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TRANSACTIONS

—OF THE—

AMERICAN FISH-CULTURAL ASSOCIATION.

TWELFTH ANNUAL MEETING,

HELD AT COOPER INSTITUTE, IN THE CITY OF NEW YORK.

June 6th and 7th, 1883.

NEW YORK.

1883.

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TWELFTH ANNUAL MEETING

OF THE

Fish-Cultural Association.

FIRST DAY.

The Annual Meeting of the Association was held in the Farmers' Club rooms of the Cooper Institute, New York, on Wednesday and Thursday, June 6th and 7th, President Page in the chair. On opening, the President said:

"A year has rolled round since our last meeting, and there are evidences on every hand that the good work is progressing. It can be said with truth that, since the beginning of fish-culture in the United States, there is no other branch of industry that has made such progress. It has spread from Maine to California, and from Minnesota to Texas, until nearly every State and Territory has its Fish Commission, and most of them have an appropriation to work with. These funds have been put in the hands of Commissioners, who give their time and energies to the work, and but few receive any compensation for it other than the knowledge that they are doing good to their fellow men. It will be needless for me to go into detail in this matter, for I see before me men who have for years carried on the work in its broadest form for the National Government, and who are familiar not only with the work which they have been engaged in, but are also familiar with the whole literature of the subject, and know what fish-culturists in other lands have done. I might, however, be permitted to refer to the efforts in stocking waters heretofore unknown to the black bass, which has come to be known as the American game fish. In the West and in the

South it is found in the creels of the angler and on the slabs in the markets. They are now so abundant in Maine and the New England States, where they were unknown a few years ago, that they can be bought in the markets at a price within the reach of the poor man.

"Coming recently from the interior, I had an opportunity of examining the markets in St. Joseph, Mo., and found among the marketmen frequent acknowledgements of the work of fish-culturists, and of the teachings of this Association, and a thorough knowledge of the fact that, if the bass are protected in the spawning season, they become, like the commoner fishes, plentiful everywhere, and tend to lower the price of other fishes.

"We who live on the shad rivers, mark the manner in which the supply is kept up, in spite of the increasing demands of a growing population. Col. McDonald now has one hundred thousand shad eggs in process of hatching at Mr. Blackford's in Fulton Market, which he brought on from Washington to show the process. After they are hatched, they will be taken charge of by Mr. Mather, of the New York Fish Commission, and deposited in the Hudson, near Troy, where Prof. Baird sent a car load of one million a fortnight ago.

"Pardon me for relating a bit of my personal experience abroad: Happening in London at the inception of the plans of the Fisheries' Exhibition, now in progress there, I met many of the officials conected with it. At that time it was not known that our Government would make a display, and by request, as there was only three days before the passage of the yearly appropriation bill, I cabled to Senator Frye, of Maine, on the subject, and also sent a duplicate message to Prof. Baird. At this time there were many bills trembling in the balance, yet in two days an appropriation was introduced into both Houses, and was signed by the President. Our exhibit at London is a most creditable one, and it is generally acknowledged that no nation shows so favorably. Another fact: Making the acquaintance of Sir James Maitland, of Stirling, near Edinburgh, I found that within seven years he had achieved great results in fish-culture. He had hatched 997 trout out of 1,000 eggs, all alone, without assistance from any of his men. His extensive ponds have cost sixty thousand dollars, and he has made fish-culture a success in Scotland. Up to April, of this year, he has sold ten thousand dollars' worth of young trout and salmon, and his example has been largely followed in England, Ireland and Scotland."

The Secretary then read the report of last meeting, and the following new members were proposed: W. H. Schieffelin, Frank D. Butler, and Col. M. A. Bryson.

A FEW FACTS IN RELATION TO THE FOOD AND SPAWNING SEASONS OF FISHES ON THE ATLANTIC COAST.

BY E. G. BLACKFORD.

For a number of years past at the meetings of this Association, inquiries have come up as to the time or season of the spawning of striped bass, sheepshead, and bluefish, but no one was able to answer these questions with any accuracy, and the amount of knowledge on this important subject was apparently very limited.

During the summer of 1882, the Senate Sub-committee on Foreign Relations visited several fishing points on the coast, for the purpose of taking evidence from the fishermen, dealers and others, as to the food and habits of the menhaden, and also as to the fact that this fish formed one of the principal sources of food for the bass, bluefish, and other valuable fishes of our coast. The results of this inquiry conclusively proved that no accurate information could be obtained upon which to base any national legislation for the protection of the salt-water fisheries.

At the suggestion of Prof. Spencer F. Baird, I determined to avail myself of the facilities afforded by Fulton Market to begin a careful examination of the viscera of all the important fishes that came through my market. My numerous business engagements precluded my giving personal attention to this important work, and I was fortunate enough to obtain the assistance of

Prof. H. J. Rice, a gentleman who is peculiarly well qualified to make these investigations, and have now his report on the subject brought down to this date. It is proposed to continue these investigations for at least two years, and longer if it should be deemed important.

BROOKLYN, June 4th, 1883.

Mr. E. G. Blackford:

DEAR SIR.—I beg leave to report to you as follows in regard to the work which I have been carrying on under your direction during the past few months, in the line of ascertaining the food of the various food fishes and their time of spawning. I began operations upon the 24th day of February last, and up to the present time (June 4th) have worked upon two hundred and five (205) specimens of eighteen different species, divided as follows: 52 striped bass, 14 cod, 30 mackerel, 33 bluefish, 17 shad, 19 sea bass, 12 sheepshead, 8 porgies, 6 weakfish, 4 eels, 3 black bass, 1 smelt, 1 flounder, 1 angler fish, 1 mossbunker, 7 salmon, 1 sturgeon, and 1 moonfish.

Of the 52 striped bass 12 were males, varying in weight from 2 up to 46 lbs., and the rest were females, varying in weight from 3 up to 78 lbs. The first which I examined showed very little ripeness, and excepting a few scales, only a thick chyle-like material in the stomach; but gradually more evidences of feeding, in the shape of backbones, scales etc., presented themselves, and on the 23rd of March a fish was taken in the Chesapeake Bay weighing 66 pounds and having eight large alewives in its stomach. Since then rarely a fish has been examined that did not have in its stomach from one to seven fish in various stages of digestion. The species which I have been able to identify were alewives, eels, flounders, menhaden, and, in one instance, one of its own species. In this last case I found in the stomach of the small bass, which was about six inches long, a considerable quantity of shrimp. In only two other instances have I found any evidence that the food of the striped bass was anything but fish, and these were, first, in finding the claw of a small rock crab among some fish remains in the stomach of one of the large bass, and it may be that this claw had been swallowed by one of the fishes which the bass had swallowed, rather than by the bass itself; second, in finding two small shrimp in the stomach of a large male from Sing Sing on the Hudson. Among the males the spermaries gradually softened, until on May 11th, I found two, one of 22 and one of 26 lbs. in weight, and on the 12th one 18 lbs., which were spent. In the females the ovaries began to ripen somewhat earlier than with the males, one being taken on May 5th, off Governor's Island, weighing 46 lbs. and partially spent. Another was taken on May 11th of 7 lbs., quite ripe, and one on May 12th of 36½ lbs., from which the ova were running. On May 22nd one of 6 lbs. was found spent, and another of 3 lbs., which showed signs of ripeness.

Of the fourteen codfish which were examined, all except two were spent fish, accordingly all investigation was directed to find out their food. The two exceptions were that on March 28th, a female thirteen pounds in weight was found with perfectly ripe ovaries, and on May 12th, one was taken in which the ovaries were quite soft and some of the ova transparent. The food of the cod is quite miscellaneous, consisting, so far as I have noticed, of various kind of fishes, such as alewives, flounders, whitebait, etc., and sea-anemones, rock-crabs, razor-shells, small shrimp, hermit crabs, sea-cucumbers or holothurians and mussels. In fact, anything that is handy may find a resting place in a cod's stomach. Of the above-mentioned fishes, the first striped bass and cod were examined on February 24th, the last cod on May 16th, the last striped bass on May 26th.

The results as obtained from examination of the rest of the fishes may be summarized somewhat briefly as follows:

March 2nd. Smelt.—Ovaries quite ripe; piece of a marine worm in stomach.

March 21st to April 27th. Eels.—3¾–5¾ pounds; ovaries quite soft; nothing in stomach.

March 24th. Flounder.—Two pounds; nothing in stomach; ovaries nearly ripe.

March 31st. Angler fish.—Yellow perch in stomach; ovaries very large and very soft.

April 14th to May 19th. Mackerel.—Up to May 4th the ovaries and spermaries gradually became softer, upon which date one nearly ripe ovary was found. On May 11th others, both ovaries and spermaries were found, and on May 19th, the last examined, one quite ripe ovary was found. The stomachs of most of the specimens examined were filled with small reddish crustacea, copepods, small shrimp, small shells, and in the last two specimens examined, the stomachs were literally packed with the ova of some other fish.

April 20th to May 16th. Shad (North River, 16).—Ovaries not examined; stomachs of part of them with small shrimp, and a few fish scales. In some, the stomachs were full of the shrimp. In one Southern and three Connecticut shad nothing in stomach.

May 4th. Menhaden.—Male; first of season, spermaries not showing very much evidence of ripeness. Stomach with decomposed material.

May 4th to May 19th. Porgies (8).—3 males, 5 females; ovaries and spermaries getting quite soft. Stomachs with gelatinous chyle-like material.

May 5th. Salmon.—Female from the Penobscot; small gammarus and some gelatinous material in stomach. Ovaries small—just beginning to develop.

May 5th. Black Bass (3).—Males; stomachs empty, spermaries getting soft.

May 11th to June 2nd. Sea-bass.—11 males, 8 females; stomachs generally with small fish; one with crab. Ovaries and spermaries of most were soft. On May 21st one male ripe and flowing; on June 22nd two ovaries nearly ripe.

May 12th. Bluefish, North Carolina (20).—Apparently all males; stomachs literally crammed with fish—small bluefish, weakfish, butterfish, kingfish, menhaden, Lafayettes and gurnards.

May 26th. Bluefish (13).—All males; spermaries small; stomachs full of half digested fish remains.

May 21st to June 2nd. Sheepshead.—6 males, 6 females; stomachs all empty, but in intestines of one remains of crabs. Spermaries and ovaries mostly somewhat soft, and one, on May 2nd, appearing spent.

May 21st to June 2nd. Weakfish (6).—5 males, one female. Three males quite ripe; female and other males nearly so. Stomachs with fish and shrimp.

May 22nd. Sturgeon, Gravesend Bay.—Female, 200 pounds; ova nearly ripe.

June 2nd. Moonfish.—Female; stomach empty, ovaries apparently just spawned.

Very respectfully,

H. J. RICE.

MR. BLACKFORD.—I will state that the time covered by the investigations was so short that we are not prepared to draw conclusions as to the general food of the fishes examined, but they will be continued, and next year Prof. Rice will also observe the times of spawning of the fishes. Fulton Market is probably the best place in the country to pursue these studies, as there are specimens from all parts of the coast found there.

MR. PAGE.—This question of the food of our fishes is a most important one, and one in which there has been much interest taken lately on account of the discussions which have been going on in the *Forest and Stream* and other papers concerning the menhaden fisheries. It has been claimed that the capture of the menhaden for oil is depriving the striped bass and other valuable fishes of their natural food. The menhaden fishers have denied that the striped bass eats the menhaden, but it is generally believed that they subsist largely on this fish. It is evident that the general government must investigate this question before long.

COL. MCDONALD.—I would call the attention of the Association to the following extracts from a letter from Mr. S. P. Worth, Superintendent of Fisheries of South Carolina, on the spawning of the rockfish or striped bass, in the Roanoke River. He writes under date of June 2nd, 1883, and says:

"In regard to the propagation of rock I am gratified to mention successful operations. Last year I caused an examination to be made of these fish in the market at Weldon. Eleven ripe fish were reported. Having spawned, in 1880, a fifty-seven pound fish, the eggs of which reached the number, according to my estimate, of 3,000,000, I regarded the capture of eleven ripe fish at Weldon, within a brief period, quite sufficient reason for placing spawn-takers there this season. On May 9th, with confidence, I put in position at Weldon sixty-five McDonald jars, and while there nine ripe fish were found, the weights varying from thirty-five pounds to as low as five pounds. Four of these were taken by the fishermen before the jars arrived. The spawn was taken from three afterward captured, while two other fish were unwittingly sold, their ripeness not being detected by the possessors. Six hundred and sixty-five thousand eggs were taken, impregnated and hatched. The plant was twenty thousand fish put in the Roanoke, at Weldon. I estimated the rock eggs at 20,000 to the liquid standard quart, regarding them of the approximate size of shad eggs. I observed the following points, viz., that viewed in water the yolk only can be seen; that the yolk, or embryo fish, by gravitation, always occupies the lower portion of the egg; that the egg shell contains an oil globule, which causes it to float without reversing its position; that the eggs are very oily and appear to undergo greatest loss in the progress of impregnation, suggesting that they should be taken in water; that a loss of forty per cent. took place before hatching began; that the unimpregnated egg is of a decided green color, the yolk of the impregnated egg being a paler, though beautiful shade of green; that a glass tube filled with impregnated ova and tightly corked at either end remained over night, a period of twelve hours, at a tempe ature of about 65 to 70 degrees, without change of water, and that the same eggs on a tray produced fish. I was particularly struck with this. Also, that the liberated fry is about 3-16 of an inch long; that the body projects beyond the posterior end of the sac only 1-22 of the total length; that in water at 75 degrees the sac is absorbed in four days and the length of the fish is then only ¼ inch; that during the ten days' confinement in jars, in water varying from 69 to 82 degrees, the fry gained but little growth, yet considerable dark coloration, and were constantly striking, as if to feed on drifting particles; that the eyes at time of hatching, after close scrutiny with a pocket glass, revealed no pigment, even among those hatched slowly on trays. I further observed that the catch of rock at Weldon this year reached 4,500. I was told that last year five times as many were caught; that several years back as many as 300 fish of thirty pounds weight have been taken on one slide in a single day; that the numbers of the fish have steadily declined; that the river is infested with innumerable catfish, reaching to millions, the great majority, in fact, nearly all, not exceeding a hand's length."

SUNFISH: THEIR HABITS AND EXTERMINATION.

BY FRED MATHER.

A pest which the fish-culturist who has large ponds often has to contend with is the little fish, or fishes, for there are several species, which are popularly called sunfish, pondfish, pumpkinseed, etc. These fish belong to the family *Centrarchidæ*, and are closely related to the black bass, both in structure and habits, an intermediate link being found in the "red eyes," "rock bass" and the "war-mouth" of the South. Within the district east of the Mississippi and north of North Carolina, Prof. Jordan, in his "Manual of the Vertebrates," enumerates eleven genera and twenty-six species of sunfishes, and this region would be several millions of dollars richer if there were none.

The sunfish is among the first of the scaly acquaintances made by the boyish angler in his Saturday trips to the mill-pond; and although there is a feeling of sentiment in favor of a fish that is connected with early angling, and on whose account I was many times called into the wood-shed by a stern parent to account for absences from school, I now look upon the little fish as a great nuisance. Sentiment has no place in the struggle to produce food, and the sunfish consumes a vast amount and produces nothing. It does not even furnish food to other and better fishes to any extent, for its strong spines, which are erected when in danger, make it a thorny mouthful. Even when these fins are trimmed off it is the poorest of baits, for the pike and bass know the fish by sight, and do not seem to investigate its improved condition and thus learn that the individual before them has been disarmed. There are comparatively large species, which in some waters grow to a quarter of a pound in weight; but take the fish as they run in the ponds, they seldom reach two ounces.

The food of the sunfish is worms, flies, crustaceans, fish eggs, and small fish, especially those which have soft fins, for they do not relish their own spinous relatives. Consequently they are formidable competitors for the food of the young of valuable fishes, even if they did not devour them; but when their predatory habits are added to their consumption of other food, and their fecundity is also known, they at once become recognized as among the most injurious foes to fish-culture.

My attention was strongly called to this fish this spring. Near the hatchery at Cold Spring Harbor, Long Island, of which I have had charge this year, are the mill ponds belonging to the Messrs. Jones, by whose liberality the hatchery was leased for a nominal sum to the New York Fish Commission. I had some young land-locked salmon, and Mr. Townsend Jones wished to try some of them in the lower pond, which is deep and cold, but is infested with sunfish. I recommended placing the fish in the upper pond where the trout are more plentiful, and where the spring streams would afford food and protection to the fry, until large enough to run down into the two lower ponds. Mr. Jones feared they would interfere with the trout, and we compromised the matter by placing some in each pond. In the lower pond, where the sunfish are most plentiful, we placed 3,500 young land-locked salmon, of an inch or more in length, by setting them out in the springs bordering the pond. We watched them, and saw the sunfish waiting for those which went down into the deeper water, but could not see that any were caught. The next day Mr. Jones captured a sunfish which had thirty-five young salmon in its stomach, just one per cent. of the plant! At this rate it would only require one hundred sunfish to consume the entire lot in one day, and we estimated that there were tens of thousands of sunfish in the large pond.

About the middle of May, in this vicinity, the sunfish makes its nest near the shores or on shallows, by sweeping a spot twelve or fifteen inches in diameter in the gravel. The male and female occupy the nest and fight off all intruders. In the pond mentioned there is a spot near the flume where a space twenty-five feet long by fifteen wide contains over two hundred nests, lying as thickly as it is possible for circles to lie. On the first day of June I noticed that they were spawning, the female slowly turning round in the nest, and the male going around outside of her. They would come together and lie upon their sides, with their vents in contact and their heads apart, and, by motion of their tails turn round on a point of which her dorsal fin was the pivot. I incline to think that all the eggs are not laid at one time, but that altogether each female deposits from five to ten thousand eggs in the season. There are probably ten thousand such nests in Mr. Jones's pond, as they can be seen all along the shores in from two to four feet of water seldom deeper than five feet.

In the course of my fish-cultural life, I have been applied to many times by persons who wished to stock ponds with valuable fish, to know how to get rid of sunfish. They have often asked if explosion would not be effective, and I have told them that it would, but it would also kill every other living thing in the water, and that their pond would be barren of all such valuable fish-food as insect, larvæ and crustaceans, and that the remedy was as bad as the disease All that then suggested itself was persistent netting, and this entails much labor and seldom catches the last fish. This spring, while watching the nests, it occured to me that the young crop could be effectually killed off by rowing around the ponds and dropping a piece of quicklime as large as a robin's egg upon each nest, perhaps through a tube, which would deliver it exactly. This plan would not interfere with the waters in the deeper parts, nor with the fishes, and if pursued until the original stock died out would appear to be effectual. I have recommended this plan to Mr. Jones, and, if time permits, will assist him in carrying it out.

LOBSTERS.

Mr. Phillips.—I have here a paper on lobster culture, by Mr. S. M. Johnson, of the firm of Johnson & Young, the large lobster dealers of Warren Bridge, Boston, but think it best to preface it by some extracts from a report on the Collection of Economic Crustaceans, Worms, Echinoderms, and Sponges, sent to the Great International Fisheries' Exhibition at London, by Mr. Richard Rathbun, Curator of the Department of Marine Invertebrates in the United States National Museum. The report says:

"The lobster is by far the most important crustacean occurring upon the coasts of the United States, and gives rise to an extremely valuable fishery. It is confined to the Atlantic side of the continent, and ranges from Delaware in the south, to Labrador in the north. The most southern fishery is a small one in the neighborhood of Atlantic City and Long Branch, New Jersey. Lobsters were once moderately abundant in New York Bay, and were taken there for market, but the pollution of the waters of the bay by numerous factories and other causes have combined to nearly exterminate the species. At numerous places through Long Island Sound, lobsters are sufficiently plentiful to permit of limited fisheries, which are mainly confined to supplying the local demand. Further east, on the southern New England coast, in the region of Block Island, Montauk Point, the Elizabeth Islands, and Martha's Vineyard, they become much more abundant and afford a very profitable fishery, extending through the spring, summer, and early fall. The entire coast line of Massachusetts abounds in lobsters, whenever the character of the bottom is suitable for them, but overfishing has nearly depleted some of the shallow water areas, which were once prolific, as at Provincetown. The sandy shores of New Hampshire furnish only a moderate supply of lobsters. Lobsters are very much more abundant on the Maine coast than anywhere to the southward, and the yearly fishery exceeds in quantity and value those of all the other States combined. This State is, in fact, the main source of supply for all the principal markets in the United States. The fishery continues in some localities throughout the year, but is most active during the spring, summer, and fall, and especially from April 1st to August 1st, when the canneries are open.

"The lobster fishery, as a distinct industry, commenced on the Massachusetts coast about the beginning of the present century, and on the Maine coast about 1840. It has rapidly developed to the present time. At first, lobsters were frequently found during the summer, in some favorable localities at or near low-water mark, especially on the Maine coast, where they could be gaffed out from under the protection of overhanging rocks and seaweeds. They rarely occur in such situations now, and the fishery is mainly carried on in depths of a few fathoms to 20 or 30 fathoms, but sometimes in depths of 40 to 60 fathoms. On the coast of Nova Scotia, lobsters are about as common as on the Maine coast, but further to the north they become less abundant again. They have been taken on some of the outlying fishing banks, such as George's Bank, but are not fished for at any great distance from land.

"The lobster fishery is regularly carried on by means of wooden framework traps, or pots, generally constructed of common house-laths. They are usually made semi-cylindrical in shape, being flat below, rounded at the sides and above, and with a net-work or wooden funnel-entrance at each end, or at one end only. The ordinary size is four feet long, and about 18 inches broad and high, with two funnels; smaller sizes with one funnel, and larger sizes with four funnels are occasionally used, as are also rectangular-shaped pots The old style of lobster pot, employed when lobsters were more abundant and the fishery less important, consisted of a wooden or iron hoop, of variable size, up to 4 feet or more in diameter, carrying a net which sagged but little, and furnished above with a cross-hoop arrangement, or with twine leaders, to which the line for lowering it, as well as the bait, was fastened. This style of pot has now almost entirely disappeared from the coast, as it required constant attention, and only a few could be tended by each fisherman. The lath or cylinder pots are baited in the center with cheap or refuse fish, which are fastened on an upright spear-like holder. They are weighted with stones, and lowered and raised by means of a rope attached to the end of the pot. The number of pots used by each fisherman varies in different localities, ranging all the way from 8 or 10 to 100. The average number may be said to be about 50 or 60. The pots are set either singly or attached together in trawls, the character of the bottom, abundance of lobsters, and custom regulating this matter. When set trawl-fashion, the pots can be handled much more easily than otherwise, and this method is generally preferred on the coast of Maine, wherever lobsters are abundant and the bottom not too rough. The pots are fastened together in strings of 10 or a dozen to 50 or 60, at distances apart of 15 to 20 fathoms, and have a long buoy line at each end. The fisherman pays out his lobster trawl in a straight line, beginning at one end, and marks the ends with kegs or small wooden buoys. After remaining down a sufficient length of time, generally twenty-four hours, he proceeds to examine his pots, beginning at one end of the trawl and underrunning it to the other. The general arrangement of the trawl is not, therefore, disturbed; but the pots, after they have been examined, fall back again into nearly the same places which they previously occupied. In setting the pots singly, each has a separate buoy line and buoy, and the fisherman passes in succession from one to the other. Where lobsters are much scattered, this is the preferable way of setting the pots, as they are shifted slightly every time they are hauled, and are supposed thereby to fish much better. The latter method is probably the one most universally employed along the entire coast. It is customary to visit the pots early every morning, or, otherwise, when the tide serves best.

"The principal lobster markets in the country are Portland, Boston, and New York. Three-fourths of all the lobsters disposed of to the fresh trade are carried by well-smacks or railroads to one or other of these three centers, where they are sold locally or distributed through the country, either alive or boiled, but generally in the former state. The dealers have large cars, in which a considerable stock can be stored awaiting orders Lobsters are in season during the entire year, but are much more abundant in the markets, and much more highly prized as food during the late spring, summer, and early fall. For most lobster fishermen the season is of short duration, lasting only about two, three, or four months, after which time, and until the next season, they engage in other fisheries, or in farming, mining, or other pursuits. Their season's stock seldom exceeds a few hundred dollars.

"The canning of lobsters in the United States is entirely confined to the coast of Maine; and most of the provincial canneries are controled by American capital. Without its canning interests the Maine lobster fishery would lose much of its prestige as the majority of the lobsters canned are below the regulation size established by custom for the fresh markets. The market-smacks will seldom buy lobsters measuring less than ten or ten and a half inches in length, and those under this size are sold to the canneries. The canning industry was first started about 1840, at Eastport, Me., but several years elapsed before it was successfully introduced. In 1880 there were twenty-three canneries in Maine, with a total capital of $289,000, remaining open from about April 1st to August 1st, and giving employment to about 650 factory hands and 2,000 fishermen. The quantity of fresh lobsters used amounted to about 9,500,000 pounds, valued at $95,000 to the fishermen. The value of the canned products was $238,000, an enhancement in value by the process of canning of $143,000. Seventeen provincial canneries are owned by Americans, as follows: One each in New Foundland, the Magdalen Islands, and Prince Edward Island, three in New Brunswick, and eleven in Nova Scotia. The total amount of capital invested in 1880 was $213,000; 10,000,000 pounds of fresh lobsters were consumed that year, and the value of the canned products was $246,000. These products are all exported to Europe and other foreign countries, none passing into the United States.

"The total catch of lobsters on the Maine coast for 1880 amounted to 14,234,000 pounds, valued at $268,000, first-cost, or fishermen's prices. The catch for Massachusetts was 4,315,000 pounds, valued at $158,000, and that of the entire coast of the several lobster States was 20,128,000 pounds, worth $483,000, first price. The quantity of lobsters handled by the several large fresh markets during 1880 was as follows: Portland, 2,000,000 pounds; Boston, 3,637,000 pounds; New York, 2,500,000 pounds; a total of 8,137,000 pounds. The enhancement in value of these lobsters in passing through the large markets was $105,000, making the total value of the lobster products, as they entered the hands of the smaller wholesale and the retail dealers, $732,000. The prices received by the fishermen for lobsters vary greatly, according to their size and the season. Canning lobsters, which average about one pound each, bring about one cent per pound, but those above ten inches in length are worth from four to seven cents each.

"Legislation relative to the lobster fishery is entirely under the control of the several interested States, all of which excepting New Jersey, have passed protective laws. The Maine law is the most lax of all, permitting the capture and sale of lobsters of any size between the 1st of April and the 1st of August, and of lobsters above 10½ inches in length the balance of the year. The remaining State laws prohibit the taking of lobsters at any season below a certain size (ranging from 8 to 10 inches), and make other restrictions as to a close time, etc.

"The propagation of the American lobster by artificial means has been attempted, but so far without much success. Unsuccessful attempts to transplant the same species to the California coast have also been made."

LOBSTER CULTURE.

BY S. M. JOHNSON.

Your kind invitation to prepare a short article on lobster culture was duly received, and I hereby briefly comply with your request:

The true sportsman angler when he carefully releases the fingerling trout and returns it to the stream, intuitively recognizes the true economy of fish-culture. With an application of this same law to lobsters, we claim that great good might be done. By returning to the grounds all that are immature, and placing the limit so as to allow time for reproduction, a constant and sufficient supply would be insured, which result, I think, can be accomplished in no other way. The merits of this plan seem to be very generally understood, but the great difficulty is in determining what good has been, or may be, accomplished, arises from the fact that the laws of the different States are not uniform, and that, moreover, they are often disregarded altogether; so that no satisfactory knowledge of the benefit derived is possible until these difficulties are adjusted.

There is a plan which, as far as I know, has never been tried as a means of protection, and which, if adopted, would effectually accomplish this purpose, and it would often serve to overcome an objection often raised by the fishermen to the present law, namely, that by returning to the grounds the lobsters below the required standard, they are obliged to retake them again and again. For these, and other reasons, I would respectfully submit for the consideration of the Association and all others interested, the following:

That all traps or pots be so constructed that the laths or sticks shall be sufficiently far apart to allow all small lobsters to escape, and that a funnel hoop shall be used of not less than five and one-half or six inches in diameter. The adoption of this principle, which is used in many kinds of net fishing, to the lobster industry, would be perfectly just to all, and the chances for replenishing the grounds would be greatly augmented. I hope that whenever and wherever the subject of protection for lobsters is brought under consideration, this plan may receive the attention its importance demands.

The disposal of the spawn-bearing lobster is important and worthy of consideration also. My individual opinion, however, is that if the limit fixed is large enough, a sufficient quantity would be included in the number returned to the grounds to provide for breeding necessities. This is a matter of no small consequence, and should be carefully looked up. The plan of having a close time is frequently advanced, and I do not wish to be understood as altogether opposed to it, but I am unable to find a good and sufficient reason for adopting it. I will briefly consider some of the difficulties that appear in selecting the time.

Suppose we take April, May and June, the months when lobsters are most numerous, there seems to be no necessity for a close time then, because at this season the supply is equal to the demand, and any reasonable limit could be applied without hardship to either fishermen or consumers. We find then no reason for a close time during these months. Now suppose we select the other extreme, January, February and March, the months when fewest lobsters are caught. Here they are a law unto themselves, and enough cannot be captured under the most favorable conditions to interfere with or in any way endanger the future supply. The correctness of this statement seems to be confirmed by the fact that although the time mentioned is when the consumption is least from lack of supply, the price advances. So I fail to find a reason for a close time during these months also.

In the cases alluded to, the economic and commercial aspect appears prominent. We may seek for a scientific or natural reason, and find ourselves still undecided, being unable to say when the lobster spawns or when the eggs are hatched. In fact, it is very generally conceded that these events—which are separate and distinct—may, and do, occur at all seasons. So, if a close time be advocated, it would be extremely difficult to choose such a time, as it is impossible to show that any better results would be obtained at one time than at another.

I leave this part of the subject without further discussion, except to say that I am open to conviction.

The difficulty in the way of procuring reliable statistics in regard to the benefit derived from the laws we now have, arises from the fact that even were these laws strictly enforced, the catch is so much influenced by the weather and the number of men engaged in fishing at different seasons, that what comes to the market gives no real information as to their relative scarcity from one year to another. It is not a matter of conjecture, but it is a settled fact that lobsters are becoming more and more scarce every year, and it is of the greatest importance that a new interest in the matter should be awakened, and that continued and increased efforts for their protection should be made.

Mr. Mather.—It seems to me that Mr. Johnson has solved the problem of lobster protection, and the only wonder is that no one has thought of making the lobster pots with apertures large enough to permit the small ones to pass out before this time. Perhaps some some of the men engaged in the fishery may have thought of this, but as they sell the small lobsters to the canneries, it is their present interest to catch them. If the States will regulate the apertures in the lobster pots as they do the meshes in fish nets, then the small ones will have a chance to grow.

Mr. Page.—Mr. Johnson's long experience as one of the largest lobster dealers in the country certainly gives great weight to his propositions, which seem to me to be eminently practical. Probably if this Association brings this matter to the notice of the different Fish Commissioners, some such laws regulating the catching of lobsters may be enacted.

Mr. Blackford moved that the election of officers be postponed until the next day, on account of the small attendance, which he thought was caused by the heat and the change of the time of meeting. Carried.

The meeting then adjourned until 2.30 P. M.

When assembling again the following paper was read:

ON THE DISTRIBUTION OF THE BLACK BASS.

BY DR. J. A. HENSHALL.

In this brief paper the writer intends merely to give the facts, as they exist, relative to the distribution of the black bass species, without attempting to draw any conclusions therefore from the laws which govern the geographical distribution of fresh-water fishes, or to offer any theory concerning the same. A study of the habitat of the black bass, however, will, no doubt, aid the biologist very materially in solving the problem of the distribution of animals.

The geographical distribution of the black bass is remarkable for its extent; the original habitat of one or other of the two species ranging from Virginia to Florida, and from Canada and the Red River on the north to Louisiana and East Mexico. In other words, it might be stated that the original geographical range of this representative American fish embraced the whole of North America, south of the British possessions and east of the Rocky Mountains, except the waters flowing into the Atlantic in New England and the Middle States, thus far excelling any other fish of America in its distribution. Of the two species, the large-mouthed bass had the widest distribution, occurring all through the vast scope of territory mentioned above. The small-mouthed bass had a somewhat limited range in comparison, not extending east or south beyond the Alleghany Mountains, though occurring everywhere else with the large-mouthed species.

At the present day the habitat of the black bass has been extended by transportation, and by means of artificial canals, so that it may be said to inhabit every State of the Union. It has also been successfully introduced into England, Scotland and

Germany, thus occupying a wider range than any fresh-water fish in the world.

The fact that the original habitat of the black bass does not embrace New England and the Pacific slope is not remarkable, for the characteristically American forms of fishes, as has been observed by Prof. Jordan, are, generally speaking, rare or absent in the waters of these sections. This fact was noticed by Prof. Louis Agassiz, who called New England "a zoological island," on account of its faunal peculiarities as compared with the rest of the United States. Thus, of more than a hundred genera of fresh-water fishes now known to occur in the waters east of the Mississippi River, only about one-fourth occur in New England, and of these all except a half-dozen genera are represented by but a single species each; and not more than thirty-five genera occur in the waters of the Pacific slope. Almost any stream of any extent of the Ohio or Mississippi basins will furnish double the number of genera and species as the entire waters of either of the above named sections. Thus, as Prof. Jordan states, " In the little White River at Indianapolis, seventy species, representing forty-eight genera, are known to occur—twice as many as inhabit all the rivers of New England."

The distribution of the black bass does not seem to be much affected by geological formations, climatic influences, or the character of waters; for although one or both species may have been absent originally in certain localities, they readily adapt themselves to the waters of these sections when transplanted, and rapidly increase.

Originally both species were at home among the primordial rock of the eozoic period of Lake Champlain, Northern Wisconsin, and along the Appalachian chain in the Carolinas and Northern Georgia. They flourished amid the paleozoic rocks of the Great Lake region and the Mississippi Valley, and in the coal measures of the Ohio, Illinois and Missouri river basins. While in the marine tertiary formations of the cenozoic period, along the Atlantic and Gulf slopes of the Southern States, the large-mouthed bass alone occurs. Thus, while the small-mouthed bass seems to be restricted naturally to the older formations, the large-mouthed bass roams at his own sweet will through the regions of metamorphic and stratified rocks and glacial drift, down to the recently formed coral rocks of the peninsula of Florida.

Climatic influences do not seem to affect the distribution of the large-mouthed bass in any degree, in the United States, and of the small-mouthed bass only to a small extent. The original habitat of the species extended through twenty-five degrees of latitude and thirty degrees of longtitude, the small-mouthed bass alone not occurring in the extreme ten degrees of southern latitude, and the ten degrees of extreme western longitude of this range. Thus, while the small-mouthed bass is naturally restricted to cold and temperate waters, the large-mouthed bass bids defiance alike to the ice-bound streams of Canada, the tropical lagoons of East Mexico, and the sunny streams of Southern Florida. He flashes his bright armor under the firs and birches of the St. Lawrence basin, and erects his spiny crest in the grateful shade of the palms and live oaks of the southern peninsula. To him it is given—

> "To bathe in fiery floods, or to reside
> In thrilling regions of thick-ribbed ice."

The character of waters has but little influence upon the distribution of the species, less upon the large-mouthed bass than upon his small-mouthed congener. If the water is reasonably pure, both species will thrive in it; but, as has just been intimated, the small-mouthed bass naturally seeks cooler and clearer waters. Thus, while he is found in the headwaters of certain rivers flowing into the Atlantic (notably those of the Alleghany region of the Carolinas, Georgia and Alabama), co-existing with the large-mouthed bass, the latter only occurs in the lower portions of the streams. (There are several rivers in Hernando county, on the Gulf coast of Florida, that burst out from the base of a sandy ridge running parallel with the coast and some twelve miles from it, whose sources are large springs fifty or sixty feet deep, and of half an acre in extent. Their waters are remarkably clear and cool, with a strong current until tide water is reached; and I have no doubt but the small-mouthed would thrive wonderfully well in the upper portions of the streams if introduced into them, as the conditions all seem favorable, and the large-mouthed bass is very abundant in them).

As we approach tide water the small-mouthed bass disappears. The large-mouthed bass, however, true to his cosmopolitan nature, descends the streams to their mouths, where he seems to be as much at home in the brackish waters of the estuaries as in the pure and crystal rapids of the highlands.

The black bass being in a manner omnivorous, is probably not restricted in its range to any great extent by the supply of any one article of his food; though it would be affected, of course, by an abundance or scarcity of its food, as a whole. Crawfish and minnows are the principal food of adult black bass, and these are more or less plentiful throughout the waters of the United States. In addition to these they feed upon insects, larvæ, frogs, etc. Prof. S. A. Forbes, in his studies of the food of fishes, ascertained that the food of young bass, when less than an inch in length, consisted entirely of minute crustacea (*Entomostraca*). When from one to four inches long they feed almost wholly upon insects; while crawfish and small fishes constituted the principal diet of adult bass, the small-mouthed species showing an especial fondness for the former. The great prevalence of crawfish in clear, rocky streams may throw some light upon the preference of small-mouthed bass for such waters.

I wish to say a word in this connection in reference to objections heretofore urged before this Association against the introduction of the black bass into eastern waters, upon the theory that the presence of the voracious bass would militate against the increase of shad and salmon. The objections are not valid or founded on fact, for the black bass prefers a diet of crawfish, when he can get it, varying it with minnows, insects, larvæ and frogs, and in eastern waters he would not object to young eels. The pike, pickerel, pike-perch and garfish are almost entirely piscivorous in their habits, which might be expected from the character of their teeth, and their sins have no doubt been charged to the black bass. But while the bass will take in a young shad or salmon, if it comes his way when hungry, he will not make them special objects of pursuit, like the canine-teethed fishes above-named.

The failure to restock such streams, if any such failure exists, must be attributed to other causes than the introduction of the black bass, prominent among which is the unrelenting pursuit of the young fry by the predatory fishes mentioned. They are only exceeded in their destructiveness by the genus *homo*, with his miles of gill-nets at the mouths of the streams, to prevent the return of the shad or salmon during the breeding season; and should a few run the gauntlet and succeed in depositing their spawn in the upper reaches of the rivers, the eels, bull-heads and suckers take good care of it. All of which is truly deplorable, and deplorably true. But in your just and righteous indignation do not make a scape-goat of so good a fellow as the black bass.

In Western waters where the bass exists with the usual varieties of fishes, there is no perceptible decrease in the numbers of either. If any species suffers it is always the black bass on account of over-fishing, spearing, etc. I know of isolated lakes in Wisconsin where the black bass has co-existed with the cisco (one of the salmon family), longer than the memory of man runneth to the contrary, without a decrease of the latter fish. If then the bass cannot "get away with" the cisco in confined waters, how can he "clean out" the shad or salmon in large flowing streams? Moreover, I know of a small stream that abounded in black bass and crawfish, in which brook trout were introduced to the discomfiture of the former fish, for the trout increased while the numbers of the bass grew smaller by degrees and beautifully less.

If then there are waters in which the brook trout or the rainbow trout will not thrive, do not hesitate to aid in the further distribution of the black bass by introducing that desirable species. It is easily done, and success is already assured. You have only to look at the Potomac, the Susquehannah, the Delaware, and many other streams for evidence of its rapid increase in new waters.

The black bass is excelled by no other fish that swims for gameness, and among fresh-water species by but one, the whitefish, for the table. And furthermore, he will not eat the spawn of his mate, or that of his fellows' mates. His natural food is the crawfish and the minnow; he prefers them, and they are easily procured. On them he will wax and grow fat, increase and multiply. The man who alleges that he depopulates the streams of valuable food fishes, or asserts that he "kills for the love of it," has never looked into the mouth of the bass with his eyes open.

MR. ENDICOTT.—I have listened with great attention to the interesting paper by Dr. Henshall, and I feel constrained to take issue with him on the subject of introducing the black bass into trout waters. Dr. Henshall is well known as the apostle of the black bass, and he therefore defends him against all charges of bad habits. It is a deplorable fact that the introduction of black bass into some of the Adirondack waters, notably in Raquette Lake, has resulted in the thinning out of the trout, so that angling for bass is all that can be looked for with any certainty of sport. There is no doubt of the value of the bass in all waters that are not inhabited by trout, but the latter is so far the superior of the bass as a game fish that it is vandalism to place bass in trout streams or lakes. In regard to large shad rivers I can agree with Dr. Henshall, for those rivers contain other predatory fish which may be kept in check by the bass, for it is well known that in many waters the bass have thinned out the savage pickerel. The learned doctor, living far from trout streams, and having caught the bass for years and learned to love them, does not seem to place as high a value upon the trout as we do, for he evidently considers the bass the equal, if not the superior, of the trout. This is an assumption which I cannot assent to, nor will trout anglers generally. Years ago while fishing in the Adirondacks for trout I was annoyed by the continued rise and capture of small black bass, and turned to my companion and said: "The trout must go, for the black bass is more fatal to them than the sunfish are."

COL. MCDONALD.—I agree with Mr. Endicott concerning black bass in trout waters, but do not think they have any bad effect in shad rivers.

MR. ENDICOTT.—I regard the black bass as the bluefish of fresh waters, and Professor Baird has characterized the bluefish as more ravenous than the shark.

COL. McDONALD.—The black bass is of great value to some rivers. I sent to the Holston River for bass to stock New River, Virginia, and the bass were so lively that they jumped the seine, but we caught some, and it was a great gain. They increased and made a summer resort of the river, where hundreds now go to fish. The black bass are worth five dollars per pound to the people who keep hotels and boats, for they get that, on an average, indirectly from the anglers, and others who resort there.

MR. MATHER.—I do not think that Dr. Henshall has advocated the placing of black bass in trout waters. He is very enthusiastic on the bass as a game fish, and personally may prefer it to trout, but he is too well-informed not to know that trout anglers do not agree with him. I know of a gentlemen in this city who has taken trout for years, and only fished for black bass for a limited time, who prefers the bass. For myself I prefer trout fishing, but think very little of either trout or black bass for the table. For me a fresh codfish is far ahead of them. I would never put black bass in good trout waters, but our large rivers are not trout waters, and the bass there will prove the most valuable of fishes to the angler.

FOOD FISH AND FISH FOOD.

BY A. N. CHENEY.

Repeated experiments and close and intelligent observation for years, has enabled the fish culturist to lay down certain principles and formulæ which, if adhered to, make the artificial hatching of fish an improvement upon nature's ways to the same end.

Nature is said to be, and is, a bountiful provider; but at one time it seemed as though the natural and acquired habits of destructiveness in man, and his small boy, had not proper representation in the great place, and nature, too heavily handicapped, must give up the contest so far as fish were concerned, at least in certain localities.

The science of fish-culture came to the relief of outraged nature, and it was then seen that a part of the great plan was to use man as an instrument to prevent the extinction of certain, if not all, species of food fishes of our inland waters.

Fish-culturists have done their work well to make over ninety fish grow where only five, or less than that number, were grown before, but their labors are not completed with the stocking of public waters with food fish for the people. Many waters, from the merciless warfare that has been waged against their finny inhabitants at all seasons, have become totally barren; others only partially depleted; but in both instances radical changes may have taken place, with an equally important item in the fish-culturist's plan to reinhabit which may prove a bar to success—the item being fish food. The purity and temperature of the water may remain suitable for artificially-hatched food fish, but the fish food may have taken its departure, and remain only as a legend. Still there may be food in plenty for certain species of fish, but a desire for a certain kind may render the stocking or restocking of some waters a failure. To be sure this error would only be made by one not versed in the requirements for the well being of the different kind of fishes, but many fish are, of necessity, sent out from State hatcheries to be deposited as the judgment of those sending for the fish may dictate. With the exercise of the greatest care mistakes will be made, as in instances that have come under my notice. An abundance of proper food introduced into a body of water, barren of fish food, changes the food fish thereof from a very indifferent fish to a more excellent one for the table.

My attention was called to the importance of fish food more than twenty years ago in a very practical manner. Near where I live was an artificial pond, on a stream that had once been a trout stream. I could recollect when the brook contained trout, but I could not remember when the dam, that formed the pond, was built. Neither contained trout at the time to which I refer.

Thinking that here, near at hand, was a body of water that only required trout to be introduced for the species to propagate and grow to a proper size to afford good fishing, I obtained permission from the owner of the pond to use it as a fish storehouse. I then introduced a quantity of brook trout from six to eight inches long, and waited patiently for the fulfillment of the programme as I had marked it in my mind. Water, trout and time, all the conditions to insure success. I think it was only a year afterward, when I found that I had neglected a very important ingredient—something for my trout to eat. Their growth was so slight that I failed to discover it, and a friend suggested that I add more fish, but this time a more common kind, those generally known as minnows. The canal was near at hand, and I procured and put into the pond a large quantity of small bait fish, I did it entirely out of sympathy for the trout, for at the same time I noticed that my scheme was a failure. A number of years later a piscatorial friend informed me as a great secret, that there were some great trout in Perine's Pond, and we at once proceeded there in a body. As I caught trout after trout—great lusty, fat fellows—the scales fell from my eyes, and fish food became of as much interest to me as food fish had been, and afterward the mere creeling of fish, that showed by their condition a lack of proper food, failed to satisfy the angling spirit that was born within me, for I was confident that a little labor would bring a change that the fish, and afterward the angler, would appreciate.

At the first meeting of the Schroon Lake Fish-Culture Association I urged the importance of introducing food for the fish with which it was proposed to stock the waters from whence the association derived its name. In reply, it was stated that the lake already contained whitefish, the natural food of lake trout, and the latter fish was the only one we proposed to deposit the first year, to keep up the supply of the disappearing native trout. Whitefish here may have been bad, they must have been few in numbers comparatively, for the lake trout would come on the shoals for the yellow perch, and were taken in August while trolling for bass near weedy shallows. As the home of this trout is in the cool depths of the lake, hunger alone would force them into the warmer surface water during the warmest month in the year. Besides one only required the use of his eyes to see that the trout taken from the lake were in poor condition as compared to trout from more favored waters. In our interior lakes, whitefish seem to be pre-eminently the food for lake trout. They will not take the hook, and as the law forbids the use of nets, they have only to multiply to do good to their conscience and fellow fish. Inhabiting, as they do, the deeper waters of the lakes with the trout, the young whitefish come to the surface only where the water is deep, and at a season when other fish cannot utilize them as food. Undoubtedly they are sacrificed to the appetite of other fish at spawning time, but they do not contribute to this demand in a manner to destroy their usefulness as trout food. I never yet have found a whitefish inside of any fish but the lake trout, and I have examined the contents of the stomachs of hundreds of bass and pike taken in autumn from waters inhabited by whitefish. A species of whitefish has, since the memories of man, been found in greater or less quantities in the waters of Lake George, N. Y.

Previous to the introduction of artificially hatched trout to this lake, the native trout were hardly in what is called good condition, and this state of affairs was unchanged until the New York State Fish Commission deposited 100,000 young whitefish (*Coregonus clupeiformis*). Then the trout began to "take on fat," until now I do not know of a lake in Eastern or Northern New York that can furnish such fine, fat lake trout as are taken from Lake George, and the whitefish are seen in myriads.

The frost-fish, found in a few of the Adirondack waters, notably Blue Mountain and Raquette lakes, have been likened as fish food to the blue-back trout, that is supposed to be a prime factor in the immense growth of the Rangeley trout. The frost-fish—a species of whitefish, so said—is somewhat similar in its habits to the blue-back trout, resorting in great numbers in the fall—just before ice is formed on the lakes, hence the name—to the shallows and inlets for spawning purposes. They generally move in the night, and their numbers are so great that they make a noise as though the surface of the water was being threshed. They are in themselves a delicious food fish. Other than the above facts, the habits of the frost-fish for the balance of the year are as little known as those of the blue-back trout; only, like the latter, they are a deep-water fish.

Within a few days I have examined lake trout from Blue Mountain Lake and compared these with Lake George trout. The former, although good-conditioned fish, lacked the abundance of fat inside the abdominal cavity, and the cream-like curd between the flesh flakes that the Lake George trout possesses. I understand fully that this one instance of comparison does not decide the merits of either the frostfish or whitefish as fish food. One lake may provide fat-giving properties that the other does not, but the fact remains that lean trout in Lake George become fat trout after the arrival of the whitefish from the Caledonia hatchery.

The qualities of the alewife or "saw belly" as fish food, have been praised because it is a spring spawner, and the alewives resort to both deep and shoal water, thus giving fish, other than the lake trout, an opportunity to test their edible qualities.

The "saw belly" is found in some Western lakes, and has been introduced into others, and investigation may prove that it is, from its accommodating habits, superior to the whitefish as general fish food. Spawning in the spring is in its favor, as also the short time required for its eggs to hatch.

Crawfish or crayfish are excellent food for black bass, and multiply more rapidly than a like number of "bait fish" would; but an angler might as well bait his hook with a cork as to use a crawfish in waters where previously it was unknown. Bass must be educated to eat them, and it is the same with the helgramite, or dobson, and the bass. There were 18,000 crawfish placed in Lake George as food for fish, but it was three years before the bass would pay any attention to them on the hook. Schroon Lake abounds with crawfish, and it is one of the best bass baits that can be used.

In the above statement I refer to the small-mouthed black bass, *M. dolomieu* of Henshall, and I take into account the capricious nature of the bass as a biter. I have read several accounts of ponds or streams that contain black bass that will not take the baited hook, because the waters have such an abundance of food minus the barbed steel intestine. It does not seem possible for any water to contain more food, in the shape of minnows, than a small pond in Northern New York; still this pond has yielded the largest small-mouthed bass of which I ever heard, and the fishing is always good in season, and the bass are so fat that they seem stall-fed. Yellow perch appear to be a favorite food of the black bass, even in waters where other small fish are as plentiful as the perch. In the pond mentioned above are silver or gold shiners and "minnows" in swarms, and perch in equal quantities, but nearly every large bass that has been caught on a hook has been taken with yellow perch for bait. In dressing bass caught in this pond, in Schroon Lake, in Lake George, in the Hudson River, and in Sacondaga River, I have found that a large majority of the bass have perch inside of them, when they have anything that can be identified.

It is certainly more satisfactory to anglers to catch well-conditioned fish, and it is more satisfactory to eat such fish, and I have no doubt but it gives the fish-culturists pleasure to provide such fish, when the means at his command will enable him to do so.

Mr. Page.—This paper by Mr. Cheney is a most interesting and timely one. Although the subject is not a new one it is one that will bear continued agitation. Too many people make ponds and put fish in them either to starve or to drag out a miserable existence. The cases cited by Mr. Cheney are to the point and show conclusively that attention should be paid to fish food as well as food fish.

Mr. Mather.—There is a popular idea that fish can live on water, an idea that it is unnecessary to tell this association is erroneous. That fish will live long without food is shown by that persecuted fish—the goldfish, which is kept for months in glass globes without food, the owners declaring that they live "on what they get from the water." That newly hatched fish and small species get some microscopic food in ponds and streams is well known, but a fish a quarter of a pound weight requires something more substantial; besides fish do not breathe in their food, at least our game fishes do not, but first see it and then seize it. It is doubtful if a trout or bass of a quarter of a pound weight can see the minute daphnia and the other small animal life on which it first fed.

COL. MCDONALD.—The paper of Mr. Cheney presents interesting facts. In our plantings of whitefish and shad, we have left out the food question entirely. I remember that years ago Mr. Seth Green made the statement that shad could be produced in such numbers as to flood the James River when they returned full grown. Perhaps this could have been done if the fish went to sea for their food as soon as they began to feed, but they remain in the rivers for six or more months and must have food. To this food there is a natural limit. Take the Hudson, for instance. At Troy and below there is only a certain amount of food, and only a certain number of fish can live and grow. All above this number will be insufficiently fed. The only manner in which an extra quantity of shad can find food is to open the gates and let the fish go higher.

MR. BENKARD.—At the South Side Club we have kept trout in preserves, and found that small preserves would not support many fish without additional food. We have also let out young trout into our streams to seek their own food. I do not think that any one will question the fact that fish should be provided with food, yet it seems from the discussions and reports that insufficient attention has been paid to this important item in fish-culture by some beginners.

MR. ENDICOTT moved that a vote of thanks be given to Mr. Cheney for his interesting paper. Carried.

MR. BLACKFORD moved that on account of the heat and small attendance, the election of officers be postponed until to-morrow.

Carried.

The meeting then adjourned until the following day.

SECOND DAY.

HISTORY OF THE EXPERIMENTS LEADING TO THE DEVELOPMENT OF THE AUTOMATIC FISH-HATCHING JAR.

BY MARSHALL MCDONALD.

The work of practical pisciculture was, until a comparatively recent period, confined for the most part to the hatching of the different species of the salmonidæ. The incubation of the eggs was at first effected in troughs having the bottoms covered with a layer of gravel, upon which the eggs were placed, and over which a current of fresh water was allowed to flow.

In succession followed the "grill system" of M. Coste and the different devices of movable trays now in common use for handling this class of eggs. In all these various methods the separation of the dead eggs from the live ones was effected by means of hand-picking. The necessity for the separation, although not so urgent in the case of the eggs of the salmonidæ as in that of those eggs which develop in warmer waters and in much shorter periods of time, still entail a vast amount of labor in connection with the hatching operations.

Although the ingenuity of our fish-culturists has greatly improved the forms of hatching-apparatus for these heavy eggs, yet up to a comparatively recent period no other effectual means of separation than that above indicated has been found practicable. The United States Fish Commission, in the development of its work, had presented to it the necessity of dealing with the eggs of the whitefish and the shad upon a scale unprecedented in the history of fish culture. Millions of eggs were to be hatched where fish-culturists formerly handled only thousands, and the old methods of hand-picking were soon found to be impracticable.

In all the forms of apparatus for bulk-hatching, no adequate means is employed for the separation of the dead eggs from the living. All, as they come from the fish, the unimpregnated as well as impregnated, are placed in the apparatus and remain together.

In the case of the whitefish, and more especially in the case of shad eggs (which run through their period of incubation in a much shorter time), fungus rapidly develops among the dead eggs, communicating itself to the living, and large numbers of them, which would otherwise reach the period of hatching, are destroyed. The percentage of loss produced in this way is always considerable. and in many cases none of the eggs undergoing incubation are saved. The attention of fish-culturists was early directed to the serious losses thus arising, and various experiments have been made with a view of effecting the separation of the dead from the living eggs.

In 1878 Mr. F. N. Clark, the superintendent of the United States Hatchery at Northville, Mich., attempted to effect the separation by introducing a gate into one side of the Bell and Mather cone, through which the shells and fish and dead eggs might go out into appropriate receptacles. This device, so far as it served for the collection of the young fish, was quite successful; but it was not found capable of doing the work for which it was first planned by Mr. Clark, and was abandoned. Similar experiments, looking to the same result, were made by him with the Chase jar—the form of apparatus employed for the whitefish work at the Northville Station. The result of these experiments, however, led Mr. Clark to the conclusion that an automatic or self-picking arrangement for effecting the complete separation of the dead from the live eggs was not practicable, and a paper to that effect was written and published by him in Vol. I., Bulletin of the United States Fish Commission (1881, p. 62). The present method employed by him for the separation of the dead whitefish-eggs is to siphon off the dead eggs and such live eggs as are necessarily drawn over with them, and to transfer them to what he terms "hospital jars," the live eggs thus drawn over being left to take their chances with the dead ones.

This mode of treatment undoubtedly has served to diminish materially the percentage of loss in the eggs thus treated by him, as in this way, by the sacrifice of a small proportion of the eggs, he secured the complete separation of all elements of contamination and disease from the great bulk of the eggs.

In 1881, while I was in charge of a shad-hatching station on the Potomac River, and in position to observe closely the performance of the hatching apparatus in use, the question of the separation of the dead from the living eggs was taken up systematically, with the view of devising a form of apparatus which would accomplish the purpose, and which would be of such shape as to be of easy and convenient use in practice. Knowing that there was an apparent difference in the specific gravity of the living and the dead eggs, I determined to see if I could not avail myself of this difference to effect the separation. The first form of apparatus employed is presented in fig. 1.*

In the use of this apparatus, I found that a fair separation could be effected, but to accomplish this required perfect stability of the vessel and careful manipulation. When the barges were lying quietly on the water, and there was no tide swell in the river, the separation went on perfectly, the dead eggs being continually thrown off from the mass of living eggs, and swept by the current over into the exit trough and carried off from the apparatus. The slightest oscillation, however, of the barge, produced by waves, would derange the orderly movements of the

* This consists essentially of an oblong trough with wooden ends and sloping glass sides, glass being used in order to be able to observe the movement of the eggs under the influence of the currents. This trough rests upon a rectangular box made of boards, which serves at once as a firm base for the support of the trough, and as a chamber for the equable distribution of the water pressure. The water which enters the rectangular box forming the base of the apparatus through the supply pipe I, passes to the trough proper through a slot extending the whole length. The influx of the water to the trough is regulated by the valve V V, which, by means of the set rods S S, can be pushed down so as to cut off the flow of water entirely. By setting so as to have the opening between the valves and the glass sides about one thirty-second of an inch, the water enters the hatching trough in thin sheets which are directed up the glass sides of the trough. The effect of this is to give the eggs a continuous movement in the direction shown by the arrows. The water flows over the edges of the central trough, and escapes from the apparatus at O. The dead eggs in their circuit float higher than the living, and the force of the entering current may be so regulated that the former will be swept out by the escaping water.

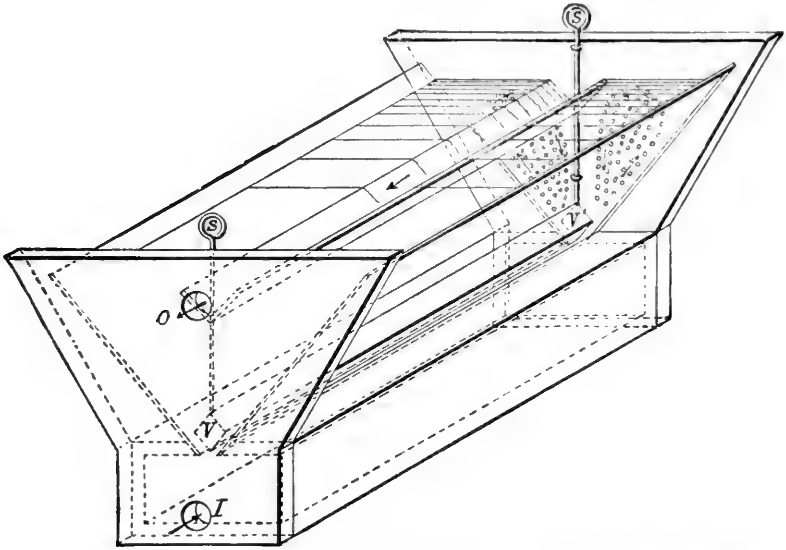


Fig. 1.—Original form of apparatus employed in the experiments. Used May, 1881, on the Potomac barges.

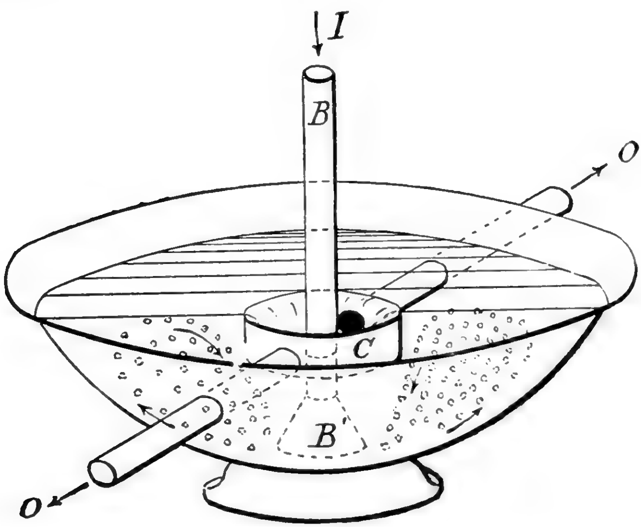


Fig. 2.—An alternate form, used in the spring of 1881.

eggs, and required continual watchfulness on the part of the attendant to prevent considerable losses of live eggs. A second form of apparatus, looking to the accomplishment of the same result, is shown in fig. 2.

The results with these forms of apparatus were not satisfactory in developing a method which could be conveniently applied in practice, yet they pointed the way to it. Later in the spring, near the close of the hatching season, at the suggestion of Professor Baird, and in conjunction with Professor Ryder, we insti-

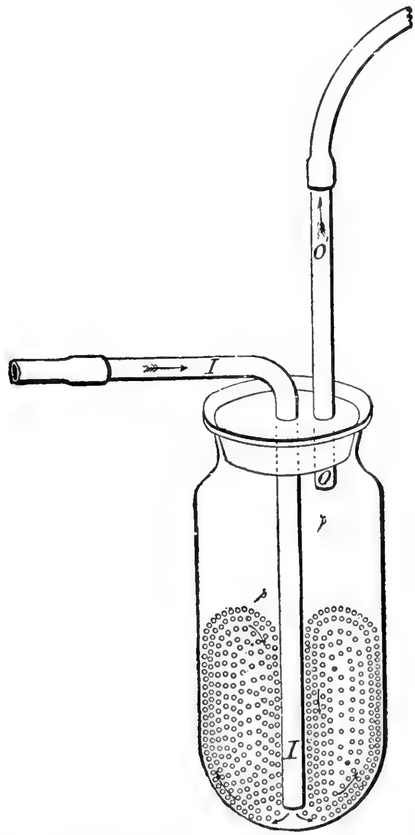


Fig. 3.—Original form of apparatus in which the method for automatic separation of dead from living eggs was demonstrated.

tuted, in the basement of the Smithsonian Institution, a series of experiments in order to determine the limit of healthy retardation of development that could be effected by lowering the temperature of the water employed. In order to subject the eggs conveniently to the action of the current of cold water, they were placed in small two-ounce laboratory flasks, closely corked. Through the centre of the cork was passed a glass tube which descended to within a short distance of the bottom of the flask, and through which the current of water was admitted to the apparatus. This is shown in fig. 3.

An exit tube, the lower extremity of which extends a short distance below the neck of the bottle, provided for the escape of the water. Whilst this form of apparatus had been devised by me in connection with the experiments on retardation above referred to, I had no sooner fixed upon the apparatus than I felt at once I had arrived at the solution of the question of automatic separation of the dead from the living eggs. An eight-ounce wide-mouthed glass jar, such as is used in the National Museum for holding alcoholic specimens, was fitted up as indicated (fig. 3).

Six thousand shad eggs were placed in this apparatus and a current of water turned on and regulated. The movement of the current established a regular rolling, boiling motion on the eggs, which brought all in succession to the surface. The dead eggs remained there, forming as they were freed from the mass a layer upon the upper surface of the others. By pushing down the exit tube a suitable distance, I found that the dead eggs were taken up by the escaping current—were by degrees drifted under the lower end of the tube, lifted through it by the current, and swept out, leaving an absolutely clean mass of live eggs in the jar.

This lot of eggs was successfully hatched, and at the time of hatching not a dead egg was found in the bottle, nor do I think a live egg was lost in the whole course of the experiment.

The first experiments had been framed solely with reference to the assumed slight difference in the specific gravity of the living and the dead eggs. Attentive study of the movement of the eggs in the jar showed a still more potent influence for separation than the difference in the specific gravity. It is true there is a slight difference in this respect, but it is hardly appreciable. The more important difference, and that upon which the success of the apparatus depends, is the close adhesion which exists between the living eggs, the effect being that the live eggs rolling in mass are always in contact, even when they reach the surface, and are by this adhesion carried around in regular sequence. On the other hand, the dead eggs having once reached the surface, their adhesion to the underlying layer of eggs is not sufficient to draw them along with it in its regular movement; consequently when they once reach the surface of the mass they remain their until they are carried off by the exit tube. Several experiments made with different lots of eggs gave uniformily the same satisfactory results.

In May, 1881, the apparatus in actual operation was exhibited before a meeting of the Biological Society held in the basement of the Smithsonian Institution. These experiments were so decisive that I did not hesitate to recommend and urge the adoption of the new method in the work of the United States Fish Commission.

In the spring of 1882, it was determined to convert the old Armory building into what is now known as the Central Hatchery and Distributing Station. Professor S. F. Baird was pleased to manifest his confidence in the success of the new form of hatching apparatus by authorizing me to equip the station with them. The working form of apparatus not having been then even designed on paper, it was not possible to prepare the drawings and to have the jar complete in all details ready in time for the shad-hatching season. An improvised form was devised in which cork stoppers were substituted for the screw cap and metal tops employed in the form now fixed upon. Ten tables suitably planned to receive the waste water from the jars and carry it off from the building were constructed; the pipes for the distribution of water supply to the tables were introduced, and the station was equipped with 300 of the jars. Each jar having a capacity of 60,000 to 70,000 shad eggs, gave a total hatching capacity to the station of 21,000,000 eggs at one time, or 900,000,000 for the entire shad-hatching season. This was,

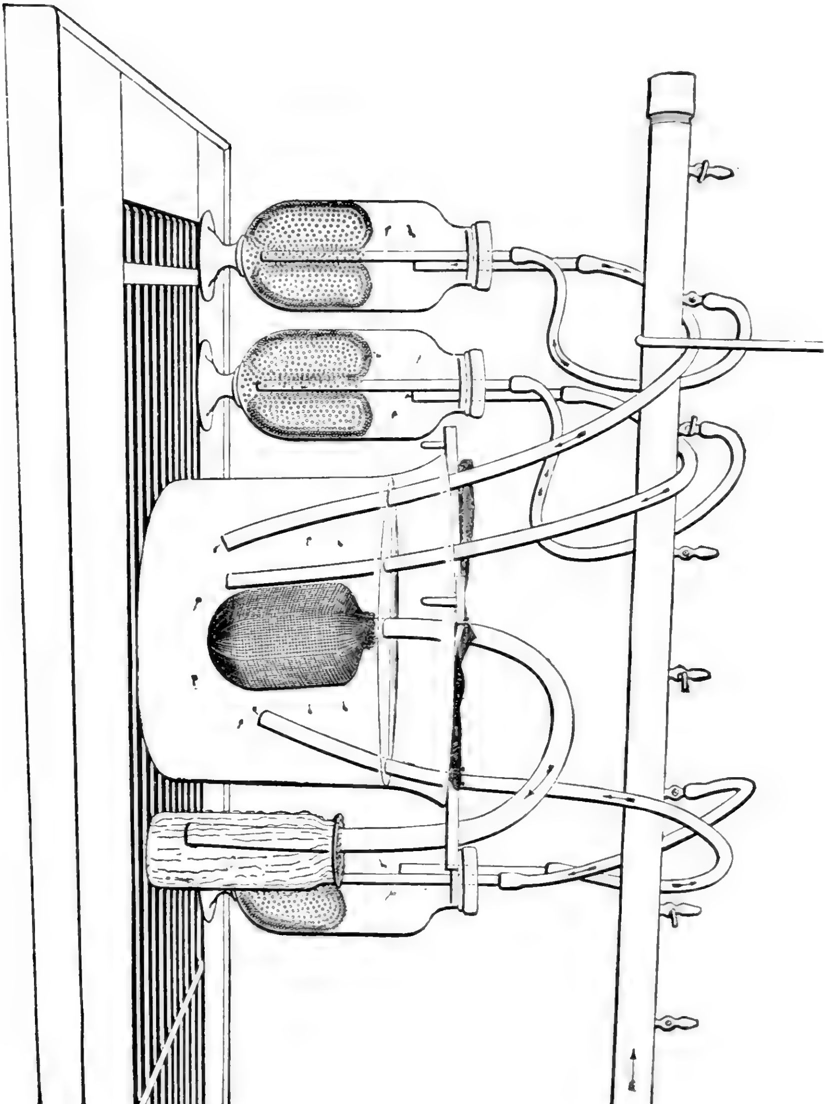


Fig. 4.—Details to illustrate hatching and transfer of shad fry to collectors

of course, in excess of any expected production; but in the organization of a shad station it is necessary to provide for the contingency of the great bulk of the eggs coming within an interval of a few days of each other. The form of hatching apparatus used during this season is shown in fig. 4.

The general arrangement of a hatching-table for the collection of the young fish as they hatch in appropriate receivers or aquaria, is also shown in fig. 4. The present form of apparatus and the form contemplated in the first design, but only completed recently, is indicated in fig. 5.

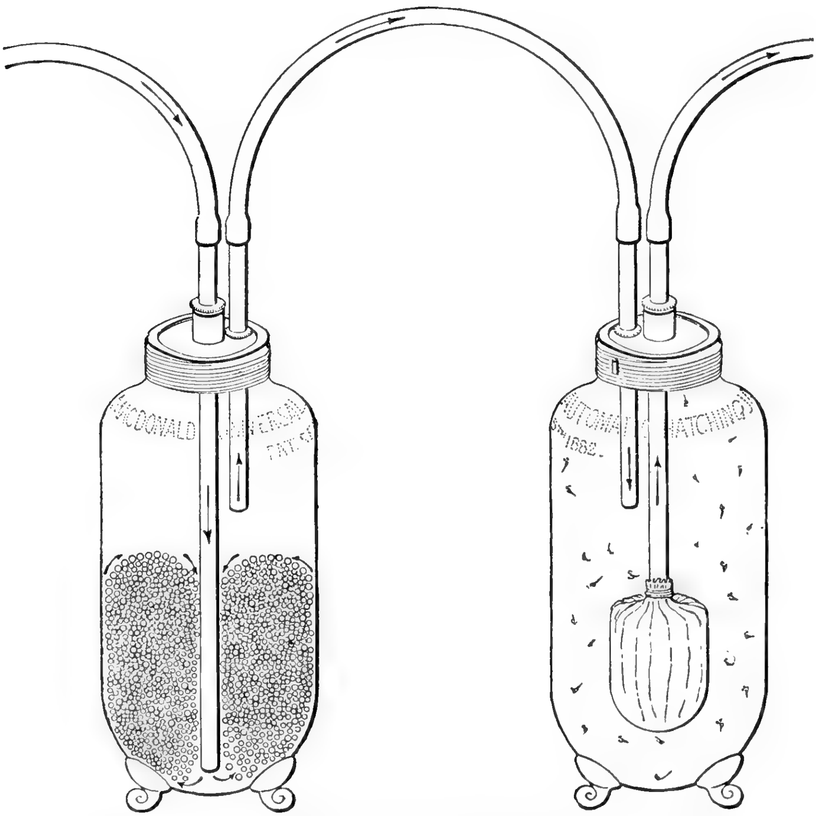


Fig. 5.—Arrangement of jars for hatching and collecting, as in use at present.

In this figure we have shown a pair of jars fitted up, one for the hatching of the eggs, the other for the collection of the young fish.

The jar consists essentially of a cylindrical glass vessel with hemispherical bottom. These are not blown, but pressed, in order to secure perfect regularity of the interior surface, upon which depends to some extent the perfect working of the jar. The glass foot which is shown in the improvised form has been omitted in the form now in use, the jar being supported upon a tripod of three glass legs, this form of attachment being adopted to prevent the distortion of the bottom of the jar which would necessarily result from the attachment of a single foot to it.

The top of the jar is made with threads to receive a screw cap, and both the bottom and the top surfaces are ground so that the plane of each shall be perpendicular to the axis of the jar, and so that when the jar is resting upon its feet its axis shall be perfectly vertical.

These are all-important considerations to secure the proper working. The top of the jar is closed by a metallic disk perforated with two ⅝-inch holes—one perfectly central, which admits the tube that introduces the water into the jar; the other equally distant from the central hole and from the edge of the plate. A groove in the inner surface of this metallic plate carries a rubber collar, and when the plate is in place the tightening of the metallic screw cap shown in the figure seals the opening hermetically. Both the inlet and outlet tubes pass through stuffing-boxes, by which means the tubes can be slid up and down easily, and tightened firmly in any desired position. The construction of the jar is such that when the metallic disk is in place the central tube takes the central position necessarily; by loosening the screw cap of the stuffing-box, the central tube can be slid up or down so as to produce just such movement of the eggs as is desired. If the quantity of water entering be small, or the head of water slight, without changing the feed of water we may vary at will the force and velocity with which it enters the jar. By pushing the tube down so as to be almost in contact with the bottom of the jar, we make a relatively small quantity of water do the work of a larger quantity in producing motion. Moreover, as in the season of shad-hatching, a full supply of water is needed and not a great deal of motion, this is arranged for by increasing the feed and raising the lower end of the central or supply tube, so that the delivery of the water from it will be under less pressure. This central tube is connected by a rubber pipe with the pet cock, which furnishes a supply of water under a constant head.

The exit tube serves a double purpose—first, as an outlet for the water; and secondly, at our pleasure to remove the layer of dead eggs from the surface. This is accomplished at stated intervals, say once in twenty-four hours, by loosening the screw of the stuffing-box so that the tube will slide readily, pushing it down until the dead eggs nearest to the lower end are seen to begin to pass off. By allowing it to remain in this position a few minutes the layer of dead eggs is swept off entirely. They may be either allowed to pass off in the waste, or better, collected by screens and fed to the fish in the aquaria, thus serving the double purpose of preventing the fouling of the water and furnishing a very appropriate food for many varieties of fish. When the period of hatching approaches, instead of allowing the water from the hatching jars to pass directly into the sinks, it is necessary to conduct it through the collecting jar. This is precisely similar in construction to the hatching jar. Indeed it is the hatching jar with some special arrangements to adapt it to its new purpose. The water passes from the hatching jar through the rubber tube into the eccentric opening of the receiving jar. The tube and opening then serve for the inlet instead of the outlet of the water. On the lower end of the central tube is placed a wire frame, over which is drawn a bag made of cheap cotton, the texture of which is such as to permit the water to strain through, but the meshes of which are so fine that the suction of the water will not hold the young fry against it, as would be the case if a wire screen were used.

The surface of this strainer should be as large as is convenient. It is adjusted to the lower end of the central tube in such position that the end of the tube is in the centre of the wire cage, or as nearly so as possible, the object of this being to make the draw of the water equal in all directions. The water is allowed to pass out of this second receiving jar out into the waste. The young fish, if they be whitefish or shad, as soon as they burst their shells, begin to swim around vigorously in the hatching jar, drifting with the current. They pass into the exit tube and are carried over into the receiver, in which they may be collected to any number desired, being retained there without injury until it is convenient to make a shipment.

In extensive work in hatching I have found it more convenient to make use of large glass aquaria for receivers, four or five hatching jars being disposed around one, which serves as a common collector for the young fish from all. A siphon, arranged as shown in fig. 4, with a wire cage and strainer on the shorter end, serves to give free discharge to the water, while the strainer prevents any fish from passing out. I have found the hatching jars to be a very compact form of apparatus for handling the eggs of the salmonidæ. In this case it is not desired to nor do we give any motion to the eggs. The jar is filled with them from one-half to two-thirds full. The current of water being introduced at the bottom filters up through them, enveloping each egg in a stratum of fresh water, and placing each under the best possible conditions of development. From fifteen to eighteen thousand eggs may be readily placed in each jar. Of course, in the case of these eggs, we must have recourse to hand-picking. This is readily accomplished by opening the jars, placing the hand over the mouth to prevent the escape of water, inverting and placing the mouth under water over a broad shallow tray. The eggs by gravity flow out and spread over the bottom of this, and when picked over are returned to the jar, the precaution being observed to have the jar full of water, and to use a broad flat funnel to return the eggs. They may be poured from the tray into the jar in bulk without any injury.

From the experience had during the winter of 1882, in hatching this class of eggs at Central Station, I am convinced that large numbers of eggs up to the very period of hatching can be handled in this jar

The necessity of arriving at methods of hatching the light or floating eggs of many of our salt-water fishes has for several years impressed itself upon the United States Fish Commission

No form of apparatus heretofore devised has been satisfactorily operated to the accomplishment of this purpose. The experiments made during the summer of 1882 in the Chesapeake Bay, with the eggs of the Spanish mackerel, led to the hope that the hatching jar, fitted up as a receiver, may be with equal advantage employed in hatching this class of eggs. The number of eggs obtainable was not enough to give results sufficiently decisive to establish this assertion. But these eggs, being subjected under the conditions presented in the receiving jar, to a current of salt water, being confined so as to prevent escape, and this confinement effected without the use of appliances that would injure the delicate membrane of the shell, there seems to be no reason why we may not use the jar as successfully with this class of eggs as with those of the whitefish and the shad.

UNITED STATES FISH COMMISSION,
Washington, D. C., April 6th, 1883.

TRANSPORTATION OF CRUSTACEANS.

BY FRED MATHER.

Of late years those who have stocked trout ponds and streams have realized the necessity of furnishing their fish with a permanent diet of natural food in the shape of crustacean life. A few years ago, Mr. James Annin read a valuable paper on this subject before this Association, and it awakened much interest in the subject. Since that time, Mr. Annin has sent out many thousands of the so-called "fresh-water shrimp" from his Caledonia ponds. Such life has usually been sent in cans of water and plants, I believe, and is therefore somewhat bulky, and the express charges are an item in the cost. This winter I have received at the Cold Spring Hatchery many thousands of whitefish and trout eggs from Mr. Frank N. Clark, of Northville, Michigan. The eggs came on the usual flannel trays, with mosquito netting, and I noticed several shrimps, *Gammarus*, etc., among the eggs, at different times, and in all cases they were alive. As they will live so long out of water if packed in a damp medium, there seems to be no reason why they cannot be sent in quantity in this manner. This would cheapen the transportation on them, and do away with the return of cans. I would recommend that they be packed on trays and covered with netting and moss, precisely as eggs are packed.

MR. PAGE—This is certainly a new and inexpensive way of stocking waters with fish food from a distance, and one that will no doubt be followed. There are often small things which are of the greatest value, and this short note by Mr. Mather may be classed among them.

THE BEGINNING OF FISH CULTURE IN AMERICA.

BY DR. T. GARLICK.

BEDFORD, O., May 13th, 1883.

Barnett Phillips, Esq., Secretary American Fish-Cultural Association:

DEAR SIR—Your esteemed favor of the 21st inst. is received. If possible, I will write a brief article to be read at the meeting of the American Fish-Cultural Association on the 7th and 8th of June next. I am very sick, and write this note lying on my lounge; and it may be probable that I shall not be able to write even a short paper. I have been sick twenty years last January, and am almost worn out with age and disease. I was 78 years old on the 30th of last March. I mail to your address to-day a copy of the second edition of my little book on fish culture, which I present to the Association through you. In case I am unable to write anything to be read, perhaps you may find something in the prefaces and introduction of the book that may answer the purpose of the paper. You mentioned the fact that I had been made an honorary member of the Association. I shall esteem it an honor to be a member of the American Fish-Cultural Association.

T. GARLICK.

BEDFORD, O., May 25th, 1883.

I do not believe it possible for me to write a paper to be read at the A. F. C. A., as requested by the Executive Committee. I am suffering at this moment indescribable torture, and last night was a night of dreadful suffering. Were I able to write a paper, it would be on the topics named by you in your letter.

My attention was first called to artificial methods of propagation of fishes by seeing a notice in a newspaper of the methods employed by the two fishermen of the Vosges. I saw, or thought I saw, in this discovery one of the most important discoveries of modern times. And I at once determined to make the same experiments, but not with the remotest view of making money by it, but simply to demonstrate an important discovery. The history of my experiments are all recorded in the book I sent you a few days since, also in the published proceedings of the old Cleveland Academy of Natural Sciences.

My experiments were eminently successful. I exhibited both young and old fish at two of our State fairs, one at Cleveland and one at Cincinnati.

This was, no doubt, the beginning of breeding fish by artificial methods in the United States. When we look at what has grown out of these experiments through the active agency of the fruitful brain of Professor Spencer F. Baird, we begin to realize the value of this discovery. I have never regretted the hard work, precious time, nor the money it cost me to make the experiments. I believe that artificial fishculture is only in its infancy at this time. When we consider the vast extent of our inland waters, our mighty inland seas, great rivers, down to the little streamlets and springs, we can guess what will follow. Hoping you may have a pleasant and a profitable meeting,

I am truly yours,

T. GARLICK.

Mr. Phillips read extracts from the book mentioned, and a vote of thanks was given to Dr Garlick, the pioneer of American fishculture.

EXPERIMENTS IN OYSTER PROPAGATION.

BY H. J. RICE, SC. D.

During the past three or four years a number of efforts have been made by different individuals to ascertain the practicability of propagating the American oyster (*Ostrea virginiana*) by methods similar to those already so successfully employed with a large number of both fresh and salt water fishes, or, in other words, to assist "Dame Nature," first, in giving an existence to a greater number of embryo bivalves than would be found under ordinary conditions, and, secondly, in bringing to maturity a goodly proportion of those "immigrants" which, if not "assisted" during their rotation for existence, would inevitably, as the Germans so forcibly express it, "zu grunde gehen." This expression, however, of "assisting nature," ought not to be misunderstood, since nature has many ends to accomplish in her methods of increase among the lower tribes, while for man there is but the one end—to supply raw material to recuperate the ranks so incessantly and ruthlessly devastated for his use, and it is with this end in view, and by reason of the rapid deterioration of the productive beds in various parts of the country, that artificial propagation is desirable, if it can be rendered practical. The first work in the direction of strict orthodox oyster propagation, so far as I am aware, was performed by the writer in the summer of 1878, at the Chesapeake Zoological Laboratory at Fort Wool, in conjunction with Dr. Brooks, the director of the station. The work at this time was confined chiefly to ascertaining whether or not it was possible to impregnate the eggs of the oyster by taking portions of the generative organs of the two sexes and mixing them together in a little water, after having cut them into fragments, so as to allow the generative products to get out of the retaining cavities or tubules. But this attempt did not prove successful, neither did those which I made later in the season, when I had moved my quarter in conjunction with the U. S. Coast Survey, to Pocomoke and Tangiers Sounds, in the upper part of the bay.

In both places numbers of experiments were made, but we were using oysters all this time from shoal water, and it has since been pretty well established that oysters in shoal water shed their generative products earlier, on account of the generally higher temperature of shore waters, than those found along the deeper portions of the coasts.

This is not true in all cases, but probably is true in a large majority of instances. Accordingly, we were using oysters which had shed their ripe products, and the only practical results that I obtained for the first season's work were to ascertain beyond a doubt that the American oyster is bi-sexual, and that as a rule they do not carry the young in the gill-chamber upon the "beard," as appears to be the case with the European oyster, for out of hundreds examined I only found two with young upon the gills and mantles, and even in these instances it may not have been the normal position of the embryos.

The next season, Dr. Brooks located himself at Crisfield, Md., early in May, and getting oysters which had not spawned, was immediately successful in impregnating the ova, and in keeping the young alive for a few days, but in no case did he succeed in keeping them longer than a week. He found it impossible, with any means at his command, to arrange vessels which would retain the embryos, on account of their minuteness, and at the same time permit of a current of water to pass through the vessels, and thus give food to the growing animals. Others have repeated the experiments, but no progress beyond that already noticed above had been made when I began my experiments last summer. I had been present during a portion of the time Dr. Brooks was carrying on his investigations at Crisfield, and noted the difficulties with which he had to contend, and it was not until later in the season that I thought of a method of arranging apparatus which seemed feasible for the end in view.

I did not, however, have an opportunity to test this new arrangement until last summer, when being in New York, Mr. Blackford, who is so well known among you for his enthusiasm in scientific fish work, kindly placed at my disposal, not only a room at the Fulton Market for the purpose of continuing my experiments, but with great liberality arranged to supply me with such specimens of oysters and such amount of sea-water, from the neighborhood of Sandy Hook, as I should need in my experiments. Thus equipped I began work early in July, and was able before I left the city to present to the gaze of those interested in this class of bivalves, young oysters which had been kept alive for fourteen days, and were at that time apparently strong and healthy. Unfortunately I was obliged to leave the city at this stage of the experiments, and thus they were brought abruptly to an end sooner than desirable, but not without demonstrating that the process on a small scale was at least partially successful. In arranging my apparatus I had in view two things: first, the necessity of a nearly constant flow of water and, so far as possible, water that had not been previously used; and, second, of such an interchange that the entire mass of water in the vessel should be set in motion a number of times during the day. The first was the more difficult of accomplishment, since, in order to get a flow of the water, an outlet to the vessel was necessary, and any outlet, however guarded by screens, was liable to allow the escape of the young during the free-swimming stage, when, for the most part, they congregate at the surface of the water. To obviate some of the difficulty, I concluded that it was necessary during the earlier periods, at least, to draw the water from the bottom of the vessel, and in order that the flow from the vessel should be steady and of a nature not to permit of the escape of the young, I determined to employ capillary attraction as exhibited in the fibres of various cloths when immersed in liquids. For the first week, I was employed principally in experimenting with various kinds of cloths, as to their capacity for transferring water from one vessel to another, their continuous action and the effect of the sea water upon the coloring-matter and the coloring-matter upon the sea water.

Some of the fabrics employed did not allow of sufficient water to pass through them, or in other words the capillary action was not strong enough; others were too coarse and were liable to allow the young oysters to become entangled in the meshes, and remain there as in a cage, or be carried over and out of the vessel in the outflowing current, while others lost a portion of their coloring material and thus discolored the water, and while I cannot say that this would prove injurious to the young animals, I did not think it desirable to try experiments in this direction. As the result of this labor I finally concluded to try a fine quality of white flannel used in strips and laid over the side of the vessel containing my young animals. As a rule the pieces extended to the middle of the inside of the vessel, and I found by carefully manipulating these strips as to position and size, that the breeding vessel would be practically self-regulating, since the nearer the liquid was to the top of the vessel, the greater the flow of water on account of the less distance it would have to be raised by capillary attraction. But by having my outlet strip freely suspended in the liquid, the absorbing surface extended throughout its whole length, or at least of that portion in the hatching vessel, and hence the young animals might be drawn against the flannel and either killed or carried over from mesh to mesh. To prevent this, I introduced a small lamp chimney of the Argand pattern and placed my flannel upon the inside of this. The end of the lamp chimney resting upon the bottom of the vessel allowed water to pass out only by going in at the bottom of the chimney, working up the flannel and so out at the top. In this manner no young oyster could get into the current of outflowing water, or into the meshes of the flannel except those few that might be directly under the end of the chimney. The inflow of water was arranged in a similar manner but without the chimney, simply allowing the piece of flannel to pass over from a supply tank into the breeding vessel.

As a whole, my apparatus then consisted of two vessels, two strips of flannel and a lamp chimney. The large vessel or supply reservoir was kept full of sea water; from this a strip of flannel passed over and down to the small breeding-vessel, keeping it full and constantly supplied with fresh water so long as the reservoir was well supplied. The chimney was placed upon the opposite side of the breeding vessel from the entrance or inlet strip, and the second piece of flannel passed from it out and over the side of the vessel, allowing the overflow to take place into a waste tank placed some distance below the apparatus.

With this arrangement and with strips of flannel about three inches in width, I found that I could pass about two gallons of water per day, through a small tumbler which I used as my breeding-jar. I also introduced water several times a day by means of a small sponge.

I found that with this arrangement of the vessel I had no difficulty in keeping my young oysters alive, and so far as I could tell I lost none in the outflow.

Practically then, the difficulty of maintaining a circulation of the water had been overcome, and I maintained an equable temperature by placing all my vessels, that is, both supply tank and breeding vessel, in a constant stream of water flowing from the hydrant; the temperature of the water in the vessels thus changing only with the change of the surrounding stream, which was, during the course of the experiments, from 74 to 80 degrees. On the 25th of July, with a temperature of the water at about 74 degrees, I placed my first hatching of young oysters in the apparatus.

My method of impregnating the eggs was as follows: Upon opening the oysters, I took a small portion of the generative products and examined to see whether the specimen was a male or female, and if ripe. Having thus selected a good specimen of either sex, I slit the ovaries and spermaries lengthwise with many gashes, and then pressed out the products, and gathering with a knife, placed them together in a small watch glass and mixed them with a little water. Afterward they were transferred to a larger vessel containing more water, when they were allowed to remain quiet for a considerable time. The surplus of milted water was then siphoned off and thrown away, and the vessel again filled with fresh water. During the time the water in the vessel is quiet, most of the ova settle to the bottom, and remain there as a thin layer, which with care will remain undisturbed, while the light ova and the unused spermatozoa are drawn off from above. The ova can be washed several times if thought necessary, in order to thoroughly cleanse them from any particles of organic matter and spermatozoa which may be at the bottom, and which by decaying might tend to affect the water unfavorably. By the method which I adopted of slitting the ovaries and spermaries, and then pressing out the contents, I obviated the necessity of cutting the parts to pieces, and afterward cleaning the ova from the minute fragments of tissue before allowing development to go on. Another method which I have employed, and one which is even better than this, is to clear the animal from all flesh, such as gills, mantle aud muscle, by cutting off the parts with a pair of small scissors, then taking the body between the fingers, place the outlet of the generative organs against the side of the small vessel or plate, and with a flat instrument of some kind, such as a dull knife, gradually manipulate the sides of the organ, and press the products down and out into the dish. In this manner, if the specimen is ripe, you will have a clear milky liquid, with none or only a very slight admixture of foreign material. The mixing of the male and female elements can then be performed as already explained. After thoroughly cleansing the ova they were left quiet for some considerable time, and in from two to four or six hours a layer of embryo could be seen at the surface of the water, each individual moving about in a very brisk "go-as-you-please" sort of fashion. These were then siphoned off into a larger vessel, and after several layers had been disposed of, the assembly was placed in the breeding-jar, and the water set in motion through their new locality. In the case of the experiment begun on the 25th of July and above mentioned, specimens were examined every few hours in order to denote the development, and during one such examination on the 17th inst., about forty-four hours after the ova had been impregnated, one of the young oysters, which had developed so far as to be entirely enclosed by its two shells within the field of the microscope, thrust out a portion of the velum and firmly secured itself to the glass slide upon which it had been placed. Further observation seems to show that this is their normal mode of attachment, that is, to thrust out the velum from between the shells and adhere to whatever is within reach, afterward the animal falls over to one side, generally the left, and the shell of that side gradually forms around and out beyond this attachment of the young animal. Later a portion of shell material forms under the attachment and firmly solidifies the shell proper to the attached substance, and the fleshy attachment atrophies, so that while at first the animal itself is attached to the outer world, later in life the shell is the part attached, and the animal itself becomes attached to the shell, but in an entirely different place from where the first attachment was made.

During this first period of attachment, when the shell itself is not firmly attached, but simply held firmly down to the substance with which it is in contact, the young animal gets its food, or a portion of it, by means of a sort of proboscis, of elongation of the mouth part, which is capable of being moved about freely within the shell cavity. This proboscis stage lasts until the gills are fully formed and become of sufficient size to supply food to the animal, when the proboscis, or, rather, its flexible end, is transformed into the labial palps, which become closely connected with the gill-leaves. It will thus be seen that the life of the oyster can be practically divided into three portions. First, a free swimming condition which lasts for a longer or shorter time, in accordance with the temperature of the water, and during which time the young animal can move about with perfect freedom, although generally at or near the surface, and in a somewhat limited range. It is, during this stage, subject to the greatest dangers. Second, a condition when it is covered by a shell, is unattached, but is not capable of moving freely from point to point, except to whirl about, and thus roll around upon whatsoever substances it may rest; and third, its condition when attached to some permanent and stationary object, and including of course, the "proboscis stage." During its first condition it can be affected by its own movements and the movements of the tides; during its second condition, chiefly, if not solely by the tides, and during its third condition by neither, except in so far as the tides bring food to it in its resting-place.

All efforts at artificial propagation should then take into consideration these three conditions. First, to guard it from escape during the first period; second, although perhaps not absolutely necessary, except in so far as it resembles tidal action, to move it about during the second period, until it can attach itself to some solid support; and third, to afford food for it during all periods.

With the apparatus which I have described to you the first two ends were accomplished, that is with the aid of the syringe with which I introduced strong currents into the breeding vessel several times per day. This was clearly demonstrated by keeping a large number of the young animals alive for fourteen days. How many of the number were attached to the bottom and sides of the dish I have no means of knowing; but if one attached itself on the second day, it is perhaps fair to infer that others attached themselves to various portions of the vessel during the period they were confined in it. In regard to introducing food it is probable that not a very large amount went through the flannel strip, but some was put in the water with the syringe. So far then it appears that we can maintain a circulation in our breeding vessel without losing our young animals, and we can also introduce food by introducing fresh sea water which has been reduced to the temperature of that of the breeding vessel, and which has not passed through the flannel sifters.

The practicability of the artificial cultivation of the oyster, then, seems to hinge upon the care with which these steps or processes are carried out. Oysters seem to feed upon the inflowing tide, and if an apparatus is so arranged that the water can be drawn down steadily by means of the capillary attraction exerted through flannel or some other substance, until low in the dish, and then brought in with a steady stream of evenly-tempered water, with sufficient strength to move the young oysters about from place to place, and carry food about with it, it would appear as if practical success could be attained. In such an apparatus pieces of glass or small fragments of shells could be suspended, to which the young animals could attach themselves, and these pieces could be withdrawn and examined from time to time for the purpose of tracing the progress of the hatching. I propose to continue my experiments in this direction the coming summer as occasion may permit, and although the disadvantages are great of working with animals so small that a microscope has constantly to be used, yet I hope to be able to show that with care and good weather something practical can be accomplished.

A NEW SYSTEM OF FISH-WAY BUILDING.

BY MARSHALL M'DONALD.

It is a well established fact that the river fisheries of the Atlantic States have steadily decreased both in value and annual production for many years past. In some instances, species that were at one time common in certain of our rivers, are no longer taken. Indeed, the annual run of these fish which still continue their migration to the rivers, has undergone alarming decrease; and in many cases become too insignificant to furnish the motive or material for organized fisheries. Several causes, probably, have concurred in producing this decrease.

First—The capture of the greater portion of the run each year may not have left sufficient to maintain production under natural conditions.

Second—The erection of dams or other obstructions in the rivers, has in some cases, absolutely excluded certain species from their spawning grounds; the result being eventually to exterminate the species referred to in those rivers. In all cases the existence of such obstructions, has determined a decrease in the natural productiveness of the stream *pro-tanto*, with the diminution of the breeding and feeding area.

The remedy for the condition of things above indicated is to be found:

First—In the enactment of such legislation as will control excessive, and prohibit destructive modes of fishing.

Second—In compensating for the insufficient natural supply by artificial propagation and planting.

Third—In extending the area for breeding and feeding, by overcoming natural obstructions by means of fish-ways.

If the anadromous fishes only entered our rivers for the purpose of spawning, and their progeny spent no part of their life in our fresh waters, then the increase which we could determine by artificial propagation would be practically without limit. The fish-culturist, in order to maintain supply, would only have to produce the young fry in numbers sufficient to replace losses by capture or by casualty.

As regards all the anadromous species, however, which are the object of commercial fisheries, viz.: the salmonidæ, the shad, the herring or alewife, etc., it is necessary that the young, after hatching, should remain for some time in our fresh waters, feeding and growing, and of course, finding the necessary food in these waters. The extent of the breeding and feeding area of any river basin is, therefore, necessarily the measure of its possible productiveness. A given area when pressed to its maximum of production cannot provide for more than a given number of individuals. The extension of the area of production is, therefore, the rational means by which we may determine permanent increased productiveness. Hence arises the necessity for fish-ways, which are, in short, various constructions designed for the purpose of enabling different species of fish to surmount obstructions which would be otherwise impassible to them.

A fish-way to be effective must fulfill certain conditions, which are clearly stated by Mr. C. G. Atkins in an admirable article on the subject of fish-ways, published in the anuual report of the United States Fish Commission for 1872–73, as follows:

"First—It must be accessible; that is, the foot of the fish-way must be so located that fish will readily find it.

"Second—It must discharge a sufficient volume of water to attract fish to it.

"Third—The water must be discharged with such moderate velocity, that fish may easily enter and swim against the current."

To the conditions above stated we may add: Fourth—The route to be travelled by the fish should be as short and as direct as possible, and the floor of the fish-way should simulate as nearly as may be the bed of the stream.

The first condition may be always fulfilled in the location, by arranging so as to have the discharge of water from the fish-way in a line with or in the immediate vicinity of the obstruction. The second condition is more embarrassing. The larger the volume of water discharged through the fish-way the better it will be.

In the plans of fish-ways which are common throughout New England, the volume of the discharge is necessarily limited by condition inherent in the constructions; is compelled to travel a circuitous channel, and usually is delivered from the fish-way in such a sluggish current that it offers no sufficient invitation to the fish to enter and ascend it. As before stated, the difficulty of a limited capacity for water is inherent in all of these fish-way constructions.

The attention of fish-culturists and fish-way builders has been heretofore chiefly directed to different devices for controlling the velocity of the water in the fish-way. All these devices may be referred to one or two general forms:

First—In what is known as the "step" or "pool and fall" fish-way, the water is brought down from its elevation by a series of short drops or falls with intervening pools; the pools being of such dimensions in comparison with the volume of water entering them, as to bring it practically to rest after each drop, so that the whole volume of water is eventually delivered from the lower end of the fish-way, with no greater acceleration than it obtains in falling from one pool to the next. This form of fish-way is very common in England and upon the Continent. Possibly some examples of such constructions may be found in the United States, but I have no information of any.

Second—In what Mr. Atkins terms inclined plane fish-ways, the descent of the water is effected by a regular inclination of the floor of the fish-way, instead of by "steps" or "pools and falls."

In order to control the tendency to acceleration under the action of gravity, the base of the incline is made very long in proportion to the height, and by a series of alternating transverse or oblique partitions, the water is constrained to follow a narrow tortuous path with continual changes of direction; the friction developed in its movement being sufficient to overcome the tendency to acceleration.

Of this second general form we have many examples in the United States, especially in New England. The common rectangular fish-way, the Brackett, the Foster, Pike's, Atkins', Swozey's, Brewer's, and Roger's, are examples of the various designs that have been employed, each differing in minor details of construction, but all belonging to a common system. Most of these forms may be built either on an incline leading straight down from the dam, or with a return section so as to deliver the discharge from the fish-way close up to the foot of the dam, or they may be built in spiral form and boxed over so as to be made secure against floods and ice.

The fish-way of Mr. J. D. Brewer is peculiar in the fact, that the channel to be followed by the fish is a zig-zag groove excavated or framed in the floor of the incline, which is built either of masonry or strong timbers. The strength of the construction being such, it is presumed, as to prevent its destruction by floods or ice. The Roger's fish-way is recessed into the dam, and boxed over the lower end, discharging the water on a line with the face of the dam. This construction could, however, be applied to any of the forms above indicated and has been proposed in several of them.

The experience of fish-way builders in New England has shown that for dams ten feet in height or more, it is not allowable to build the incline with a rise of more than one foot in twelve to sixteen, requiring a length of incline of 140 feet for a ten-foot dam. The actual path, however, travelled by the water and traversed by the fish ascending, would be some two or three times the length of the incline, so that fish passing up an inclined plane fish-way rising ten feet vertically, would necessarily travel a distance forty to fifty times the height of the dam. For example, in the fish-way over the Hadley Falls Dam on the Connecticut River, the total length of the incline is about 450 feet. The distance to be travelled by the fish ascending it is not far short of 1500 feet, to overcome an ascent of about 29 feet.

All the different designs of fish-ways constructed according to the incline plane system, have when judiciously located, proved more or less successful in passing certain species of fish. In all, however, the labrynthine route to be traversed, and the insignificant flow of water through them, constitute very serious objections.

AN IDEAL FISH-WAY.

If it be possible, by any practical construction, to deliver the whole volume of a stream, over a dam or other obstruction with such moderate velocity, that the weakest and least adventurous fish could readily swim against it, we would practically destroy the obstruction, and would establish for the migratory species a passage up to their spawning grounds as free and unrestrained as if no obstruction existed.

In practice, of course, this ideal can be realized only in exceptional cases, for industrial necessities or consideration of cost will necessarily limit the dimensions of the fish-way, and the amount of water that may be discharged through it, but just in proportion as we approximate this ideal in our fish-way constructions, do we approach more nearly the solution of the problem of free circulation of the anadromous fishes in continental waters.

When the Commission of Fisheries was inaugurated in the State of Virginia, in 1875, one of the most important questions presented to it was, how to make adequate provision to get the anadromous fish over the innumerable dams that obstruct the main water courses of the state, and all their tributaries.

The white shad (*Alosa sapidissima*) is one of the most important food fishes in all the tributaries of the Chesapeake, and in times past has furnished the motive of immense and profitable fisheries. The restoration and maintenance of this valuable fishery was one of the most serious questions presenting itself to the consideration of the Commission. The James and the Rappahannock Rivers were obstructed at the head of the tide by insuperable dams, interposing effectual obstructions to the further upward migration of the anadromous species.

Years ago, before obstructions existed, the migration of the shad in James River extended into the heart of the Alleghaneys two hundred and fifty miles above tide water, and in the Rappannock to the very base of the Blue Ridge Mountains. The curtailment of the breeding area by the erection of dams on both rivers, had determined a corresponding reduction in the productive capacity of the streams, and in concurrence with the irrational and unrestrained methods of fishing pursued, had rendered franchises, once valuable, worthless; industrious, once profitable, precarious and unproductive. A fish-way that would freely pass shad up over these obstructions, and recover to production the breeding area of water from which they had been excluded, promised the means of restoring these most valuable fisheries.

The gentlemen who were then Commissioners of Fisheries for the State of Virginia, were pleased to select me to visit the Centennial Exposition, at Philadelphia, with instructions to make a careful study of the models of all the forms of fish-ways there exhibited, with the view of finding one that would be adapted to our purpose. A careful study of all was made, and I was reluctantly forced to the conclusion that none of them fulfilled the necessary conditions of successful operation, and I returned discouraged, with the conviction that an efficient shad-way was a thing of the future.

The conditions to be satisfied in a successful fish-way construction are as follows :

First—The water should be delivered down a straight unobstructed channel.

Second—In sufficient volume to invite the entrance of fish.

Third—With such moderate velocity as to permit their ready ascent.

Fourth—With a view to economy in construction, it is important that the inclination or slope of the way, should be much more considerable than in the ordinary inclined plane fish-way.

How to construct so as to fulfill these conditions was the problem to be solved. Two methods suggested themselves. It was possible to make the water do work in its descent and thus control velocity. A fish-way could be constructed on this principle by an evident modification of the ordinary turbine wheel, and such a fish-way could be made to serve both as a passage-way for fish and as a motive power for machinery. This idea, however, was soon abadoned for the double reason of its complexity, and the limitation of its application that would necessarily exist.

The second fruitful idea was that if each molecule of water could be compelled to traverse a constrained path, its final direction in any one circuit being against gravity, it could be brought to rest at a lower level—the friction developed in movement having neutralized in part the force of acceleration.

The molecule falling from its second position of rest through a similar circuit, and in succession through any number of circuits, would finally reach any defined lower level with no greater velocity than that attained in the first circuit described. Were it practicable to subject every molecule of water passing through a fish-way to the constrained movement above indicated, the result would be a descending current, the average velocity of which would not exceed the average velocity of a molecule in

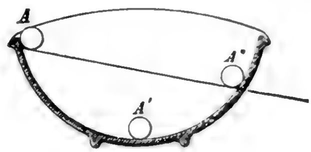


Fig. 1.

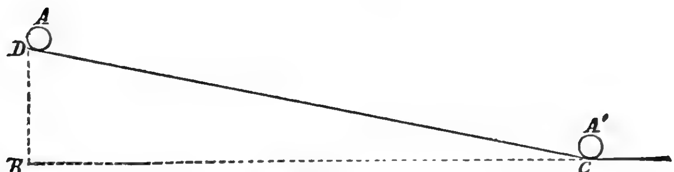


Fig. 2.

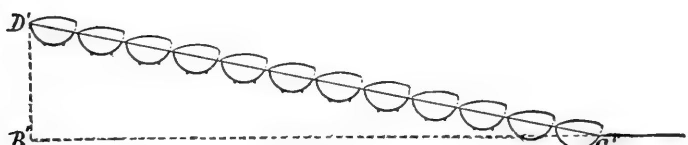


Fig. 3.

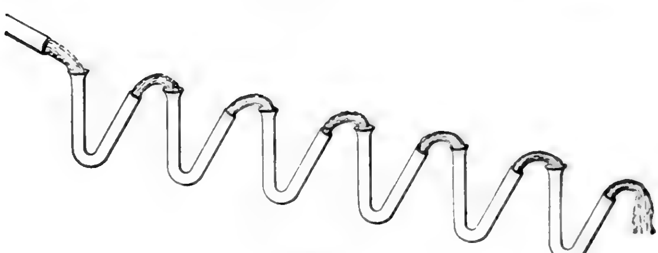


Fig. 4.

passing to consecutive positions of rest under the conditions above stated. How this idea has been realized in practical constructions, will be understood by references to the figures and descriptions.

If we take a hemispherical bowl (fig. 1) and holding a marble at A, upon the edge of the bowl, we release it, it will fall under the influence of gravity through A^1 to A^2, coming to rest at A^2, some distance below the edge of the bowl The vertical distance between the positions A and A^2, measures the force of acceleration that has been counteracted by friction by traveling the constrained path A, A^1, A^2.

If now, we take a number of similar bowls and cut them off to the line $A\ A^2$, and arrange them as in fig. 3, and start a marble at D^1, it will pass from D^1 to C^1, reaching C^1 with no greater velocity than that acquired in passing from A to A^2. If, however, the marble was allowed to roll unobstructed from A to A^1 down the incline plane D, C, (fig. 2) it will have acquired a velocity equal to $8\sqrt{Db}$, approximately.

We see, then, in this case how it is possible to deliver a molecule from a given position to a definite lower position, without the increase of velocity that would arise if the molecule fell freely under the action of gravity or rolled down a smooth incline. If it be possible to compel every molecule of water descending through a fish-way to submit to the conditions above indicated, then the problem how to control the velocity of a descending current would be solved. Now to apply this to liquids, we arrange a series of bent tubes, shown in fig 4. By suitable arrangements we keep the longer branch of the higher tube of the series full of water. The water escaping from each tube will rise against gravity until it comes to rest; then falls into the longer branch of the adjacent tube in the series, and after passing through the entire series be finally discharged from the shorter branch of the lowest bent tube, with no greater velocity than it acquired in passing through the first member of the series.

Construct a series of these tubes with branches brought close together, cut away obliquely the upper end of the longer branch of each member of the series, so as to permit access of water pack them side by side, in oblique position in an inclined

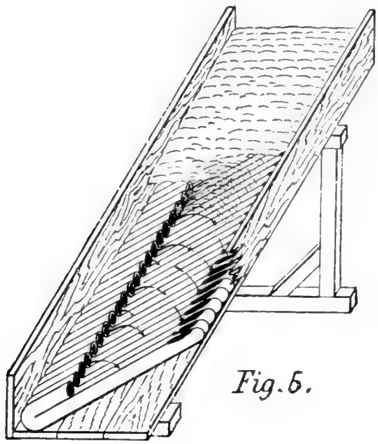


Fig. 5.

sluice, as shown in fig. 5, and we have the solution of the problem with which we started. For if we suppose a current of water to be running through the inclined trough or sluice-way, the first effect will be to fill the tubes with water and establish a flow through them; the water entering the longer branch of each tube will escape from the shorter branch with a velocity due to the head or vertical distance between the two ends of the tube. This final direction being obliquely up the slope, each particle of water will describe a path as is indicated by the curved arrows shown in fig. 5. The effect will be that we will have an ascending current in the sluice—on that side of the sluice where the shorter branches of the tubes are situated. The velocity of this ascending current will become less and less as we pass towards the middle of the sluice, where there will be a line or section of practically eddy water, and beyond a descending current, becoming more rapid as we pass to the further side of the sluice, where we find a current descending with uniform velocity, the maxium limit of which will be the velocity of the water escaping from the shorter branches, provided the supply of water and the capacity of the tubes are properly proportioned. The illustrations here given present briefly and graphically the principles applied in the McDonald system of fish-way building.

The flexibility of the system adapts it to the widest range of conditions occurring in practice. An effective passage may be provided for the fish over obstructions, with the supply of water that will flow through a cross section six inches square, or the fish-way may be expanded so as to take the entire discharge of a river. Constructed roughly of boards, it furnishes at a nominal cost the means of reestablishing our innumerable trout streams to the natural conditions of reproduction.

These fish-ways may be made so light as to be readily portable, so that, in the season when the fish are not running, they may be stored away under shelter and thus protected from decay or destruction by ice or floods. In public parks and trout preserves, where considerations of cost are not controlling, the fish-way may be built of iron in ornamental designs, and while serving its essential purpose, made to contribute to the picturesqueness of the landscape. Solidly built of stone and iron, and of dimensions proportioned to the volume of the stream, it may be made strong enough to resist the utmost force of floods and ice, and by furnishing an easy passage for shad, salmon and other anadromous species of fish, make possible the restoration and maintenance of our valuable river fisheries, in spite of the obstructions which are the inevitable and necessary adjuncts of civilization.

As an example of construction, we have given in fig. *6a* the elevation, and in fig. *6b*, the plan of a double fish-way built of timbers. It consists of an inclined sluice-way of boards, the sides and bottom of which are supported by suitable framing. The sluice has in this case an inclination of one foot in three. The upper end is let into the dam so that its upper line is flush with the crest line of the dam. The lower end descends to the water below the dam, and is firmly anchored by being secured by bolts either to the rocky bed of the stream, or to piles suitably placed, or by other suitable means. Intermediate supports may be provided, by trestling, as shown in the figure, by log cribs or by rubble masonry. The incline flume or sluice thus established

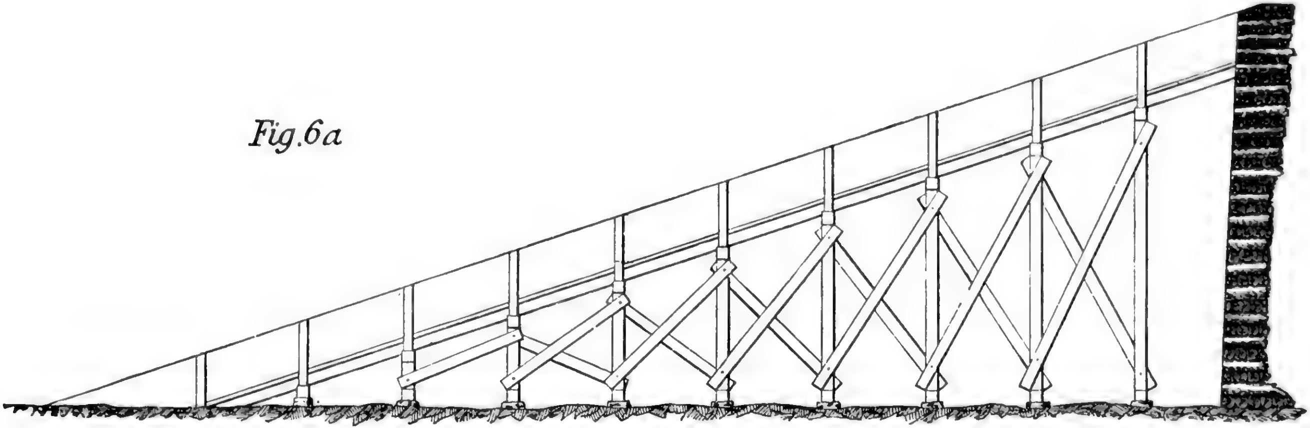


Fig. 6a

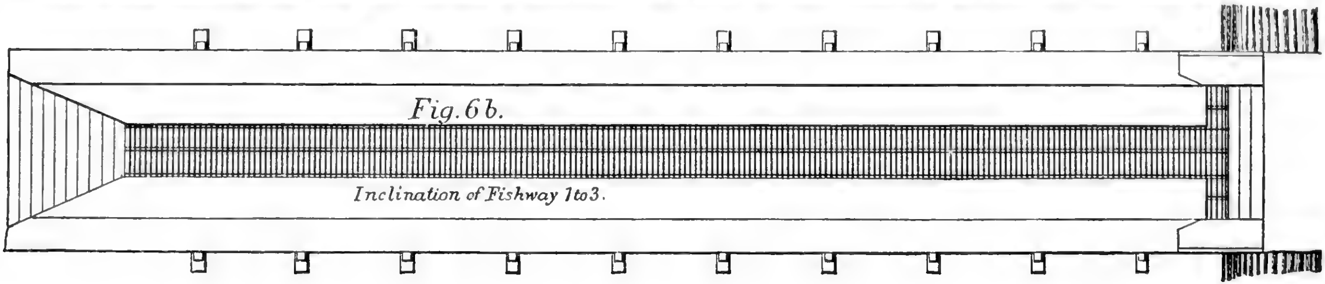


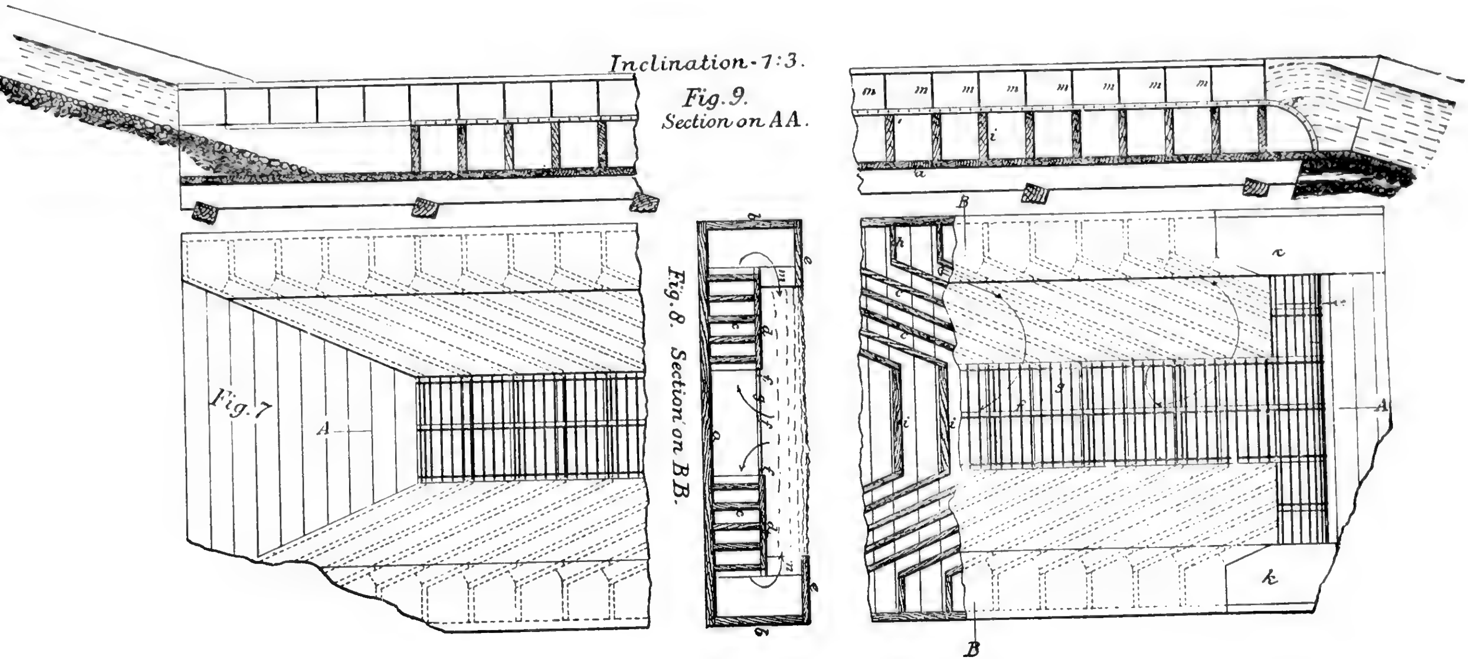
Fig. 6b.

furnishes the foundation for the structure of the fish-way proper which is placed within it.

Details of construction are given in figures 7, 8 and 9, which are on a scale of one-fourth of an inch to the foot. The substructure having been established, we begin by setting up along the centre line of the trough or sluice, the bulkheads *I*, *I*, *I*, and *C*, at intervals of twelve or fifteen inches. These are made of planks one and a half inches thick, two feet long and fifteen inches wide. These are firmly attached to the flooring of the sluice either by spikes or bolts. Posts *H*, H^1 and *C*, of one and a half inch stuff, nine to twelve inches wide, and extending from the floor to the upper edge of the inclined trough, are now set up at similar intervals of twelve to fifteen inches, and firmly secured to the sides and bottom of the trough. To the posts *H*, *H*, and bulkheads *I*, *I*, the fifteen inch joists are securely nailed or bolted. The floor *D*, fig. 8, of one and a half inch plank is next laid and nailed to the inclined joists as shown in figures 7 and 8, upon the floor *D*. Next set up the short return buckets *M*, *M*, and *C*, figures 8 and 9, securing the same to the parts *H*, *H*, and to the floor by nailing or other suitable means. The cap *E*, *E*, fig. 8, made of a single two inch plank is fastened securely to the sides *B*, *B*, the posts *H*, *H*, and the return buckets *M*, *M*, thus completing the construction.

We have here realized in timber the same construction and secured the same control of the descending current as shown in the experimental apparatus, fig. 5. The course of the water is shown by the arrows. When a sufficient supply of water is brought to the head of the fish-way, we will have an average depth of water way above the floor, *D*, of ten to twelve inches. Any excess of water over the amount needed to fill the fish-way will be shed over the sides, and the fish-way will continue in efficient operation in any stage of water.

In the drawings figures 7, 8 and 9, the open spaces between the bulkheads *I*, *I*, and *C*, and also the head of the fish-way where the water passes under the floor *D*, directly from the dam, is represented as guarded by a wrought iron grating. This is only necessary where the exposed position requires that the weak points be protected from injury by ice or drifting timbers


Inclination-7:3.
Fig. 9.
Section on AA.
Fig. 7
Fig. 8. Section on B.B.
A
B
m
a
b
c
d
e
f
g
h
i
k
n
x

The grating may be dispensed with where other safeguards are made use of.

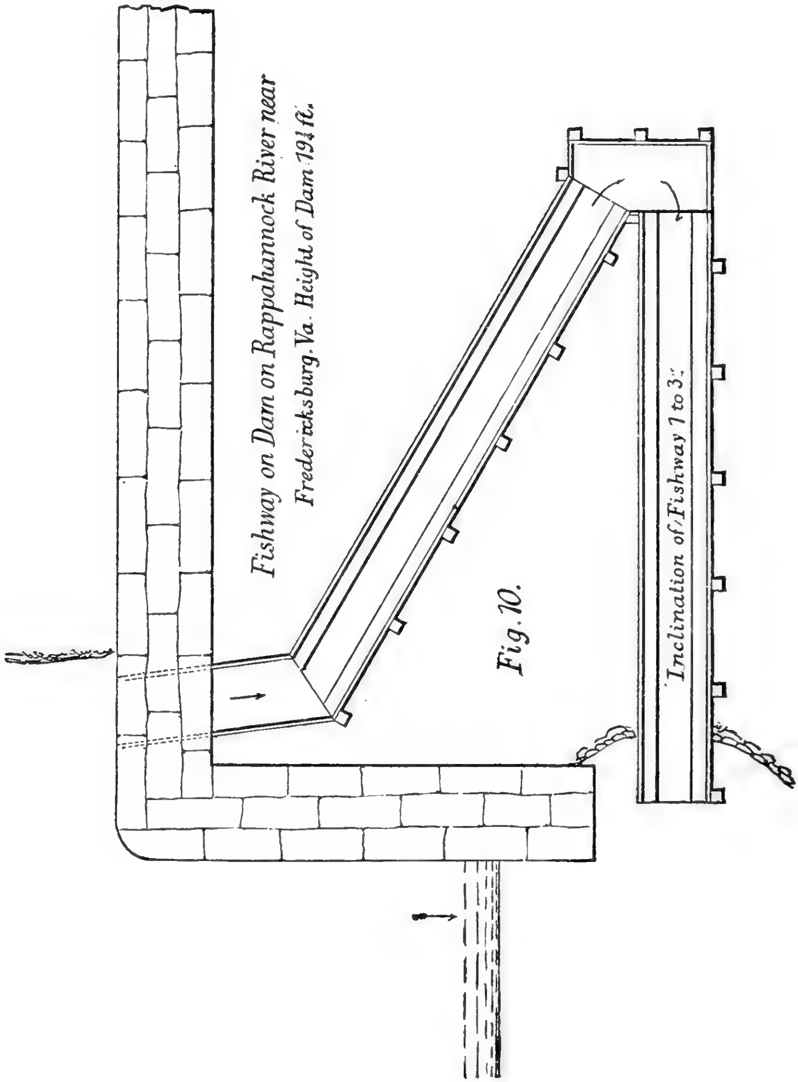


Fig. 10.

LOCATION.

The proper setting or location of the fish-way is a matter of prime importance to secure satisfactory operation. Where the cost of the construction is considerable, the location should be made under the direction of a competent engineer, and after a careful study of the locality. In all cases the following conditions are to be observed in the construction:

First—The water capacity of the fish-way must be in proportion to the volume of the stream. The more water we can discharge through the fish-way the more satisfactory it will be in operation.

Second—The upper end of the fish-way must be set at such a level as to run full at ordinary spring stages of the stream.

Third—The discharge from the fish-way should be made close to the face of the dam.

Fourth—The fish-way must be so located as to be sheltered from ice and drift, or when this is impracticable it must be built strong enough to resist injury.

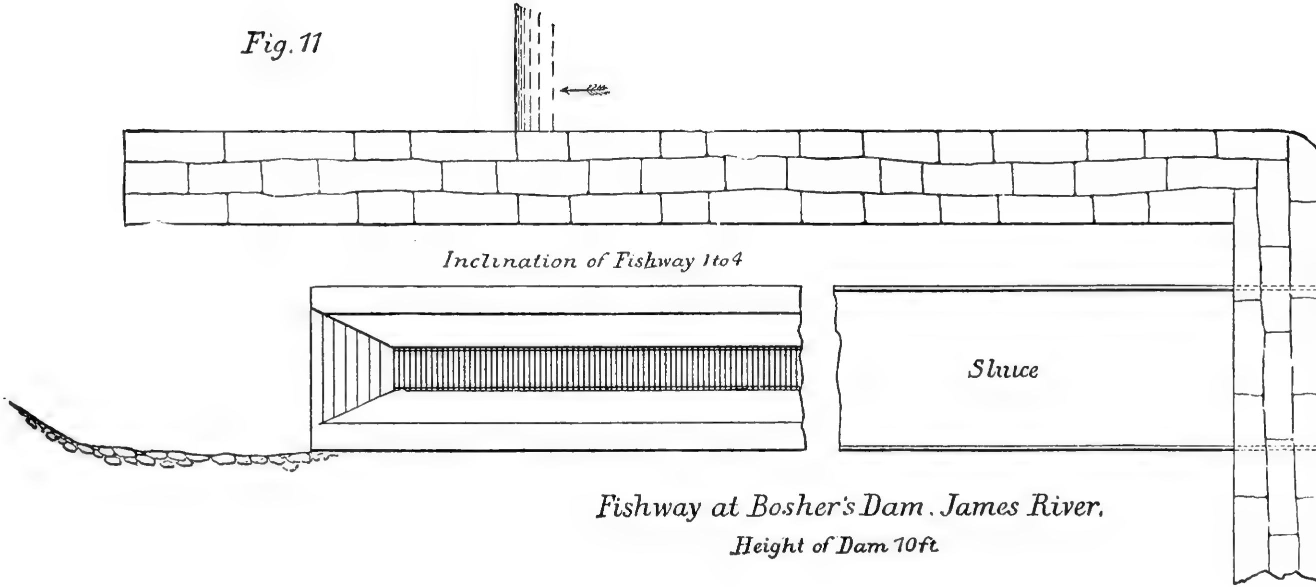
Where these conditions are realized in the construction, complete satisfaction in operation may be expected. In figures 10, 11 and 12 are presented three plans of actual constructions, which will furnish useful suggestions as to location.

Figure 10 shows plan of fish-way on the Rappahannock River, near Fredericksburg, Va. The water is brought to the head of the fish-way by a culvert piercing the flood wall. The fish-way is built on a slope of one foot in three, and in two sections, so as to bring the discharge close to the abutment. This has been in successful operation two seasons.

Figure 11 shows plan of fish-way at Bosher's Dam on James River, Virginia, nine miles above Richmond. This is a later and improved design, though embodying the same principles of construction as shown in the Fredericksburg way.

Here advantage was taken of the locality to shelter the way behind the high flood shown in the drawing. Two arched culverts admit the water to a sluice which conducts it to the head of the fish-way. This discharge of water is too far from the face of the dam to secure the best results, and it will be

Fig. 11



Fishway at Bosher's Dam. James River.
Height of Dam 10 ft.

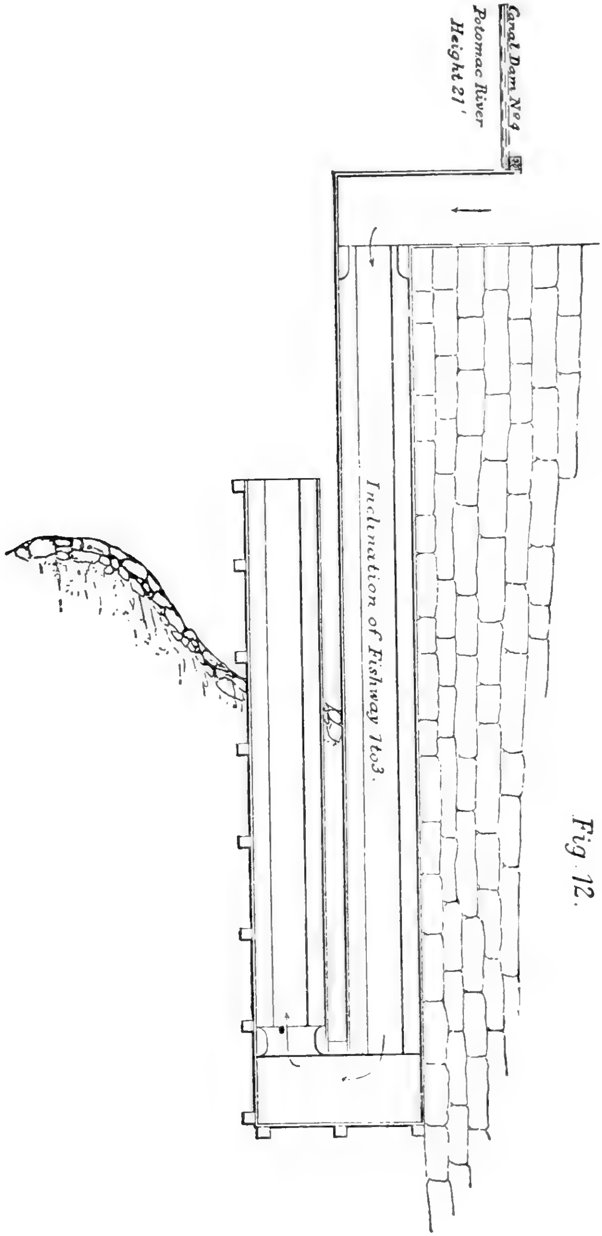

Canal Dam No 4
Potomac River
Height 21'
Inclination of Fishway 1 to 3.

Fig. 12.

necessary to erect a deflecting wall at the lower end, to turn the current around the abutment. This fish-way has been in operation since the middle of May, 1883, and since the water has been turned on, all the river species except the shad, have been observed passing in large numbers. Very few shad have reached the dam this season; the total catch by the nets being less than two hundred.

Figure 12 shows plan of fish-way on Canal Dam No. 4, on the Potomac River, near Sheperdstown, W. Va. This was built in the winter of 1882, stood without injury, the heavy ice drifts and floods of the late winter, and during the season just past, has given full satisfaction to those who have watched its operation.

The black bass and other river species have been observed to pass it in numbers and with ease. In this case the fish-way is sheltered behind the abutment on the Maryland side of the river, the upper section being suspended to the abutment by stout wrought iron brackets. The water is conducted to the head of the fish-way from the crest of dam by a trunk leading around the face of the abutment.

MR. PAGE: There has heretofore been no certainty about the action of fishways, but it is now generally acknowledged that Col. McDonald has invented one that will accomplish all that is sought in effecting the passage of fish over dams in the easiest and best manner, and also at the least expense.

MR. PHILLIPS: I would bring to the notice of this Association the death of M. Charbonnier, the very celebrated fishculturist of France, whose reputation was world-wide. He was particularly interested in introducing and acclimatizing foreign fishes, either of value as food or ornament, and was the first to introduce the gourami into France. During the siege of Paris, when fuel was scarce and the weather too cool for his gourami, he burned his furniture to warm them, and so saved them through those dreadful days. Originally he was a tin-smith, but came to love nature and study it, until his name was widely known in both hemispheres for his practical knowledge, and he was elected to membership in many learned societies.

Resolutions of sympathy and regret at the death of M. Charbonnier were passed.

MR. BENKARD: I would like to bring up the subject of the pollution of our waters, which brings many of our fishcultural efforts to nought. I would respectfully offer the following:

Whereas: It is the sense of this Association that the continual and increasing pollution of the waters of New York bay from the refuse of certain factories, threatens eventually to kill or drive away all fish, shellfish and bivalves natural to said waters;

Therefore, be it resolved that this Association beg to call the immediate attention of the Fish Commissions of the States of New York and New Jersey, also of the members of their legislatures, to this impending calamity.

MR. BLACKFORD seconded the resolution, and said that it was important that our labors should not be destroyed, as they would be if some way were not found to prevent this pollution. Complaints are made that the shad taken in the harbor taste of kerosene and that the pollutions have driven out the shrimp. New York bay, adjoining Jersey City, formerly produced lobsters, there are none there now. Each year they deteriorated in quality, became watery, with bad flavor, and finally disappeared. But few are found at Hell Gate now, and even the clams are scarce, probably because of the refuse from the Standard Oil Works. Near Rockaway and Barren Island the oysters and clams are about exhausted and the fish driven away. The fishermen have called on the Fish Commissioners for action, but the latter have power only to cultivate, not to protect. The substance called sludge acid pollutes the water about New York, in addition to the filth of the city. I hope the secretary will put himself in communication with the legislatures of New York and New Jersey.

COL. BRYSON: The Supreme Court has decided that the State has no jurisdiction over navigable waters. We should communicate with the general government at Washington, and the States should have concurrent legislation.

Mr. Page: Mr. Blackford referred to Hell Gate. Nearly all the Standard Oil Works are near there, at Hunter's Point. The residuum must amount to 25,000 barrels, emptied into the East River in twenty-four hours. 100,000 barrels are swept through the kills into Newark bay, and the oysters are destroyed.

Col. Bryson: I am a stockholder in the Standard Oil Company, but think it will be profitable to them to be forced to find some use for their refuse.

Mr. Blackford moved that the Recording Secretary take charge of the papers and prepare them for speedy publication. Carried.

Col. Bryson moved that if the indebtedness was not cancelled within ten days that the Treasurer receive voluntary subscriptions. Carried.

The meeting then adjourned.

TREASURER'S REPORT.

Dr. *American Fish Cultural Association in account with Eugene G. Blackford, Treasurer.* **Cr.**

By Membership dues received, - -	$146 00
By balance due Treasurer, - -	$89 55
	$235 55

1882.	To balance from last report, -	$57 26
Dec. 30th,	" Cash paid J. M. Davis, for printing Reports, etc. -	175 00
1883.		
Jan. 2d,	" Cash for Stamped Wrappers, -	1 59
May 12th,	" " " Postage, - -	1 30
		$235 55

New York, June 7th, 1883.

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American Fish-Cultural Association.

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Whipple, John, Union Club, New York.
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White, David T., Mayor's Office, New York.
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Wood, Benjamin, New York City.
Woodruff, G. N., Sherman, Conn.
Woods, Israel, Fulton Market, New York.
Yarrow, Dr. H. C., U. S. A., Washington, D. C.