Mr. Kellogg, "I think all who have experimented will allow. It is perhaps somewhat difficult to point out the causes of failure, which seem to lie principally in the uncertainty of fecundating the ova, a very large proportion of which often proves barren, in spite of every care and precaution. We must suppose that some one of the conditions necessary to thorough fecundation has been disregarded or not understood. There is no reason to doubt, however, that the careful observations of experimenters, each succeeding year, will overcome the difficulty, and will lead at last to complete success.

"The rapidity with which fish grow with good feeding is truly surprising. In the basin of a fountain in my garden a single trout has lived during this season. For some time no care was taken to feed this fish, it having been left to depend for its existence upon the few insects which chanced to fall into the water, and for several months it increased in size very slightly. After being fed daily with worms for a few weeks, its growth was remarkable. In a single month it has more than doubled in weight.

"During several winters I have kept in a small tank in the cellar a considerable number of trout, and although quite thin after the spawning season, they have become fat and in excellent condition before spring, by means of generous feeding. It is astonishing, also, to notice how easily fish may be domesticated. Wary trout, after only a few days' confinement, will eat readily, watch daily for their accustomed allowance, and even become so gentle as to take food from the hand, like chickens."

PRACTICAL HINTS TO FISH BREEDERS.

The following instructions, upon several points connected with the different stages of artificial fish breeding, are partly the results of our own observation, and partly condensed from an essay by Professor Vogt, of Geneva, Switzerland, translated for Mr. Marsh's report, before alluded to. This essay contains a very great amount of valuable and curious information, in respect to the reproduction of fishes, and the best methods of securing success in artificial fish breeding. It is worthy of perusal entire, by any one to whom it may be accessible.

1. The mere contact of spawn and milt does not suffice to effect fecundation. To insure the production of a living creature from the egg, the active element of the milt, which consists of moving microscopic corpuscles, provided with a thread-like tail, and called seminal animalcules, must penetrate into the interior of the egg, and there unite with its substance. Every egg is, therefore, infallibly lost, unless it has thus absorbed the constituent of the male generative fluid.

2. The perfect eggs of fresh-water fish consist of an external skin, or shell, within which, enveloped in a second thinner membrane, called the *vitelline membrane*, is the yolk. The yolk is always bright and clear, sometimes quite colorless and transparent, like water, (as in the white-fish,) sometimes of an amber or orange color, as in the trout and salmon. The outer coat of the egg and the vitelline membrane lie in close contact, so long as the spawn remains in the body of the fish; but, as soon as the eggs are deposited in the water, a rapid absorption

commences, the water penetrates through the external coating, which swells and becomes distended, thus leaving a space between itself and the vitelline membrane around the yolk, this space being filled with water. The vitelline membrane is impervious to water, so long as the egg is in a healthy state, and its contents remain perfectly clear and limpid. But the penetration of water into the yolk is at once betrayed, by its assuming a milky color; and this is an infallible proof of the unsoundness of the egg.

3. An orifice is observed in the eggs of most fresh-water fish, opening at the surface, through which the seminal animalcule penetrates to the interior of the egg.

4. Since the spawn can be impregnated only by the reception of the animalcule, it becomes of much practical importance to ascertain how long this minute being retains its power of motion and impregnation. At low temperatures, this power may be retained for hours, and even days, *if the milt remains in the organs in which it is secreted.* The eggs of trout have been impregnated by milt taken from the male after it was stiff-frozen. But, when once the milt is placed in water, the power of moisture is very soon lost. It has been found that the animalcule of the mullet perishes in three minutes and ten seconds; that of the carp in three minutes; that of the perch in two minutes and forty seconds; and this in the degree of heat most favorable to vitality. *Very slight variations, above or below this point, destroy the animalcules with great rapidity.* The temperature which seems longest to maintain their vitality is, for winter fish, like the trout, 41° to 48°; for those which spawn in early spring, 50° to 55°; for those of early summer, 63° to 68°; and for those of hot weather, 77° to 87°.

5. It becomes, therefore, a matter of the greatest practical importance to perform the processes of impregnation in the *very shortest possible time.* Some operators mix the milt first with water, and then immediately drop the spawn into it, believing that the minute currents, formed by the absorption of water by the egg, have the effect of directing the movement of the animalcule toward the orifice. It is also supposed that the swelling of the egg, in consequence of the absorption of water, tends to close the orifice, so that the animalcule cannot enter, after the envelope is full of water. However this may be, it is found, by experience, that the *simultaneous* mixture of the milt and the spawn is most likely to effect the impregnation of the greatest proportion of the eggs; and hence it is recommended, when practicable, that *two* persons should work together, one manipulating the male fish and the other the female.

6. It is absolutely necessary that the ova be *mature.* Fish do not deposit all their spawn at once, but usually through several successive days, as the eggs become ripe. The operator should, therefore, use no violence in forcing the eggs from the female; since those which are fully mature, and fit for impregnation, will fall from her with very little pressure. After she has emitted that portion which is fully ripe, she should be placed in the tank again for a day or two, when a second portion will be ready for impregnation. The milt of a single male is usually sufficient for the eggs of several females; and it may be obtained likewise in successive portions.

7. An apparatus for enabling the fish to spawn naturally, thereby obviating the necessity of taking them into the hand at all, has been used in France. It consists of a sort of double-bottomed cage, the upper bottom being an open frame-work of wire, the lower a movable sieve of metallic cloth. It is suspended in the water of the pond, and the male and female fish placed in it. The female, by rubbing against the bars of the open-work floor, emits her eggs, which fall through upon the sieve below, and are impregnated by the male in the same way. We are not definitely informed as to the success of this contrivance, but it may easily be tested.

8. After the eggs are fecundated, their hatching still requires care. The essential points are an abundant supply of well aerated water, at a proper temperature, removal of unsound eggs, and protection against insects and parasitic mildew or fungus. Since light is indispensable to the production of this destructive microscopic vegetable, it has been recommended to keep the eggs, during hatching, in darkness. Different species require different degrees of warmth. The eggs of the trout will bear a temperature nearly as low as 32°, but would be destroyed by remaining in water as high as 55°. They require the purest water; and that of a running spring, or stream, which can be constantly renewed, is best. If this cannot be had, filtered water is recommended. The eggs should be examined once or twice a day, and every one which shows the least degree of disease, indicated by the opaque, whitish color of its yolk, should be removed with a pair of small tweezers or forceps. The accumulation of sediment which would be likely to breed mildew, should be also removed, by passing over the eggs a soft hair pencil. *During the first few days of development, the spawn should be agitated as little as possible,* since it is at this period that the foundation of all the organic processes and of the whole structure of the fish is laid. After the eyes of the young fish begin to be visible through the egg-shell, appearing like two disproportionately large black dots, the egg is much less sensitive to rough treatment, and may be handled, or transported to a distance, with less risk than at any other period of its development.

9. As to the hatching apparatus, it may be said that any is good which admits a free circulation of water, excludes rapacious enemies, and permits ready access to the eggs, and the easy removal of such as may become infected. A very successful operator, Mr. Knoche, thus describes the apparatus used by him:

"For a breeding chest, I employ a stone trough seven feet long, two feet broad, and one foot deep, and provided with a wooden cover fitting into a rabbet, and secured by a lock. To one end of the cover is nailed a frame, whose length is equal to the breadth of the cover, and which is four inches wide and five inches deep, forming a small trough placed across the cover of the large one at the upper end. Within this frame several holes are bored, through the main cover, so as to allow the water, supplied from above, to pass into the trough. A piece of coarse linen cloth is nailed across the frame, and through this all the water which enters the trough is strained. Within the breeding-trough there is a perforated box, which distributes the water received from the frame evenly and quietly through the trough. At the opposite end of the trough, six inches above the bottom, are two square holes, covered with finely-perforated tin plate, and so adjusted as to permit the escape of the same quantity of water as is admitted through the frame. The trough is sunk in the ground, near a spring, which is raised by a dam to the height of a foot, and the water is conducted directly to the middle of the frame, on the cover of the trough, through a pipe about an inch and a half in diameter. The bottom of the trough is filled up to the depth of three inches with clean-washed sand, or gravel, and the water always stands three inches deep on the sand. When the eggs are to be introduced, the flow of water from the spring is shut off, and the impregnated spawn, after standing three hours, is carefully poured into the trough, and so distributed that the eggs are not in contact with each other. The distribution is effected, *without touching the eggs*, by agitating the water over them with the bearded end of a quill. The trough is now closed, *and left undisturbed for twelve hours*, after which the water from the spring is again admitted, and kept regularly flowing."

This process may be greatly varied according to circumstances, as in the cellar experiments of Mr. Kellogg. Like the latter, Drs. Mayor and Duchosal, of Geneva, used the common drinking water from the public reservoir. They placed the eggs in square earthen pots, arranged on the steps of a stand, like those used for flower pots.

Each pot had a small aperture in front, into which was introduced a pipe, to convey the water to the next tier below, and so arranged as to keep the water in all the pots one inch deep. The pipe from the reservoir was pierced with holes, corresponding to each pot in the upper tier; these pots, which were about a foot square, received a constant stream of about a line in diameter, directly from the aqueduct pipe, and the lower pots received their supply from the tier next above. The eggs hatched equally well in all; but, from the partial exhaustion of the air in the water in passing through the upper tiers, the eggs in the lower tiers were somewhat longer in hatching. Other contrivances, adapted to peculiar contingencies, will be readily suggested to persons of ingenuity. For hatching eggs in spring or summer, flat-bottomed earthen pots may be used, with small holes in the sides, about an inch from the bottom, so as to admit a free circulation of water. These may be inserted in small rafts, made of wood, and thus left to float in the current, the rafts being secured by a cord, so that the pots may be drawn to the bank at any time for examination. No gravel would be necessary in these pots.

10. After the exclusion of the young from the eggs, so long as the yolk-sac remains attached to the abdomen of the fry, little attention is required. It is well to remove them to a larger receptacle, as a long trough, with a foot of water, to allow them space for their movements. A floating box may be used for this purpose, so loaded as to swim horizontally, and moored so that the current of the water will pass through it from end to end, fine wire net-work being fixed at each end to prevent the escape of the brood.

11. After the yolk-sac is exhausted, the young fish require food. Small insects and larvæ form their principal natural nutriment, and these abound in every brook and pond, so that the fry may usually be

left to take care of themselves for awhile. The pond into which they are admitted should be carefully cleansed, and should not contain any of the larger fish. A small stream running into the pond, up which the young can proceed, would be peculiarly favorable for the prosperity of trout. Left thus to themselves, Mr. Knoche has generally found about half the original number at the end of the year, the rest having perished or escaped. When little water can be commanded, and only small artificial reservoirs can be used, feeding becomes necessary. Small trout devour with avidity coagulated blood, boiled or dried flesh, fragments of boiled fish, or any other animal substance which can be divided into fine fibers, thus resembling worms while sinking in the water.

12. It is important to determine what particular species should be selected for artificial breeding in particular localities. As a question of profit, it is obvious that we should breed the kinds most valued in the market for which they are bred, commanding the highest price, and best accommodated to the natural or artificial conditions at the disposal of the breeder. If fish from distant localities promise a better return than native species, they may be introduced. On these points no precise rules can be laid down. The introduction of fish from remote localities is not difficult. The best period for transporting the eggs is, as already noticed, when the eyes of the embryo appear through the shell.

13. Of the success of private operations, where the breeding is artificially conducted from the spawning to the market, an opinion may be formed from the following statement of Mr. Knoche:

"For the last six years I have hatched, annually, about eight hundred fish (trout) from a thousand or twelve hundred eggs. At the end of a year from hatching, I seldom find more than half that number in the pond, the rest having perished or escaped, probably the latter, as it is very difficult to make a pond so tight that the fry cannot sometimes pass out, at either the inlet or the outlet of the water. My fish, in general, thrive well, and for the last three years my ponds have supplied, annually, from three to four hundred artificially-bred trout, of three and four years old, those of the latter age weighing from three quarters of a pound to a pound."

FISH AS AN ARTICLE OF DIET.

It is generally admitted that fish supply an article of diet at once palatable, nutritious, easy of digestion in most cases, and conducive to good health. But what are their nutritive qualities as compared with other kinds of animal food? whether different species of fish differ materially in degree of nutritive form? and whether, as food, fish possess any peculiar or special properties? These are questions of great interest to consumers of fish, but to which it is even yet difficult to give a satisfactory answer. An inquiry into these points was made, a few years ago, by Dr. John Davy, inspector general of army hospitals, &c., the results of which he read before the Royal Society of Edinburg. Taking for granted the proposition "that the nutritive power of all the ordinary articles of animal food, at least of those composed

principally of muscular fiber, or of muscle and fat, to whatever class belonging, is approximately denoted by their several specific gravities, and by the amount of solid matter which each contains, as determined by thorough drying." Dr. Davy subjected portions of several species of fish, and also several kinds of meat and other alimentary substances, to the test of very accurate processes, in order to ascertain their several nutritive powers. The following tables show some of the results, the fish, selected from those upon which Dr. Davy experimented, being either common to both shores of the Atlantic, or quite similar to fishes known by the same name among us:

TABLE I

Species of fish	Specific gravity.	Solid matter, per cent.	Time when obtained.
Haddock	1056	20.2	August.
Hake	1854	17.4	October
Pollock	1060	19.3	October
Whiting	1062	21.5	March.
Common cod	1059	19.2	April.
Mackerel	1043	37.9	October
Salmon	1071	29.4	March.
Trout	1053	22.5	March.
Trout	1050	18.7	October
Smelt	1060	19.3	March.
Eel	1034	33.6	June.

TABLE II

Kinds of food	Specific gravity	Solid matter, per cent	Time
Beef, sirloin	1078	26.9	March.
Veal, loin	1076	27.2	November
Mutton, leg	1069	26.5	November
Pork, loin	1080	30.5	January.
Common fowl, breast	1075	27.2	November.
Grey plover, breast	1072	30.1	November.

"These results," says Dr. Davy, "I wish to have considered merely as approximate ones. Casting the eye over the first table, it will be seen that the range of nutritive power, as denoted by the specific gravity and the portion of solid matter, is pretty equable, except in a very few instances, and chiefly those of the salmon and the mackerel; the one exhibiting a high specific gravity, with a large proportion of solid matter; the other, a low specific gravity, with a still larger proportion of matter, namely: muscle and oil, and, in consequence of the latter, the inferior specific gravity."

Oil also abounded in the eel, and hence the large amount of residuum it afforded.

Comparing, *seriatim*, the first table with the second, the degree of difference of nutritive power of those articles standing highest in each, appears to be inconsiderable, and not great in most of the others. Thus the salmon, the mackerel, and the eel contain more solid matter than beef; and the specific gravity of salmon is greater than that of mutton. These results are certainly surprising, and not in accordance with popular and long-received notions.

"That fish generally are easy of digestion," proceeds Dr. Davy, "excepting such as have oil interfused in their muscular tissue, appears to be commonly admitted as the result of experience—a result that agrees well with the greater degree of softness of their muscular fiber, comparing it with either that of birds or of the mammalia, such as are used for food. A more interesting consideration is, whether fish, as a diet, is more conducive to health than the flesh of the animals just mentioned, and especially to the prevention of scrofulous and tuberculous disease. From such information as I am able to collect, *I am disposed to think that they are.* It is well known that fishermen and their families, living principally on fish, are commonly healthy—may I not say above the average? and I think it is pretty certain that they *are less subject to the diseases referred to than any other class, without exception.*"

This statement is proved by reliable statistics, collected with care by Dr. Davy, who proceeds to remark that if this exemption be mainly owing to diet, and that a fish diet, it may be presumed that there enters into the composition of fish some element not common to other kinds of food. This element is believed by him to be *iodine*, distinct traces of which have been found in every instance in which he sought for it in sea-fish, though not so strongly marked in the migratory fish, and not at all in the fresh-water fish. The medicinal effects of cod-liver oil in mitigating, if not in curing, pulmonary consumption, appear to be well established, and as this oil contains iodine, the analogy seems to strengthen the inference that sea-fish generally may be alike beneficial.

In concluding this imperfect notice of fish culture, which we hope to follow by a second in the next Report, we refer those readers who may have become interested in the subject, and who may desire to obtain further information as to many points upon which the space here accorded will not permit us to be more explicit, to two works, which are easily accessible to American readers, and which they will find useful assistants in practical fish breeding. They are, "A Complete Treatise on Artificial Fish Breeding," &c., published originally in 1854, by D. Appleton & Co., New York; and "A Treatise on the Artificial Propagation of certain kinds of Fish," &c., by T. Garlick, M. D., published at Cleveland, Ohio, by Thomas Brown, 1857.

ENGLISH PLOWS AND PLOWING.

BY HENRY F. FRENCH, OF EXETER, NEW HAMPSHIRE.

Even a casual observation of the operation of plowing in England must suggest to an American farmer a series of questions for solution, respecting both the form and structure, and the mode of use of the plow. The plows made by Ransome and Simes, which I saw on exhibition at the shows of the Royal Agricultural Society, and of the Suffolk County Society, perhaps rank as high, at present, as any plow in England. I was informed, at the warehouses of the manufacturers, at Ipswich, that their plow in common use as a seed plow, for two horses, weighs two hundred and eighty pounds, and its length is twelve feet. It turns a furrow of eight or nine inches in width, and five or six in depth, which may be increased to one of ten by seven inches.

Actual experiment, at the warehouses in Boston, shows the average weight of American plows designed for the same work, with wheel and cutter, to be about two hundred pounds, and their average length about seven and a half feet.

The English implement is entirely of iron, of fine workmanship and finish, with two wheels, and is much less simple in its structure than the American; yet the American plow seems to be more firm and strong than the other. Indeed, the extreme length of the handles and of the beam of the English plow, notwithstanding they are of iron, gives to a hand accustomed to the American implement a feeling of insecurity, as if the material were elastic, and would not be stiff enough to control the work were a stump or fast rock to be encountered in the furrow. This apprehension, however, is idle in most English fields, which for a thousand years, perhaps, have felt the pressure of the plowshare.

But the difference between English and American plowing is fully as striking as that between the plows. The worst-plowed field which I saw in a summer's ramble through old England might be said, literally, to appearance, to be done better than the best-plowed field that can be found in a New England farm. There seems to be no such thing in England as a crooked or irregular furrow, but, however extensive the field, the work appears uniformly as straight as a line could be laid down by a civil engineer with his instruments; and whether the operation be really more thoroughly performed than with us or not, it has at least the merit of being accomplished precisely as the plowman desires.

Our first impression upon these observations would naturally be, that notwithstanding the English plow is more clumsy and expensive than the American, yet that the former must have advantages of structure, which, for use in old and thoroughly-tilled fields, at least, more than compensate for these objections. Yet this, however natural, would be a hasty conclusion.

Within twenty miles of Ipswich, where Ransome's highly-finished