50.—SELF-REPRODUCING FOOD FOR YOUNG FISH.

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Every person who has been interested in the artificial propagation of fish, and particularly trout and the several other species belonging to the genus *Salmo*, knows what care and labor are necessary to carry the young fry through the period immediately following the absorption of the umbilical sac, and to bring them to such a stage of maturity that they can be safely turned loose in open ponds or streams to shift for themselves. The mere hatching of the eggs involves no difficulty, and, under fair conditions, is ordinarily so successful as to make the propagation of fish in almost any quantity an apparently easy matter. But with the commencement of artificial nutrition the serious part of the task begins, and it is usually a small percentage of the swarms which are hatched that reach the maturity of yearlings, at which period the dangers of infancy are past. During the intervening months it has been customary to feed the young alewives on curdled milk, coagulated blood, finely hashed meat and liver, grated yolk of eggs, macerated brains of animals, etc., the preparation of which, and the frequent feeding of the dainty little creatures, involves constant and more or less costly labor. Moreover, none of these forms of nutriment have been found entirely satisfactory, for the reason that they are all distinctly artificial and different from the living, organic food which nature provides for those species of fish during their tender, infantile period. The difficulty of providing proper nutriment results often in turning out the young fry into open water too early, when the temperature of the stream or pond is so much below that of the tanks in which they have been hatched that they perish by thousands from chill and inanition, without making an effort to find natural food in their new element. Accordingly the problem has been to devise a natural, self-reproducing food, so easy and certain in preparation that it may be cheaply and abundantly provided, and thus facilitate the maintenance of the alewives during the first ten or twelve months of their existence, by the end of which time they should be so strong and active that a large majority may be relied upon to survive the struggle for life in larger waters.

The result seems to have been fully attained by a discovery made several years ago by Mr. F. Lugrin, of Geneva, and practiced since 1884 in the piscicultural establishment at Gremaz, in the department of Ain, in eastern France. As this process has been examined and approved by eminent experts, sent specially for the purpose by piscicultural societies of England and other countries, it is thought that some account of it may be of interest to the large and rapidly growing class of fish-culturists in the United States.

Mr. Lugrin was for many years a practical fisherman on the Lake of Geneva. He noted the steady diminution of the more important species of fish in the lake, and sought to ascertain the cause. He gradually reached the conclusion that the germ of the trouble lay in the growing scarcity of minute crustacea and the larvæ which are the natural food of the trout and other fish, especially during their first months of nutrition.

After elaborate experiments, he hit upon a system by which *Daphnia*, *Cyclops*, fresh-water shrimps (*Gammarus pulex*), etc., could be bred in countless myriads at a merely nominal cost. The hatching and rearing of a generation of these minute creatures is the work of from twelve to fifteen days, and as the process may be repeated—or rather repeats itself—again and again in the same water, the problem would seem to be solved.

Whoever has watched from a place of concealment the trout feeding in an American stream has admired the adroitness with which they work down stream, raising with their noses the up-stream edge of flat stones until the current, catching underneath, aids the clever little forager to turn over the stone and expose the minute larvæ and crustacea on which he so voraciously feeds. It is the purpose of the process now under consideration to raise by artificial means these same species of organisms, and in such quantities that the young fry may not only be abundantly fed in tanks or small inclosed ponds, but ample supplies provided for enriching larger streams and ponds where, for some reason, the natural supply may be insufficient.

The apparatus is simple, and visitors properly introduced have no difficulty in seeing the entire establishment at Gremaz, which occupies a gently sloping piece of ground, about 6 acres in extent and watered by three springs, which yield collectively about 500 gallons of water per minute. The tanks are rectangular excavations, about 120 feet long by 12 in width, with a depth of 5 feet. The ground being of a gravelly character it was necessary to line the walls and bottom of some of the tanks with cement in order to retain the water, but in close clayey earth this would be needless, and the natural dirt bottom, if not too muddy, would be preferable to cement. The tanks have the same general level, and are divided by sliding gates of wire gauze sufficiently fine to prevent the passage of the fry. Thus far all is simple and obvious. The process of Mr. Lugrin, which has been patented in several countries, consists in spreading upon the bottom of these tanks a material impregnated with the elements necessary to produce spontaneously a limitless number of *Daphnia*, *Cyclops*, *Limnæa*, as well as fresh-water shrimps, and the larvæ of various *Ephemera* which form the natural aliment of trout and other *Salmonidæ* at all stages of their growth. Once constructed and inpregnated with this producing material—which is of trifling cost—these tanks go on with their work automatically and indefinitely.

The water, from 2 to 3 feet in depth, being left undisturbed two or three weeks, is found peopled with swarming myriads of minute organisms of the species above named. Twenty thousand trout a year old, or 3,000 two years old—which last should average about one-half pound in weight—are considered sufficient for a pasture of that size, and the avidity with which they rush to occupy and ravage their new feeding-ground is a delight to the pisciculturist. If the propagation has been ordinarily abundant these 20,000 young fry or 3,000 yearlings will subsist royally in a tank of the size indicated for an entire month. They will eat on an average 20 to 25 pounds of food per day, or 600 to 800 pounds per month. Careful experiment has demonstrated that each tank at Gremaz will produce 650 to 900 pounds of *Crevettes* (fresh-water shrimp), to say nothing of the myriads of *Daphnia*, *Cyclops*, and other species produced in the same water during the same time. When, at the close of the month, the tank has become depleted, the gate is opened and the fish driven like a flock of sheep to a new and similar pasture. The first tank, being closed and left in quiet, immediately begins the process of reproduction, and at the end of two or three weeks is swarming again with the varied minute organic life which far surpasses in value, as food for fish, anything that has been yet devised by man. Thus the simple, inexpensive process goes on from year to year, the fish always healthy and vigorous and larger at two years old than those artificially fed are at the age of three years. Yearlings bred in this way are strong, and capable of making their way in any open stream or pond supplied with food and suitable for their existence. One thousand of such yearlings have been found more effective in stocking a depleted trout stream than fifty thousand young fry turned in, as has been so often done heretofore, in order to get rid of them at the tender age when artificial feeding first becomes not only necessary but difficult and troublesome. For these tender nurslings all open waters, particularly when inhabited by older trout or other voracious species, are beset with a thousand dangers which the vigorous yearling is able to escape.

It is evident from all this that the system practiced at Gremaz is equally applicable to the industrial raising of trout and other fish for market, and to the restocking of streams and ponds for purposes of sport. In the first case, it is only necessary to provide a series of tanks or small ponds from one to another of which the fish can be changed monthly, as hereinbefore described, until they reach a marketable size; and it is to be remarked that trout raised by this method have the natural firmness and flavor of wild fish, and not the flabby, degenerate character of those which have been fed on liver, offal, and other unnatural, degrading food. Once prepared, a tank or pond is permanently productive. However voracious the young fish may be, they leave the bottom of the water still peopled with myriads of parent organisms which reproduce so rapidly that, before the end of a month, the placid water

becomes clouded with swarming millions of their progeny. The fecal matter dropped by the fish during their month of occupancy is sufficient to maintain the fertility of the bottom, and thus the system, once established, becomes automatic and self-sustaining.

A single attendant can have the care of a large establishment, his only duty being to drive the fish periodically from one feeding ground to another and close the gate behind them, as a farmer changes his flocks from one pasture to another.

It remains to be explained that while the *Daphnia*, *Nais*, *Cyclops*, and other extremely delicate species can be profusely grown only in still water, the fresh-water shrimp (*Gammarus pulex*) grows abundantly in living streams. At Gremaz, rivulets are provided which flow from the springs into the tanks and carry away the overflow. These rivulets, the bottoms of which have been impregnated by the Lugrin system, are filled with cresses and other water plants and produce the minute shrimps in such abundance that they are gathered daily in panfuls by a few sweeps of a gauze scoop-net and fed to the fish in the swarming tanks. This part of the process is easily applicable to natural streams where a sufficiency of food does not already exist.

As to the applicability of this system to American pisciculture, there is apparently no room for doubt or question. The same natural conditions which exist at Gremaz can be found in nearly, if not quite, every State in the Union. The same food which is produced there may be used in growing nearly every species of fish which is artificially reared in the United States. American brook trout, the rainbow trout and California salmon thrive admirably in the tanks at Gremaz.

To conclude with the verdict of Prof. Francis Day, who, in October last, came specially from England to investigate and report upon the system which has been so successfully established there:

"When I remark that a tank, 35 meters long by 3 broad, and 40 centimeters deep, and capable of containing 20,000 young trout, can be fully stocked with food in fifteen days, so as to be able to sustain the residents for one month without any additional supply, I can not help thinking that Mr. Lugrin has solved a difficult problem, and that his mode of cultivating the natural food of fishes will prove a great and lasting benefit to fish culturists."

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