct, they kept jumping and lashing themselves against the sides of the enclosures, and now comparatively exhausted by their efforts and bruises they were beginning to die from the effect of them. Fortunately there were enough more in the river to get eggs from, for had we depended on our stock on hand when the first eggs were taken we should have obtained a very meagre supply. As it was, I kept on fishing

and replacing the dead salmon with live ones, so that we had no lack of eggs, and obtained in the end the full two millions at which number I had set my limit. Nothing further occurred to intercept our steady progress. We continued to take eggs every twenty-four hours, both night and day, and the number in the troughs increased rapidly.

On the 10th of September, at noon, we had a million eggs laid down. On the 14th of September, at daylight, we had a million and a half, and on the 22d, at daylight, the quota of two millions was complete. On the 12th of September the first eye spots were visible in the eggs taken on the 26th of August, making sixteen days for the interval between the extrusion of the eggs and the appearance of the eye spots, (the formation of the choroid pigment.) The water in the river had a temperature of 53 degrees at sunrise, when the first eggs were taken, but it always rose in the hatching troughs during the day, sometimes to 58 degrees, and sometimes as high as 64 degrees, so that the exact average temperature of the water for the whole time cannot be stated.

On the 20th of September I sent 300,000 eggs to the Atlantic coast, and on the 30th of September I went east myself with 600,000 more, leaving the camp in charge of Mr. Woodbury. On the 6th of October Mr. Myron Green left camp with a third lot of a quarter of a million, and about a week later Mr. Woodbury forwarded the balance of the eggs, amounting to another quarter of a million or more.

RESULTS.

The results in detail of these shipments have been given in the papers several times, so I will only make the following brief statement here: Of the 2,000,000 eggs taken and laid down in the hatching troughs, nearly one million and a half were shipped eastward and consigned in various proportions to Dr. J. H. Slack, New Jersey; Seth Green, New York; James Duffy, Pennsylvania; George H. Jerome, Michigan; F. W. Webber, Charlestown, N. H.; Charles G. Atkins, Maine; R. G. Pike, Connecticut; A. P. Rockwood, Utah; E. A. Brackett, Massachusetts; Dr. J. H. Slack receiving the largest number. Nearly a million arrived at their destination alive, and a large proportion of the fish hatched from them have since been distributed in various streams and lakes throughout the United States.

PACKING AND SHIPPING THE EGGS

The taking of the eggs and the maturing of them for shipment was a marked success. Indeed, I have never seen a finer lot of salmon eggs than we had in the hatching troughs under the mammoth tent at the McCloud. Nothing could be wished for, more happy and prosperous than our progress up to this point of shipping the eggs. But here came a

formidable and threatening difficulty. Between our camp and the waters which were awaiting the eggs, there lay a long stretch of 3,000 miles, which must be crossed by the young embryos before they could be made available for the service for which they were intended. It was enough to make the most confident enthusiast falter. We all looked forward to this dangerous journey of the eggs with dread. When we packed them in the moss and screwed down the covers, it seemed like burying them alive, and when we saw the crates containing them, loaded into the wagons and sent off to the railroad station, and thought of the almost interminable journey, and the ten thousand chances of injury that these frail creatures would be exposed to on the way, it seemed nothing less than infatuation to expect that they would survive them all, and ever see the light again alive. They must go, however, and we packed them as well as we could and sent them off. The boxes in which they were packed were all two feet square and a foot deep. The eggs were packed as usual with first a layer of moss at the bottom of the box, and then a layer of eggs, then another layer of moss, then another layer of eggs, and so on to the top. Midway, in the interior of each box, there was a thin wooden partition to break the force of the superincumbent mass of moss and eggs. We packed about 75,000 in a box. When the box was filled the cover was screwed down and it was packed with another one of the same size in a crate which was three inches and a half larger on all sides than the combined bulk of the two boxes enclosed, this intervening space being filled with hay to protect the eggs from sudden changes of temperature. On the top of the crates was a rack for ice.

The nearest and only suitable moss that we could hear of was seventy miles away, at the sources of the Sacramento river. I accordingly sent Mr. Woodbury to Mt. Shasta to procure a supply. He returned in a few days with thirty-five bushels of moss, all of which we used in packing.

The manner of the packing has been made a matter of considerable criticism. On this point I will only say that I had but one precedent to be guided by, viz: the shipment of salmon eggs from the same place the last year. It was reported concerning this consignment, that the eggs which did not hatch on the way arrived in excellent order. In a critical and difficult undertaking like the one in question, there seemed to be no choice between adopting a method which had succeeded, and others which had never been tried, so I adhered to the plan of the last year's shipment, and packed these eggs in precisely the same way.

THE METHOD OF PACKING DISCUSSED.

To give the pro's and con's of this method of packing would lead to a long discussion, which would perhaps be out of place here, so I will simply say that the packing was no hap hazard affair, but the result of

careful thought and the exercise of as much foresight in regard to the journey as we could bring to bear upon the subject, and even now, after plenty of leisure for reflection, I do not know of any other practicable method of packing salmon eggs, which are to be sent this overland journey without an attendant, which secures as many favorable combinations or which is not open to quite as many objections as the one adopted. Indeed, I think the results were a decided vindication of the merits of the packing. The first lot forwarded in September was undoubtedly destroyed by the heat. The second lot arrived in as good order as could be expected. The third lot was reported to arrive in excellent condition, and the fourth and last lot came the best of all.

Of those sent to Great Salt Lake, distant a thousand miles, only three per cent. were lost. What more could be asked of the packing? A method that will carry salmon eggs a thousand miles with a loss of only three per cent. cannot be a very bad one. Seth Green reports a loss on the 200,000 eggs consigned to him of only eleven per cent. both in transportation and in hatching. This certainly does not seem to reflect any discredit on the packing of the eggs, and when we remember that they came from a climate where the mercury stood 110 degrees in the shade, and that they were conveyed twenty-two miles in a wagon, to begin with, over a very rough mountain road, and after that 3,000 miles by rail, I think it is rather creditable to the packing than otherwise. I am open to conviction, however, and if there is any better way of packing the salmon eggs for their overland journey, I should like to know it, and should be thankful for any light on the subject. I should be glad to hear the subject discussed.

COST OF THE EGGS.

The cost of getting the ova and preparing them for transportation was about $4,000. There were very nearly 1,500,000 impregnated eggs in good condition for shipment. This makes the cost of the eggs at the hatching works $2.66 a thousand. I think in future with the experience that has been acquired, and with the work that has already been accomplished, that it is highly probable that the eggs can be got out at a still less expense, and I should not be surprised in the event of the undertaking being repeated on the McCloud river another year, if 5,000,000 eggs could be obtained at a cost of $5,000, or at the rate of a dollar a thousand.

I beg to say in conclusion that the particulars of the first McCloud expedition for salmon eggs are printed in the report of the U. S. Fish Commission for 1872. The details of the Clear Lake experiment, of the overland trip with shad, and the operations on the McCloud river

last season, will be found in the report of the U. S. Fish Commission for 1873, and a full account of the aquarium car enterprise in the California Fish Commissioners' report for 1873.

EXPERIENCES OF A PRACTICAL FISH CULTURIST.

BY SETH GREEN.

My first attempt at taking brook trout spawn was in 1861. I took a few thousand daily for sixteen days. On the seventeenth I made up my mind that I could tell which spawn was impregnated and which was not. I counted several hundred and found that I had twenty-five per cent impregnated. I was sure I had to pick out all of the bad ones. I did not like the job. About that time Mr. Ainsworth came to my place. I told him what I had discovered. He said that twenty-five per cent. was a good percentage as ever had been hatched. I was not long in making up my mind. If that was the best that could be done, I should not stay in the business long. That night I thought it over and took a common sense view of it. I had used a good deal of water, and but little milt. I made up my mind to try a little water and a good deal of milt. I found when sixteen days had come around that I had ninety-five per cent. impregnated, and even better. I kept using less and less water until I used scarcely any. I kept it a secret, everybody wanted my spawn. I sold a great many, and my secret was as good as though I had a patent for it.

I will tell you how I discovered that the sun would kill spawn. The spawn in one of my troughs kept dying and in all the others they were good. I picked them out for several days and tried several experiments, but it was of no use, the spawn kept turning white. So I thought I would leave it for two or three days. The third day I learned the cause. The sides of my trough were six inches high, and the side shaded one half of the trough, and the shady side was all good, but where the sun hit they were all bad. I left them a couple of days and scooped them out and shaded my window, and I did not have any more trouble from the sun. One of the one hundred and one difficulties I had to overcome was rats. They left their tracks and I caught them; I took 304 trout spawn out of one of their stomachs.

I must stop telling you the difficulties I had to overcome or I shall not have time to tell you about anything else. The year 1867 the Commis-

sioners of Fisheries of four of the New England States came to my place and wished me to go to Holyoke, on the Connecticut river, and see if I could make a success in hatching shad artificially. I agreed to go. I arrived at the fishery at South Hadley dam and told the people that I had come to hatch shad artificially. They thought I was crazy and treated me accordingly. My first experiment in the use of hatching apparatus was to build the same kind of troughs that I used for hatching trout, with the exception that I slanted some of them a great deal more than I did others. I put the spawn in the troughs and I found that in the troughs that had the most fall the spawn floated down and out of the end. That was the first time that I had discovered how light the shad spawn was. It is as light in the water as a bubble is in the air. The next morning I came to see my troughs; they were nearly all broken down by some malicious person. I fixed some of them so that I kept the spawn in the trough; the next day they were nearly all dead. I could see the fish begin to form, but it was suffering for lack of circulation of water. The next day they were all dead. I saw what I had to contend with. I saw that the spawn needed a great circulation of water, and the difficulty was to get some thing that would give them the circulation and not float the spawn away. The second day I had a dozen different kinds of hatching apparatus. All failed until the sixth day, when I was standing in the water with a candle box with a sieve bottom, and tipping it one way and another until I tipped the lower edge so that the current struck the bottom. The spawn began to boil up and kept in motion. The mystery was solved! The second day the fish showed life in the eggs, and the next day they hatched. I made two trials to see what percentage I could hatch. I put ten thousand eggs in the box and hatched all but seven eggs. The next trial I hatched all but ten. The Commissioners and everybody was delighted—myself in particular. In about fifteen days I hatched fifteen millions, and in 1870 the Commissioners of Fisheries reported that there was sixty per cent. more shad in the Connecticut river than there was in the year 1802, and I believe the fishing has been as good every year since.

In 1869 I experimented in hatching whitefish. I took the spawn in the same manner that I do the trout, except that they have to be stirred gently for twenty minutes to keep them from sticking together. I have hatched a good many every year since that time. I hatched them the three first years on gravel and on trays four inches deep in the trough. Last year Mr. M. G. Holton invented a hatching box that will be the means of stocking all of our great lakes with whitefish and salmon trout equal to their best day, and I believe it can be done in four years. It saves nineteen-twentieths of the room in the size of the house, and can

be taken care of with one half the labor required for any hatching apparatus that I have seen. I have used ten of Holton's boxes in our State Hatching house this winter, and find them a great success in hatching salmon, salmon trout, brook trout, and whitefish.

I have hatched fifteen different kinds of fish artificially, viz: brook trout, whitefish, herring, shad, Otsego bass, wall-eyed pike, salmon trout, salmon, red side suckers, creek suckers, shiners, white and yellow perch, mullet, striped bass, frogs and lobsters.

SALMON BREEDING AT BUCKSPORT.

BY CHARLES G. ATKINS.

The method of obtaining salmon eggs pursued at Bucksport is extremely artificial. The parent fish are caught in June, in the tidal part of the Penobscot river, before they have ever entered fresh water, are transported in drays overland to a fresh water pond that was never naturally frequented by salmon, and in its character is far enough removed from their ideal haunts, and there confined within an inclosure of nets from June till November, are then caught again in traps or seines, and deprived of their eggs and milt by artificial manipulation, marked with metal tags and sent back to the river on drays. The eggs are fertilized by mixing the milt with them in a pan without water, and and developed on wire cloth trays in wooden troughs, and are for the most part packed up in moss and sent away in February and March to be hatched elsewhere.

All previous efforts at the collection of salmon eggs of which I am informed were made in the immediate vicinity of the natural spawning grounds, and the parent fish were never taken until the near approach of the spawning season, when they had been a long time in fresh water. At the outset of this experiment, therefore, there were no examples from which to learn the best modes of proceeding or to augur success or failure, and there were not wanting reasons for thinking the latter quite as probable as the former. The unknown quantities in the problem were numerous. It was not known whether, of the salmon caught in salt water near the mouths of the rivers in early summer, all or in fact any were going to produce eggs and milt at the coming spawning season. It was not known whether they would survive the handling to which they must be subjected in capture and transportation, or, if they did survive,

whether, from the change from salt to entirely fresh water being premature or too sudden, or from the effects of confinement, the normal and healthful development of the eggs and milt might not be prevented.

The inquiry naturally arises, why select a site for operations where all these impediments are to be encountered? Why not go to the headwaters of the river where salmon go to spawn of their own accord, and where they are found at the breeding season with spawn and milt matured under natural conditions?

These questions received due consideration in the beginning. The headwaters of the Penobscot were examined, and the probabilities of success in the collection of salmon spawn there were carefully weighed. The principal fisheries of the Penobscot are in the tidal portions of the river and bay, and here it seems probable that the majority of the salmon that seek to ascend the river are caught. The remainder is still further reduced by the fisheries at the dams above Bangor, and after passing Oldtown they scatter far and wide in nearly all the tributaries. Though salmon are caught at several places on the main river and the Mattagamon, it is quite doubtful whether two hundred could be collected at any one point. The remoteness of their principal resorts from railroads, and indeed good roads of any kind was another serious objection to a location on the headwaters of the river.

The first experiment was therefore tried at Orland, a few miles east of the present location in Bucksport. It is unnecessary for me to detail the many mishaps and mistakes and final success of the first trial. It is enough to state that though in various ways the hundred and ten salmon purchased were, before the spawning season arrived, in one way and another reduced to the small number of eighteen, those that remained suffered in no perceptible degree from the unnatural usage to which they had been subjected, and that the excessive mortality among the parent salmon was found to be fairly attributable to causes whose operation could be prevented.

Only about 70,000 eggs were obtained, but the success in fecundation was flattering, being at the rate of ninety-six per cent.; and the subsequent development and hatching of the eggs were all that could be desired. As the parent fish had been kept in ordinary pond water in an enclosure which in midsummer was only fifty feet square and less than four feet deep, the healthy state of the eggs is to me a convincing proof that no evil result need be anticipated from the confinement itself, and that ordinary pond water is well adapted to sustain them.

In 1872 the site of operations was removed to Spofford's Pond in Bucksport, and the present extensive works undertaken. This is a shallow, muddy pond, of about sixty acres in the summer, but spreading

in the winter over twice that area of meadows. The muddy character of the bottom is believed to be of positive advantage, since it tends to deter the salmon from spawning in the pond, and impels them to seek the brooks where they can be easily caught. The pond lies about a mile from the Penobscot river, and as the brook through which it discharges its waters is small and has falls too steep for even salmon to climb, it is necessary to carry all the breeding salmon from the river to the pond on a dray. This is of course a disadvantage, but it does not appear to be a very serious one.

The hatching house is near the outlet of the pond, and is supplied with water from the stream. No available spring could be found in the neighborhood, but the absence of spring water is less to be regretted since the majority of the eggs collected here are sent away to be hatched in other places, and since general experience seems to indicate that it is better to set young salmon at liberty as soon as they begin to feed than to attempt to rear them in artificial ponds with artificially prepared food, for which purpose spring water would be desirable.

The proximity of Bucksport to the most productive salmon fisheries of the Penobscot renders it the best point at which to collect breeding salmon. There are within five miles of Bucksport village about fifty weirs that yield not far from four thousand salmon per year. In case they were wanted probably three quarters of these could be obtained for breeding purposes. Thus far a small part of these weirs have furnished all the salmon necessary.

The weirs being made for the purpose of catching alewives, menhaden and other small fish as well as salmon, the nets are of so small a mesh that salmon never catch in them, and swim to and fro until they are left by the retreating tide on a board floor. In taking them for breeding purposes it is necessary to anticipate the fall of the tide by dipping them carefully out and placing them carefully in perforated boats in which they are conveyed to Bucksport. At Bucksport they are dipped from the boats and placed in boxes in which they are carted to the pond. Of course with the most careful handling the salmon are sometimes fatally injured before they reach the pond, and die soon after. In 1872 one hundred were found dead in the pond in the course of the summer, and nearly all these in June and July, while the collection was going on, and within two weeks after its close. In 1873, out of 652 bought, only seventeen were found dead, owing, it is thought, to improved apparatus, greater care and increased skill in the persons who handled them.

Each year preparations have been made to confine the breeding salmon within a small enclosure. The first season, 1872, the hedge made for the purpose proved quite inadequate, and the salmon being scattered

over the pond a large number escaped capture in the fall, and many of them stole into a diminutive tributary, temporarily swollen by heavy rains, and laid their eggs before they were discovered. In 1873 the enclosure contained about ten acres, and was made by stretching across the mouth of a cove a strong net, held down at the bottom by the weight of a heavy chain, and at the top tied to stakes several feet above the surface of the water. This proved pretty effectual, and but very few escaped.

The inclosure includes the outlet of the pond which is commanded by a dam. At the spawning season a gate about a foot square is kept open and the salmon have free access to it. In their anxiety to find running water in which to spawn they run through this gate and fall immediately into a trap, which leads them through a long, narrow sluice in a grated pen whence they are taken to be manipulated. Natural instincts are not, however, strong enough to impel all the salmon to enter this narrow place, and seines are used to drive or catch the reluctant.

The spawning season begins the last week in October and continues until the middle of November. These, I think, would be the extreme limits with these fish if they had free access to a large, natural spawning bed, but under the unnatural conditions to which they are subjected they in many cases retain their eggs till a later date. A female confined in a pen on a board floor has retained her eggs for three weeks after they were ripe. The two sexes are found together at this season, and though no attempt has been made to distinguish one sex from another, in June, when they are collected, the females have always been found to exceed the males in number at the spawning season. In 1873 the ratio of the disparity was almost two to one. This is a fortunate circumstance, and it would be still better if the disproportion were four to one, for there would still be an ample supply of milt.

The salmon that enter the brook of their own accord after the twenty-fifth day of October, are, with very few exceptions, found to be fully ripe, and yield at once all of their eggs, except such as lie too far forward to be reached by pressure. The number left in each fish after the first manipulation is from two to five hundred. The seines have never been used to take fish from the ponds earlier than November eighth, so that we have no means of knowing the condition of the fish previous to that date; but after they were brought into use, the salmon taken in them were fully ripe. My observation leads to the conclusion that the ripening of the eggs of salmon occurs, in all individuals inhabiting the same waters, at about the same time, and that in cases where the eggs are not deposited until after November tenth in the latitude of Bucksport, the delay is commonly owing to some other circumstance than the immaturity of the eggs.

The mode of fecundation adopted is an imitation of the Russian method, differing from it in this point, that the milt is applied directly to the eggs and through contact secured before any water is used: while the Russian experimenter used to put water with the milt before applying it to the eggs. I don't know that there is any advantage in our method, but I think it rather safer. It requires no great haste: the pan of eggs and milt may even be made to await for many minutes the convenience of the operator without detriment. The ratio of fecundation obtained at Bucksport by this method is about ninety-eight per cent., and the average rate of fecundation in all eggs taken in 1872, including numerous experiments, was 96.7 per cent. The average at Oriand in 1871 was 96 per cent. These results are so satisfactory that I have made no attempt to apply any other method except in an experimental way.

The rate of fecundation is obtained by very careful observation. At a certain stage of the development of a fecund egg, the germ begins to expand laterally, sending out a thin fold, which at last completely encloses the yolk. At any time during the growth of this fold, the position of its advancing margin can be traced by a line of colored oil globules, arranged in a circle on the surface of the yolk. This circle is at first quite small, and surrounds the colored disk so plainly visible on the upper side of the yolk. It enlarges day by day until it divides the surface of the yolk into two equal parts. As it progresses beyond this point, it becomes smaller, and finally it closes entirely. This process begins, in water of the temperature of forty-three degrees F. at about the thirteenth day and is completed in seven or eight days. As it never takes place in an unfecund egg, its occurrence is positive proof of fecundation. To observe it, a strong light should be thrown up through the egg, and the most convenient way of effecting this is to place the egg over a hole in a piece of sheet metal, and hold it up to a window. To obtain the ratio of fecundation, a definite number of eggs is examined from each lot, and the result made the basis of a strict calculation.

The manipulation of the fish is performed at a distance of some twenty rods from the hatching house, to which the eggs are carried in pails after they have completed the absorption of water. The hatching house is a wooden building seventy feet long and twenty-eight wide. A feed trough runs down one side of it, and discharges water into forty hatching troughs that run across the room. The feed pipes are of inch-and-a-half lead pipe, and are all set into the feed trough at exactly the same height, so that if a partial stoppage of water accidentally occurs, what still continues to run will be divided amongst all the troughs instead of being drawn away from part of them by others at a lower level, as might be the case under a different arrangement. The volume of water used is about ten

thousand gallons per hour. The hatching troughs are a foot wide and six inches deep; and the most of them are twenty-three feet long. They rest on the floor, the only position practicable, owing to the low level at which we are obliged to bring the water into the building. They are quite level from end to end, except four troughs that are inclined four inches. The latter have dams at frequent intervals to break and aërate the water.

The eggs are deposited on trays of iron wire cloth tacked to wooden frames, and coated with water-proof varnish. This apparatus was first recommended to me by Mr. E. A. Brackett, of the Massachusetts Commission, and has proved exceedingly serviceable. Four nails, projecting half an inch from the lower side of the frame of the tray, one at each corner, furnish it with legs, which serve to keep it up from the bottom, or from the tray beneath it, when, as is generally necessary, the trays are placed in tiers one above another to economise space. A single tier of trays throughout the trough will contain without crowding, a million and a half of salmon eggs, and three tiers, the utmost capacity of the house at present, will afford room for four-and-a-half millions.

The troughs are all fitted with covers, so that there is no occasion to exclude light from the room. During the first season the troughs, which were then sixty feet long and ran lengthwise the building, were not covered, but the windows were covered with white cotton cloth. Too much light was thus admitted, and its effect on the eggs, both directly and by encouraging the growth of confervoid vegetation in the troughs, was the cause of serious mischief. The confervoid spread over the eggs in some of the troughs, shut them out from the influence of the pure water that was flowing above them, and exposed them to the deadly influence of a stratum of stagnant water that had accumulated beneath the trays in consequence of the space between them, and the bottoms of the troughs being so long and narrow as to prevent the existence of a current. A large number of eggs were lost in this way. All those difficulties are now remedied, and the present season, with fifty per cent. more eggs, the loss up to this date (February 7,) is seventy per cent. less.

The water used for hatching is very cold, though not quite as cold as that used by Mr. Leonard at the Sebec Salmon Breeding Works, where the temperature has been above thirty-three degrees but three days since November 15th. At the Bucksport Hatching House the temperature of the water ranges from thirty-two and one-half degrees to thirty-four degrees F., through the most of the winter. When the earliest eggs are first deposited it is about forty-four degrees F., and before the last of those kept here hatch out early in May, it rises again to the same point. The lowest temperature of the whole season is experienced in April, when the snow and ice are melting.

Development goes on very slowly, and the eggs are not generally in the proper state for transportation according to the common standard, the coloring of the eyes, until February, at which time the eggs are divided amongst the several patrons of the enterprise. Of those falling to the share of Maine in 1873, a portion were kept and hatched at Bucksport. The most forward of them began to hatch in March, but only a few individuals came out then; the fall of temperature that accompanied the opening of spring appearing to almost suspend growth. The hatching proceeded very slowly until the last week in April when the ice was all thawed in the pond above, and the temperature began to rise. I do not know that there is any disadvantage connected with this low temperature. On the contrary, I think it quite likely that the delay of hatching until April and May is rather advantageous to young fish that are to be turned out to seek their own food. Fish hatched out in January and grown to the feeding stage in February or early in March, must either be turned out into streams that are so cold as to arrest their growth and keep them a long time small and weak, besides being perhaps lacking in natural food, or they must be fed artificially. If the latter course be adopted, I fear the fish will be unfitted, to a certain extent, to take care of themselves. The natural date of the hatching of salmon in the rivers of Maine must correspond closely with the date in the Bucksport Hatching House.

The eggs distributed in 1873, numbering 1,241,800, were sent to every State in New England, and also to New York, New Jersey, Pennsylvania, Ohio, Michigan, and Wisconsin. The young fish hatched were in every instance set at liberty as soon as the yolk sack was absorbed. The whole number thus turned out was 876,000. The present season the number of eggs distributed will probably exceed 2,200,000, and, unless some extraordinary mishap interferes, the number of young fish will be more than double that of last year. The distribution is so wide that hardly any river receives an adequate stock, but I trust that in some instances the number will be sufficient to produce a decided impression.

WORK OF THE U. S. FISH COMMISSION.

BY SPENCER F. BAIRD.

The subject of fish-culture and the fisheries continues to increase in importance, and in view of the economical value of the products of the sea and the interior waters, and in the amount of capital and effort directed toward their acquisition, this interest is amply justified.

Several exhibitions during 1873 have been made of fishery products and interests, the most important being that at Vienna during the past summer. Legislation has also been initiated or continued looking toward the judicial determination of the rights of the general public and of the individual, the most important step in this direction being the decision of the United States Supreme Court in reference to the obligation of the corporation controlling the dam across the Connecticut River at Holyoke to construct a suitable fish-way. This river in former years abounded in shad and salmon from its mouth to its sources, and furnished a vast amount of excellent food to a large population. The erection of dams along its course obstructed the upward movement of the anadromous fish, with the result of finally exterminating the salmon, and of reducing the supply of shad to a minimum. The most considerable of these obstructions, and the first met with above tide-water, was the great dam at Holyoke. An Act of the Massachusetts Legislature, authorizing the Fish Commissioners of that State to require the construction of a fish-way over this dam, was resisted by the company, and the case carried successively to the Supreme Courts of Massachusetts and of the United States, judgment being given by both tribunals against the company, which was thus obliged to yield. A fish-way was constructed during 1873 upon the plan of Mr. E. A. Brackett, of Massachusetts, which, it is hoped, will answer the purpose in view.

In no country, however, has the subject of the fisheries and their legal relations been more thoroughly considered than in Germany; and a very elaborate system of regulations is now under discussion, which it is expected, will be the most complete in existence.

The number of States having Fish Commissioners for the improvement and regulation of the fisheries within their borders has been increased during the year by the addition of Pennsylvania, Ohio, and Michigan; so that at the present time all the New England and Middle States except Delaware, and all the States bordering on the great lakes with the exception of Indiana, Illinois, Wisconsin, and Minnesota, are provided with these important State officers. Movements are in progress, however, which it is probable will result during 1874 in the appointment of Com-

missioners in Minnesota, Illinois, Maryland, Virginia, North Carolina, and possibly Iowa.

Numerous statistical publications in reference to the fisheries of the Old World and the New have made their appearance, although mostly relating to 1872. We have also a very elaborate communication from Dr. Francis Day on the fresh-water fisheries of India, and another by the Minister of Marine and the Fisheries of Canada. It is to be regretted that no provision is made by the United States government for the collection and publication of accurate and exhaustive details on this branch of industry, so ably worked up by France, Norway, and other foreign nations.

The special fisheries of the world have been prosecuted with their average success. The herring has furnished provision and employment for immense numbers of people both in Europe and America. The Astrachan herring (*Alosa caspica*,) a species probably like our fresh-water herring or alewife, which was, up to the years 1854 and 1855, only used in extracting the oil, has taken a prominent place as a food fish since that time. The Russian name, *bescheuka* (the furious fish,) seems to have incited a prejudice against it; but through the efforts of Mr. Baer, and a board of commissioners appointed to investigate the fisheries of Russia, the prejudice was largely overcome, and, under the name of herring, as a salted fish it has become an important element in the Caspian fisheries. In 1858 there were salted in the rivers of Astrachan 43,000,000 of this fish. The number in 1871 was 140,000,000; and in 1872, 160,000,000; while in 1872 only 30,000 were used for oil.

The cod fisheries of both the Atlantic and Pacific have also been abundantly worked. The occurrence of cod in immense numbers in the Pacific is a fact of recent appreciation; and it is satisfactory to know that, should the supply from the Atlantic be at all seriously impaired, the deficiency can be made up from the Pacific. According to a San Francisco journal, 583,000 cod-fish were taken by seven vessels off the coast of Alaska in the summer of 1873. No estimate can at present be formed of the captures off the Banks of Newfoundland and the coast of Norway. New cod banks have lately been discovered off the coast of Spitzbergen.

The trade in frozen herring off the coast of Maine and in the Bay of Fundy continues to be of great importance. This comparatively new interest has been increasing gradually for many years, and now employs a large force during the winter season. The fish are taken in gill-nets and immediately frozen, and then shipped to the western markets of Portland, Boston, New York, etc. The Bay of Fundy is particularly favorable for this trade; and the recent establishment of a signal station

at Eastport has been of great moment, by enabling those engaged in the business to anticipate the occurrence of a period of hot or cold weather in time to take measures to protect themselves from loss. The application of the signal telegraph in the service of the fisheries in the United States is comparatively recent, and promises to be of great benefit by communicating information of the occurrence of schools of fish along the coast, and of their movements, to those interested in their capture.

Another application of the signal telegraph is made by the dealers in fish both on the lakes and the sea-board, who regulate their orders and shipments of fresh fish by the knowledge thus obtained of impending atmospheric conditions.

The American salmon trade continues to increase, and the number of establishments engaged in canning and preparing them for market on the Columbia River and in Puget Sound becomes larger every year. It would almost seem that the vast numbers taken for this purpose must soon bring about their extermination, but as yet no perceptible decrease is reported. Numbers of these fish are brought fresh to the East in refrigerator cars to supply the market earlier than the period during which the eastern salmon can be taken.

In view of the great increase of the halibut fisheries off the coast of the United States, the hardy fishermen of Cape Ann, who more especially carry on this branch of industry, are obliged to resort to distant seas to obtain a supply; and even Greenland is not too far for their efforts. The coast of Iceland, too, has also been visited by a Gloucester vessel for this purpose; but, although the halibut were abundant, the stormy nature of the region and other impediments rendered it impracticable to continue the effort.

A rapidly increasing trade is that connected with the menhaden, mossbunker, or pogy, (*Brevoortia menhaden*,) a large species of the herring family valuable for the oil and scrap—the refuse after extracting the oil from the boiled fish, which is used in direct applications to the land, or in the manufacture of fertilizers. Some idea of the magnitude of the interest may be learned from the fact that in 1873 sixty-two factories were in operation on the coast of New York and of New England, requiring the use of 383 sailing vessels and 20 steamers, the factories and vessels employing 2,306 men, with an investment of $2,388,000. The total catch of fish amounted to 1,193,100 barrels (250 fish to the barrel,) yielding 2,214,800 gallons of oil, and 36,289 tons of guano. The oil is used principally in dressing leather, and to some extent in rope-making and for painting, but not as yet for lubricating.

Another increasing fishery in the United States is that relating to the sturgeon, which, though abundant, has been but little utilized, thousands

annually taken in pursuit of other fish having usually been thrown aside as worthless. Now several dealers on the lakes, especially the Messrs. Schacht, of Sandusky, are entering into the trade, and manufacture caviar, isinglass, and dried smoked meat in great quantities.

The demand for fish-sounds continues very great, and the shores of New England and the provinces are carefully gleaned of all air-bladders procurable of the cod family. Of the species, the bladder of the hake is most sought after, bringing about one dollar a pound, and is used chiefly, it is said, in the manufacture of gum-drops.

The seal fishery during 1873 has also been very productive, the number taken at the Fur-Seal Islands in the Behring Sea being up to the maximum—namely, 100,000. The seals resort by millions to these islands, and it is said that a considerably larger number might be caught without any detriment to the trade. The capture of the hair-seals off the coasts of Labrador and Newfoundland, although less extensive than 1872, has also been a source of great profit. This business is now carried on entirely by steamers, of which not less than twenty belonging to Newfoundland were occupied, some of them getting two full cargoes. The largest catch of any vessel, it is believed, was about 42,000; these having been taken in the course of a few weeks, and, from the skins and oil, yielding an immense profit.

The rapid decrease of lobsters on the coast of the United States, and the extent of the interest connected with canning them as an article of food, has induced a special effort to bring back the supply. The amount of this interest may be appreciated when we are told that during 1873 more than twenty thousand tons of canned lobsters were brought into the United States, or shipped elsewhere, from the shores of New Brunswick and Nova Scotia alone. An ordinance has been issued by the Canadian authorities prohibiting, under severe penalties, the capture of any lobsters weighing less than a pound and a half; and Massachusetts will probably enact a law prescribing a limit of size—namely, a minimum of eleven inches in length. In Maine, the legislation anticipated is that of a close time of two or three months in the summer, when none shall be taken, but imposing no restriction at other seasons as to size or weight.

The oyster fisheries, as far as the canning interest is concerned, suffered a severe shock during the financial panic, from which it has not yet recovered, although the consumption of the oyster while fresh is perhaps as great as usual. Vessels now carry entire cargoes from Maryland and Virginia to England, where they are becoming an established article of trade.

It will be of interest to announce that the United States Fish Commission is experimenting on a method of effectually freeing beds of planted oysters from the ravages of the starfish, so destructive to them.

Much valuable information has been obtained in reference to the fishery statistics, and the conditions affecting the fisheries generally, by the labors of the United States Fish Commission, which continued its investigations under the direction of Commissioner, Professor S. F. Baird, assisted by Professor Verrill, on the coast of Maine during the summer of 1873. Detailed information was obtained in reference to the habits of the herring, cod, and other useful food fishes, which will have an important bearing on these interests. Numerous questions in reference to the preservation and reproduction of lobsters and oysters were also met. One result was the frequent capture of two-year-old shad in gillnets many miles out to sea.

In connection with the subject of the fisheries, the modern methods of preserving fresh fish for an indefinite period of time should not be lost sight of, especially as their introduction has imparted immense activity to the trade in fresh fish, and enables the dealers to supply salmon, shad, Spanish mackerel, bluefish, striped bass, etc., at all seasons of the year.

Of these devices there are two principally in use, one consisting in placing the fish in sealed metal boxes in a mixture of ice and salt; and the other, much more convenient, being the construction of a chamber enclosed within double walls, and filled with the same mixture. The fish are placed in the centre apartment, the temperature of which can be readily maintained at from eighteen to twenty-five degrees above zero, and are preserved indefinitely. It is only necessary to renew the supply of the mixture every week or month, according to the mass, and the temperature above referred to can be kept up indefinitely. Some establishments in New York and elsewhere keep many thousand pounds of fish in this way, subject to call at any time.

The various methods of increasing artificially the supply of fish and other marine animals, technically known as Pisciculture, have been prosecuted with increasing vigor during the year 1873, the earlier experiences warranting the adoption of more enlarged plans for securing the desired result. Associations have been formed, and State Commissioners appointed, while numerous private establishments have been erected. The most important action in this direction is that taken by the United States Fish Commission, established in 1871, which is now largely occupied with this work, in addition to special researches in reference to the condition of the fishing interest on the sea-coast and lakes.

The measures adopted have had more special relation to the multiplication of shad, salmon, and whitefish; and in these operations the United States Commission was fortunate in securing the assistance of Mr. Seth Green, Dr. J. H. Slack, Mr. Livingston Stone, and other fish culturists. Its operations have been conducted on a much larger scale than by any other nation, and with very gratifying success.

With a view of securing a sufficient supply of the eggs of the California salmon, Mr. Livingston Stone, as in the previous year, was sent out to the United States salmon-breeding camp on the McCloud River, near Mt. Shasta, where he obtained about a million and a half of eggs which were shipped to the East (a portion to Utah), and about half of them successfully hatched out, at various State and private establishments, and placed in different streams in the Northern, Middle, and Western States. The more important waters supplied are several streams in Maine and Massachusetts, the Connecticut, Hudson, Delaware, and Potomac rivers, Lake Champlain, Lake Ontario, Lake Erie, and Lake Michigan, and the Ohio River.

During the year, also, the establishment at Bucksport, Maine, under Mr. Atkins, continued its operations, on an enlarged scale and with very satisfactory success. While the salmon are seined when wanted on the McCloud, at this establishment they are purchased living from the fishermen, who capture them in weirs in the months of June and July, and place them in a large pond, to await the period of reproduction. Here they remain until October or November, when the instinct of spawning seizes them, and they run down into the outlet of the pond, where the hatching works are situated. The spawn is removed by gentle pressure into a vessel, and fertilized, and the parent fish returned alive to the water, and allowed ultimately to run down to the sea. Previously, however, they are marked by a label, so as to determine whether any come back again; and in this event to ascertain the growth and increase of weight in the interval, their original length and weight being recorded.

These eggs are then brought forward to a proper degree of development, and finally distributed to State Commissioners, by whom the operation is completed, and the young placed in the public waters of the States. It is expected that, as the result of the operations of these two establishments during 1873, not far from three million young salmon will be planted in the eastern, middle, and northern waters of the United States, including those placed in the tributaries of the Great Salt Lake.

Another enterprise of a similar character has been the erection of an establishment for the hatching of the eggs of land-locked salmon on Sebec Lake, in Maine, in which the Commissioners of Massachusetts and Connecticut have united with the United States Commissioner. It is hoped that, when this is fairly in operation, a large supply of this most valuable food fish will be secured.

Operations looking toward the multiplication of shad in American waters, both on the part of the United States and of some of the States

themselves, have also been conducted on a large scale. The work was prosecuted by the United States on many of the coast streams from the Savannah River to the Penobscot, and large numbers of young fish were not only turned into the water at the points where they were hatched, but transferred to tributaries of the Mississippi and of the great lakes. A successful shipment was also made to the Sacramento River of 35,000, and a small number to the Jordan, a tributary of Great Salt Lake.

As in previous years, Massachusetts, Connecticut, and New York carried on similar operations for the benefit of the local waters, while a beginning was made in the same direction by the Commissioners of Pennsylvania in the Susquehanna River.

The cultivation of whitefish has also been prosecuted with great zeal, particularly by the States of Michigan and New York, while a considerable number belonging to the United States Commission was sent to the Commissioners of California, and by them successfully planted in the waters of Clear Lake.

The operations in connection with whitefish have of late years been prosecuted on a very large scale by the State of New York, under the direction of Mr. Seth Green. In 1872 the State hatching-house at Caledonia contained about 3,000,000, which were duly planted when hatched. The number was less in 1873. In 1872 the United States Commission engaged the services of Mr. N. W. Clark, in connection with the whitefish eggs, and transmitted about 400,000 to the State Commissioner in California. In 1873 the State of Michigan collected a large number of these eggs for introduction into its own and adjacent waters. This fish, as is well known, is the most important of any species taken in the lakes, and it is fortunate that the method of their artificial propagation proves successful, and promises so satisfactory results. Only by such a process can the numerous waste and drain caused by the fisheries as at present prosecuted be met and replaced, an expenditure of ten or fifteen thousand dollars per annum being sufficient to secure the return in value of many hundred thousand dollars in productive results.

The discovery of a species of grayling (*Thymallus tricolor*) in certain rivers of Michigan, has suggested the importance of making this fish more widely known, by introducing it into appropriate waters elsewhere. Fish of this genus are much esteemed in Europe, both as an article of food and as furnishing excellent sport in their capture; and the American variety will probably be much sought after when arrangements can be made to supply the spawn in sufficient quantity.

A very important advance in the artificial propagation of fish was made by Seth Green and party while in the service of the United States Commission, in the discovery that striped bass, or rock-fish (*Roccus lineatus*,)

may be bred as easily and in much the same manner as the shad; special effort will probably be made during the coming year toward increasing the supply of this most valuable fish.

THE FISHWAYS OF PENNSYLVANIA.

BY JAMES WORRALL

[*Read before the American Fish Culturists' Association.*]

Some attention having been drawn to the Fishways constructed in the Columbia Dam, on the Susquehanna River, in the State of Pennsylvania, in consequence of the fact that no work of the kind as yet erected in the United States has been known by ocular demonstration to have permitted shad (*Alosa Prastabilis*,) to have passed through it, and having been connected with the Pennsylvania Fishways from the commencement of the restoration movement, the undersigned hopes that a few words in the form of a paper, to be read before this Association at its present meeting, will not be uninteresting as an endeavor toward the establishment of the facts as they have occurred.

The restoration movement in Pennsylvania originated in a Convention of citizens, most of them riparian to the Susquehanna, which assembled in Harrisburg early in 1866, and while the Legislature was in session. A bill was drawn up in this Convention which subsequently became a law, requiring Fishways to be erected in the dams of the Susquehanna and its tributaries; containing other provisions for the restoration and protection of the fisheries; and providing also for the appointment of a Commissioner who was required to be a civil engineer, whose duty it was, amongst other prescribed duties, to plan and have these fishways constructed. It so happened that vested rights precluded the erection of fishways in any dam on the river except the Columbia Dam; so the Commissioner's attention was exclusively confined to the Columbia Dam. The undersigned was appointed Commissioner, under the act, by Gov. Curtin, and immediately proceeded to the performance of his duties. His only qualification at the time of his appointment was derived from his experience as a civil engineer. He did not know the form required for such a structure, although he believed himself competent to construct the work as soon as the form could be ascertained. The only successful fishway at that time known, was the Foster Fishway, and to that, therefore, his attention was naturally directed. Most, if not all the Foster Fishways at that time constructed protruded from the dam down stream.

In considering the form of a fishway which would invite shad to pass through it, after enquiry amongst experienced fishermen and river men, the undersigned considered the Foster ladder decidedly objectionable, for he ascertained that shad moved more frequently in schools and flocks than in pairs or small numbers. He made up his mind then that the true form for shad should be capacious in size and as gentle as possible in inclination. Further, that it should be so located as that it would be easy to find. All these views indicated a cutting into the dam rather than a gradus or ladder below it. He was strengthened in this view by advice received from Mr. Daniel Shure, at that time Superintendent of the dam, and from Major George M. Lanman, (now deceased,) who had been engaged in its construction originally.

Advice was sought on the subject in Massachusetts also, whither he repaired and consulted with the Fishery Commissioners of that State, but especially with Col. Theodore Lyman. This latter gentleman stated that he believed an inclination of 1.10 would be overcome by the shad, but agreed otherwise with the undersigned as to the form of the fishway. Returning to Pennsylvania, Mr. Shure was consulted again, who also recommended 1.10 for the slope. The inclination of 1.15 was however eventually adopted, and a simple trough cut into the dam forty feet wide at its mouth, narrowing to twenty feet at its inlet by means of three or four rectangular offsets; these being the suggestions of Mr. Shure, who believed that they would create eddies and resting places for the fish, should they fail in gliding through the whole chute by a single impulsive movement. The rise to be overcome was about three feet,* and the length of the fishway was consequently forty five feet, obeying the inclination of 1.15. The width of the chute was considered very small by the undersigned (only forty feet in six thousand eight hundred, the length of the dam,) but its cost was to be about $5,000, and the whole affair being but an experiment, he hesitated in putting the owners of the dam to a greater expense than that for a mere trial of a principle. He felt sure that a few fish would ascend the chute and these would soon cause a feeling in favor of the system which once established would eventually induce the Legislature to make ample appropriations for more extended works. Thus also the fishway was located near the off shore or right bank of the river, in expectation of having another closer to the nigh shore or left bank. The work was finished in 1866. In 1867 it was looked to with great interest by a few friends of the measure, but it was treated with ridicule by most others. The winter of 1866-7 caused an abrasion of the dam, and this aiding the fishway, produced a consider-

*The dam is six feet high, but the floor of the weir is two feet below the top of the dam, and its lower end one foot above the bottom of the dam.

able run of shad above it so that a very fair catch was the consequence. This circumstance helped the reputation of the fishway no doubt, nor has that fact ever been denied.

In 1868 the catch was not so great, for there was no abrasion, but the catch exceeded the average of former years, and so matters continued, the catch always increasing till 1871-2, when the extraordinary catch estimated at some 100,000 as against ten, twenty and thirty thousand in ordinary seasons occurred on the Susquehanna below the dam.

Fishing was prohibited by the law of 1866 within half a mile of the dam, but local pressure in the Legislature repealed the prohibition, and since 1867 fishing has been allowed nominally to within 200 yards of the fishway, but actually there has been no prohibition as to distance, so that it has endured the most adverse circumstances. A good catch, however, was made above the dam in 1871-2, and from that year onward the river has been regarded as having been partially reinstated in its fisheries.

New "batteries" have been prepared below Columbia by men who, having but small capital, would not have invested in them had they not believed that the chances for remuneration were very much improved.

At Newport, on the Juniata, fifty or sixty miles above the dam, since 1867, a steady increase has been observed, and in these neighborhoods no one believes otherwise than that shad in greater or less numbers may be confidently expected every year.

At Newport, in 1872, the catch was quite small, but that is the only year since 1867 in which a decided increase has not been observed there. This, however, arose from local causes. The river at their fisheries was too low during the whole season. The fishermen saw the fish but could not catch them. But the series of increments met with no real break, for at Sunbury, above a second dam, and just below a third one, on the Susquehanna, the extraordinary catch of 2,000 was made in 1872. In which year there was no abrasion of the Columbia Dam, and 2,000 represents a large multiple of the number caught near Sunbury at any period in the quarter of a century preceding 1867.

There are facts current amongst the people of the upper Susquehanna and the Juniata, and which are implicitly believed, so much so that whereas the restoration movement commenced in utter incredulity and ridicule, the Legislature now finds itself encouraged by its constituencies riparian to the great rivers in appropriating money for carrying out improvements which have already borne such good fruit. People of Sunbury have stated to the undersigned that previous to 1867 a shad of the upper Susquehanna would fetch in their markets always more than a dollar and sometimes as high as three, four and five dollars, whereas they look for them now every spring and scarcely have to pay more than a dollar a pair for them.

The people of Maryland riprarian in the lower Susquehanna have observed a change for the better in their fisheries. They have done nothing to effect this, and the conclusion is inevitable to them that their neighbors up the river have been doing something, so that they are now exceedingly anxious to know what they shall do to aid and abet in the good work. There is scarcely any doubt that a commission will be appointed for that State at their present session of the Legislature. The abrasions in the Columbia Dam of 1873 were not easier of ascent for the shad than those of 1867. Yet the most extravagant claim for the catch of 1867 above the Columbia Dam was 20,000, the estimates varying between 12,000 and that number. If the fisheries of the river had not improved then since 1867 how could 50,000, (the number justly claimed,) be caught in 1873, whilst the utmost amount for 1867 did not exceed 20,000? In both years every available seine was employed.

It is entirely fair to infer that a large natural spawning took place year after year above the dam in years when there were abrasions of the dam as well as in years when there were not. The dam was originally so unfortunately located that abrasions have followed each other regularly on the recurrence of a severe winter as often before 1866 as since that time. But before 1867 there was no regular annual increase. There would be a good year and a bad year, due almost alone to the abrasions of the dam, the number ascending the navigation chutes being always very small, the great bulk of the runs of shad missing their mouths probably from their out-of-the-way locations.

There are navigation chutes in all the dams, yet shad only seem to ascend the first and second of them. The Shamokin Dam, just below Sunbury, has a large chute in it, yet shad, it may be said, are never caught above that structure. Yet, up to last year it was only about a foot higher than the Columbia Dam, say seven feet five inches, the Clark's ferry dam, up the chute of which a few always have passed, being seven feet in height.

When ordered by the Senate of Pennsylvania in 1871, to make a Report on Fishways, the undersigned again called upon his friends, the Massachusetts Commissioners, and with the experience gained up to that time, they agreed with him that the simple inclined trough was the best for low dams and shad. The gentler the inclination of course the better.

When the Pennsylvania Commission was appointed, with money in their hands to construct fishways, they adopted the idea of the inclined trough, employing the undersigned as engineer to construct it, and to make assurance doubly sure, reduced the inclination from 1.15 to about 1.35, whilst they added fifty per cent. to the width of the opening in the dam. They, however, regard the success of the old chute with incre-

dulity and hesitate even to pronounce beforehand in favor of the new one until shad shall absolutely be taken in nets placed at its head.

Herewith is submitted a diagram of both the chutes, in plan and in profile, in order that a correct idea may be formed as to their form and their inclinations.

[It is impossible to give these diagrams as they would occupy too much space.]

In December, 1873, the Pennsylvania Commissioners, Messrs. Reeder, Hewit and Duffy, visited both the chutes when the water as it entered them was about four feet in depth, the stage at which the shad are usually running in the spring. At this stage the chutes can only be approached in a steamer. The inclination of the new chute appeared so gentle that it was the unanimous opinion of all on board the vessel, that if shad could not ascend that comparatively gentle current they would ascend no artificial incline that can be made for them. I have not the slightest doubt that shad can and will ascend it. But the old chute was also visited, in which they did not express the same confidence. For in the first place, the area of the early chute is not one-fourth that of the second, whilst the inclination of the first is as 1.15 is to 1.35. Certainly the latter structure is much the more easy of ascent. But the effect of the two chutes in the water below was very similar. A long stream beginning in white caps and undulating in diminished graduation, was observed below each of them in the line of the axis of the chute, produced and plainly preceptible for about two hundred yards below the steeper chute and about one hundred and fifty yards below the gentler one. It may be mentioned here as a memorandum that the river below the dam, even in high water, is not deep. At low water the dam stands on a bottom scarcely averaging a foot in depth. And the fishways both fall into water at that stage not more than three feet deep, and when the shad are running the water below the dam scarcely averages four feet.

It is well known that shad are always attracted from their very earliest infancy by an opposing current; and that they are equally attracted by both these currents below the dam can scarcely admit of a doubt. So attracted, in the one case 200 yards below the dam and in the other 150 yards below it, they would undoubtedly stem both currents without preferring one to the other. For how could they know what there was to overcome at the head? Admitting the fact of the shad entering the currents at all the question left to be decided is: Can they overcome the velocity of the chutes. There is no hydraulic rule on the subject of water moving down inclined planes, which will give the water in either of these chutes a greater velocity than ten miles an hour.

Impeded by friction and by the water below the dam always endeav-

oring to enter the chute, for it must be remembered that if the water above were arrested, the water below the dam would back up the chute, nearly, if not quite, to the head of the incline, thus impeded, then, the velocity must be considerably less than ten miles an hour. It cannot indeed, by any possibility, be so great as ten miles an hour. For a body falling *in vacuo* at the third foot does not exceed that velocity, as the rule for falling bodies is $\sqrt{64.3} = v$ where s equals space in feet fallen and v the velocity in feet per second. Here the space in feet fallen is three, and this subjected to the rules gives about fourteen feet per second for the velocity, which is less than ten miles per hour as any school boy may easily ascertain with a slate and pencil. Now then can a shad stem a current of ten miles an hour? If he can, then either of these chutes he can ascend easily, *if he will*. It is easy to conceive that although the shad can ascend a chute, that he may not choose to do so. For he is an extremely timorous fish, and unless the chute be made attractive to him he may avoid it or be scared away from it. But a chute from forty to sixty feet wide ought not to repel him, and one still wider of course would be less repulsive. It is fair to suppose that width would attract him, and that having in Pennsylvania adopted a capacious width, we are at least on the road to a successful fishway. As to the velocity a shad attains in swimming, it may, and probably does, reach fifty miles an hour. The velocity then of the Pennsylvania chute cannot be an obstacle to him. The reason why shad did not ascend the Pennsylvania chutes in large numbers is, that they were not there to ascend. Go back of 1867, and ascertain when there was any catch of 50,000 shad immediately below the Columbia Dam. Come this side of 1867, and in 1871 there was a catch of some 100,000 at least, below the dam; and in 1873 we have a catch above the dam estimated, no doubt fairly, at 50,000, whilst there was an ordinary catch immediately below the dam. As stated then the reason why shad did not ascend the fishway in large numbers in the early years following 1867 was, that they were not there. They had to be made first, and where were they made? Above the Columbia Dam, assuredly, whilst their mothers could not have got there in sufficient numbers had they not been aided by the early chute. There is not a navigation chute in the river that will not admit shad. But these chutes are not located in the right places, they are not in the runways. A few get up at Columbia, a few at Clark's ferry—these are the first two dams, but none get up at Shamokin, the third dam, the navigation chute of which is as easy as the other two and the dam not more than a foot higher. Now both the fishways in the Columbia Dam are well located. The earliest runs of shad take the right centre of the river; the latter runs take the left centre of it—(right and left in describing rivers are

always referred to as looking down stream.) So now we are ready for them at both sides, and proper structures thrown out from the navigation chutes guiding the shad to their mouths will bring very large runs to them. In Pennsylvania then, we are on the way to a good chute for a low dam, and if success be assured, it will be easy to accommodate things to a high one. The principle is wide capacity and low velocity. But velocity increases in a very strong ratio in falling water; it increases about as the square of the fall, and the difficulty of a fishway for a high dam is therefore nearly as the square of its height.

In making a chute then, for a high dam and for shad, you must divide it into a series of low dams, thus interrupting the uniformly accelerated velocity so that the proportion may be directly as the height, instead of as the square of the height nearly. There will be difficulty and expense then to be overcome in the case of high dams. Difficulties from freshets, difficulties from ice, but American engineers have not often been beaten, and it is fair to presume they will not be beaten in this instance. Fishways have been made which are a success for almost all other kinds of migratory fishes. Mr. Brackett's improvement on Foster's being perhaps the best of them. The timidity of the shad has baffled us a little at the outset, but we will yet accommodate him, and fishways will be made as attractive to him as to the salmon, the alewife, the rock and the eel.

The history of this fishery movement will become interesting one of these days, and I read this paper in the interest of the truth of that history. Its initiation and progressive steps ought to be known and understood. There may be mistakes and errors of judgment. Nay, there must be, because it is managed by human creatures. But let us have as few mistakes and errors as possible.

I close by saying that the Pennsylvania fishway is believed to be the only fishway in the world that has as yet, in appreciable numbers, admitted shad; that the first one will not admit as many as the second only because it is much smaller and steeper, they both being built on the same principle; that that principle is due to consultations held by the undersigned, in the first place with Daniel Shure and Geo. M. Lanman, of Pennsylvania, the latter now no more, and with Theodore Lyman and Mr. Brackett, of Massachusetts, and latterly with H. J. Reeder, James Duffy and B. L. Hewit, the present Fishery Commissioners of Pennsylvania, whose orders were obeyed in the construction of the latter work. There is no doubt of ultimate success, for we are moving in the right direction, even if we have not struck the actual pathway.

LAWS FOR THE PRESERVATION OF FISH.

BY CHARLES HALLOCK.

It is an evident fact that but one general law, identical as to time of close season, can ever thoroughly protect the fish, birds or beasts of our country. It is perfectly possible to imagine a case where on a river of no great length it may be illegal to catch fish fifty miles from its source at certain times in one State, when one hundred miles below in another State the catching of such fish would in no way infringe on the fish statutes of that State.

Again, since we owe a great deal to the Canadian Fish Commissioners, it might frequently happen that rivers rising in the States and flowing into the Dominion might be depopulated of fish at their source by us while protected in the Provinces, or that exactly the reverse might happen. A commercial question enters here into the subject which occasions no end of dispute and unfortunate consequences. Fish may be legally caught in one State at one particular season of the year, then shipped and exposed for sale in another State where the time for catching such fish may be against the law, and it becomes a nice question to decide whether the seller or the purchaser of the fish are acting in contravention of the law.

The following is the preamble and resolution offered and accepted by the Convention of the American Fish Culturists' Association, with Mr. Hallock's remarks on presenting them:

I beg to bring to your notice a subject admitted to be of the greatest importance, though I doubt whether it comes fully within the scope of this association; but having heard one of your most distinguished members yesterday assert that, "protection must go hand in hand with propagation, and that all efforts in breeding fish will be nullified by neglect to protect the young fish and fish in spawn by judicious legislation and wardenship," I am encouraged to speak. We set the highest value upon provisions and penalties to prevent the use of nets, giant powder, *cocculus indicus*, and other devices for the wholesale and indiscriminate catching of fish, and for the taking of gravid and spent fish and all unseasonable fishing whatsoever, and for the means devised to prevent poaching in private or public waters, and for all those wholesale restrictions intended to govern angling on leased and open rivers, lakes and streams. All these go far towards the consummation of the main objects desired to be accomplished, but it is evident that the imperfect operation of the existing laws and the great loophole of escape for transgressors

lies in the fact that game and fish taken in one State may be sold in the markets of another State with impunity.

What is needed, therefore, is such a co-operation of States as will procure the enactment of a law which shall make it illegal to expose for sale in the markets of one State fish illegally taken in another State within the periods for which their taking is prohibited in such States. Some such measure is by universal consent acknowledged to be necessary, and we are pleased to observe that a draft of a bill with this object in view has been presented to the Legislature of Massachusetts by the Massachusetts Angling Association, of which Dr. J. P. Ordway is the very earnest and efficient President, and that the works and efforts of this society have been endorsed by the Fish Commissioners of Maine; and

WHEREAS, The Committee of the said Anglers' Association has, in a series of resolutions, invited the co-operation of their sister States, and urged the formation of similar associations for this purpose; therefore be it

Resolved, That it is the special province of the American Fish Culturists' Association, composed, as it is, of the State Fishery Commissioners, and the leading Fish Culturists of the country, to promote and encourage, either within or outside of its own body, the formation of a similar society as that of Massachusetts, and for the like objects. Also, in view of the difficulty that has hitherto attended the identification of species by a confusion of local names whereby we are unable to distinguish by the vernacular a trout from a black bass, a pike from a pickerel, and a bluefish from a taylor fish, it is of the utmost importance that an uniform nomenclature be adopted to enable us to designate each species as may be named within and coming under the provisions of any sumptuary act, so that the same be known and recognized in all those States included within the limits of said act, and that the better to decide upon and establish such uniform nomenclature a Committee or Board of Reference be formed to be composed of delegates, one from each naturalists' and sportmen's association in each State, whose qualifications shall be defined and determined by a convention composed of one delegate from each naturalists' and sportsmen's association in the States so co-operating, and the decision of which Board of Reference or Committee shall be final.

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