XXIV.—TREATMENT OF YOUNG SALMONOIDS AND COREGONI FROM THE TIME THEY LEAVE THE EGG TILL THEY ARE FULLY DEVELOPED AND CAN BE PLACED IN OPEN WATERS.

By Director Haack.*

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Young salmonoids and coregoni, after having left the egg, remain in the hatching apparatus until the umbilical bag has been completely consumed, and they have thus been enabled to swim about and seek their food.

Immediately after the hatching process and for some time after it, it will be well to decrease the influx of water a little, because otherwise the weak and helpless little fish are pressed against the grate and are injured. Gradually the influx of water may be increased in the place where the salmonoids are kept, and after a few weeks have elapsed it can scarcely be strong enough, for the fish have then become so strong that they can easily resist the current.

For the tender coregoni, however, the influx of water must never be very strong, if losses are to be avoided. Nor can the exit-grate ever be too fine for these little fish. The exit-grate should be carefully fixed with putty all round the edges (common putty will do), for even the smallest opening may become a door of escape to these diminutive and scarcely visible fish.

Some time after being hatched the young salmonoids lie perfectly helpless at the bottom of the hatching apparatus, only their pectoral fins are in constant motion to admit fresh water to the gills. From time to time such a young salmon or trout rises to the surface and paddles about with considerable difficulty, but only to sink again immediately to the bottom.

The young coregoni, however, immediately after being hatched, swim about quite lively. Scarcely anything is visible of this little fish except the head with the two large eyes; the body, thin as a thread and transparent as water, can only be seen by a very close observer.

During the early stages of their existence young salmonoids generally

* Herr Director Haack: "*Behandlung der ausgeschlüpften jungen Salmoniden und Coregonen bis zu ihrer völligen Entwickelung und das Aussetzen derselben.*" [Translated by Herman Jacobson.]

keep very close together, and sometimes they even gather into such a dense heap that the lower ones are squeezed to death.

In old-fashioned hatching apparatus, therefore, such gatherings of the fish should, as much as possible, be prevented by moving the boards of the lid and by changing the current of water. In the California and Wilmot apparatus there is no danger of fish squeezing each other to death, because the rising current of water makes such a gathering of the fish impossible. For this reason alone apparatus with a rising current is to be decidedly preferred.

During the whole umbilical period the whole work of the pisciculturist consists in constantly renewing the water and in removing any dead or dying fish. In the California apparatus the inside boards can be moved up and down from time to time, and thus any dirt gathered in the grates can be removed.

If the water is pure, and the young fish are strong and healthy, a single man can superintend several millions of young fish during the umbilical period.

The umbilical bag grows smaller every day, and the little being, which at first did not at all resemble a fish, gradually assumes the shape of a fish. The body, in the beginning only a thin thread, grows thicker every day; the fins grow stronger; the color, at first only a monotonous pink, white, or orange, becomes more directly marked; dark cross-streaks and reddish dots begin to appear, and the inner organs gradually develop more and more. Finally the young fish is completely formed; it no longer rests quietly at the bottom, but rises to the surface and meets the current; it begins to snap after little particles floating about in the water by making a pushing motion. The little fish hereby shows its desire for food, and now is the most suitable time to place the fish in open waters, or, at any rate, in larger boxes or tanks. This, in most cases, finishes the work of the pisciculturist.

There has been a good deal of dispute as to where it would be most advantageous to place the fish after they have been hatched, and even at this day opinions differ greatly on this point. As a general rule I consider it best to place the young fish in open waters immediately after the umbilical bag has disappeared, or, better still, shortly before it disappears. My reason for this is simply this, that in a large piscicultural establishment it is utterly impossible to feed and raise the young fish in accordance with the dictates of nature. By giving artificial food, either ground brains, chopped meat, liver, blood, &c., the fish are easily tamed. They forget—or rather they never learn—to seize their food, which naturally consists of living animals. In the narrow tanks the young fish never learn to know their enemies, and consequently are not able to escape the manifold dangers threatening them in open waters.

Other experienced pisciculturists maintain that it is far more advantageous to keep the fish, if possible, for a whole year in inclosed waters, and thus to let them outgrow the majority of their enemies.

The adherents of this method base their views on the experience of many years. They say that when they placed the young fish in open waters immediately after the disappearance of the umbilical bag, their stock of fish was not perceptibly increased, while upon one-year-old fish being placed in open waters the stock increased rapidly.

Many readers will doubtless wonder how, in the face of such observations, I can advise to place the fish in open waters when quite young.

I must reply, in the first place, that I said "I advised it as a general rule," and in spite of the above-mentioned experience, which I by no means doubt, I feel constrained to abide by this view.

"As a general rule," it is certainly best to place the young fish in open waters immediately after the umbilical bag has disappeared.

The increase of our migratory fish, especially of the salmon kind, is justly considered by our most prominent pisciculturists as the main object of rational pisciculture, and for this object governments have granted subsidies.

Where there is a question of repopulating large streams and their tributaries, a few thousand fish are of no avail, but millions must be placed in the rivers. But who could raise artificially even a single million of salmon in narrow inclosed waters?

A well-fed young salmon or trout (the latter grows a little faster) can weigh as much as 30 to 35 grammes in a year's time. A million of such fish therefore represent a weight of 300 to 350 kilograms, valued at $48,000 to $57,600. If a sum like this could be made so easily our country would swarm with piscicultural millionaires.

Even if my calculation only includes really well-fed, one-year-old salmon or trout (and it is based on exact weighings) the management of one million of fish, even if they are not all well-fed, involves such enormous weights and values that any one can see the impossibility of carrying on pisciculture in this manner on any very large scale. And then we do not even take into account epidemics which will always occur among large masses of fish.

We shall most decidedly reach far more satisfactory results if annually at a trifling expense we place several millions of young, strong, and healthy salmonoids (but only such) in open waters immediately after the umbilical bag has disappeared, and there let these little fish fight their own battle for existence. Success will and must crown such efforts.

If most fishermen and many pisciculturists entertain very little hope for the future of fish which have been placed in open waters at so early an age, this must simply be ascribed to the very generally entertained idea that such young fish are simply food for larger fish, an opinion based on the idea that a little fish hatched in a hatching-apparatus is an entirely different being from a fish hatched in the open water.

Unfortunately this idea is not altogether erroneous; for by far too many "artificial" young fish have been placed in the open waters. We

have been altogether too "artificial"; our whole system of pisciculture has been too "artificial."

The chief mistake which we have made in all our piscicultural efforts is this, that we have principally used the convenient, pure, and clear spring water in our hatching apparatus.

It is true that a piscicultural establishment using only such clear spring water presents a very pretty appearance. The eggs lie in water transparent as crystal; they can be distinctly seen at all times; the water is never muddy; no sediment ever disfigures the eggs. Altogether such a piscicultural establishment is a thing of beauty.

The pisciculturist can tell you accurately that on the twenty-fourth or twenty-fifth day the eye-dots become visible in the egg; he can calculate almost to the minute when the first young fish will be hatched; he even knows, when he places the impregnated eggs in the water, when the young fish will have lost their umbilical bag and when the apparatus will be ready to receive other eggs. Such a hatching apparatus, furnished with clear spring water, is very convenient indeed, if it has an even temperature of + 7 to 8° Réaumur.

The poor pisciculturist, however, who has to work with brook water, often has to wait one hundred days instead of twenty-three or twenty-four, before he can see the first eye-dots in his eggs; then many, many days have to elapse until the young fish are hatched and have lost their umbilical bag. How often does it happen moreover, that the most carefully arranged filtering apparatus does not make the water quite clear. In the muddy water the eggs and young fish are frequently not to be seen! and then the endless time till the hatching process is finished!

Whilst the whole development of the embryo can be finished in six weeks in the beautiful clear spring water having a temperature of 8° Réaumur, it often takes six months in the cold, muddy, and ugly-looking river water!

Who would not under these circumstances prefer the beautiful spring water?

And still!

The spawning season of the trout and salmon commences about the end of October and lasts till the middle of November. The pisciculturist who works with spring water must therefore place his young fish in the water towards New Year, whilst he who works with river water cannot do this till the end of April or the middle of May.

Which of the two is to be preferred under these circumstances?

The first food of the young salmonoids, and probably of most fish, are small crustaceans (*Cyclops*, *Daphnia*, &c.). Most of these diminutive animals, which fill the water in enormous quantities, had in autumn cared for the propagation of their race by laying winter eggs. They then bid adieu to this hard world and died. They departed this life with the consoling hope that the life-bringing sun of spring would from the eggs laid in the mud, where they would peacefully rest all winter, produce lively

little animals like themselves, and that these animals would either produce live offspring or lay summer eggs, and thus soon again fill the water with milliards of young crustaceans.

Young salmon or trout placed in the water at the coldest season of the year—towards Christmas or New Year, or even four to five weeks later—find the water almost empty of animal life. Only a few stragglers of the more hardy *Cyclops* kind are still swimming about. Otherwise, everything is dead. The young salmon or trout therefore seek for food in vain. Days will pass before they can catch a single crustacean; they grow weak and miserable, and become an easy prey to their numerous enemies.

These young salmon and trout, however, which were placed in the water towards the end of April or middle of May, found their table already spread. Numberless swarms of different little aquatic animals filled the water, and often it would require only the opening of the mouth to obtain ample food. It is a pleasure to watch these little fish during April or May. The little stomach is filled almost to bursting, and you can almost see the fish grow. In a very short time such fish have far outstripped their poorly-fed brothers, which were placed in the water a few months sooner. The well-known farmers' rule, that if you wish to raise fine cattle you must give the animals good strong food whilst they are young, applies likewise to fish.

Only he who having eyes to see does not wish to see can, after what has been said, advocate the spring-water theory.

Fish hatched in spring water having a temperature of 7 to 8° Réaumur are in nowise fit to be placed in open water. Such *artificially* hatched fish can only be raised in inclosed waters by *artificial* feeding.

In nature a trout will, as a general rule, never go close up to the spring for the purpose of spawning; and whenever it is done, the quantity of water is so small that its temperature is altogether influenced by the temperature of the air.

In some rivers which are "rivers" almost from their springs, and where consequently the temperature of the water cannot be much influenced by that of the air, the trout will not spawn till March. This is, *e. g.*, the case in the river Blaue, near Blaubeuren, in Würtemberg. The salmon almost exclusively spawn in the open river, where for months the temperature of the water is almost zero (Réaumur).

I therefore say, if so-called artificial pisciculture can so far not boast of any great results, the sole cause must be found in the very generally employed method of hatching in spring water.

If pisciculturists, therefore, in spite of having placed young fish in open waters year after year, have not been able to see any increase in their stock of fish, a searching investigation will invariably reveal the fact that "artificial" pisciculture, in the truest sense of the word, has been the cause; in other words, that young fish hatched in warm spring water, effeminate beings, had been placed in the open water.

A fish hatched in cold water in a hatching apparatus differs in nowise from a fish naturally hatched in the open water. Just as little as *all* the naturally hatched fish are destroyed by their enemies, just as little will this be the case with artificially hatched fish.

The artificially-hatched chicken does by no means present a parallel case, for even a fish born in the open water does not enjoy a mother's tender care.

The pisciculturist has done enough by protecting the eggs and those young fish which still have an umbilical bag against their enemies. Fish that are able to swim about must protect themselves and fight their own battle for existence.

I consider it already as an immense gain if of the young fish placed in open waters only 10 per cent. grow up to be fit for human food. In nature scarcely 1 per cent. of the eggs laid develop into mature fish; for even 1 per cent. would in a short time fill our rivers to overflowing.

It would, however, be too rash a conclusion if we were to maintain that the only right way in all cases would be to place the young fish in open waters at a very early age. I therefore repeat what I said before, "I recommend it as a *general* rule."

As far as our European salmonoids and the more common kinds of *Coregonus* are concerned—of whose eggs it is easy to obtain many millions—it is decidedly best to place them in the open water immediately after the umbilical bag has disappeared.

In the case of fish, however, of whose eggs only a few thousand can be obtained, *e. g.*, the American *Salmo fontinalis* and *Coregonus maræna*, it would be decidedly wrong not to let these valuable fish enjoy further care. In this case it becomes a duty to put off the fight for existence as far as possible, and not to place them in open waters until they have outgrown most of their enemies.

But even here it will be preferable to raise the young fish strictly in accordance with the dictates of nature. Fish which are to be placed in open waters should, therefore, not be confined in too narrow receptacles and be fed in too artificial a manner, but in ponds carefully cleared of all enemies and fully secured against intruders by grates. Fish which are to be raised for the open water are not intended to be tamed.

Thus, *e. g.*, the Madui-marœnes flourishes in ponds one to two meters deep, fed with spring water, without introducing any artificial food. The number of fish should, of course, be in due proportion to the size of the pond. In such ponds the marœnes may be kept one or two years and then placed in a lake.

Also, regarding the saibling, I rather incline to the opinion that it is better not to place this fish in open water until it is one to two years old.

The saibling has the peculiarity of living (with the sole exception of the spawning-season) at a very great depth. It has, therefore, never learned to know its enemies, and has never learned to fight for its own existence.

So far, at least, it has been my experience that saibling which were placed in the water at the same time with trout of an equal size were rarely caught again, although these fish, if alone in the same water, continued to flourish.

Wherever, therefore, it is not possible to place in lakes which already contain saibling several hundreds of thousands of these fish, I would advise not to place them in the open water until they have reached the age of one to two years. The same may be done by a pisciculturist who can only operate with 1,000 to 2,000 trout-eggs, provided that he has a chance to raise his trout for one to two years, according to the dictates of nature, in inclosed but tolerably large waters.

It is not advisable to place in open waters trout which one to two years have been fed on brain, meat, &c., in narrow inclosed waters. Such fish must be raised to the age of maturity in inclosed waters.

Where are the young fish to be placed? Young fish which are able to swim had therefore best be placed in locations which naturally-born fish would prefer. For trout and salmon this would be a place in a brook containing a good many stones and aquatic plants. It does not matter if the current is pretty lively if it only does not become a rapid or waterfall.

The young trout and salmon will here soon find suitable hiding-places among the stones and aquatic plants, and it will not be long before they begin to hunt for little aquatic animals. It need scarcely be mentioned that it is best to distribute the fish over as large a space as possible.

It will hardly be possible to select a place for the restless coregoni. Care should only be taken that these tender young fish are not placed in bays of lakes, in ports, &c., because the numerous cyprinids generally gathered in such places might mistake the little coregoni for small worms, and therefore devour them.

It is therefore advisable to place the young coregoni in the middle of the lake and let them select the most suitable dwelling-places.

I would, finally, ask all pisciculturists, beginners as well as those possessing much experience, to examine carefully all I have said. I feel convinced that, after a careful and conscientious examination, every thinking pisciculturist will abandon the injurious spring-water theory and adopt the less convenient but more natural method of hatching the fish in brook-water.

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