

XIV.—REPORT ON THE COLLECTION AND DISTRIBUTION OF SCHOODIC SALMON EGGS IN 1877-'78.

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1.—PREPARATIONS.

The collection of eggs of Schoodic Salmon in 1877 was carried on at the same site and substantially with the same fixtures and in the same methods as in former years. A series of pounds built of stakes and fine-meshed nets on the gravelly shallows below the dam at the outlet of Grand Lake sufficed to entrap almost the whole run of breeding fish, and no other means of taking fish were provided. The eggs were brought forward in the old house at the spring, half a mile up a little brook tributary to Grand Lake Stream.

Though the general plan of the fixtures for entrapping and keeping the parent fish was the same as in previous years, considerable improvements were introduced. The "main lead" by which the fish descending the stream approached our enclosures was narrowed to about 20 feet, and brought to resemble a long tunnel flaring at the upper end to about 60 feet, and at the lower end abruptly contracted to 5 or 6 feet at the point of entrance into the first pound. The water was rapid throughout nearly the whole of this main lead, and afforded so good spawning-ground that we were compelled to exercise great vigilance to prevent many fish making their nests there. It was found necessary to drive down, by means of a small seine in the hands of two men, all the fish that lingered on this ground. As they were apt to take the alarm and dart up stream beyond reach on the approach of any one, a net stretched on stakes across the very head of the lead, and weighted with a heavy chain, was so arranged that it could be drawn up from the bottom by means of a line running ashore and held suspended so as to allow fish to pass freely down into the lead. At fixed hours during the night this net was suddenly dropped, and all retreat being thus cut off the reluctant fish were driven down into the enclosures before they had time to lay their eggs. Probably the fish saved in this way amounted to 10 or 20 per cent. of the total catch, the remainder passing down at once and entering the pounds without compulsion.

Another change introduced this year was the entrapping of the fish in a small pound where they could be examined and counted before placing them in the main enclosure. This was a very satisfactory arrangement. The examinations were made at stated times each night, immediately after driving the fish in from the lead, and the record of

these examinations affords us the data not only for a daily summary of the breeding stock of either sex on hand, but also for some generalizations on the movements of the fish as affected by the weather and other phenomena.

The main pound, where the most of the fish were kept, was, as before, very commodious—about 70 feet long and 40 wide, with a maximum depth of about 5 feet. In this many hundred salmon lay quietly together, making, so far as we could observe, no very strenuous exertions to escape, except a few cases. Another pound of equal size was provided for the spawned fish to lie in while awaiting their transfer to the lake. Besides these, the two trap-pounds, and the "main lead," five other enclosures were provided to enable us to properly assort the fish as we were using them; for instance, in one would be placed those that were tried and found unripe; in another those that had yielded their eggs and were waiting to be pressed the second time, which was always done; another would contain surplus males; another, fish notable for any peculiarity which it was desired to observe further. All these enclosures were formed of fine-meshed nets hung on stakes and for the most part held down at the bottom by the weight of chains, which rendered it easy to transfer a whole body of fish from one enclosure to another by lifting the bottom of the net and driving them under.

The only change made at the hatching-house was the complete cleaning out of the brook which afforded an outlet both for the water of the spring and the surface water of the vicinity. This flows for a long distance over flat, low ground, and on two former occasions sudden rains had raised the water until it reached the tops of our hatching-troughs, threatening, but not accomplishing, serious mischief. To avoid a disaster from this source the brook was cleared out, widened, and deepened for a distance of about 140 rods. Even with this improvement, however, the site of the hatching-house is a very unfavorable one. Both spring and brook water can be used, but the brook is a tiny one, and in cold and dry weather shrinks to a very insignificant volume, while the spring issues from the ground at such a slight elevation above the swamp through which it flows that at best we can barely get our troughs high enough to avoid flooding by freshets. There is thus no opportunity of aerating the water by a fall, and the trough must be placed on a level with the floor, an unfavorable position for work. However, no better arrangement could be made. No larger spring could be found in the neighborhood; there was no clean and ample brook; and the water of Grand Lake Stream itself, though probably unsurpassed for such a purpose by any in the world, could not be used on account of certain physical difficulties which I saw no way of surmounting with the means at my disposal.

2.—THE FISHING.

The main nets were placed in the stream September 17, and at the same time a strong movable net placed across the head of the canal

leading from the lake to the neighboring tannery. These measures placed the fish practically within control, though some had already passed down the stream below our fishing-ground. There were many salmon seen about the dam as early as the first week in October, and on the 6th they were seen lying in groups above the nets. The first ridd was found October 24, and by the beginning of November a good many could be counted on the ground accessible to the fish. The imprisoned fish did not, however, make any attempt at spawning until much later.

The first eggs were taken October 31, but few fish were ripe at that time, the females taken the following night, 51 in number, affording but 12 ripe specimens. On the 5th of November the work of taking spawn was begun in earnest, and continued almost daily up to the 24th, when that part of the work was brought to a close. From the beginning it was the common practice to examine each morning the fish caught during the night, and take eggs from all that were ready, placing the unripe in the general enclosure, which was overhauled only once a week. At first, and indeed until the middle of November, about half the female fish were unripe when they first came to hand, and up to the very last day there were still some that were not quite ready to yield their eggs. This is in marked contrast to my former experience with the sea-going salmon at Bucksport, where, after the 1st day of November, an unripe fish was rarely found.

As usual the male fish were earlier on the ground. Up to the 6th of November, when, for the first time, the entire stock had been examined, 59 per cent. of the fish were males, while of the entire catch for the season they constituted only 43 per cent. The proportion of males in 1875 was 40 per cent., and in 1876 only 27 per cent. Of the whole number of fish taken all were mature males and females except barely three specimens whose sex was not ascertained, their reproductive organs not being sufficiently developed; these were a little smaller than the gravid females, which they much resembled (being, however, much slenderer), and very likely were simply strays from a large brood in the lake not yet arrived at adult age.

By reference to the tabulated statement of the fishing (Table I) it will be seen that, for the most part, the fish ran much plentier in the early than the late part of the night. This predominance of the evening catch was most marked during the period of the heaviest run of fish, the first ten days of November. During the day their downward movements were almost entirely suspended except on one or two days, especially at the time when at the height of their run, for instance on the 10th of November, when 111 fish came in before 4 p. m.

The influence of the weather was not very marked. So far as our observations go they indicate a slight preference of the fish to run into our enclosures in clear weather rather than cloudy, and without regard to the moon or the force of the winds. Of the five nights when the morn-

ing catch exceeded the evening catch, the record shows that two began with stormy weather, but cleared off before morning; two others were rainy nights nine and ten days after full moon, while the fifth and most notable instance (November 9-10) was on a night partly clear and partly cloudy, succeeding a rainy day, five days after new moon, when, of course, the evening was light and the morning dark. On ordinary pleasant nights the greatest run was commonly in the evening, whatever the phase of the moon. The very best catch (425 fish, November 3 and 4,) was with light northwest wind, and clear sky all night, with no moon. The next best three (of 375, 368, and 362 fish, respectively,) were also on nights with northerly wind, mostly clear. Of the next two (291 and 272 fish, respectively,) one was on a clear evening followed by a cloudy morning, and the other on occasion of a storm which cleared away during the night and gave us a heavy morning catch.

3.—TAKING SPAWN.

In taking spawn the ordinary procedure was about as follows: The fish to be operated upon were brought close in front of the spawning-shed by means of a fine seine, and were then dipped up, two or three at a time, in a dip-net, and passed to the operators in the shed, who, armed with woolen mittens, sat on stools, with ten-quart tin pans before them. The fish that came first to hand, whether male or female, was immediately used, if ready. The males were always ready. If a female, her condition was first judged from her appearance when held up by the tail. If ripe, the mass of spawn would settle down towards the head, distending excessively the anterior part of the abdomen, which was very soft and yielding to the touch, and leaving the posterior part very lank. Such a fish was immediately pressed and the eggs received in the pan. If the fish, when suspended in this way, retained its shape, and its abdomen felt firm to the touch it was pronounced unripe without being subjected to pressure. The eggs of from six to ten females (averaging 1,000 eggs apiece), and the milt of about the same number of males (or less) were pressed into the same pan, and after using each fish the eggs and milt were brought into more complete contact by swaying the pan. Not much regard was paid to the order in which the fish were used. When six to ten thousand eggs were gathered in one pan, it was, after repeated swaying, passed over to be weighed and afterwards watered and rinsed off. There was no fixed rule as to the length of time the milt and eggs should remain in contact. Commonly some of them were in contact half an hour or an hour and others only a few minutes. After rinsing, the eggs were covered with water, the pans being nearly filled, and then placed on shelves to await the complete distention of the shell, after which they were taken to the hatching-house in pails, as soon as convenient. If compelled to stand several hours in the pans they were treated with a change of water. No water was placed in the pans until contact between eggs and milt was supposed to have been secured, but

no special pains was taken to avoid the dripping of water from the fish into the pan while the process of taking the eggs was going on. I have thus minutely described the method pursued in order to explain the occasional reference to the "usual method" in the tabular statement of spawning operations (Table II). Occasional variations of the method were made for experiments' sake, and such variations are noted in the table. Subsequently, as soon as the eggs had reached the proper stage for examination, the date of impregnation of each lot was ascertained by taking 50 to 200 and examining each one critically. This number was, I am convinced, too small for the purpose, and the results obtained and indicated in the table can only be considered as rough approximations to the actual rate of impregnation. The proper estimation of the impregnation of a large lot of eggs, say 100,000, would, I think, require the careful examination of as many as 500 eggs, or, better still, 1,000, taken from different parts of the lot, which, for a large number of such lots, would be quite a task. Such as it was the examination showed the ratio of impregnation to have ranged from 87 to 100 per cent. Probably the true average ratio was not much less than 95 per cent. No advantage is indicated as resulting from the pains taken on several occasions to give the eggs an extra quantity of milt, nor from unusual care in selecting ripe and rejecting unripe fish. I am not, however, willing to accept these indications as conclusive.

It is a matter of some importance to ascertain in what way, if any, the percentage of eggs lost through non-impregnation may be still further reduced, and many experiments were tried, for this as well as other objects, but they need to be supplemented by repetitions another year, and can best be described in a future report.

When we were not too much pressed with work, all the fish were weighed and measured immediately after leaving the hands of the spawn-takers. A summary of the results is given in Table IX. From this it appears that the average length of the males was 16.8 inches (= 43 centimeters); longest, 22 inches (= 56 centimeters); shortest, 14 inches (= 35 centimeters). The males weighed, on the average, 1.8 pounds (= .8 kilogram); the heaviest, 3.7 pounds (= 1.7 kilograms); the lightest, 1.1 pounds (= .5 kilogram). These are the results of the measurement of 235 fish. Of gravid females, 343 were weighed and measured, with the following results: heaviest female, 3.6 pounds (= 1.6 kilograms); lightest, 1.2 pounds (= .5 kilogram); average, 1.9 pounds (= .9 kilogram); length of same females, average, 16.1 inches (= 41 centimeters); longest, 20 inches (= 51 centimeters); shortest, 13 inches (= 33 centimeters).

At the close of the season's work the fish were taken in cars specially arranged for such work, and towed about two miles up the lake, where they were turned loose. Some of the males found their way back to the stream within a few hours of being set at liberty, but the most of them, and nearly all the females, staid in the lake.

4.—INCUBATION.

The only apparatus in use at the hatching-house for the incubation of eggs was that devised by myself in 1875. As adapted to use in a hatching-trough, it consists of movable frames, each a little more than a foot square and about eight inches deep, and holding each 10 or 11 wire trays so constructed that a horizontal aperture of one-eighth inch extends on all sides (except a small space at each corner) above each tray, thus permitting the passage of a horizontal current of water. The frames are made to fit the troughs pretty closely, and the water was thus compelled to flow through between the trays. The picking was done on a table, to which the frames were removed for the purpose. This form of apparatus is very compact, simple, and easily managed. We had about 20,000 eggs in each frame, occupying a trifle more than a square foot of space in the trough. There were six troughs, each 25 feet long.

5.—DISTRIBUTION OF EGGS.

The total number of eggs obtained was, according to the estimates made from day to day, 2,159,000. I think these figures too large by 5 per cent., but as the distribution of the eggs was made on that basis, the estimate is retained. Early in January it was found necessary to begin shipping eggs to other points for hatching, and the last case was sent off February 19. The distribution may be summarized as follows:

Shipped to order of Commissioners of Fisheries of Massachusetts	255,000
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Shipped to order of United States Commissioner of Fish and Fisheries	890,000
Retained to be hatched for Grand Lake Stream.....	470,000
Losses previous to distribution of eggs.....	289,000
	2,159,000

The number of eggs obtained was far in excess of my expectations. It was twice as great a number as I had expected the hatching-house would ever have to receive. The volume of water flowing through the troughs was, on the 16th November, twenty-two gallons per minute. This would have sufficed, but in December it shrank to the very small volume of five or six gallons per minute. This was due partly to a leak under the dam that was not discovered until several months later, but mainly to a long period of dry, cold weather. The result was a serious injury to a portion of the eggs. There is now no doubt that they were overcrowded. The water appears to have been of good quality, but too warm, and the site of the spring, as already explained, did not admit of the application of any practicable method of aeration. The water afforded an ample supply of air to the eggs that first received it, but be-

fore it reached the lower ends of the troughs it was too far exhausted to sustain and develop the eggs lying there. The volume of water was renewed at a later date, and the eggs that remained to be hatched for the stream did very well, but a very considerable number had been so seriously affected as to unfit them for transportation to distant points. No excessive mortality occurred on the route, most of the packages, even those sent to a great distance, opening in fine shape; but there was a premature hatching immediately after unpacking, followed by a torpid condition and subsequent death of a great many of the fry. One case of eggs (and I think several), which I am confident would have turned out excellently if they had received proper treatment while in transit, were, in spite of legible placards attached to each box warning against heating, left by careless messengers close to hot stoves, and on opening were found to be actually heated through. The loss sustained on the various shipments ranged all the way from 5 to 100 per cent. and averaged about 40 per cent. The details may be learned by comparing Tables III and IV.

Subjoined are eleven tables embodying statements of the work done and results obtained, including certain observations made in 1875 and 1876, and not before reported.