23.—HISTORY AND METHODS OF WHITEFISH CULTURE.

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The history of fish-culture is claiming the public attention as never before. From earliest time the art has been rife among all peoples, even among the more rude and uncivilized. We read of the fisheries of Byzantium, old Constantinople, that were both lucrative and extensive. The fisheries of Rome in the vicinity of Sicily and in the Carpathian Sea and those of the ancient Egyptian inland lakes are all of historical interest. Egyptian fisheries were protected by the most stringent laws. The revenues of the fisheries of Lake Maerie amounted to more than $500,000 annually, which is evidence of their extent. Early in the ninth century laws went into effect in western Europe touching the immense European fisheries. But while fish have been used as an article of food since the dawn of the race, pisciculture never reached its practical and scientific position till more recent years.

The Chinese practiced the art of rearing and fattening fish in confined bodies of water, by placing twigs in the water during the spawning time of carp and removing them when covered with the spawn. The Romans followed a like method, while the Egyptian pictorial relics show a similar custom, a large vivary being built and maintained for the purpose of growing fish for table use and religious sacrifice. The historian of ancient Rome tells us of the extensive and complete fish ponds of the Romans. The Roman Hortensius was more concerned about his mullet than his men, and his fish servants were for number almost countless. He employed sailors to procure food for them, and when the weather prevented the tars from leaving port in search of fish food, butchers and provision dealers would bid for supplying the fish with provender. His head man, or "nomen-clator," not only gave a name to each individual fish, but taught them to "wag their tails, fawn like dogs, and permit themselves to be scratched and clawed," when exhibited to visitors. There is much fable concerning the affection of the Romans for individual fishes, but the fact that they were successfully reared is well established. This, briefly, is the general character of ancient fish-culture. It did not include what the culturist of to-day considers the most skillful item of his work—the taking of the eggs from the female fish, impregnating, and hatching them.

As early as 1741 Stephen Ludwig Jacobi, a young German, discovered this art and successfully practiced it years before making it public. Since then, with various changes and improvements in methods, it has been in vogue in different countries, but nowhere has larger success been obtained than in the United States. When in 1880 the International Fishery Exhibition occurred in Berlin, which was one of the most notable events in fish-cultural history, the grand prize was awarded this country for the best collection illustrating the fisheries, while the United States captured six out of ten gold medals awarded, Germany securing three, and Russia the remaining one.

And so the history of our profession has had its birth and growth, and is of vital interest to those who care for these matters. With this general introduction I turn to briefly consider the history of whitefish culture from the beginning of the work to the present, with methods, apparatus, etc.

The first intimation we have of the artificial work with whitefish is found in a paper by Mr. Milner, deputy U. S. Commissioner of Fisheries, on "The History of Fish Culture," in which he says:

> In November, 1857, Mr. Carl Miller, of New York, and Mr. Henry Brown, of New Haven, Conn., visited Lake Ontario, and, taking males and females of whitefish alive from the nets of the fishermen, impregnated a large number of eggs, estimated by them at 1,000,000. They were packed in alternate layers with fine wet sand, presumably in a box, but not stated, and transported to Saltonstall Lake, Conn., and there deposited upon sandy spots in the lake. The eggs had the appearance of being in good condition when they arrived at their destination. In March and April following, the young were said to have been seen in large numbers. Again, in 1858, 10,000,000 ova of trout and whitefish were obtained and placed in the lake, and considerable numbers were believed to have been hatched.

Mr. Milner notes that the numbers were probably overestimated in both cases.

From the Maine commission report for 1870 we find that in November, 1868, they laid down in the hatching troughs for experiment a number of whitefish eggs, and in the following March and April a large number of young fry made their appearance. The fry escaped to a stream below the hatchery, and later in the season whitefish of 4 to 5 inches in length were noticed and some shown at the Provincial Show at London

The first successful series of tests were begun in 1868, by Seth Green and Samuel Wilmot in applying artificial culture to this species, and in the succeeding year by my father, Mr. N. W. Clark, with whom I was associated at that time.

Mr. Milner further says:

> They were found to be very delicate and difficult to hatch in the first few years of experimenting, but methods were perfected that made their production as certain and losses nearly as small as in other species.

From this it will be noticed that Mr. Wilmot and Mr. Green began their experiments one year previous to my father and myself. I have not been able to obtain the facts as to Messrs. Green and Wilmot's plan of handling the eggs, but it may be presumed that it was carried forward in a manner similar to our own.

Commencing, then, with the fall of 1869, we find that Mr. Clark, through the courtesy of Mr. Green, obtained 50,000 whitefish ova and placed them in gravel hatching-boxes fed by spring water at the temperature of 47° F. It was found they required much closer attention than trout ova and the constant removal of the dead eggs was necessary to avoid the growth of fungus, the whole becoming one mass of vegetable mold. However, 2,000 were hatched and through the wire mesh escaped into a lake below the hatchery.

Again, in 1870 a like number was obtained through the courtesy of Mr. George Clark, of Ecorse, Mich., placed in the same troughs with the same temperature of water. A much larger number were hatched, bursting the shell about January 15 to January 20. By the use of finer-mesh wire the young fry were retained in the troughs. Soon after the hatching Mr. J. W. Milner, deputy United States Commissioner, visited the hatchery at Clarkston and took some one hundred of the fry with him to his home at Waukegan, Ill., to experiment, and, if possible, learn the food of the whitefish; some 3,000 were retained in the troughs, but later they all died, only surviving four weeks.

In the fall of 1871 a larger hatchery was erected further down the stream, and a dam constructed, flowing over a large area, for the purpose of cooling the water. My father's experiments led him to believe the eggs should be retained to such a time as would seem to be more nearly the natural hatching time of the eggs spawned in the Great Lakes. Through the courtesy of Mr. John P. Clark and George W. Clark, he was able to obtain upwards of 500,000, a fair percentage of which was hatched and planted near the hatchery and Detroit River.

Again, in 1872 a fair number were obtained, hatched, and planted, a portion being carried forward for the U. S. Fish Commission. An estimate, by Mr. Milner, of good eggs, placed them at 66 per cent; the first considerable shipment of eyed eggs was made to California from the Clark establishment by Mr. Milner, the deputy commissioner.

In 1873 the take was 800,000. Experiments were inaugurated with reference to the growth of the fish. Eggs were hatched in spring water in sixty days, and by a series of mixing the spring and ice-cold waters from the creek, it was possible to bring fry out weekly. From January 15 to April 1 weekly hatch experiments were conducted with regard to growth. Success was not very marked, however, till toward the last of the hatching. The fry produced after March 15 seemed stronger, and from this lot we find that by June 18 those in the lake water had reached a length of 1½ inches.

As to the apparatus in use for transporting the eggs from the fishing-grounds on the Detroit River to the hatchery at Clarkston, I quote from Mr. Milner:

> An improved case for the carriage of eggs long distances by railroad is another device perfected by Mr. N. W. Clark in 1872. It is a modification of the ordinary case containing circular cups, the cups being square, and in this form economizing space very much. The cups of tinned iron, about 4 inches square and 2 inches high, rest in trays with low partitions forming low compartments that retain the bottom of each cup and hold it solidly in place. The trays are set within a square tin box, in which they fit with moderate tightness, and are placed, when containing the cups, eight or ten in a box, one above the other; this box is set within another box of tin large enough to leave an open space on all sides, to be filled with sawdust; a tube is inserted through the bottom of the inner box, piercing the bottom of the outer one, so as to permit communication with the air on the outside; the whole is then placed for protection within a strong wooden box, in the bottom of which is a frame resting upon stiff springs which relieve the eggs from heavy jarring; rubber or cloth bumpers on the sides of the box prevent lateral swaying and jolting. A cover is fitted on the inner box, which may then be covered with sawdust to the level of the higher outer one, when the cover of this is to be shut down. The outside wooden box is fitted with handles and with a tight lid on hinges, which may be locked. Small auger holes are bored through the outer or packing box and air may be admitted to the whole interior of the egg case through the tube referred to in the bottom, the cups being pierced with small holes, so that when placed they are directly over circular openings in the trays and a communication of air is established throughout.
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> The eggs may be packed in moss, in the ordinary manner, in the cups, which experience seems to prove to be the best manner for long journeys.

The fall of 1874 brought out the flannel trays for transporting eggs from the fishing shore to the hatchery. These were used by Monroe A. Green and my father, for carrying the whitefish eggs to their respective hatcheries. A model of this carrying tray and box may be seen in the Fish Commission exhibit. In transporting whitefish and lake trout-eggs from fishing-grounds to the hatcheries, this apparatus has been continually used to the present time, as no other carrying device has met with the success and convenience of these trays.

During the winter a small number of whitefish eggs were carried forward as an experiment in the hatching of whitefish eggs, which were laid in single layers of woolen

cloth stretched on very thin frames of wood, packed in a box imbedded in moss within a refrigerator, and the whole kept by ice at a temperature a little above the freezing point. Mr. Milner notes that "the eggs are left entirely undisturbed after they are first arranged; the only care on the part of the attendant is to keep the temperature above the freezing point." It is true the eggs necessarily occasioned very little care. Once in two or three weeks the trays were overhauled and dead ova removed. Very little confervoid growth appeared, and in March the eggs were removed to hatching trays, where, in a very few days, the fry hatched. Other experiments were tried at this time, such as placing the eggs in fine sand with a drip of water falling on the case containing the sand and eggs. This period, up to the spring of 1873, is what I term the first stage in whitefish hatching.

We now come to the invention of the Holton, Clark & Williams box, a description of which you are all familiar with, and a model of which may be seen in the exhibit. The Clark box was used successfully in hatching some 2,000,000 whitefish during the winter of 1873–74, at which time my father and myself were engaged in hatching for the Michigan Fish Commission, thus inaugurating the work of turning out whitefish by the State. I quote from the Michigan Fish Commission report of 1874:

> During the winter of 1873–74 there were hatched at Clarkston, Oakland County, under the auspices of the fish commission, upwards of 1,500,000 of whitefish. The eggs were laid in the latter part of November, 1873, and commenced hatching the latter part of February. The hatching operations at Clarkston last winter were eminently successful and have established, beyond all cavil or doubt, the absolute feasibility of multiplying, to any desired limit, the whitefish, the acknowledged queen of the lakes.

The Holton box was not used to any great extent until the season of 1875–76, when the Michigan Commission placed them in a newly constructed hatchery located at Detroit, Mr. O. M. Chase, superintendent. The work of laying in the eggs and hatching was very successful, and a large number were deposited in numberless lakes and the Detroit River.

The Clark box was used the same season in successfully turning out upwards of 2,000,000 for the U. S. Fish Commission.

The tray-box method of Holton, Clark & Williamson was of great importance in economy of space, in the facility of manipulation of the eggs, and in saving expense, because smaller buildings were sufficient for the accommodation of the apparatus, from the compactness of which more labor can be accomplished than with the extended trough method.

The shipment of 216,000 whitefish eggs made by the U. S. Fish Commission early in February was not successful, as they arrived in bad condition. This lot was packed upon alternate layers of sponge and eggs, the whole surrounded with fine sawdust. Early in March another shipment was made of 116,000, which arrived in good condition, being packed in moss.

We now pass from the tray-box method to the more compact form of bulk hatching. During the season of 1875–76, Mr. Oren M. Chase, of the Detroit establishment; Mr. Welsher, of Wisconsin, and Mr. Samuel Wilmot were at work on a bulk hatcher for the whitefish. Messrs. Chase and Wilmot continued these experiments, and the use of the Chase jar has become quite general, notably with the States of Michigan and Wisconsin. Up to the period of bulk hatching of whitefish eggs the dead and fungused eggs were removed by tweezers, and it was necessary to devise some method by

which the bad eggs might be removed automatically and thus lower the cost of production. By the tray method whitefish fry in 1874 and 1875 were costing from 50 cents to $1 per 1,000, but by the bulk hatchers the cost has been reduced to from 5 to 15 cents per 1,000. The Chase jar was somewhat modified and successfully used by myself in the Northville establishment in 1877.

Other devices have been invented for handling whitefish, such as the Bower trough hatcher, and a hatcher consisting of tin, devised by Mr. Holt of New York State; but none of the devices, to my knowledge, has been used to any great extent. The Chase and Clark jar (a modified Chase jar) were practically the only ones used up to about 1880, when the McDonald jar was invented for the hatching of shad, from which time the McDonald jar has taken the front rank with that of the Chase jar for hatching whitefish, being used in the Put-in-Bay hatchery, the Alpena hatchery, and, I think, at the hatchery at Erie, Pa. Since the invention of these jars they have practically brought the hatching of whitefish almost to perfection, and no practical invention has been brought out to take their place or supersede them.

GROWING WHITEFISH.

To my knowledge, the first whitefish grown that were held for rearing, to amount to anything, was in 1882, when at Northville we held some few thousands of the fry, of which we succeeded in raising several hundred to be one year old. These fish were raised entirely upon chopped liver, and we kept them at the Northville Station until they were large enough to spawn. We have taken the eggs from the parent and hatched them in the automatic jars. In packing and shipping whitefish eggs since 1876 we have practically followed the same plans each season, namely, that of the flannel-tray method, and in shipping to long distances, such as New Zealand, Mexico, etc., the tray has been packed in a refrigerator box.

It is a rare thing nowadays to find any of our shipments of eggs arriving at their destination in poor condition, hardly an instance in a season. The work of collecting eggs is practically carried on after the same method as in the beginning, with the exception of certain localities where the fish, after being caught, are held in crates till ready for manipulation. The work of the Michigan Fish Commission in collecting their whitefish eggs is almost wholly upon this plan. Whitefish fry have been planted in our great lakes from 10,000,000 upwards to 60,000,000 each season since 1876, and it is to be regretted that the increase of whitefish in these lakes has not been larger. The cause has not yet been satisfactorily demonstrated. The fish are planted in the same time of the year that the eggs naturally spawned are supposed to hatch. They are also planted upon the natural grounds where the fish spawn, and still the increase is not so great as we might suppose.

Since 1876 there have been planted in the Great Lakes and inland waters throughout the United States by the U. S. Fish Commission 677,176,000 whitefish fry. The majority of these have been planted in the Great Lakes, and by Canada and the States of New York, Ohio, Michigan and Wisconsin there has, undoubtedly, been planted double this number, and it would seem proper that the time has arrived when we should see if there might not be some better means for introducing the fry in the Great Lakes especially. It is true that in some few of our inland lakes throughout the United States the whitefish planted have done remarkably well, but for our Great Lakes some new method must be adopted for introducing the fish in the waters.

Statement of the distribution of whitefish eggs and fry by the U. S. Commission of Fish and Fisheries, from 1872 to 1893.

EGGS.

Assignments.	1872.	1873.	1874.	1875.	1876.	1877.	1880.	1881.	1882.	1883.	1884.
State fish commissions.											
California	332,000	25,000	20,000	100,000	250,000	500,000	500,000	750,000	500,000	.....	.....
Maine	.....	.....	.....	.....	.....	.....	1,000,000	.....	.....	.....	.....
Iowa	.....	.....	.....	.....	.....	.....	500,000	500,000	.....	1,200,000	1,000,000
Minnesota	.....	.....	.....	.....	.....	.....	250,000	.....	5,000,000	5,000,000	20,000,000
Kentucky	.....	.....	.....	.....	.....	.....	500,000	.....	.....	.....	.....
Nevada	.....	.....	.....	.....	.....	.....	25,000	.....	.....	.....	.....
New Jersey	.....	.....	.....	.....	.....	.....	.....	100,000	.....	.....	.....
Connecticut	.....	.....	.....	.....	.....	.....	.....	10,000	.....	.....	.....
Maryland	.....	.....	.....	.....	.....	.....	.....	.....	150,000	200,000	1,000,000
New York	.....	.....	.....	.....	.....	.....	.....	.....	1,000,000	1,000,000	1,000,000
New Hampshire	.....	.....	.....	.....	.....	.....	.....	.....	200,000	200,000	200,000
North Carolina	.....	.....	.....	.....	.....	.....	.....	.....	250,000	500,000	.....
Pennsylvania	.....	.....	.....	.....	.....	.....	.....	.....	2,000,000	.....	.....
Wyoming	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	250,000
Private applicants.											
Wisconsin	.....	.....	.....	100,000	.....	.....	.....	.....	.....	.....	.....
Pennsylvania	.....	.....	.....	.....	.....	.....	100,000	.....	.....	.....	.....
Missouri	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	50,000
Foreign countries.											
Germany	.....	.....	.....	.....	.....	.....	250,000	312,000	510,000	1,000,000	1,500,000
France	.....	.....	.....	.....	.....	.....	.....	250,000	200,000	.....	.....
New Zealand	.....	.....	.....	.....	.....	.....	.....	.....	.....	1,000,000	.....
Australia	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1,000,000
England	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	250,000
Switzerland	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	500,000
Total	332,000	25,000	20,000	200,000	250,000	500,000	3,125,000	1,922,000	9,810,000	10,100,000	26,750,000

Assignments.	1885.	1886.	1887.	1888.	1889.	1890.	1891.	1892.	Total.
State fish commissions.									
California	.....	.....	.....	.....	.....	.....	.....	.....	2,977,000
Maine	.....	.....	.....	.....	.....	.....	.....	.....	1,000,000
Iowa	.....	.....	.....	.....	.....	.....	.....	.....	3,200,000
Minnesota	15,000,000	10,000,000	10,000,000	.....	.....	.....	.....	.....	65,250,000
Kentucky	.....	.....	.....	.....	.....	.....	.....	.....	500,000
Nevada	.....	.....	.....	.....	.....	.....	.....	.....	25,000
New Jersey	.....	.....	.....	.....	.....	.....	.....	.....	100,000
Connecticut	.....	.....	.....	.....	.....	.....	.....	.....	10,000
Maryland	500,000	.....	.....	.....	.....	.....	.....	.....	1,850,000
New York	1,000,000	1,000,000	1,000,000	.....	1,000,000	4,000,000	.....	5,000,000	16,000,000
New Hampshire	500,000	.....	.....	.....	.....	.....	.....	.....	1,100,000
North Carolina	.....	.....	.....	.....	.....	.....	.....	.....	750,000
Pennsylvania	16,500,000	10,000,000	15,000,000	24,400,000	10,000,000	14,000,000	12,500,000	.....	104,400,000
Wyoming	500,000	.....	.....	.....	.....	.....	.....	.....	750,000
Delaware	800,000	1,600,000	.....	1,000,000	1,000,000	.....	.....	.....	4,400,000
Wisconsin	.....	.....	.....	5,000,000	6,000,000	10,000,000	.....	.....	21,000,000
Indiana	.....	.....	.....	.....	10,000	125,000	100,000	200,000	435,000
Ohio	.....	.....	.....	.....	.....	47,500,000	8,000,000	.....	55,500,000
Private applicants.									
Wisconsin	.....	.....	.....	.....	.....	.....	.....	.....	100,000
Pennsylvania	.....	.....	.....	.....	.....	.....	.....	.....	100,000
Missouri	.....	.....	.....	.....	.....	.....	.....	.....	50,000
Foreign countries.									
Germany	2,000,000	1,000,000	.....	100,000	.....	100,000	.....	.....	6,772,000
France	.....	.....	.....	.....	.....	.....	.....	.....	450,000
New Zealand	1,000,000	1,500,000	.....	.....	.....	.....	.....	.....	3,500,000
Australia	.....	.....	.....	.....	.....	.....	.....	.....	1,000,000
England	2,000,000	2,500,000	.....	150,000	200,000	200,000	100,000	.....	5,400,000
Switzerland	1,000,000	.....	.....	.....	.....	.....	100,000	.....	1,600,000
Total	40,800,000	27,600,000	26,000,000	30,650,000	18,210,000	75,925,000	20,800,000	5,200,000	298,219,000

Statement of the distribution of whitefish eggs and fry by the U. S. Commission of Fish and Fisheries, from 1872 to 1893—Continued.

FRY.

Waters stocked.	1876.	1879.	1881.	1882.	1883.	1884.	1885.	1886.
Lake Erie*	1,000,000		2,250,000	4,750,000	7,000,000	12,000,000	25,000,000	15,000,000
Lake Michigan	130,000		5,000,000	7,500,000	11,000,000	20,000,000	25,000,000	29,000,000
Lake Huron			2,000,000	2,000,000	16,000,000	27,500,000	34,000,000	30,000,000
Lake Ontario				3,500,000	9,000,000	6,000,000		12,000,000
Lake Superior					4,000,000	6,000,000	4,000,000	6,000,000
Inland lakes of Michigan	1,340,000					500,000		
Inland lakes of Iowa	100,000							
Inland lakes of Indiana	100,000		15,000					
Inland lakes of New Jersey		90,000						
Nebraska waters					400,000			
Potomac River						1,600,000	1,550,000	2,000,000
Total	2,670,000	90,000	9,265,000	17,750,000	47,400,000	73,600,000	89,550,000	94,000,000

Waters stocked.	1887.	1888.	1889.	1890.	1891.	1892.	1893.	Total.
Lake Erie*	12,000,000		40,700,000	31,028,000	10,000,000	6,000,000	22,370,000	188,598,000
Lake Michigan	17,000,000	1,000,000	3,000,000	6,000,000	4,500,000	4,000,000	2,000,000	135,130,000
Lake Huron	30,000,000	15,000,000	20,320,000	24,400,000	14,560,000	10,750,000	11,140,000	255,070,000
Lake Ontario	3,000,000	2,912,000	4,595,000	3,800,000	3,312,000	3,990,000		52,109,000
Lake Superior			8,000,000	24,850,000	13,830,000	16,727,000	10,627,000	94,034,000
Straits of Mackinac					2,500,000		1,500,000	4,000,000
Inland lakes of Michigan	70,000	2,000,000				2,000,000	2,000,000	8,410,000
Inland lakes of Wisconsin						2,000,000		2,000,000
Inland lakes of Iowa								100,000
Inland lakes of Indiana				100,000				215,000
Inland lakes of New Jersey								90,000
Inland lakes of Idaho			3,250,000					3,250,000
Inland lakes of Oregon			885,000					885,000
Inland lakes of Washington			385,000					385,000
Nebraska waters								400,000
Potomac River								5,150,000
Total	62,070,000	20,912,000	81,135,000	90,178,000	48,702,000	45,467,000	49,637,000	732,426,000

* Includes Detroit River.

Prof. Rasch, of the Norwegian University of Christiania, has made a very successful and, at the same time, suggestive experiment in the method of propagating salt-water species. Finding a deep natural lagoon that extended about a mile inland from the sea, narrowing at the end to the width of a large trench, a basin was formed, covering some 300 acres, with a mean depth of 40 feet, into which the waters emptied. A fence was constructed across the lagoon, which, while it did not interfere with the ebb and flow of the tide, prevented the outward passage of fish. Within the inclosure the hatching apparatus was erected for salmon and sea-trout spawn, having connection with two small fresh-water lakes supplied by springs. The fry in the ponds are for a time fed on fine-chopped mussels and then permitted to go into the salt-water basin. Thus they become "acclimated," so to speak.

A like experiment might be tried with our fresh-water fish. The matter should come before our State commissioners and the National Government. Suitable places

could readily be found. The work might prove costly, but unquestionably the results would evince the expediency and wisdom of the attempt. Ponds and grounds in close proximity to the Great Lakes—and indeed a part of them, as in the instance above cited—with a hatchery within the inclosure, would procure for the fry the most natural and therefore the best accommodation and preparation for a larger and stronger life. The plans might take in such extensive cribbing as lake commerce demands, where the "breakwater" and storm harbor are necessities. If 10,000,000 fry could be placed in such confinement till they were from 2 to 5 inches long, and at the proper time permitted to escape into the larger body of water, it would not be death to them, for "what seems so is transition." They would find no change in element or provender, and our lake fisheries would soon begin reaping the rich reward of an experiment in pisciculture that must of necessity yet lead to a wider field in the domain under our consideration to-day.