It is employed for several useful and ornamental purposes, such as the making of ear-rings, necklaces, brooches, snuff boxes, knife handles, etc. It is particularly worn as mourning jewelry; it requires, however, much care in working, being extremely brittle. It is ground on lead wheels with emery, and polished with rotten-stone. It is kept in favor by the jewelers, on account of its high polish; but its value is very indifferent, excepting that of the iridescent obsidian, which commands a high price, and is sometimes seen cut in cabochon, and set in rings.

There is no doubt but that obsidian is of volcanic origin, being mostly found in the neighborhood of volcanoes, and that it is a glass, produced by volcanic fire, as it is a combination of silex and alkaline substances. The Neptunian theorists have endeavored to prove that it is occasionally found with the remains of decomposed granite, gneiss, and porphyry, with which it even alternates in layers.

FISH CULTURE.

BY CHARLES J. ATKINS.

Nearly all of our common fishes are *oviparous* which term, as distinguished from *viviparous*, we may apply to those species of animals which are reproduced by eggs laid in an undeveloped state. In most cases not only are the eggs extruded from the female fish before their development, but also that contact of the male element which impregnates them, and without which no development is possible, is effected after extrusion.

The operation of spawning, or depositing and impregnating the eggs, as performed by the parent fishes, is essentially as follows. At the spawning season, mature fishes of both sexes repair to a suitable locality; and, having selected a place, a female extrudes her eggs, which sink to the bottom among the pebbles, or, if glutinous, adhere to sticks, weeds, and stones. At the same time, or immediately afterward, the male emits the milt, the fecundating element, which, diffused through the water, comes in contact with the eggs and impregnates them. In due time, nourished by the water in which they are deposited, and quickened by its heat, they develop and hatch into living fish.

Now a little examination into circumstances will make it evident that a great waste must here occur. A multitude of greedy creatures hover around, ready to devour the eggs as soon as they are left by the parent, or are swept within reach by the current; a portion fails to come in contact with the milt; others are destroyed by noxious sediment or parasitic fungi, or buried deep beneath the shifting sands which the floods may bring down upon them. Should a portion of the eggs escape these dangers, the newly-hatched and defenceless young are eagerly hunted out by all the carnivorous tribes of the water. In the end, comparatively few of the eggs laid result in mature fish; it is perhaps impossible to ascertain the proportion with precision, but one per cent, would be far more than sufficient to maintain and increase the numbers of any species, so enormously fecund are they. Indeed, a rough calculation shows that were one per cent of the eggs of a salmon to result in full grown fish, and were they and their progeny to continue to increase in the same ratio, they would in about sixty years amount in bulk, to many times the size of the earth. Nor is the salmon among the most prolific species. I have counted in a perch (*Perca flavescens*), weighing three and a half ounces, 9,943 eggs; and in a melt (*Osmerus viridescens*), ten inches in length, 25,141. Some of the larger fishes produce millions at each spawning.

Now if in some way the eggs can be protected from these various dangers that threaten them when abandoned by the parent fish to the ordinary course of nature, it will at once be seen that a great gain will be made in the number hatched from the spawn of each mother; and if, farther, the young fish can be protected from their enemies until they have acquired size, strength, and agility sufficient to care for themselves, another gain will be thus effected. These two problems are among the most important with which Pisciculture has to deal, but have, we think, been satisfactorily solved.

An interesting experiment was made in Sweden in 1761, by Charles Frederick Lund. He obtained some breams, perch, and mullets, with mature spawn, and placed them in large submerged or floating wooden boxes, in which he had placed quantities of pine boughs. In these boxes the fish were kept several days, until they had completed the process of spawning; they were then removed. The eggs had adhered to the boughs. These species hatch quickly, and in a short time multitudes of young fish emerged from the boughs. In this way he obtained from fifty female breams, 3,100,000 young; from one hundred female perch, 3,215,000 young; and from one hundred female mullets, 4,000,000 young. These are certainly wonderful results. They were placed in the Lake of Ræxen, and dismissed to care for themselves. In a similar way those species, like the trout, whose eggs fall free from each other to the bottom of the stream, may be made to spawn in places where it will be convenient to protect them by enclosures from marauders; and, with a suitable arrangement of small ponds and streams, the young fry of all species may be separated from the old ones that would devour them.

But the crowning discovery in Pisciculture was that of artificial fecundation. This discovery was made during the last century, but was turned to no practical account, and was hardly practised except in laboratories, when it was re-discovered in France a few years ago, under circumstances that brought its economic bearing prominently before the attention of learned men.

Since the operation of extruding the eggs and milt is essentially mechanical, it can be as well performed by man as by the fish, and, once extruded, the milt performs its own office upon the eggs, and fertilizes them, with no other interference than suffices to bring them into contact. Nay, man can do better than the fish: he can express the eggs into a vessel where none of them will be swept out of reach of the milt, or into the maws of the expectant throng of bystanding fishes; he can then press the milt into the same vessel, and, by stirring them together, insure that the milt shall reach every egg. This is artificial fecundation. But let us examine the method employed.

The operations of Pisciculturists, who have practised artificial impregnation, have been mostly confined to a few species of the family of Salmonidæ. The processes pursued will therefore apply only in a limited extent to the members of other families.

Perhaps salmon and trout have received the most attention. Both these species always seek, running, shallow water, and spawn in the autumn or early winter. A female and male, both ripe and ready to spawn, seek a proper place, and on a gravelly bed, swept clean of sand for a small space, the female deposits her eggs, and the male his milt. The operation is described with great minuteness by European writers but I think that our brook trout (*Salmo fontinalis*) has not been observed sufficiently to ascertain whether its habits are precisely those of the European trout.

All fishes, when spawning, are so intently engaged upon it, that they take very little notice of anything else. Trout can be captured with the greatest ease at this time—not unfrequently they can be taken with the hand. The following is the artificial process as described by a practical breeder of the brook trout.

The trout, male and female, must be taken with a net, or in some manner that will not injure them, just at the time they are preparing to spawn, and placed in baskets standing in the water in some convenient place. A pan or pail with three or four inches of water in it is brought near the baskets containing the trout. All things being ready, a female trout is taken out of the basket with one hand, and with the other the abdomen is gently rubbed from the gills downward, whereupon the spawn flows in a continuous stream into the vessel. The rubbing is continued until the spawn is wholly extruded, and the trout is then quickly replaced in the water. This operation must not continue more than one minute if possible. On one side of the egg is a small white speck; this is where the impregnation takes place. This side of the egg being lightest, it always falls uppermost. A male trout is now taken, and in like manner the milt is expressed; it falls through the water and settles upon the eggs. All the trout in the baskets are served in the same manner. The spawn and milt are then placed in shallow vessels, and deposited in water, where they are allowed to remain an hour more. (Other operators find a few minutes sufficient to insure impregnation, and at the end of that time rinse the eggs thoroughly.)

The manner of proceeding with salmon and other species is essentially the same.

The eggs, being thus artificially impregnated, may be deposited in a natural stream, under circumstances as closely as possible resembling those chosen by the fish, and left to themselves; or, as is far better, they may be subjected to artificial hatching. By this they may be guarded from various mishaps, the supply of water can be so regulated that it will be uniform, and the eggs can be examined from time to time, and dead and diseased ones be removed before they can injure their neighbors.

It is essential that the incubation be conducted under circumstances like those under which it naturally takes place. The temperature, quality, and state of the water are the main conditions. Some species spawn in fresh water, and some in salt; some in rapid streams, and some in lakes and ponds; some in winter, and some in summer. The temperature required by trout is about forty one deg. Fahrenheit, ranging, however, from several degrees below this, to about fifty deg. while some species of summer-spawning fish require a temperature higher than sixty degrees. The time required for development varies with different species, and is much affected by temperature. Some species hatch in five days, while the trout is rarely less than fifty days, and at thirty-seven degrees of heat requires one hundred and thirty-six days.

The apparatus employed in artificial incubation is of various kinds. A metal box, with many holes to admit a free circulation of water, was one of the first employed; this is immersed in the water. Troughs of stone, vessels of earthenware, willow baskets, and wooden boxes have all been used in the incubation of salmon and trout.

A favorite form of hatching box for trout is a long wooden trough, its bottom inclined sufficiently to cause a gentle flow of water through it, and covered with a layer of gravel; the whole covered in by a lid. The eggs are deposited in the gravel or sand, and a stream of water, an inch or two deep, led through the trough.

At the French Piscicultural establishment at Huningue, and the Stormontfield salmon-breeding ponds, the hatching apparatus consists of a series of horizontal troughs, arranged side by side like the steps of a stairway, through which a stream of water falls in succession from the uppermost.

After the eggs are deposited in the hatching-boxes, a proper supply of pure water must be kept up until they hatch. They must be frequently examined to remove diseased eggs, and guard against the collection of sediment. It is better that they be kept in darkness, for light encourages the growth of a parasitic fungus.

When trout hatch they have still a large portion of the egg attached to the abdomen; that is gradually absorbed, and while it remains they require no food. It is the "yolk-sack." Upon its complete absorption the young trout begins to feed, and must be placed where he can find his own food, or must be regularly supplied with such as is adapted to his infantile condition, and will attract his attention, and tempt his appetite.

The whole process of producing fish, by artificial impregnation and incubation, is in practice remarkably successful. More than ninety per cent of the eggs become living fish. Mr. Ainsworth, the authority quoted above, has this year obtained twenty thousand trout from twenty-one thousand eggs, being more than ninety-five per cent.

In another point of view this process is of vast importance. It facilitates the transportation of species from one water to another. Salmon eggs, fecundated, were carried from Scotland to Australia in 1865; were successfully hatched in the River Plenty; and, having returned from their first migration to the sea, may now be considered as established there. In a similar manner the Merrimac River has been sown with salmon eggs brought from New Brunswick, and a harvest may be expected therefrom.

The rearing of fish in artificial ponds and reservoirs, and then bringing them into marketable and eatable condition by regular and systematic feeding, has been successfully carried out, and it is found to be quite practicable as an industrial occupation, bringing better returns, when trout are reared, than the growing of any other kind of animal food. Yet to determine with certainty what are the conditions of success in this branch of Pisciculture requires further experiment.

Pisciculture is not a new art. It was practised among the ancient Romans; yet not as an industrial pursuit, but as a source of amusement to men of wealth and leisure, or to supply with delicacies the tables of a gluttonous nobility. In Catholic countries, since the establishment of monasteries, fish preserves have been commonly attached to those institutions, to supply the devotees with food during their frequent religious fasts. There is no reason, however, to suppose that they had any knowledge of artificial impregnation. In China, it has long been an important branch of industry, and although we know very little of the process that they employ, it is certain that they succeed in making fish an abundant and cheap article of food.

Since the awakening of the public mind to this subject in Europe, government establishments have been put in operation in France and Germany, and private operations of great importance have been carried on in the British Isles. It is thought that primitive abundance may be restored to their now exhausted rivers, and not many years hence an acre of water shall be made to produce as much food for man as an acre of land. In America many persons have engaged in pisciculture as an experiment, and some attempts have been made to carry it farther; but as nothing has been done on a large scale, no great results have yet been attained.—*American Naturalist.*

Correspondence.

The Editors are not responsible for the opinions expressed by their correspondents.

What are the Comets?

MESSRS. EDITORS:—It seems that as yet no satisfactory explanation has been given about these mysterious heavenly bodies. After seeing the article in No. 6 of the present volume, I beg leave of presenting herewith my hypothesis, which I have developed during many years past, and by which all known phenomena can be explained in a more satisfactory manner than by any other hypothesis.

The comet consists of gaseous matter which by the force of gravitation is formed into a perfectly round sphere. This sphere is of much greater dimensions than is generally supposed. The tail of the comet represents only the radius of the whole sphere; it is the visible part of the gaseous matter, while the rest of the sphere is perfectly transparent and consequently invisible to our eyes.

On its solitary travel through the space of our stellar system, and in consequence of the loss of heat by radiation, this sphere of gaseous matter is in a state of condensation and has the appearance of a cloud or of a sphere of mist. But as soon as it approaches our planetary system and becomes visible to our eyes, it comes under the influence of the caloric rays of the sun, by which the misty or cloudy matter is reduced to a perfectly transparent gas, and thus becomes invisible. Only the more dense mass that is collected around the nucleus, withstands the action of the sun's rays and thus remains visible as the head of the comet. On the opposite side from the sun, that portion of the gaseous matter which is shaded or protected by the head against the caloric rays of the sun retains its cloudy or misty appearance by which it is visible to our eyes as the tail of the comet. This tail is in perfect equilibrium with the rest of the invisible gaseous matter that forms the sphere; it is in fact a cloud in the shape of a column within a large sphere of a perfectly transparent gas.

Based on this hypothesis I can explain all known phenomena in relation to comets in such manner that no scientific man could contradict me. But it would make a book to represent my hypothesis in full in all its details, and I could hardly expect that so much of the valuable space of this journal could be devoted to one single subject. I wish to add only a few words.

Against this hypothesis perhaps the objection might be raised, how could such a great sphere of gas pass our planetary system without a collision, or without causing some great catastrophe upon our planet, the earth? As an answer to this I would refer only to an article in No. 2 of Vol. XIV., new series, of the SCIENTIFIC AMERICAN, which contains a