

# XXXVII.—POND CULTURE—THE FOOD AND SPAWNING OF CARP.\*

By ADOLPH GASCH.

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In traveling through Central Europe the tourist frequently sees dikes in the gentle valleys of those regions, some of these dikes being well preserved and even covered with old trees, others very much damaged, occasionally plowed and cultivated like the flat pond area back of them. Pond culture must therefore have been carried on more extensively in former times, and a larger area must have been covered with water. Many ponds have been laid dry in the hope—justified in the beginning—of obtaining a larger income from agriculture, and the primitive way of treating ponds and fish was certainly not encouraging to pond farming.

Under the so-called “old method,” unfortunately still employed in many places, it was customary during the first warm days of spring, as early as possible, to place several spawning carp in flat, sunny ponds; and if the weather was favorable, a number of very small carp, meas-

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uring only an inch in length, was the result in autumn. But sometimes the eggs spoiled, or the tender fry were destroyed through lack of food or by animals, and the many spawners, to the great astonishment of the cultivators, produced but few offspring, which, because they did not have to share the scanty food with other fish, sometimes developed nicely, reached a length of 4 inches, and were known by the name of "May fry." If the summer was unfavorable, or if nature did not furnish certain conditions in the spawning-ponds, the fish did not spawn at all, and hope was deferred till the following year, or older fry, often very poor fish from the preceding year, had to be planted in order to raise carp. Frequently it was also expected of a pond to produce fry and at the same time to feed the larger carp. The characteristics of the "old method" are: great uncertainty, at best great irregularity, consequently small results quantitatively and qualitatively, and great loss of time.

At the present time matters are much better. Fish-culture and pond culture have become sciences, which are still in their infancy, and therefore far from being fully developed, but which undoubtedly have a great and promising future. By the artificial raising of fine food-fish, pond farmers, and more especially carp raisers, have been filled with a desire to become as independent as possible of nature. After many vain attempts we have again returned to nature, the great teacher, and have found that all which is needed to raise fish successfully is to give them those conditions which their instinct demands for spawning. It will be sufficient, in this place, to state this leading principle of modern fish-culture. To give all the details of my method, which had best be done privately, would not further the interests of fish-culture, because here likewise the old adage holds good that "there are many roads which lead to Rome," and because, improbable as it may appear, some other method may be discovered for carrying out the principle laid down above, which will answer the purpose still better.

If the natural requirements of the fish are properly met the result is certain. Within twenty-four hours after being placed in the pond they will spawn, and soon finish this process. Many people would like to know how this is done, but not much can be said on the subject. All that can be seen in the pond is that the fish rub against each other, and with their tails beat the water, which is thrown the higher the shallower the spawning place. But, as far as I know, it has not been definitely settled where the eggs are impregnated, whether inside or outside of the mother fish. According to Dubisch the grains of roe are impregnated inside the female fish, whereupon they immediately commence to swell, thereby exercising an increased pressure on the sides of the abdomen, which finally causes them to be ejected. Physiologically correct as this view seems to be, I cannot share it until I have become convinced by the microscopic investigations of an experienced naturalist, because it seems impossible that the spermatozoa can, during the short

period of twenty-four hours—the normal spawning time of the carp—effect the impregnation of from 600,000 to 700,000 grains of roe, which are to be ejected within that same period of time. If Mr. Dubisch is correct, the fish would be much less dependent on the temperature of the water than they really are. So far, therefore, I share the general opinion that the grains of roe are impregnated outside of the female fish. The denser the mass of spermatozoa in the water the larger will be the number of eggs which are impregnated, and having immediately become sticky, adhere to blades of grass, &c., and the less will be the number of eggs which fall to the bottom without being impregnated. The very circumstance that there are unimpregnated eggs seems to indicate the probability that the view generally entertained is correct.

It would be possible to get at the truth if a female fish engaged in spawning could immediately be examined microscopically. Professor Benecke, who has already put all fish-culturists under many obligations, would again earn our deepest gratitude by solving this exceedingly interesting problem. He has already proved the important fact that the spermatozoa of fish do not confine themselves to entering the ovary through the micropyle, but that they (at least in the case of the sticklebacks and probably also in the case of other fish) pierce the sides of the ovary in different places and thus effect impregnation. This peculiarity explains the fact that it is easier to produce bastards of fish than of higher animals, where, according to Professor Rueff, the spermatozoa strictly confine themselves to the micropyle, and here need a corresponding size and shape.

I consider it utterly impossible that carp can spawn thoroughly twice a year. The production of from 600,000 to 700,000 grains of roe in one year is such an enormous undertaking for a carp that more can hardly be expected. An exceptionally fine female carp, which, after it had already spawned in Kaniow, spawned in my pond for three years in succession, and which annually produced about 60,000 young carp, finally showed withered fins, an indication that this exorbitant production had been too much for her.

Wherever fish have been observed to spawn late in the season, they have been prevented from spawning in spring either by some slight bodily injury or by being still too young, or by having been placed previously in too cold water, where spawning, of course, could not take place until these evils had been remedied and all the necessary conditions had been supplied. As in analogy with other animals we must presume that both father and mother transmit some of their characteristics to their offspring, it will be necessary with peculiarly fine breeds to put only one male and one female together for the purpose of spawning. Wherever the main object is to produce a large number of fish it is customary, and entirely to the purpose, to put two or three milers to one spawner. There is considerable difference of opinion as to the proper proportion between the number of spawners and milers.

Thus, in the Upper Palatinate, people were, at least till I traveled through that country during last year, in the habit of putting ten and more milters to one spawner. Unfortunately it was also very common to put in the spawning pond other fish of different age. Unless certain conditions are complied with, a large number of spawners will not insure success.

Provided these conditions are all there, I would, according to my experience, advise to place in one spawning pond, for the purpose of producing 60,000 young carp, only one spawner and one or two milters, because this is amply sufficient, and, as will be seen from the following, is decidedly better for raising the young fish. If several set of spawners are put in a pond, or many milters to one spawner, it may happen that the fish, regardless of their possible offspring, and eager merely to satisfy their sexual desire, are too vehement in their sexual intercourse, and make the water muddy; and especially in ponds containing refuse from factories, some of this mud may settle on the eggs, produce fungi, and thus destroy them. But if the pond has been carefully selected and prepared for spawning, and if—the weather being favorable—everything goes on in its regular course, the young carp slip out of the eggs in from four to eight days, so that, as a rule, there will be young fry eight days after the spawners have been placed in the pond. The quicker the spawning and hatching is done the better it will be, as even in the seemingly cleanest spawning pond a number of enemies of the spawn and fry spring up as if by magic. The more plentiful and suitable the food which the young fish find in the pond, the quicker and more successfully will they develop and be able to escape from their enemies. If the raisers of fine food-fish would let them grow a little larger and stronger in their establishments, natural and good food, of course, being supplied in abundance, instead of placing the young fish in open waters when they are still quite tender, and when they are still impeded in their movements by the umbilical sac, the results of the culture of fine food-fish would soon become evident, and general confidence in artificial fish-culture, which, especially in a flat country, with many lakes and few natural spawning places, will always be of the greatest importance, would soon be restored.

To protect the young fish better against their enemies is not the only advantage of the new method. It is well known that good and ample food improves the shape of the fish, makes them broader, and favors the formation of flesh, so as to make the proportion between flesh and bones, *i. e.*, between useful and useless parts, more favorable. Moreover, a larger number of fish is produced for the pond area, stronger and (in the future) more productive fish are raised, as I have pointed out in my pamphlet published for the Berlin International Exposition of 1880, and finally, by constantly repeating this method, and by carefully selecting the very best fish for breeding, a well-formed and rapidly-growing breed of fish will be the result. The finer the kind of fish and

the younger and better fed the individual fish, the smaller will be the head, and the larger, broader, and fuller the body of the fish, without being shapeless. Thus, from large-headed carp, which are small for their age, a correct conclusion may be drawn as to bad management, a poor breed, and also poor ponds. Thus, in Prussia, on a large pond farm, which might easily have occupied a front rank among the German fish-cultural establishments, in spite of the fine and naturally favorable ponds, which, owing to the ignorance of the managers, had been sadly neglected, I found lean, small, thick-bellied fish, which even at the age of six or eight years hardly weighed one-half kilogram [1 pound], and of these only one-fourth of the number which, with proper management, the pond area might have produced.

In Bohemia I visited a pond farm which was otherwise well managed, but where the new method was not employed, and where the young fry, produced according to the old method, were in their raising ponds, *i. e.*, in their second year, favored so much by placing only a comparatively small number of fish in each pond, that, with unusually ample food, these fish developed very well, and in one year made up for lost time. The pond area used for this purpose, however, was too large, so that finally the fish intended for the market had less area than the fish which were still passing through the raising process, while the reverse should have been the case. It is evident that this way of managing, although momentarily having a good effect, is nevertheless very expensive. Better results, and in a cheaper way, are reached by the new method, which is characterized by safety in the production of the fry, by its excellent quality, and by a great saving of time.

From time immemorial it has naturally been the object to favor the growth of fish, especially those intended for the table, by supplying them with plenty of food outside of that found in the ponds, and it was recommended to throw in the ponds the excrements of cattle, malt, boiled potatoes, turnips, meat, ground meat, &c. Thus, about fifteen years ago, on a pond farm belonging to Archduke Albrecht, of Austria, a large horse slaughter-house was established, where cheap horse flesh was chopped fine by machinery, and in that condition fed to the fish. In the beginning the fish ate a little of it, but finally refused it altogether; the water became putrid and injurious to the fish, and it was soon found an urgent necessity to return to the natural food contained in the ponds, which, of course, was not so abundant, but much more wholesome. Of late years, also, fish-culturists, especially Carl Nicklas, have taken great pains to prove the advantage of the artificial feeding of fish in ponds, and have proposed different mixtures of food.

Although these suggestions are well-meant, I cannot agree with them, because as a rule it is erroneous from an economical point of view to give to fish articles of food which might be used otherwise, especially when it is very questionable whether the results of employing such food will correspond to its cost. In my opinion, nothing but refuse and ar-

ticles of food which cannot find any other use should be given to fish, and even then only exceptionally, always, of course, provided that the fish will readily take to this food and derive some benefit therefrom; but even then one would always run the risk of polluting the water and injuring the fish rather than benefiting them.

To show incontrovertibly the usefulness of employing such artificial food for fish, an Emil Wolf or Grouven would have to treat of this subject. As long as this is not the case, and all the results are based merely on more or less arbitrary suppositions, because in making experiments the natural, vegetable, and animal food contained in the ponds has nowhere been taken into account, it is better, for the present at least, to stick to the natural food, and to put the powerful productiveness of nature to the best possible use. I would, in this connection, direct attention to the easy way in which myriads of infusoria can be produced, and to the, unfortunately not entirely voluntary, production of various kinds of flies, gnats, and other insects. So far, however, we fish-culturists are very one-sided persons. If we are to fulfil our duty in the highest sense of the word we must aim at being at the same time raisers of insects, mollusks, &c., so that we can at all times supply our fish with healthy, palatable, and cheap food.

I again appeal to the kindness of men of science, like Dr. Brehm, Professor Semper, Professor Jaeger, and Professor Taschenberg, to aid us with their observations and advice, whereby their highly interesting and instructive studies will become of great practical value. If we could get so far as to enable us to increase at will useful insects, &c., and to limit the increase of the hurtful ones, our fish production would reach a stage of which at present we have no idea.

There are other animals which, particularly the young ones, might be used for fish-food, and I may be permitted to call attention to a much maligned and misrepresented animal, and by showing its usefulness establish its reputation. I mean my old friend the frog, the large green, croaking inhabitant of our stagnant and slow-running waters, which tolerably early in the season produces young ones in every stagnant water. It has often been asserted that frogs are injurious to fish-culture, because they are said to devour the young fry of fish, and even competent authorities have in their books given methods for destroying the frogs and their young ones. I know fish-culturists who pay men to gather and kill the frogs, so as to avert the damage which they are thought to inflict. It is true that, like the fish of prey, the frog has fangs, and that it is one of our most voracious, inquisitive, and imprudent animals. Thus, by splashing in the water with a switch, the large water-frog may be lured from the middle of the pond to the edge, and, hoping to find a fish on the dry land or some other animal in trouble, it advances blindly and boldly, so as even to jump on the switch or the hand. The frog will devour any live animal that it can swallow, and shows a special liking for small carp, insects, larvæ, snails,

caterpillars, &c., and even its own young when still tadpoles; frogs will sometimes swallow several large cockchafer in rapid succession without chewing them, and through their unlimited voracity they will often fill their stomachs to such a degree as to make their sides appear inflamed. I once even saw a frog jump after a hedge-sparrow with the evident intention of swallowing it.

In spite of this, the damage done by frogs to our fish ponds is not very great, and sinks into utter insignificance when compared with their usefulness by destroying many hurtful insects. The frog can, at most, catch only those fish which in some way or other have got into shallow places, or sickly or crippled fish, which even if there were no frogs would never develop into healthy fish. The frog has no gills to aid it in catching any animal in the water; its eyes sit on the top of its head, indicating that nature has intended it to snatch its food principally from the surface of the water. For the little damage which the frog does by catching young fry it makes ample amends by furnishing, in the tadpoles, abundant and nutritive food for fish, and thus renders itself exceedingly useful to the fish-culturist. The carp has good teeth, and is fully able to masticate this food. It appears that cultivated fish to a certain degree like to mix their food; thus, the carp only devours a certain quantity of tadpoles, and until these are digested does not touch this article of food, which has led superficial observers to the conclusion that the carp does not eat any tadpoles. The little water-frog is of special importance to carp-culture, as it spawns late in summer, and, as its offspring serves as food for the young fry, which have grown somewhat larger, and greatly promotes their growth, I have the spawn of the water-frog gathered every year and placed in my ponds.

Although we are still far from the highest possible aim, and although the favorable results of the fisheries given in my pamphlet must not yet satisfy us, a pond area will even now, if we take into account its occasional use for agricultural purposes, yield a more regular and better income than mere agriculture. But if we succeed in furnishing fish during their second and third year with cheap and good food, in the manner indicated, our ponds will also during the period when they serve fish-cultural purposes, produce more fish, and consequently a greater income—fully as much as that yielded by meadow lands. Taking this into consideration, many a farmer who at present labors in vain with the heavy moist soil of his old and long-since abandoned ponds, will again put these ponds in good working order; and in doing this he will not suffer any loss, but, on the contrary, if he is a good manager, the result of the fisheries will soon pay his expenses and leave him some money over. One after the other our farmers will follow this example, and gradually our whole country will regain all its old water area.

It should also be borne in mind that in parts of the country which suffer from drought, ponds by their exhalations furnish the surrounding vegetation with ample moisture, and thus to some degree counter-

act the hurtful influence of the cutting down of the forests. The forests with their rich beds of moss and dry leaves were the natural water regulators, catching the rain and gradually, but continuously, returning it in the shape of springs and exhalations. In this manner they protected us, to a certain degree, against the entire drying out of the brooks and against devastating inundations. Large ponds may well serve as reservoirs, and partially make up for the general devastation of the forests, by receiving during inundations a considerable portion of the turbid water, by letting the fertile mud settle in them, thus benefiting both the fish and the crops, which are during some years to be raised in the ponds, and finally by gradually giving up the purer water to the lower country and thus proving a blessing in many ways.