

XVIII.—REPORT ON THE ARTIFICIAL PROPAGATION OF THE CODFISH AT WOOD'S HOLL, MASS., FOR THE SEASON OF 1885-'86.

By JAMES CARSWELL.

Having received instructions on the 1st of December to proceed to Wood's Holl, Mass., and report to Capt. H. C. Chester to assist in codfish hatching, I left Washington December 2 for that place, taking with me all the necessary apparatus.

On my arrival at Wood's Holl Captain Chester was engaged in carrying on a series of experiments for the hatching of codfish eggs, and after conference with him I learned that his idea was that in order to secure success the eggs must have motion, and that all the apparatus he had tried previous to that time, and was still using, was constructed under this impression. He had several boxes fitted up with jets of water let in, one so as to merely move the eggs, the others varying in velocity from 1 to 4 miles an hour; but all of these arrangements resulted in failure. I had been sent on with apparatus constructed by Colonel McDonald, designed for using the tidal motion, but Captain Chester appeared to be thoroughly convinced that motion was the thing. There was also at the station an arrangement of barrels put up by direction of Major Ferguson which failed, and the only success which had been attained up to this time was by a series of cones, which Captain Chester called the "Tanner arrangement." In this a very small percentage was hatched out; but it had the effect of changing our minds in regard to the necessary motion, as the eggs worked very slowly with a tidal motion.

On the 4th I fitted up two tubs and glass aquaria with side and center jets, siphon bag in center, and water escaping at the bottom. On the 5th I procured 400,000 eggs and placed an equal number in each of the two apparatus. I was very much pleased with the motion, which was just enough to force the eggs slowly to the bottom, diffusing them well through the water, and then rising toward the surface. Having had no previous experience, I thought by what I had learned from Captain Chester and by examining his apparatus that I had combined all the necessary conditions to secure success. The eggs looked all right and seemed to be doing very well, although a great many ad-

hered to the siphon cloth. This, however, was easily remedied by giving the siphon bag a slight shake hourly.

On the morning of the 7th I found a great many dead eggs in both apparatus, and the following day all were dead in the aquarium. I attributed the mortality to the fact of this adhesion to the siphon cloth and to the sediment in the water.

On the 9th Colonel McDonald arrived at the station, and after talking the matter over we concluded that there was too much motion. I put 100,000 more eggs into the aquarium, using as little motion as possible, and entirely filtered the water. The eggs in the tub were still doing well, although under exactly similar circumstances as those in the aquarium, so I thought the advantage of the former over the latter was due to the larger area. I then started a large tub, fitted up in the same manner as before, with a fresh lot of eggs and a moderate circular motion. They all did well until the 13th, when I found it was necessary to do something else with them, as they were clotted together and sunk to the bottom. The fish at this time could be seen distinctly. I took them out and, after cleaning them off, placed them in a McDonald jar and worked the same as with shad. I was also compelled to transfer those in the large tub to jars, working with a small jet of water applied to the surface, which made them swing gently around the jar, but not enough to drive them to the bottom.

On the 15th all the eggs taken on the 5th, which were worked in the aquarium for five days and afterwards transferred to jars, were dead; but they were well developed and would probably have hatched out in a few days.

On the 16th I was obliged to take all the eggs out of jars and aquaria for the same reason as before, and I am convinced that cod eggs sink to the bottom as they grow older and as the young fish begin to develop. I then placed them in three jars, working one with top motion, one with bottom motion, and the other with a combined motion of top and bottom; but this resulted, as before, in their gradually dying, and on the eleventh day after they were taken all were dead. In one jar the eggs were left to adhere constantly to the siphon bag for eight days. For the first six days they did well, but after that they began dropping off, and at the end of the eighth day they had all dropped off and were dead. I tried the tubs once more with slightly altered conditions, but the result was the same. In all the methods and motions tried a great many of the eggs lived until the hearts of the young fish could be seen to beat.

Captain Chester also had two boxes fitted up, one with a copper screen in the bottom, and in another he put two of the hatching jars, but covered them with copper-wire screens. All of these experiments resulted in naught, but the experiments had been continued long enough to satisfy us that it was better than anything heretofore discovered. In putting in the next lot of eggs Captain Chester used cheese-cloth

instead of copper wire to cover the jars and placed these in the box with tidal motion as before. This lot of eggs was hatched out with a small percentage of loss.

From my own experience I have come to the conclusion that cod eggs will float for five or six days, but at the end of that time they begin clotting together and sink.

It would be impossible for me to give in detail all the different appliances and means that were resorted to, but they were all carried on with the view that it is necessary for the cod eggs to be submerged for awhile and then allowed to rise to the surface, and every notion that could be conceived was tried to attain this end. I think it a great mistake to use any metal whatever in fitting up any kind of apparatus for cod hatching.

Although prepared for applying the tidal motion, I had never up to this time fitted the tubs up, applying this motion. On the 23d of December I fitted up one glass aquarium and wash-tub with tidal motion, using cheese-cloth screens made to fit tight on the inside, about 4 inches from the bottom.

On the 25th I found that most of the eggs had gone to the bottom in both apparatus, owing to the density of the water having fallen from .025 to .021 degrees, and upon examination found that the pumps were drawing fresh as well as salt water, which, of course, put an end to this experiment, as the eggs were all destroyed.

On the 28th I put in another lot of eggs, which did very well, but do not think that I got more than 50 per cent. of young fish; but even this was an improvement on anything heretofore accomplished.

On the 6th of January, 1886, I put a fresh lot of eggs in the aquarium and one tub, which did well until the 9th; but for some unaccountable reason at least one-half the eggs in the aquarium had gone to the bottom and were dead, while those in the tub were still doing splendidly. These commenced hatching on the 19th, and by the 22d all had hatched out, not more than 10 per cent. having been lost.

After the many experiments tried both by Captain Chester and myself I have no hesitation in saying that the best conditions for success in cod-hatching are:

(1) As little motion as possible, with just sufficient change of water to keep it fresh.

(2) To use entirely filtered water, which can be easily done by filling a McDonald jar with cotton, and fitted up as is done in shad work.

(3) To avoid the use of anything like metal in fitting up an apparatus.

The work now ceased for a time, as the codfish in live cars had all died on account of the extremely cold weather, and I was instructed to proceed to Florida with half a million of the young fry. Up to the time I left I estimate that we had taken about 15,000,000 eggs, all of which were lost in experimenting, with the exception of about 2,000,000,

Five hundred thousand of these were deposited in the waters of the Gulf and 100,000 in Chesapeake Bay. The remainder, 1,400,000, were planted in Wood's Holl Harbor. The shipment to the Gulf was sent in my charge, while that to the Chesapeake Bay was made by Messrs. Moore and Robinson.

On my return to Washington I was ordered to the *Fish Hawk* to continue the collection of codfish eggs off the Isle of Shoals. In consequence of the rough weather there was only one day on which we succeeded in collecting eggs, when we procured about 8,000,000, half of which were shipped to Captain Chester by express in transfer cans, and the other half were placed in large glass aquaria which I had fitted up on board the *Fish Hawk*, applying the tidal motion, but owing to the extremely cold weather and to an accident to the vessel these were all lost. We made several attempts subsequent to this to collect more eggs, but without avail. Of the lot forwarded to Wood's Holl I am informed that one-third were received alive. These were hatched out with a small per cent. of loss and turned into the Wood's Holl Harbor.

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