

## 21.—SOME NOTES ABOUT AMERICAN FISH-CULTURE.

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A few days ago Hon. Marshall McDonald honored me with a request to write an article for the International Fisheries Congress in Chicago, containing a criticism on American fish-cultural methods. To thoroughly perform this task would require a far more comprehensive study of the subject than I was able to make during the four months I spent in America, and much more time than I have had at my disposal; still I feel it to be a debt of gratitude which I owe, both to the Fish Commissioner and the other fish-breeders and scientists with whom I came into contact during my stay in America, to write a few of my impressions on fish-culture in that great country.

The enormous extent to which the work of fish-culture has attained in the United States may be at least partially attributed to the prevalent rights of fishing there. While in Europe either the State or private persons in most cases own fishing waters, nearly all such waters are public in the United States; that is to say, anybody may fish where he likes. As private citizens in that country can, therefore, have no direct interest in preserving or trying to increase the supply of fish, the General Government or the State must perform this duty. This has been done partly by the prohibition of fishing in all waters except the very largest, *i. e.*, the sea and the large inland lakes, and partly by fish-breeding on such a large scale that Europe can not show anything approaching it. As a consequence of this enormous fish-breeding, the Americans have invented a number of exceedingly simple, cheap, and easily managed apparatus for the purpose, and have thus materially simplified the work.

In the following article I only intend dealing with the breeding of fresh-water fish, which I have principally studied. Both in America and Europe the dry method is almost exclusively used for the fecundation of the roe, and therefore there is nothing specially characteristic in this in American fish-culture. A remarkable discovery, which has lately been made in America, is, however, worthy of notice, namely, Prof. Reighard's method of preventing pike-perch eggs from sticking together after fecundation, by keeping them for some hours in a dilution of starch. The Michigan Fish Commission used this method last summer on a large scale and with great success. In Europe the artificial fecundation of pike-perch roe has also been attempted, though only on a small scale. In these cases the roe has generally been made to attach itself either to well-washed grass-roots or to myriophyllum or other water plants. It has then been taken up and hatched in self-pickers, whilst sticking in this manner to water plants or other roots. This method is, however, scarcely suitable when hatching is done on a large scale and can not give such good results as when the eggs are hatched quite free from any other substances.

The manner of hatching heavy eggs in America in wooden troughs on wire trays, in which the eggs are laid in the troughs, either in single rows, or arranged one above the other, where they are washed by the water in the trough horizontally (Atkins), or where the water runs down from above (Clark), or is forced up from below (Williamson), seems to give as good results as can be desired, and the more complicated troughs with their many partitions do not appear to do the work any more satisfactorily. The simpler method, therefore, is much more in use. One apparatus, which I only saw at the U. S. Fish Commission's excellent exhibition, but never anywhere in use, is Livingston Stone's apparatus, which consists of a Williamson trough in which Mr. Stone, instead of a row of trays, had placed a basket made of wire cloth, and then laid the roe in many layers one above the other. I have specially mentioned this apparatus because many modifications of it have been introduced and are largely used in Europe under the name of the Californian apparatus.

The difference between the European modifications and the original American type chiefly consists in the replacement of the Williamson wooden trough, with its many divisions, by various small varnished tin boxes, each containing only one wire basket in which the roe is laid. These baskets are generally so small that they will only hold about 5,000 salmon or trout eggs. These so-called Californian apparatus are arranged one below another in the form of steps, so that water can run down from one into the other, and the results given are very good. Being of tin, and of small dimensions, generally about 40 cm. long by 25 cm. broad and 25 cm. high, they are also easy and convenient to handle. I also specially recommend to the American fish-breeder Max von dem Borne's funnel-shaped apparatus, which, although giving excellent results, only holds a few thousand salmon or trout eggs. It is especially suitable for hatching the rarer kinds of fish, of which there are only a small number to be had.

Whilst Europe can still well compete with America in the breeding of trout and salmon, and even has a station, Howietoun, in Scotland, which is larger than any in America, the latter country is far ahead of Europe in the culture of fish with semi-buoyant eggs, such as shad, whitefish, and pike perch. It is solely due to the self-pickers, first introduced by Fred. Mather and Charles Bell, and afterwards improved upon and perfected in various ways by Chase, Clark, Wilmot, and McDonald, that this great fish-culture has been made possible. It would be difficult really to say which of these four last constructions is the best for the purpose. I, for my part, should be inclined to give the preference, on account of its simplicity, to the Wilmot apparatus, which is made entirely of glass, but I think it would gain considerably in effectiveness if the bottom were made a little broader in shape, like McDonald's apparatus, and fitted, as his is, with three feet, by which a more regular circulation of water would be obtained. During late years a glass self-picker, constructed by a Swiss named Weiss, has also been successfully used in Switzerland and Germany. This has the shape of a bottomless bottle, turned upside down, the water rising up through the neck and running out over the edges of the bottom.

Concerning the packing and transfer of eggs there is not much to be said. The packing most used both in America and Europe is damp moss. On the other hand, in Canada, where the eggs are hatched on trays of perforated zinc, the same trays with a layer of moss on the eggs are often used for transferring them from the place of fecundation to the fish-breeding stations. In this way one avoids moving the eggs (which are very delicate) for some time after fecundation, besides saving oneself the

trouble of doing so. Another way of packing, which is greatly praised by Mr. Wilmot, of Newcastle, Ontario, is that of covering the eggs with clean snow; and then there is the Russian method of packing in damp cotton, which, although I have never seen it done, is said to be very successful. As a rule the roe is not moved in Europe until the eye-spots are visible, but in America they seem to transfer quite newly spawned roe without any hesitation whatever, and in some cases the transit occupies several days. Thus, Mr. Clark tells me, it happens that lake-trout roe is a whole week on the way from the place of fecundation to Northville, where it is hatched without any part thereof worth mentioning becoming spoiled. I can not, however, but believe that roe which has been sent such a long way must give weaker fry than that which has not been moved, and in this belief I am supported by Mr. Page, in his address lately at the yearly meeting of the American Fisheries Society.

In the same way as the hatching of the roe is different in Europe and America, the fry are also treated differently in these countries. In America nearly all the hatcheries are exclusively intended for the production of fry or so-called yearlings, for planting in public waters. In Europe there are, however, besides stations for this purpose, a number of hatcheries where fish are bred in ponds or private waters for commercial purposes. With regard to the period before the fry has absorbed the yolk-sack, there is not much perhaps to be said, for this is a comparatively quiet time for the fish-breeder. The general experience is that it is better to keep trout and salmon fry in trays during this period, so that the water can also wash it from below and prevent its being stifled in the sediment at the bottom.

The next period is far more critical, when the fry begins to take in food. The fish-breeders of the old school have not, as is well known, troubled themselves about the fry during this period, but when the yolk-sack has begun to be absorbed they have let the fry out and allowed it to take care of itself. There is no doubt that in many cases this has also given good results, and this method will probably continue to be used for some time to come, but I, for my part, believe that as fish-culture becomes more and more developed the fry will be kept in the ponds until it has reached the age of six months or even a year. It is with the greatest interest that I have followed Mr. Atkins's experiments in feeding salmon fry until it has attained the age of one year, which required a great deal of care and attention. The results attained by this clever experimenter in breeding large quantities of salmon fry in a limited space have been very successful, and these experiments were the more interesting on account of Mr. Atkins having tried to replace liver, which until now has been almost universally used, by living food. This is, in my opinion, one of the important points for fish-breeders, as the use of artificial food, both for the animal and vegetable kingdoms, must be regarded as in a transition stage.

The feeding of fry, and also older fish, with natural food may be done in two different ways: the organisms intended for feeding the fish can either be cultivated in a separate place and then transferred to the basins or ponds where the fish are kept, or the fish themselves can be put into ponds which have been specially prepared, so as to produce a large quantity of organisms suitable for food. Each method has its advantages, but if there is plenty of room the latter way seems to me the most suitable. In America the custom is to build very small and shallow ponds, and Livingston Stone says, in his celebrated work on Domesticated Trout, "build your ponds small, that means business;" but I think you follow this advice far too closely in America.

The fish bred in especially large quantities in America, such as whitefish, shad, and pike perch, are nearly always let out as fry, in the stage when they begin to take in food. During late years, however, Commissioner McDonald has tried keeping shad in the ponds during the first year, and I think it would also be a great success if similar trials were made with whitefish and pike-perch fry. In some parts of Europe whitefish and pike perch are fed in large ponds until they reach a marketable size, and I can not help thinking that if the fry were kept at least the first year in ponds the results would be much better than those obtained by the present method in America.

The breeding of trout and shad has no doubt been attended with excellent results in many parts of that country, but as far as whitefish and pike perch are concerned much yet remains to be proved. It would certainly seem very useful to hatch the hundreds of million eggs (which otherwise would annually be lost) by catching the fish in its spawning-time and planting the fry thus saved; but statistics do not show that the supply of these particular kinds of fish is increased thereby. This may be attributed to the large scale in which the fishing trade is carried on, and it may be that, without hatching, these kinds of fish would have been exhausted, but all this is in any case only an hypothesis. It can not yet be shown conclusively how large a proportion of the whitefish and pike-perch fry that is planted attains the age of one year, and still less how many fish reach a marketable size.

We should doubtless be able to get nearer to the answers to these questions by planting the fry in large ponds and letting them remain there one or two years. But I should like to go further still. The culture of fish can not make any real progress by breeding only; there must be in addition sound legislation founded on a proper knowledge of the subject, and an effective enforcement of these laws. But how difficult it is to obtain a really thorough knowledge of the influence which the various factors exercise; what do we know as yet about the quantity of fish a certain water can produce, and how large a yearly demand it can sustain? And how little do we still know what tackle is at the same time the most advantageous for the fisherman and the least destructive for the fishery.

The only certain basis to go upon to judge of these and relative subjects is, I believe, to found experimental fishing stations, with the exclusive right to control the fishing in various lakes and streams for preference of different sizes and nature. At these stations fish would be bred, trials made as to the effect of different tackle and close times, artificial spawning beds laid down, water plants planted, and an examination made of the food produced by these waters and the best means of increasing the same, etc. In this way one would obtain a reliable account of the practical result of fish-breeding and a starting-point for fish legislation. A year ago I founded such a station in Finland, but lacking means and not having sufficient time now to devote myself to it as I should, it is not yet so organized as I would like it. It is to be for fish-culture what experimental farms are for agriculture.

There are yet many important problems to be solved in the breeding of fish, but the United States have won so many triumphs, and more especially since the formation of the U. S. Fish Commission, which has not only developed at an amazing rate, but has also done work of the most substantial value, that we must all hope for the continuance of their grand work of improving the breeding of fish, in which America is so much in advance of other civilized countries.