

## 31.—BREEDING NATURAL FOOD ARTIFICIALLY FOR YOUNG FISH ARTIFICIALLY HATCHED.

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It is an old maxim that nature's methods are the best methods; also that one can not improve upon nature. This may be true in a degree, but artificial fish-propagation, as practiced by modern scientific fish-culturists, refutes these statements in part and proves the fallibility of nature at least in one contest when opposed to the skill and fertile resources of man. When it was demonstrated that nearly 100 per cent of the eggs of fishes of the salmon family could be successfully hatched by artificial means, and that only 2 per cent of salmon eggs deposited in a natural manner were impregnated,\* it was an achievement so great, so gratifying, and so productive of good to all the world that, figuratively speaking, the disciples of artificial fish-culture rested from their labors to view the result and listen to the plaudits of the world. This was but natural, fitting, and proper, for it was a grand victory; but when the victors were crowned some were crowned with laurel and some with poppy, from the soporific effects of which they have not yet recovered.

With the hatching of 90 per cent of salmon and trout eggs there was a return to natural conditions, and the helpless fry were taken from the hatching-troughs and planted in wild waters to take their chances where their enemies swarmed to prey upon them in their helpless state. Admittedly this was a great stride in solving the problem of restocking our exhausted waters, but there were men who were not satisfied with this result and were keen enough to see that other steps were required to make fish-propagation by artificial means a complete success. Something like six years ago the chairman of this Congress said to me:

We are now seriously contemplating the establishment of a station for the special purpose of holding salmon and trout in ponds and feeding them until they are of such size as to be safe from capture by the small predaceous fish which swarm in some waters. I shall read a paper before the Biological Society at its next meeting, pointing out the reasons for our failure heretofore in successfully stocking waters with the fry of our salmonidæ. Failure in such work, barring a few exceptional cases, has been the rule, and will be confessed by those who are honest enough to confess their failures and wise enough to learn from them.

It requires courage of a superior order to admit of failure in any undertaking, particularly in a matter of this kind, that is a failure only in degree. In planting fish

\* This is not guesswork, but the results of the actual count of the eggs in a salmon river in Canada, the details of which I gave in *Forest and Stream*, February 18, 1892.

fry there have been so many successes that it made it more difficult to convince the satisfied fish-culturist that the system was wrong and a failure, in that it did not accomplish what might be accomplished by rearing the fry to a year or more of age before they were turned into wild waters. The U. S. Fish Commission was the first in this country to recognize the fact that the system of planting helpless fish fry was wrong, and quite naturally was the first to set on foot experiments to discover the remedy.

Under date of December 4, 1889, Mr. Charles G. Atkins, superintendent of the salmon-hatching stations of the U. S. Fish Commission in Maine, reported to the Commissioner the details of his method of rearing the larvæ of certain flies as food for young salmonidæ, at the Craig Brook station of the U. S. Fish Commission. This report has not been printed in any of the Fish Commission publications, but an abstract from it was printed in *Shooting and Fishing*, December 26, 1889. I believe that Mr. Atkins is the only fish-culturist in the United States who has cultivated the larvæ of insects on a large scale for the purpose of feeding young fish. In England, Mr. Thomas Andrews, of Guildford, a noted pisciculturist, has cultivated insects and crustacea in breeding boxes and in ponds, as food for trout fry, and I quote from a letter he wrote me last year:

My experience has taught me that one yearling fish is worth a hundred or a thousand fry for stocking purposes. \* \* \* I get fewer fish perhaps (by feeding natural food), but I get monsters of 6, 7, 8, and 9 inches in a year, and my yearlings fetch three times the price of some other pisciculturists.

The system of Messrs. Lugin and du Roveray, in France, of self-reproducing food for young fish, has been practiced in Gremaz since 1884, and is too well known to need more than passing mention, as it is not unlike the method pursued by Andrews, and it has been adopted by Muntadas in Spain, and is printed in detail in the *Bulletin of the U. S. Fish Commission for 1887*, and is copied into the proceedings of the *American Fisheries Society for 1892*. I do not pretend to mention all of the fish-culturists at home or abroad who practice this rearing of natural food for young fish, and what I have said has been said briefly, only that I might introduce a new experimenter in this particular field.

Early in the current year I wrote an article for the distinguished German fish-culturist, Max von dem Borne, upon the "results of artificial fish-culture in the United States," and this being translated and printed in an Austrian newspaper, was read by Carl Edler von Scheidlin, an Austrian engineer, who wrote me a letter, from which I make this extract:

The first and most important question to be solved in the artificial culture of all fish is as to the proper food for them with reference to their kind, stage of growth, and the purpose they are to serve. This question, so long unsolved by all nations, I, by following further on in the line of the Frenchman, Lugin, have solved, and have tested the solution as good, cheap, and practically feasible.

Mr. Von Scheidlin proposed to make over to me for use in the United States his method of rearing natural fish food, which is called "The Scheidlin-Rakus method of fish breeding and feeding," and I entered into correspondence with him to this end. I have already received several long papers on the subject, but the correspondence has not reached that stage where it would be proper to enter into the details of the system, but when all the papers promised are received I shall turn them over to the U. S. Fish Commission, and if they prove to be what I now believe they will, the system

of Mr. Von Scheidlin will probably be made known by the Commission. In the meantime, I quote from the letters already received:

The entire question of the food of fish rests upon two important points: (1) Upon the recognition of the fact that their food consists of insects, infusoria, crustacea, worms, amphibia, and fish, in their various stages of transformation; and (2) upon the observation of the fact in nature that the females of insects, amphibia and fish deposit their spawn only in those places in which are found suitable conditions for the future survival of the young; and if the pisciculturist produces these conditions according to the needs of the animals; he can induce them to deposit their brood in definite places, and can produce the food for the fish wherever he likes, and in greater quantities than are produced in the waters by natural processes. Fish food should be living and consist of bits or pieces as large as the mouth-opening of the fish to be fed.

The principle of rational feeding according to Justus von Liebig, Boussingault, and Gronven, is briefly this: The chemical composition of the food should conform to the chemical composition of the body of the animal to be fed—that is to say, in the case of fishes, being cold-blooded animals, they must receive food that in turn consists of cold-blooded animals—a principle that runs through all nature. For example, you can raise maggots easier, quicker, and in greater quantities upon the flesh of amphibia and fish, than upon that of mammals. \* \* \* One kilogram of food composed of insects, amphibia, or fish, is equal in quantity to 16 to 18 kilograms of the flesh of mammals.

By means of natural food the fish fry grow seven times faster than by the food of mammal flesh. \* \* \* Since May of last year [the letter is dated in August, 1893] I have been feeding carp fry with artificially-reared natural food, and the fish which when put into the pond were  $1\frac{1}{2}$  centimeters long (10,000 of them to 114 acres of water surface) are to-day 16 to 18 centimeters long. Those that were 18 decigrams in weight are now  $3\frac{1}{2}$  kilograms, and those that were 5 decigrams are now 1 to  $1\frac{1}{2}$  kilograms. \* \* \* Of all these natural foodstuffs,  $2\frac{1}{2}$  to 3 kilograms produce the same increase in the fish fed as 14 to 20 kilograms of the flesh of mammals, and it is produced three-fourths cheaper with the natural food. \* \* \* Two years ago I produced within 100 days by means of natural food, from carp fry  $1\frac{1}{2}$  centimeters long, carp of  $1\frac{1}{2}$  kilograms in weight.

At the risk of repeating a portion of the substance of what has already been quoted from these papers, I will give one more extract:

Not till now do I see from your letters that you lay the greatest stress upon the culture of young fish up to the first or second year; and that is the correct idea and the one I hold to myself. The food of the brood after the loss of the umbilical sac must be *living*, not finely-chopped mammal flesh, because while the fish upon the latter diet may become large they will not become strong. If you can not give them living food give them, at any rate, finely-chopped fiberless amphibia or fish flesh, as this is 50 per cent better than mammal flesh, while *living food*, on the other hand, is 1,000 per cent better.

The production of living food for brood and young fish is the easiest and cheapest, and this food can be fed until the fish have grown to 15, 20, or 30 decigrams, when they must have more substantial food, such as earth worms, beetles, larvæ, maggots. \* \* \* This year I introduced my method of young fish feeding in two trout-breeding establishments, as a test, in order by the result to make a reputation for my method. Both establishments were in the habit of feeding horseflesh. The one fed 50,000 the other 80,000 fish-fry, so that in two years they were fish of 1 to 2 kilograms. By my method both establishments used only one-seventh of the food formerly used, and the cost of food per kilogram was reduced more than one-seventh. One increased its plant to 120,000, the other to 200,000.

One of the "foodstuffs" reared by Mr. Von Scheidlin is the larvæ of flies, and it is interesting to note that his method is very like that practiced by Mr. Atkins already referred to. Mr. Von Scheidlin tells me that as the result of 30 years' experience and experiments in fish-culture he is fixed in his belief that to obtain the best results young fish must be fed until they are at least 1 year of age before they are turned out to seek their own living, and certainly 30 years' experience should count for something.