

mated in North America without the least difficulty, and the camel, which is the last importation of that kind, bids fair to do as well as those which have gone before it.

The enterprise of naturalizing foreign animals requires to be carried on with great judgment, both as to the species to be selected and to the places where they are to be first located. It is a remark made by an experienced naturalist, that not only are the animal species, from which selections may be made, more numerous in the southern than in the northern parts of the world, but that the acclimation of an animal from a warm region into a cold one is more easily accomplished than that of an animal from a colder into a warmer. Animals from a warmer climate should, therefore, other things being equal, be chosen in preference; and, in any country, the chief establishment for acclimation should be near its most southern border, a point from whence animals may, as they become inured to the climate, spread northward. An animal from a cold climate should, however, be carried to a warmer with great caution; for example, the fleece-bearing animals, from cold mountains and table lands, such as the llama, the alpaca, and the yak, should be naturalized in the coldest and most mountainous districts that are readily accessible.

A further very important care is requisite. Animals chosen for acclimation are often exposed to great dangers at first, from the change in climate and habits to which they are subjected, and this is more especially the case with those which have not been previously domesticated. Their death, under such circumstances, not only involves the loss of the trouble, and expense which may have been incurred in procuring them, but has a bad moral effect by discouraging a useful enterprise, and creating a false impression as to its feasibility. Such difficulties can be best met by putting the animals under the care of men who are acquainted, not only with their habits, but also with the proper means of preserving and of restoring their health. Under the charge of skillful veterinarians, establishments for the acclimation of animals might obtain them from foreign countries, watch over and support them during the first years of their transplanted life, and distribute their offspring to those places where they would be useful in domestic service, or where they would people those regions of country which are unremunerative to the labors of the husbandman, or, as yet, unsettled by him.

The naturalization of foreign domestic animals is at the present day by no means an entirely neglected subject in this country; for, not to speak of other instances of progress, it is well known that Dr. Davis, of South Carolina, has introduced into his native State more than one valuable animal, and, in fact, may be said to have commenced there a system of acclimation.

The domestication of wild animals is an enterprise which is closely connected with that of acclimation, and opens a still wider field for human progress. While the natural instincts of some animals are such as to render it practically impossible to tame them as a race, with many others it is very different; and while some of those which it is practicable to domesticate would, perhaps, not repay the trouble of doing so, there must remain many which would be exceedingly valuable.

On this point, St. Hilaire remarks: "Of the one hundred and forty thousand animal species at present known, how many does man possess in the domesticated condition? Forty-three; and, furthermore, of these forty-three species, ten are wanting in France, and eight in all Europe. Can this be held to be a sufficient conquest of Nature?"

Long ago, Buffon wrote in these terms: "We should feel from this example how great is the generosity of Nature toward us; we use but little of the treasures which she offers, the store of which is greater than we can imagine. She has given us the horse, the ox, the sheep, and all our other domestic animals, to labor for, to feed, and to clothe us; and she has yet in reserve, species which can supply to us whatever is yet wanting, and which only wait for us to subdue them, and to make them serve our wants. Men understand too little of what Nature can do, and of what they themselves could do with Nature. Instead of seeking out that which they do not yet know of, they prefer to misuse whatever is already known to them."

The voice of great philosophers has thus been raised, in former as well as in recent times, to call mankind to this path of progress, and it would become no country more than our own to respond to the call, and to none has Providence given greater means of doing so with effect, or a greater prospect of advantage from such conquests over Nature.

FISH BREEDING.

BY J. C. COMSTOCK, OF HARTFORD, CONNECTICUT.

Fluellen. * * * There is a river in Macedon, and there is also, moreover, a river at Monmouth; * * * and there is salmon in both.—KING HENRY V, *Act IV, Scene VII.*

However "goot a man in the disciplines of the wars, and in other particularities," the brave but pragmatical Fluellen may have been, his parallel between "Alexander the pig" and "Harry of Monmouth," certainly did not hold good in the "particularity" above quoted, since no river in Macedon ever did contain "salmons." The comparison would be still more liable to objection if made at the present day; for, however abundant "salmons" may have been in the Wye in the time of Henry V, their number in that river has now become so much diminished that there is serious prospect of its being at last reduced to the salmonless condition of its Macedonian compeer, and that the actual truth of a parallel between them will be found in the assertion that there is salmon in neither.—(See *London Quarterly Review*, January, 1857.)

This assertion is, unhappily, already literally true in reference to most of those rivers in the eastern United States which once were frequented by salmon, and is applicable alike to the Susquehanna, the Delaware, the Passaic, the Hudson, the Connecticut, the Merrimac, and their tributaries. The same process of extinction is gradually going on in the rivers to the northward of them; and even in the British Provinces, where, until recently, salmon have been quite

abundant, their great diminution in numbers within a few years past has excited inquiry as to its causes, and led to the enactment of laws for its prevention.

It is not probable, however, that the most judicious legal regulations, even if strictly enforced, will ever have the effect of restoring the population of our waters to its pristine abundance. There would appear to be causes for its diminution which lie beyond legislation, and which are inherent in the changes produced by the extension of human improvements over the surface of the earth. We find, in fact, that many species of animals, once numerous and important as objects of the chase, or as furnishing food to the earlier settlers of what are now densely-populated regions, have, in like manner, receded from the presence of advancing civilization, and are either quite extinct or rarely met with in the places which they formerly inhabited.

Thus, it is probable that the bison once extended its range as far to the eastward as the Hudson river, and perhaps even into New England. The wapiti, or American elk, (*cervus canadensis*), once an inhabitant of the northeastern States, and said to have been killed on Long Island within the past forty years, is now found east of the Missouri only in one or two isolated localities, if at all. The cougar, the moose, the bear, the wolf, the beaver, the wild turkey, the Virginia deer, the pinnated grouse, have all been compelled to follow the same law, have totally disappeared from many sections of country where they were once common, and are gradually, but surely, losing their residence even in those more remote regions to which they have retreated.

The effects of the changes produced by an increase of human population are not, perhaps, so soon perceptible in their operation upon the inhabitants of the waters; and it is only at a comparatively recent date that the diminished supply of most species of fresh-water fishes has begun to be seriously felt. But it is a fact, within the notice and experience of every observing person, that streams and lakes in densely-populated districts do not now afford the supply of fish which they did formerly, and that this is the case even in large rivers which had, from time immemorial, been resorted to by migratory fishes, for the purpose of spawning. On all such rivers in this country the fisheries are yearly declining in value and importance, and upon many of them the occupation of the fisherman is well-nigh gone.

The building of dams across the tributary streams, by means of which the fish are prevented from ascending to their proper spawning grounds; the erection of mills and factories, and the consequent pollution of the waters by saw-dust and the refuse of chemical ingredients used in the different processes of manufacturing; and the disturbance of the larger rivers by the passage of steamboats, may be properly reckoned among the proximate causes which induce the fish to desert their accustomed haunts. Add to this the reckless conduct of a class of persons who should be most solicitous for the preservation of the fish—that is, the fishermen themselves—who everywhere disregard all considerations of propriety and humanity in reference to time and mode of fishing, and it really seems a most remarkable test of the immense

natural fecundity of fishes, that a sufficient number remain in these localities to perpetuate their species at all.

Legislative restrictions seem entirely to have failed in checking the improvidence and rapacity of these men; and the difficulty of enforcing even the most judicious fishing laws would appear to be insuperable. Of such laws, indeed, as well as of those which respect the preservation of game, our people are exceedingly impatient, regarding them much in the light of sumptuary regulations, and sturdily resenting any interference with what has long been considered the free right of every man to take fish and fowl in any way, and at any time he pleases. It is not too much, then, to say that, in every part of the country, existing fishing acts, which are intended to regulate the time and method of taking fish, are almost totally disregarded, and with perfect impunity.

But there are also other reasons for the decline of our river fisheries, in addition to those already enumerated. These lie in the gradual but perceptible changes which are taking place in the character of the rivers themselves; and the influence which they exert upon the result in question is so important, and yet so little understood, that it should not be passed in silence here. The changes alluded to are well and clearly enumerated by one of our most accomplished American scholars, Hon. George P. Marsh,* in the following language: "Although we cannot confidently affirm that the total quantity of water flowing over the beds of our streams in a year is greater or less than it was a century ago, or that the annual mean temperature has been raised or lowered, yet it is certain that, while the spring and autumnal freshets are more violent, the volume of water, in the dry season, is less in all our water-courses than it formerly was, and there is no doubt that the summer temperature of the brooks has been elevated. The clearing of the woods has been attended with the removal of many obstructions to the flow of water over the general surface, as well as in the beds of the streams, and the consequently more rapid drainage of our territory has not been checked in a corresponding degree by the numerous dams which have been erected in every suitable locality. The waters which fall from the clouds, in the shape of rain and snow, find their way more quickly to the channels of the brooks, and the brooks themselves run with a swifter current in high water. Many brooks and rivulets, which once flowed with a clear, gentle, and equable stream through the year, are now dry, or nearly so, in the summer, but turbid with mud and swollen to the size of a river after heavy rains or sudden thaws. The general character of our water-courses has become, in fact, more *torrential*, and this revolution has been accompanied with great changes in the configuration of their beds, as well as in the fluctuating rapidity of their streams. In inundations, not only does the mechanical violence of the current destroy or sweep down fish and their eggs, and fill the water with mud and other impurities, but it continually changes the beds and banks of the streams, and thus renders it difficult and often impossible for fish to fulfill that law of their nature which impels them annually to return to their breeding place to deposit their spawn.

* Report on the Artificial Propagation of Fish, to Legislature of Vermont, 1857

The gravelly reach, which this year forms an appropriate place of deposit for eggs, and for the nutriment and growth of the fry, may be converted the next season into dry land, or, on the other hand, into a deep and slimy eddy. The fish are therefore constantly disturbed and annoyed in the function of reproduction, precisely the function of all others which is most likely to be impeded and thwarted by great changes in the external conditions under which it is performed. Besides this, the changes in the surface of our soil and the character of our waters involve great changes, also, in the nutriment which Nature supplies to the fish; and while the food appropriate for one species may be greatly increased, that suited to another may be as much diminished. Forests, and streams flowing through them, are inhabited by different insects, or at least by a greater or less abundance of the same insects, than open grounds and unshaded waters. The young of fish feed, in an important measure, on the larvæ of species which, like the musquito, pass one stage of their existence in the water, another on the land, or in the air. The numbers of many such insects have diminished with the extent of the forests; while other tribes, which, like the grasshopper, and suited to the nourishment of full-grown fish, have multiplied in proportion to the increase of cleared and cultivated ground. Without citing further examples, which might be indefinitely multiplied, it is enough to say that human *improvements* have produced an almost total change in all the external conditions of piscatorial life, whether as respects reproduction, nutriment, or causes of destruction, and we must of course expect that the number of our fish will be greatly affected by these revolutions.

"The unfavorable influences which have been alluded to," proceeds Mr. Marsh, "are, for the most part, of a kind which cannot be removed or controlled. We cannot destroy our dams, or provide artificial water-ways for the migration of fish, which shall fully supply the place of the natural channels; we cannot wholly prevent the discharge of deleterious substances from our industrial establishments into our running waters; we cannot check the violence of our freshets, or restore the flow of our brooks in the dry season; and we cannot repeal or modify the laws by which Nature regulates the quantity of food which she spontaneously supplies to her humbler creatures."

Taking all these circumstances into consideration, we are forced to the conclusion that our public fresh-water fisheries can never be restored to their pristine value and importance, but that they must everywhere gradually but surely decline. In this state of things, it becomes a matter of great interest to determine whether the supply of an article of food so wholesome, so abundant, and so cheap, as that hitherto afforded by these fisheries, can, in any manner or to any considerable extent, be still maintained by the application of enterprise and ingenuity to waters under private control, and whether the multiplication of valuable species of fish in such waters may not become an important accessory to agriculture. It is true that we believe the art of pisciculture likely to be of service; and it is in this aspect that we propose to consider the subject at present.

The breeding, preserving, and fattening of fish, as a branch of domestic economy, has been practiced in various methods, among various

nations, from time immemorial. The Chinese are said to have carried on for ages a traffic in the eggs deposited by salmon, trout, sturgeon, and other species, at the spawning season, in places prepared for the purpose, in rivers frequented by these fish; the eggs thus collected being sold and transported to different parts of the country, to be used in stocking private waters. Among the Romans the same method was practised, at a very early period, for peopling lakes and ponds with fish. At a later era, the taste of the wealthy patricians for fish-raising appears to have become a passion, and the enormous sums said to have been lavished by them upon the construction of their ponds and the feeding and preservation of choice varieties of fish, seem almost incredible.

During the middle ages, the kings and princes of Europe, as well as all the great ecclesiastical communities, maintained their artificial preserves, some of which were of great extent and supplied large quantities of fish. A fish-pond was an indispensable appendage to nearly every monastic establishment, and the priestly epicures were always well skilled in its management. They took care to stock their preserves with the most valuable species, which they often transported from distant places for this purpose. There are good reasons for supposing that the carp, the grayling, the charr, and perhaps other species, were in this way introduced into English waters, when England was Catholic. It would seem, indeed, that, in all probability, Dom Pinchon, a monk of the abbey of Réome, in France, was the inventor of the process of artificially fecundating the eggs of fish. This method of performing this operation is described in a manuscript recently brought to light, dated in 1420, and differs little from that practiced at the present day. The experiments of Dom Pinchon were, however, never published, and the credit of the modern invention of breeding fish artificially unquestionably belongs to Mr. Jacobi, a German gentleman who, in the year 1763, communicated to the Hanover Magazine an interesting account of his plan for the breeding of trout by artificial impregnation of their ova. His invention, as he states, was the result of many experiments, made during a series of not less than forty years; and it certainly contains the substance of nearly all that later practitioners consider essential to success. Though the process of Jacobi attracted some attention among the scientific men of his day, and was the means of stocking some waters in Holland, yet it appears to have fallen into disuse, and to have slumbered for a long time among those forgotten inventions which are so often claimed as new discoveries by a succeeding age.

About fifty years later than the time of Jacobi, that is, from 1830 to 1835, a series of really accurate and scientific observations were made in Scotland, in reference to the habits of fish at the spawning season—habits upon which the whole art of artificial propagation is founded. These observations would appear to have been originally instituted by Dr. Knox, of Edinburg, who watched the process of spawning, in the case of the salmon, and observed the progressive development of the ova, and the growth of the young fishes after exclusion. His hints were followed up, at about the same period, by a most acute and patient observer, Mr. John Shaw, who devoted himself for several

years to a series of well-managed observations on the natural history of the salmon, and the facts, clearly stated and thoroughly proved, which he details in regard to the time and mode of spawning, progressive growth, migration to and from the sea, and other habits of that valuable fish, will always possess the greatest interest. Similar observations were also made by Mr. Andrew Young and others, in the Scottish rivers.

It is, however, within the past ten or twelve years, that pisciculture has, so to speak, taken its place among the useful arts, and been extensively applied to economic purposes. The attention of the French government was called, in 1848, to the experiments of two fishermen of the department of the Vosges, MM. Gehin and Remy, who had occupied themselves for several years in breeding trout, perch, and other species, with which they had succeeded in stocking many of the ponds and streams of their neighborhood. The subject was eagerly taken up by some of the most distinguished scientific men of France. Inquiries were instituted, reports made, an appropriation granted by the government, and an institution established for the purpose of hatching, rearing, and transporting fish, which went into operation in 1852, under the direction of M. Coste, a savant of distinction. Since then, experiments have been made, with varied success, in different parts of Europe, and to some extent in this country. It is not yet time to pronounce positively upon the value of these experiments as applicable to the stocking of public waters. In this country especially, little has, as yet, been actually accomplished in this direction, and we are unable to present definite and reliable results. But there is great encouragement to hope that the processes of pisciculture may yet become of great public benefit.

Whatever may be the result of attempts to revive the fisheries, the stocking of ponds and streams under private control is not only practicable, but requires little more than ordinary skill and care, and there can be no doubt that, as a matter of both profit and pleasure, it is worthy the attention of agriculturists.

Having alluded to the main facts in the history of pisciculture, the natural method of reproduction in fishes may be described, since it is by imitating this method as nearly as possible that artificial propagation is most likely to succeed.

Fresh-water fishes, in reference to their time and mode of spawning, may be divided into two classes:

1. Those which deposit their eggs in the autumn and winter, in water of a reduced temperature, and require a long period of incubation.

2. Those which spawn in the spring and early summer, and the eggs of which hatch in a few days or weeks.

The first of these classes contains some of the most beautiful and valuable of the inhabitants of the waters—those which belong to the family of the salmon and trout, including also the several species of shad-salmon, or white fish. Some of them migrate from the sea into the rivers for the purpose of spawning, as the sea salmon; others, as the brook trout, perform partial migrations up the smaller streams, for the same purpose; while the lake trout and the white fish deposit

their eggs on the sandy shallows, near the shores of the more extensive waters which they inhabit. The operation of spawning, in the case of the salmon, may be briefly described as follows:

The male and female, having paired, seek a suitable spot for the location of their spawning-bed, in a shallow part of the stream, where the water runs over a gravelly and sandy bottom. An excavation is then formed, of considerable width, by the action of the snouts and tails of the fishes, burrowing into the gravel, against the current. The nest having been made sufficiently capacious, the female deposits in it a portion of her ova, and, dropping down the stream, her place is instantly supplied by the male, who emits a quantity of milt upon the eggs. The eggs, being thus impregnated, are partially covered by the loose sand and gravel brought down by the current, and a second bed is soon made, a little higher up the stream, in which another portion of the ova is deposited, to be fecundated in like manner. This process is continued from day to day, until the female has no more ova to deposit. The process being finished, the salmon drop down into some deeper pool, where they remain for a while, in order partially to recover from the exhausting effects of their labors, and then return slowly down the river to the sea. The eggs remain until spring before hatching, the time required for incubation being from ninety to one hundred and twenty days. When first excluded from the egg, the little fish measures about half an inch in length, and presents a singular appearance. The dorsal, caudal, and anal fins are continuous, like those of the eel, and form a kind of fringe, running from the head to the tail. The yolk of the egg remains attached to the belly of the fish, and communicates with the intestinal canal by a passage through which the yolk is gradually drawn inward and digested. During this time the young fish needs no other nourishment, but at the end of about a month the yolk-sac becomes exhausted, and the appetite for food begins. The growth of these fishes (the salmon and trout) is slow during the first year, but more rapid during the second and third.

The development of the ova in those fishes which belong to the second class, viz: those which spawn in the spring and summer, is much more rapid, and in some of them the process of spawning is somewhat different. Thus, the perch deposits its ova in the form of continuous clusters, attached to stones or water plants by a glutinous film, and the young are hatched in the course of two or three weeks. All the cyprionoid fishes (those belonging to the family of the carp, dace, &c.) also spawn in the spring, and their time of incubation is equally short. The same may be said of the shad, of the different species of herring, of the pikes, pickerel, &c., and indeed of all fishes which spawn during the warmer months.

The following is a list of some of the most valuable of the fishes of the United States which spawn in fresh water, classified with reference to their times of spawning: