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Paper presented before the Fourth International Fishery Congress held at Washington, U. S. A., September 22 to 26, 1908

AN IMPROVEMENT IN HATCHING AND REARING BOXES; WITH NOTES ON THE CONTINUOUS FEEDING OF THE FRY OF SALMONIDÆ.

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It will, I think, be admitted by even the most conservative exponent of modern pisciculture that there is ample scope for improvement in the type of box now used for hatching and rearing, *inter alia*, the eggs and fry of salmonoids. Speaking broadly, it appears to me that it would be impossible to conceive and, having conceived it, to design an appliance which so thoroughly combines in a small compass the minimum of utility and the maximum of imperfection characterizing the square cornered, oblong pattern of wooden box on which pisciculturists, for lack of a better form of apparatus, are forced to depend for carrying out one of the most important sections of their work. It is not improbable that this may be regarded as a too sweeping indictment of an old and valued servant—if I may be permitted so to describe an inanimate object—but, at the risk of differing from those of my hearers who later on will be my critics, I venture to maintain that, apart from the fact that by its agency fish ova can be brought to maturity, the rectangular wooden hatching box has not a single redeeming quality attached to its name. Indeed, so much so is this the case that I will advance a step further and assert that any utility it may possess in this connection is altogether nullified by the facilities it provides for the unchecked production of fungus, which render it a constant menace and danger to eggs, alevins, and fry alike, so long as they are confined within its sphere of influence.

Three factors are responsible for this unsatisfactory state of affairs. These are the material of which the box is built, its rectangular form, and, last but not least, the position at which the waste-water outlet is situated. A moment's consideration will convince anyone with a practical knowledge of the interior of a hatchery of the correctness of my statement. From either a practical or a

scientific point of view, wooden appliances leave more to be desired than they give. Not only are they heavy, unwieldy, and liable to leakage at odd and inconvenient moments, but they have the additional disadvantage of becoming water sodden and readily receptive to the spores of fungus. With the object of preventing any possibility of attack from this, the pisciculturist's most insidious enemy, the services of the charring iron are brought into requisition to antisepticize the interior of the box by superficial carbonization. A more brilliant method of holding in check an ever-present evil of any kind has seldom or never been devised. The only fault that can be found with it is that when those parts of the box which have undergone carbonization are subjected to the action of water any antiseptic properties they may have possessed while dry rapidly disappear, and in a short time the last state of that box as a fungus-fighting appliance is worse than its first. The mischief does not, however, end here. In the course of a few days the inside of the box up to water level—assuming, of course, that it is in use—becomes covered with a viscid slime, and this, in conjunction with the roughened, semispongy substance of the carbonized wood, forms a secure resting place on which particles of excrement and of unconsumed food, as the case may be, can decompose and generate a more or less plentiful crop of fungus.

Turning to the form of the box, what do we find there? The supply, whether it falls in from above or is so arranged that it enters from below, has to force itself against the whole volume of the contents of the box, and consequently its force is expended and ceases to make itself felt before it has, at the outside, reached more than 3 inches from its point of entry. In other words, it is absorbed into and assimilates with the water into which it is poured instead of forming, as it should, a gentle current running over the eggs from end to end of the box. This raises a question as interesting as it is important scientifically and commercially, viz, are the eggs under conditions such as these, which in no wise conform to natural conditions, properly oxygenated by the water in its upward progress toward the outlet? Furthermore, is the passage of the water from the inlet to the outlet equal or intermittent? In regard to each I hold an opinion which is not an affirmative one, but I leave the definite solution of this very interesting problem to those who have more time and opportunities at their disposal than I have for carrying out the necessary experiments.

No doubt many of you have watched a pair of trout making preparations for spawning, and as you have watched you have wondered at the marvelous instinct which prompts the male fish to select a point above the redd, i. e., the spawning bed, with just sufficient stream to carry the milt as he discharges it in a milky cloud over the eggs which have been deposited by his mate. But the two fish—and to the lady must be accorded her fair share of credit in their

joint undertaking—have a much deeper purpose in view than the efficient impregnation of the eggs alone. Their instinct also teaches them that the eggs, without an adequate supply of oxygen, will not come to unimpaired maturity, but will produce weakly alevins, and that unless a current of water passes over the eggs while incubation is proceeding they will not obtain a requisite amount of oxygen. Here it appears to me that the dumb instinct of the fish is far superior to the reasoning power of man, as exemplified by the latter's idea of a suitable form of box for the artificial hatching of fish eggs. You will therefore see why I asked, a short way back, whether eggs incubated in a rectangular hatching box are properly oxygenated by the water in its upward progress toward the outlet.

On this side of the Atlantic, wherever in the country districts there occur diverging roads, a handing post to indicate the direction and distance of adjacent villages and towns is erected by the local authorities. Among our rural folk, whose sense of humor is not of a wildly extravagant character, it is a standing joke that their spiritual guides are like handing posts because they point the way to all and sundry and never follow it themselves. But the pisciculturalwriters of my acquaintance can not be held altogether free from something of the same reproach. To a man they impress on their readers the necessity of extreme cleanliness as an absolute essential to success in pisciculture. No one will be inclined to dispute the soundness of this advice until he attempts to put it into application. Then he will be compelled, probably with some reluctance, to confess he has attempted an impossible task. Leaving "extreme" cleanliness out of the question, it will be found that even ordinary cleanliness can not be observed, and for this reason: The rectangular hatching box is, de facto, merely a pocket of water which can admit, but which, owing to the position of the outlet, can not eject, extraneous matter that may enter it. It therefore follows that when the alevins have arrived at the fry stage and require feeding, any particles of food that they happen to miss must in the natural order of things gravitate to the bottom of the box, where they become saturated with water, decompose, and generate fungus. In this connection it must not be forgotten that animal tissue, however carefully it is treated in converting it into fish food, can never lose its identity as animal tissue Its juices may be dissipated and dried up by the application of heat and its substance by hard pounding reduced to the finest powder, but its tendency to decompose is only dormant and will actively assert itself immediately the powder or any portion of it is brought under the influence of moisture. The filthy and insanitary condition of the interior of a rectangular box after fry have been hand fed in it for a few days can therefore be better imagined than described. My remarks on this head are of course dictated by the assumption that the methods followed by American and English pisciculturists are identical, viz, that the fry are

retained in the hatching boxes and fed until they are ready to be transferred into the rearing ponds.

The shortcomings of the rectangular type of hatching and rearing box have, I regret to say, occupied more space than I originally intended to devote to them. I am, however, assured that the interest and importance of the subject to pisciculturists will be its own apology, if an apology be needed, for the tax I have been compelled to impose on your patience and good nature before dealing with the principles in construction which should be observed in making a hatching and rearing box which will combine thorough efficiency with effective sanitation. These are three in number and are as follows: (1) The material of which the box is constructed must not only be impervious to water, but must have a smooth, hard surface which will act as a preventive against the lodgment of the spores of fungus; (2) the box must be shaped so that the water is kept in constant circulation so long as the supply is running; (3) the outlet must be placed at a point which will enable it to maintain a direct current over the eggs during their period of incubation and at the same time, when the fry have to be fed, act automatically to remove any small particles of unconsumed food.

As regards material, I have met with nothing equal to highly glazed earthenware, and were I in a position which would enable me to indulge in the luxury of an experimental hatchery the whole of its equipment would be of china or delft. These materials are, however, too fragile for the requirements of a hatchery in which from 150,000 to 250,000 eggs are laid down each season, and consequently we shall have to cast about for a material which will make an effective substitute. Thin enameled iron, such as is used in the manufacture of basins, pie dishes, and other domestic utensils, will answer the purpose admirably. To me personally it is a matter of surprise that it has not already been generally adopted for piscicultural work in preference to wood, seeing that of the two materials it is, size for size, relatively the lighter. Moreover, it has the additional advantage of being cheaper, is easier to keep clean, and possesses far greater durability.

Coming to the second principle of construction, I have endeavored to show that any approach to the conditions under which eggs are incubated in a natural state is not attainable with a rectangular hatching box. It will, therefore, be necessary to abolish straight lines in favor of curves, as indicated in the accompanying sketches. Perhaps, however, you may grasp my meaning more readily if, in imagination, you take a length of piping of fairly large dimensions and divide it lengthways into equal halves. At each end of one of these halves affix a circular head and you will then have an exact representation of the type of box I am endeavoring to describe, but as yet minus the outlet. This consists of a circular opening of at least 3 inches in diameter, cut at one end of the box,

its lower edge being exactly flush with the bottom of the box (fig. 1). The orifice to which I refer opens into a pipe which is joined to it and runs upward to within an inch of the top of the box, where it turns outward and acts as a spout (fig. 2). The pipe must be of the same dimensions as the circular orifice. In order to prevent the escape of alevins and fry, the orifice where the pipe is fixed into the box should be covered with a grating of fine parallel wires at spaces of about $\frac{1}{16}$ inch apart. The grating may be a little larger, but must on no account be smaller, than the opening of the pipe on which it rests, or the ring to which the wires are soldered will obstruct the passage of any light particles that are being carried away by the outfall. To support the box two semicircularly cut-out boards, placed on edge, will be required when it is placed in the hatchery. These, I should say, are detachable, the box being held in position by its own weight. Figure 1 will explain the action of the box. It will be seen that the supply falls in at B and, so far as the surface is concerned, follows the course marked by the arrows, while a current extending from B to C is caused by the outfall picking up and ejecting any light particles that happen to gravitate within its influence. It is needless for me to add that the box must be fitted with a cover, so that the eggs may be protected from the effects of the light during their period of incubation.

FIG. 1.—Plan,

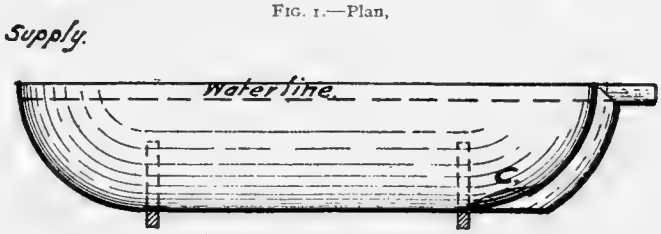

FIG. 2.—Longitudinal section.

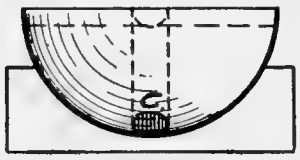

FIG. 3.—Cross section.

DESIGN OF PROPOSED HATCHING AND REARING BOX.

The furnishing of the box with baskets or with grills, as the case may be, is a matter which must be left to the discretion of the pisciculturist who has to use it. If baskets are decided upon they can be fixed in position exactly as they are in the rectangular hatching box. If, on the other hand, grilles are employed, they can be held in a light iron frame resting on a series of studs projecting from the sides of the box. Next season I hope to have one of these boxes fitted with a set of wire baskets, not more than an inch in height and divided by longitudinal slips into compartments which will take five rows of eggs side by side. The

baskets will be shaped to the curve of the walls and will be in contact with the bottom. By this means I think it will be possible for the eggs to receive the full benefit of the current caused by the outlet.

The practice of feeding fry with artificial food while they are in the hatchery appeals to me as being about as obsolete and out of date as the type of box in which they are hatched. Not only does the preparation of the food and its subsequent administration involve time and trouble, but there is attached to it the danger of fungoid outbreaks from the particles which have escaped the notice of the fry and are decomposing on the bottom of the box. It is within the knowledge of every pisciculturist that fish raised from the same batch of eggs and reared under artificial conditions always exhibit a considerable diversity of growth; that is to say, there is an ascending scale of sizes running from what may be described as ordinary fish to medium and large. In a natural state of life, fry can and do feed whenever they are assailed by the pangs of hunger, but in a hatchery they must perforce wait until the time fixed for the attendant to come round and give them their food. My experience teaches me that the divergence in growth to which I have referred is accentuated, if it is not increased, by this intermittent feeding during the fry stage. For some time past I have been using a curious little gregarious worm, the *Tubifex rivulorum*, which is more generally known as the summer worm or mud worm, and I find that it makes a magnificent food for fry from the moment they have absorbed the umbilical sac until they are ready to go into the rearing pond. These little worms are found in masses along the alluvial soil at the edges of ditches and ponds. They vary in length from an inch to 3 inches and resemble in appearance animated threads of floss silk. If the water above them is disturbed they will immediately disappear by withdrawing themselves into their burrows in the soft mud. They soon, however, recover from their fright, come out again, and at once recommence the restless movements with which their numbers and bright color attracted the passer-by. It is the tail end of the animal which is protruded out of the mud. The skin of these worms is so fine and transparent that not only can the blood be seen through it, but under an ordinary magnifying glass the internal arrangements of the creatures may be plainly observed. When taken from the water these worms resemble to the touch a piece of very soft jelly, but their full beauty is not apparent until the lump is placed in a clear glass vessel filled with water, when it assumes the appearance of a magnificent scarlet zoophyte, with a multitude of waving tentacles constantly in motion.

In using these worms for feeding fry all that is necessary is to distribute three or four pieces, about an ounce each in weight, at different parts of the rearing box, and the fry will commence feeding upon them and will require no further attention. Fry so reared make better blood and better bone than those brought up on artificial food in the usual fashion, and, unlike the latter, they

never become tame. They also rise readily to floating particles, and consequently I do not think that the slightest fear need be entertained that the use of these worms as a primary food will train the fry to become ground feeders at a later stage of their existence. *T. rivulorum* is pretty widely distributed throughout England and the continent of Europe, but I have no idea whether it extends to America. In regard to its introduction into the latter country, it is such a fragile, insignificant creature that I do not think it could, under the influence of an altered environment, do the slightest harm; and if any enterprising pisciculturist in the United States wishes to give it a trial I shall be very happy to extend to him any assistance that lies in my power. Given a nice, soft stretch of mud, covered by an inch or so of water, and an equitable climate, the mud worm will flourish apace and multiply with a truly surprising rapidity. It has been tried on trout fry in several of the leading hatcheries in England, and the reports I have received concerning it have been of a most favorable character, the only fault to be found with it being that it is an exceedingly expensive food. As the hatcheries mentioned above have had to purchase their supplies from London at the rate of 3 shillings 6 pence per quart, this complaint is quite justified, but if the pisciculturists who make it will only go to the small amount of trouble necessary for laying out a worm bed, they will find that *T. rivulorum* is a cheap and invaluable food for their fry.