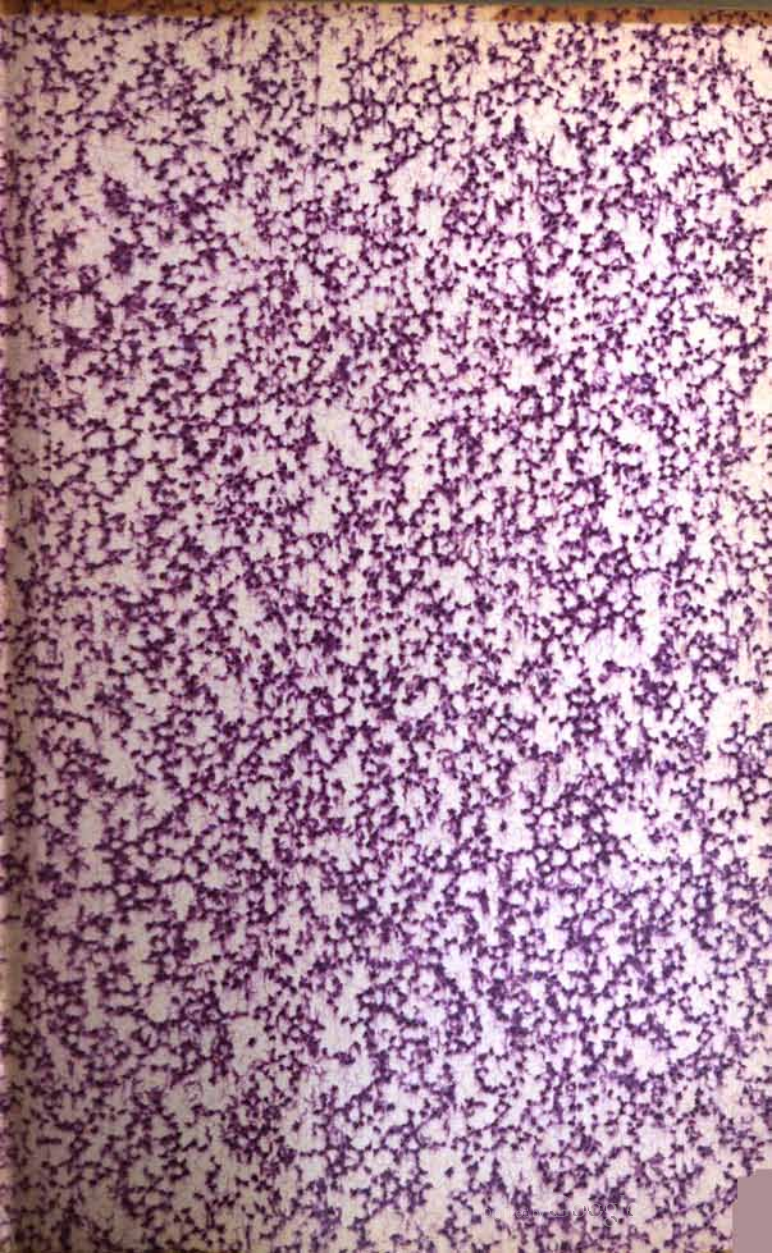

PRACTICAL WATER-FARMING.

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PRACTICAL

WATER-FARMING

BY

William
WM PEARD, M.D., LL.B.

EDINBURGH
EDMONSTON AND DOUGLAS
1868

PREFACE.

AMONGST the topics of the day, few are practically of greater importance than the "Food question." The high price of provisions tells its own tale with an emphasis that attests its reality, and defies cavil; the supply is inadequate to the demand. This dogma, more or less true of all articles of consumption, is pre-eminently true of animal food, and we need the active co-operation of every art that can increase the quantity. It is vain to expect any large addition from the pastures and feeding-stalls of these kingdoms. Holland and the northern ports send us live stock. The rich savannahs of South America

export extractum carnis, salt beef, and charki; and more recently Australia has given us from her abundance a very palatable article in hermetically sealed tins. But these supply our wants in about the same proportion that a shower of rain raises the level of the sea. What we require is an amount of animal food which shall come directly within the reach of the poor consumer; and eventually, by effecting other nitrogenous products, give our labourer and artizan a diet far superior to that which he and his family now enjoy. However largely foreign countries, hereafter, may contribute, there appears little prospect of their satisfying our requirements for the present. We are compelled, therefore, to look at home for what we are not likely to obtain from abroad. It is plain our meadows and homesteads can make no adequate addition to our resources; the productive powers of the land—already taxed to the utmost—have proved insufficient,

and we turn, almost of necessity, to the waters. Hitherto these have been regarded, by those who won their bread from river and foreshore, much in the same light that the Pawnee and the Delaware regarded the prairies and primeval forest—hunting-grounds where all that could be caught might be killed with impunity. Fish were looked on as *Ferœ naturæ*, and since it is an inevitable law that these melt away before the face of man, the stock in our salmon-streams dwindled and dwindled, whilst the oyster almost disappeared from its natural beds.

In this crisis, aqueculture lifted up its voice to protest against the madness of such proceedings, suggesting that our waters should be converted into farms, and the *Ferœ naturæ* be in a manner reclaimed and brought under the care of man, just as centuries ago our present domestic stock succeeded the wild cattle and fed a nation,

where before a few painted savages only supported a precarious existence.

The little work now offered to the reader is but a sketch. The art it endeavours to illustrate is young, vigorous, and expansive, and will pass through many phases before all points of principle and practice are finally settled. It is believed, however, that "Practical Water-Farming," whilst eschewing theory, embodies all that is known, that no fact has been omitted, and enough has been said to lead to great results.

What pisciculture wants is a fair and full trial. Hitherto it has never been adopted in its entirety. *Parts* of the system have been tried at Galway, Stormontfield, and other fisheries, and wherever so tried, have been found to answer even beyond expectation. Yet this partial adoption of a comprehensive plan cannot be said to give the art a fair trial. It is as if one agriculturist gave his sole attention to drainage; a second

to fencing; whilst a third confined himself to experimenting on manures, or devoted his time to the study of farm-implements. But would this partial acceptance of the facts and doctrines of husbandry make landlord or tenant succeed in the present day? We think not.

This hypothesis seems exactly a parallel case. Water-farming, to yield a full harvest, must be conducted with skill, care, and at least with some proportion of the capital now employed on the land. We constantly hear of this or that river being enrolled into the great sisterhood of the salmon-states. That all may prosper to the uttermost, is our earnest desire, but that they may succeed, we warn proprietors and lessees to avoid half-measures. Skill, capital, and enterprise, underlie all commercial prosperity, nor are they less necessary to successful water-farming. False economy is only another name for waste, and if there is

one axiom more applicable than another to pisciculture, it is: "that which is worth doing at all, is worth doing well."

13 Henrietta Street, Bath,
20*th March* 1868.

CONTENTS.

CHAPTER XXII.

CHAPTER I.

AQUECULTURE PAST AND PRESENT.

In the dawn of the world's history, the primeval curse decreed that man should eat bread by the sweat of his brow, and as the ground was to bring forth briars and thorns, agriculture became, not only the destiny, but the necessity, of our race.

When the earth was "in the flower of her age," it may well be imagined that a virgin soil richly repaid the rude efforts of its early cultivators; but with the lapse of ages an ever-increasing population demanded improved methods of tillage, and at length the growing requirements of mankind elevated an employment once merely mechanical into a science.

But whilst the cultivation of the soil is coeval with creation, the idea of farming the water seems by comparison only a thing of

to-day. Want and the demands of luxury have ever been the parents of discovery. China, though often cited as an example of national permanence, without progression, undoubtedly possessed many of the useful arts centuries before the barbarous warriors of Europe acknowledged their utility or dreamed of their existence; and amongst these arts pisciculture held a prominent position. With a teeming population, the great food-question must always have been a problem difficult of solution in the Celestial Empire. Men cannot always live on rice, and the country was too minutely parcelled out, and too diligently cultivated, to support a stock of the *ferœ naturæ* adequate to the wants of the nation. Under these circumstances, it would be natural to suppose that a people so ingenious should early have sought from the water what the land denied; and, on inquiry, we find that aqueculture actually existed in China centuries before luxury gave birth to it in civilised Rome.

It is not necessary here to enter at *length*

into the question of Chinese water-culture. Amongst that mysterious people, unchanged and unchanging, the practice has evidently come down from remote antiquity. What they are to-day they were two thousand years ago—the same in arts and ignorance, craft and self-sufficiency, barbarism and civilisation; the same in religion, policy, and arms; and the same, doubtless, in pisciculture. Travellers have spoken of the large number of fish reared in the inundated paddy-grounds. Again, we hear that "from time immemorial" this inventive race, by means of brushwood arranged in suitable parts of their rivers, collected the spawn deposited about the dams, placed it in vessels, and sold to all who desired either to utilise barren water or increase the supply of fish in their lakes and rivers. Whether the breeders *fed* their young stock seems uncertain; it is probable, however, they did not omit so obvious a means to insure success. But, granting this, they were still immeasurably behind the pisciculturists of to-day. There is no evidence to prove they

employed filtered water—that they studied the nature and habits of the animals they kept, or guarded against the ruinous attacks of aquatic insects—that they had any fixed annual periods calculated to prevent undue waste—that they attempted to improve the beds of streams, or make or increase their natural spawning-grounds. In short, whilst we cannot but admire the early discoveries of the ancients, we are obliged to confess their practice fell far below the comprehensive views of the moderns.

What necessity created in Asia, luxury and prodigality originated independently in Europe. The conquerors of the world in the days of the empire had learned to lavish a fortune on an entertainment. Not only did every tributary land furnish delicacies for the table, but the seas also were compelled to give up their treasures. There is nothing new under the sun. Within the last few years great fishery cases have occupied our courts; the most cunning lawyers, the most eloquent counsel, have been engaged in the

defence and attack; yet, nearly two thousand years ago, the first legal talent of old Rome was occupied in assailing the monopoly of mullet, or protecting the rights of proprietors of oyster-parcs.

Every classic scholar, whose reading has carried him a little out of the ordinary track, knows to what an extent fish-breeding was followed on the foreshores of Italy, in order to supply the wants of rich and extravagant patricians. Around their villas these men had stews and pounds, as *our* country gentlemen have pheasant-covers or trout-streams, and, like them, doubtless often conversed about the effect of the season on the health and condition of "the game." Not content, however, with fattening fresh-water fish, these epicureans, by means of canals and sluices communicating with the sea, cultivated various kinds of marine luxuries, and in short, did much that we now think of doing. Some idea of the value attached to such property may be formed from the following extract:—

"Pliny tells us" (we cannot do better than quote from Mr. Francis) "that the fish-ponds made by Lucullus were sold for four millions of sestertii—a sum equal to £32,291 : 13 : 4 of our money. This will convey some idea of the height to which luxury and expenditure were carried in this taste; and if we further take the relative value of money then and now into consideration, the outlay is enormous. These ponds were situated at Lucullus's house at Tusculum, and were supplied with salt water by means of canals cut from the sea; his example was followed by others of the Roman patricians, whose villas were situated on the borders of the gulfs of Baiæ and Naples, and the practice became fashionable."

Century after century men display the same strength and weakness, the same affections, the same appetites; and the cry of "Oysters! Orata oysters! Oysters, ho!" probably resounded along the streets of the imperial city, as it now does in the thoroughfares of our own "Great Babylon."

If we look nearer our own times, we shall see how largely fish-culture must have been carried on in Britain. Every inland convent and monastery possessed its ponds and mill-dams, which, if the number of religious houses be taken into consideration, ought to have yielded largely indeed, to have supplied the wants of the Church. When fasting went out of fashion, under the reforming hands of bluff King Hal, pisciculture began to wane. Ecclesiastical property fell into the possession of laymen; meres were drained, tanks choked with mud, reeds took root, and moor-hens and frogs soon represented "the live stock."

Attached to the manor-houses of our country gentry, preserves for carp and tench were still to be found; and here fish-culture lingered for a century or two. Suddenly steam and the rail burst upon us; ice as a preserving medium came into use. Salmon from distant rivers appeared in our towns; fish from the ocean found its way to inland districts; in short, a superior commodity

came into the market, and the last faint spark of water-culture was at once quenched.

These instances are sufficient to prove that, whilst aqueculture is a new word, it only represents an art long recognised. The necessity for such tillage has increased an hundredfold since the first water-farm was enclosed, and however closely the supply of animal food may have kept pace with the demand at an earlier period, we *feel* that in the present day the deficit is lamentably great. Humanity shudders at the fact, law and order deplore it; for, whilst enduring hunger, men are apt to forget their moral and social obligations. A race such as ours requires support beyond what mere vegetable diet can supply. Nor can our countrymen be deprived of a higher order of food, without inflicting a sensible injury on society. Epidemics find their victims more frequently amongst the ill-fed than amongst those who, though living in localities notoriously unhealthy, are yet better nourished. Insufficient nutriment promotes and extends disease. If

men are fed like brutes, experience shows they are apt to live like them, and semi-starvation is at the bottom of half the crime which fills our gaols, and fourth-fifths of the sin that flaunts along our streets.

Can this be avoided? I believe it can in a great degree. Present prices make animal food an unapproachable luxury to thousands and tens of thousands of our population. Our pastures are taxed to the uttermost point of production; every rood of ground contributes its full share towards supplying the butcher. It is in vain to expect more from the land, but we have a right to look for something from the water. Let us inquire, therefore, what may reasonably be expected from aqueculture towards supplying the deficit.

The art of to-day is widely different in its origin and aims from that whose rise and progress we have briefly sketched, and whose decay we have hastily chronicled. It has again been warmed into life by the necessities of a great people, fostered by the example

and exertions of a few good and far-seeing men, and is now cherished by philosophy, capital, and science. True, the art is but in its infancy, yet it is no effete second childhood. It will live, and flourish, and grow into a manhood so great and beneficent, that we who now only see the babe in weakness can form little idea of what its maturity will bring forth.

"Practical Water-Farming" is intended to be confined to no one speciality. We shall treat alike of salt and fresh water; of rivers and lakes, meres and ponds; brooks, rivulets, and mill-dams.

The present introductory chapter has, almost of necessity, been general, sketchy, and unpractical. In the next we shall glance at our barren rivers, and then enter into detail on the choice and construction of a salmon-farm.

CHAPTER II.

"UNITY IS STRENGTH."

THE great and increasing value of many Scotch and Irish rivers naturally suggests the inquiry, "Can nothing be done to fertilise the vast majority of our streams?" To this question a definite answer may be given—Ninety streams out of every hundred *can* be profitably cultivated, and in the ratio of their size are capable of being made as productive as any to be found north of the Tweed or in the sister kingdom. But it is an egregious error to suppose that either in Ireland or Scotland any water-farms are in the highest state of cultivation. Each country possesses many good salmon-rivers, more indifferent ones, and a still greater number which are practically worthless. Even the best of them might easily be made to yield infinitely more

than they do at present, and the rest are capable of rapid, certain, and vast improvement. Most of the Welsh streams still hold salmon. The Wye shows a steady annual increase. The Usk at the present moment is fairly stocked with breeding fish, and even our English rivers contain a "scattered remnant;" in short, though many of our water-farms have to be *created,* a large number require only to be *improved.*

But here, at first starting, a difficulty meets us—a difficulty unconnected with the actual capabilities or cultivation of our streams, but so important and essential to a proper understanding of salmon-farming in its practical aspect, that we are compelled to give it precedence. The details of salmon-culture may require modification to suit the requirements of particular streams and localities; but the general difficulty to which we have referred applies equally to all. It is, in fact, the difficulty of *uniting*—the old fable of the bundle of sticks over again.

The landed proprietor reigns over his

broad acres as an absolute potentate. Everything on the surface is at his disposal; all below the surface calls him master. The position of the aqueculturist, however, is far less favourable, and unfortunately the disadvantages under which he labours are inseparable from the property he wishes to cultivate. His estate does not lie within a ring-fence, but rather resembles a piece of ground parcelled out under the allotment system, where each man works single-handed for himself, without much regard to the interest of his neighbours; where each has more foes than friends, and where conflicting interests and petty jealousies reign supreme. No stream of any magnitude runs entirely through a single property. On the contrary, it is certain to be possessed by many owners, and it is from this subdivision that the pisciculturist's early troubles arise. Yet these separate interests *must* become one and indivisible if "the farm" is to be a success.

He has to deal with the timid and the obstinate; to conciliate prejudice; smooth

down self-will; to convince the intelligent, and convert the ignorant. In short, he must deal successfully with men of opposite opinions, inclinations, and tempers. These discordant elements must be welded into one mass, and joined in "sweet accord" by the magic link of self-interest. To achieve this may be difficult, yet the task is by no means insurmountable; at any rate, the difficulty must be encountered, and if met with patience and courtesy, will generally vanish. Time, however, will remove this stumbling-block from the path of future reformers, either by legislation, example, or a clearer view of self-interest. Each successful labour of to-day will macadamise the road for to-morrow, and every new foot that passes over it will render the way more smooth. I have dwelt at some length on this point, because unity is essential to success. *With it,* everything may be accomplished; *without it,* disappointment must ensue, or at the best so small an amount of benefit will be obtained as to be tantamount to failure.

Let us for a moment regard the question from a slightly different point of view, and suppose a landlord to attempt the improvement of his water-property single handed. He may spend money on artificial hatching, remove such impediments from the bed of the stream as exist within his own bounds, and what will be the result? Briefly this—that whilst *he* sows, *others* will reap the harvest. Perhaps he may persevere for a time, but the end is inevitable. Disappointed in a design which, whether considered morally or commercially, is alike prudent and beneficent, he abandons the task in disgust, and property which might have been improved for the common good speedily sinks back into the unproductive state from which he strove in vain to raise it. But if we suppose him to have succeeded in binding *all* the proprietors in the bonds of one common interest, then, indeed, his way is plain, and success all but certain. The body of landholders in effect have become *a great joint-stock company.* Why then should they not govern themselves

by the laws which prevail in such societies, — appoint a chairman and small working committee, with powers to arrange and allot shares in the ratio of the ripal rights of each landed proprietor, and make the necessary calls for improving and stocking the farm? When arrangements are so far matured, a handsome dividend will only be a matter of time, which can be calculated with sufficient certainty. The money question, involving profit and outlay, will more conveniently come under our notice when our "model farm" is in working order.

If we glance for a moment at the labours of the "United Association for Preserving the Fisheries of the Severn and its Tributaries," and see what they have accomplished, and where they have fallen short of complete success, I believe we shall find an argument of the greatest weight in support of the "joint-stock doctrine."

On the 30th of August 1843, this association—consisting of the *landlords,* occupiers of land, and residents of all classes in the

counties of Gloucester, Worcester, Salop, Montgomery, and, generally, throughout the entire district of the Vale of the Severn and Teme—was instituted; its object being the reformation of the fisheries.

The anniversary of the association was to be held on the 30th of August, on which day the committee were to make their report, and the treasurer produce an audited account of the funds. The affairs of the association were to be managed by the central committee, and this central committee had power to appoint from its number a sub-committee, to carry on the business of the association.

District committees were appointed, together with a general chairman, treasurer, and secretary, also conservators and underkeepers.

"The chief advantages," we quote from the secretary's masterly report, "of a central association, with *district branches* over separate societies, lies in the means it presents of carrying into effect *one uniform* system for preserving the fisheries in all counties

through which the Severn and its tributaries flow."

"Nor does the central system involve the loss of the slightest advantage presented by the separate plan. The district committees are self-governed; they expend their own money, appoint their own officers and servants, and, in a word, entirely regulate their own affairs. Their connection with the central committee takes away no power available for any good purpose. On the contrary, it gives strength, energy, and uniformity.

"The association deem that it will appear evident from the foregoing summary, that an Act of Parliament, including all the useful enactments of former statutes, and embracing all the rivers of England and Wales, is imperatively called for."

Let it be remembered that this was written twenty-three years ago, at a period when the country took little interest in the question, and we believe few will deny that it is due to the wisdom, activity, enterprise, and, above all, to the perseverance of the com-

mittee, that our rivers possess their present vitality.

The labours of the committee were indefatigable. Weirs were made passable for the fish, endless correspondence carried on with the commissioners and engineers belonging to the Severn navigation, and Mr. Andrew Young of Invershin was engaged to inspect the river at a large expense. Their attempts in 1846 to carry a bill through Parliament for the regulation of the fisheries of England and Wales would form matter for a volume. Their dauntless perseverance under disappointment and discouragement is above all praise; little by little they succeeded in their arduous struggle against the weirs, and at length triumphed by making them perfectly passable.

In 1863 the secretary wrote, "The Central Committee of the United Association for the Protection of the Fisheries of the River Severn and its Tributaries congratulate the association on its new vigour, which, there can be no doubt, has been brought about by the passing of the Act of 1861."

Such is the modest record of their labours and their success. From the foregoing analysis, it appears that the committee made the Severn passable for salmon from the source to the sea; that they preserved strictly; suppressed fixed engines; abolished illegal nets; were mainly instrumental in procuring our present excellent law; finally, that the whole river and its tributaries, with the greater portion of the estuary, have by their exertions at length been formed into a fishery district, in pursuance of the provisions of the recent salmon act. And now it may fairly be asked, "Have these measures produced *all* the advantages that might have been expected? in short, has the river, under these favourable circumstances, attained a full development? The answer, we fear, must be less satisfactory than could be wished. Doubtless the Severn *has* slowly and gradually improved, still its returns fall infinitely short of what they ought to be. The length of the river, with its tributaries, has been calculated at about 500 miles, and this great

extent of water might reasonably be expected to yield, under "the natural process," 250 tons of fish per annum, whereas it is much to be doubted whether a fifth part of that amount finds its way to the market.

During the past season the writer spent several weeks in the inspection of the Severn, and, amongst other things, endeavoured to ascertain the number of fish taken. All the lessees returned the same answer, "That salmon grew more scarce every year, and that the take barely paid the rent." This, however, was well known to be untrue, for, beyond question, these fish *have* steadily increased, though the exact degree in which they have multiplied is still a mystery.

Everything a committee could do has been done for the Severn. To what cause, then, are we to attribute the fact, that their long labours have not resulted in a more complete success?—why, simply, that they wanted power to *enforce unity*. Each proprietor leased his water to men who, having no permanent interest in the river,

killed without compunction every salmon they could catch, and so it came to pass that the stock was kept down, and the development of this noble river sadly retarded. The fishery required a liberal application of the artificial system, as well as the careful economy of breeding fish, in order to produce an approximation towards an adequate stock; but without unity this was impossible, and to the want of this principle the comparative failure of the Severn is, we believe, alone referable.

This stream, at least as large as any in the kingdom, possesses many physical peculiarities favourable to the safety of the salmon. Its depth and width, together with the irregularities of its bed, combine to make netting uncertain. Yet even with these advantages, aided by a vigilance never exceeded, the fish increase so slowly that a quarter of a century must elapse before this, the purest of our rivers, will possess anything approaching to an adequate stock. If, therefore, the independent system is injurious *here*, what must it be elsewhere?

We have dwelt on this topic at some length, and shall carry it a little further, because we sincerely believe that unity is the point on which the prosperity of our rivers will hang. It is the cement which must bind many separate elements into one mass, the foundation on which water-farms can alone be built up successfully.

CHAPTER III.

THE HAMPSHIRE AVON. "OUR MODEL FARM."

THE reader must pardon me if I again return for a moment to the subject of unity, and summon the Hampshire Avon to illustrate its importance. This stream, the most productive in the county, yields annually about 750 salmon. Owing to the size of its spring fish, the average weight of each taken through the season is unusually large, being about 12 pounds, which would make the year's total, amount to a trifle less than four tons.

FOUR TONS only for such a river, backed by all the aid Imperial care and Imperial legislation can give! Can no favourable results be traced to the Act of 1861? Have the removal of fixed engines, the erection of passes, and increased weekly and annual close time, effected no improvement? They

have *not*. Why is this? Because there is no unity amongst the landed proprietors. The holders of property near the mouth lease the river for netting, and the upper heritors sweep the fords, kill all they can, and so, by over-fishing neutralise the wise provisions of recent acts.

But it may be objected, "More salmon must now find their way up to the spawning beds than when they possessed less opportunities of ascending the river;" quite true, but they are not permitted to remain there, being mercilessly netted, though tinged with every shade of colour "from copper to carmine." What miserable fatuity is exhibited in such suicidal conduct. Everything the law could do for private and public advantage the law has done, but it cannot make men prudent. Our legislature tries its utmost to protect all descriptions of property, yet men every day set it at defiance, and steal, defraud, and overreach one another, to the common loss and their own certain ruin. And what are they who act, as too many of

our waterholders do, but amateur thieves, who, for amusement, practise the art on their own pockets.

The idea of *profit* to men so wealthy is absurd, for if pecuniary considerations exercised any influence on them, they would farm the property instead of merely sporting over it. At present the Avon, as a food-producer, is *nil;* but what would its production be if all the proprietors from the source to the sea were united? Then each man would take care that available passes were created over obstructions existing on his own property; everywhere, salmon hatching would be carried on, and preservation secured. Then, indeed, a mine of wealth would be opened, to be worked either by the proprietors, or leased on such terms as should be considered equitable, and in either case the profits divided in the ratio of ripal rights. Such dividend, we say, without fear of contradiction, would differ widely in amount from the paltry income at present derived from the destruction of stock. Every man naturally desires to

make the most of his property, but we feel convinced the owners of water-rights have hitherto erred in the mode of doing so; when, however, they seriously reflect on the question, intellects so clear and cultivated will not fail to see that their property can alone develope its true value by union. But this desirable end can only be reached by wisdom and generosity walking hand in hand; the proprietors at the head waters must share equally with the holders of land near the tideway. They who breed, must participate in the profits of those who catch the salmon, for the fish cannot *belong* to any part of a river, though they should be *taken* at one spot, and one spot only, unless the water be of unusual extent. Bred in the tributaries, they are fed in the sea, and so should be regarded as a source of revenue to all.

At present the income they yield is as nothing compared with what it might be, if a wiser and more enlightened policy were followed, and happy indeed should I be, if any poor words of mine could aid the in-

corporation of the Hampshire Avon into the first great joint-stock river-farm.

Observation and science have already done a little for us, and would have effected much, had men heeded their teaching; but, unfortunately, in almost every instance, fishery proprietors have adopted their dicta only *in part.* For example—on one stream a small nursery has been erected; on another, special care has been taken to remove all impediments to the passage of the fish; on a third, existing spawning-beds have been improved; on a fourth, they have been created. It is unnecessary to multiply instances of the partial acceptance of one great doctrine, which, to regenerate our exhausted waters, must be embraced in its entirety.

Wiser in our generation, we will embody *all* points whose practical importance has been proved by experience, and apply them to our "Model Farm." Though our aqueous freehold has neither a local habitation nor a name, it contains no hypothesis. The various stages through which it passes from barren-

ness to fertility are nearly all at this moment in operation on various rivers either at home or abroad, whilst the "Balance-sheet" of our airy company is far below that of a stream with which we have been long connected, and which has a course seven miles shorter than that selected as the exponent of what a water-farm should be—aye and will be, before the world grows ten years older.

A prudent landlord is not satisfied with the application of a single successful invention to his property. If he uses steam to reap the harvest, he will also employ it in preparing the ground for the reception of the seed; nor will he neglect drainage, the erection of improved buildings, and the like. Now, a river is only a water-farm. Skill, capital, and labour, must all be brought to bear on it; and if the reader will come with us, we will endeavour to show him how their application will result in a great commercial success.

One word more, and we pass from general observations to our subject. The stream we

design to cultivate must be supposed neglected, and nearly, if not entirely, barren; to have a length from the source to the sea of thirty-two miles, and to possess no lacustrine head. We are in some sort pioneers, about to reclaim a portion of the wilderness. This will afford us an opportunity to begin *de novo*, and our labours may serve to guide those who propose to *create* salmon-farms; nor will the arrangement be altogether useless to such as possess rivers more happily circumstanced, as it may illustrate some points hitherto overlooked, the observance of which will perhaps help them forward to a larger measure of success.

Revenons a nos mutons.—It has already been assumed that unity is effected, and that all the ripal proprietors are firmly bound together in the bonds of a great common interest. Their first act, as a matter of course, would be, to resolve themselves into a committee, and elect a chairman and small sub-committee with full executive powers, whose duty would at once lead them to

inspect the property, and for this purpose we will suppose their examination to commence at the tideway. All rivers of average size are certain to have a fair outfall, enabling the fish to ascend or descend at all times. Traffic and the quality of the water, however, may properly claim attention for a few moments, and it may be asked, Can any amount of the former scare the salmon from returning to their native stream?

Glasgow is, from the importance of its commerce, the third port in the kingdom. The estuary is literally ploughed by steamers; yet our friends the salmon are not frightened out of their propriety, but pass the busy quays, and so reach the upper Clyde. From inquiries recently made at Bothwell, the Salmonidæ appear to have diminished considerably during the last few years, but this is due to the increasing impurity of the water, and the erection of weirs; more fish, however, ascend the river at Dumbarton than formerly. We may then fairly conclude that navigation offers no serious impediment to the return of the fish.

At this part of our small farm the question of purity is not likely to arise, though the amount of mud held in solution may in some cases provoke inquiry. The Bristol Channel is the most dirty tideway in the kingdom. At Chepstow and Gloucester the water is literally as thick as pea-soup, and yet the Wye and the Severn are the most prolific of our English and Welsh rivers, and satisfactorily answer all objections that can be raised on this head.

Leaving the estuary, we now proceed to examine the entire course of the stream to its highest tributary, in search of all impediments, whether artificial or natural, calculated in any degree to hinder the periodical migrations of the salmon.

Mill-dams and their owners can rarely be trusted. The "Miller and his Men" should still be regarded as a species of amiable banditti, and, as such, receive particular attention from the river-police. Weirs are necessary evils. We cannot remove them, but we can neutralise their injurious effects,

and this brings us at once to the subject of "passes."

Unfortunately, many of these ingenious puzzles can only be regarded as injurious playthings—toy problems, which no fish can be expected to solve. Admirable in intention, too many of our ladders are, it is to be feared, sadly faulty in construction. The subject is one of such interest and importance that we may be pardoned for considering it at some length. Probably the best "pass" in the world is to be seen on the Severn, near Holt, and since it may advantageously be adopted as a pattern, we cannot do better than describe it. At its south-east corner, the weir appears to be an inch or two lower than at other parts, and this always insures a fine current. The space extending from the bed of the river below to the water-level above the dam, might be represented by an acute triangle, the base of which would rest against its south-western face; and this is filled up by blocks of stone, over which runs so captivating a stream that salmon, were they not

sober-minded and strongly disposed to attend to the serious duties of life, might waste a good deal of valuable time in sailing up and down the run, "for the mere pleasure of the thing." Such a "pass" offers at all times an easy means of *passing!* It is, in effect, a queen's gap of the most perfect kind, and very unlike some of the corkscrew puzzles, into which it is a wonder if a fish finds his way, and a miracle if he succeeds in getting through successfully.

It must not, however, be supposed that we underrate the original design; very far from it. Some assistance must be given to the salmon in his migrations, and some means found to aid him in climbing over barriers otherwise insurmountable; the only question is, how this can be best accomplished.

The great majority of the "passes" I have seen, run straight over the face of the weir, without any adequate provision being made for regulating the supply which ought to flow through them, and consequently in an average of years they are impassable—let us say for

half the season—either from having too much or too little water. We know a salmon can struggle through extraordinary natural obstacles; that he will leave the sea and rush over fords so shallow—in order to enter his own river—that half his back is uncovered; I have seen the feat performed a thousand times, but this is a different affair from scaling a difficult artificial contrivance. All animals are habitually suspicious, and a salmon that would make desperate efforts to pass an obstruction of a kind to which he had been accustomed—whether that difficulty arose from excess or paucity of water—might well be expected to halt between the extremes "of too much or too little," when flowing through so alarming a novelty as an ill-constructed pass. The consequences of this natural hesitation are obvious; delays are proverbially dangerous; and some day, in "a drought," a gaff is slipped under the animal whose too great caution has proved his ruin, and he forthwith goes to market instead of proceeding to the spawning-beds. The very

word "pass," shows assistance is intended. Why, then, not make it effective, by rendering the passage as easy as possible? In the erection of a ladder, therefore, the first points to be ensured are, that it shall be as natural, and uniformly accessible as circumstances admit. If there is always sufficient water, occasional excess will not be injurious, because salmon do not run in the height of a fresh, but either when the flood begins to rise, or else when it is about half run down.

The position of the ladder is a question of no little importance. It is the opinion of our greatest practical pisciculturists that the pass should be placed, *not in the centre, but at the side*, and this opinion rests on observation, which shows that, in ordinary cases, our friends do not agree with the proverb, *Medio tutissimus ibis*, but prefer the trottoir to the middle of the road. The angle at which the ladder is set must depend on the average volume of water which may reasonably be expected to flow over it, the rule being to make the run of moderate

depth; in fact, nature should serve as our model. Let any gentleman about to erect a pass, walk to the nearest "salmon-leap," and see how that great architect has placed a ledge here and a boulder there, as—

"Buttress and coyne of vantage;"

in short, as so many steps in the ladder, and then let him go and do likewise.

In the vast majority of salmon-rivers, stones of the exact size and shape required, are to be obtained in any quantity. If we employ these instead of well-planed oak or fir, and copy nature, we shall not often erect passes over which fish will be either unwilling or unable to climb. Should stones, however, be scarce, stumps of trees and faggots would answer the purpose quite as well. In fine, these important structures should be built at the side, not over the centre of the impediment to be surmounted; the angle of incidence should be easy; attention must be especially directed to the maintenance of a sufficiency of water—say from a foot to eighteen inches—which ought to flow with

moderate force, and the longer in reason the run is made, the more surely will these ends be gained; the base of every "ladder" should rest in the deepest part of the pool; and lastly, nature should be studied and copied, not only in general design but also in material.

CHAPTER IV.

FAMILY MATTERS.

CLOSELY connected with artificial obstructions, caused by weirs and dams, are the dangers produced by mill-lades and sluices. So far as our farm is concerned, it matters nothing whether a strong stream be diverted from the main channel for agricultural or manufacturing purposes; the evil consists in the fact, that a downward current is created, which practically is not a safe path to the sea.

Artificial obstructions—difficult yet possible—of which an instance was given in the previous chapter, indirectly affect the ascending fish, whilst the dangers usually connected with these structures are directly injurious to the smolts and kelts. It is hard to say in which capacity weirs have exercised the greatest amount of injury on our rivers.

Thousands of tributaries have been practically closed against spawning fish by the one, and countless numbers of fry and foul salmon have entered the other, destined never to return.

Immediately after the deposition of the ova, the female fish commences her downward voyage, dropping back probably at the rate of two or three miles per day, when the water is at an average height, and making much longer runs when the streams are swollen by rain. Mill-dams and sluices, though always dangerous to the descending salmon, are most to be dreaded in low water; for the animals, following their instincts, move on with the strongest current, which, especially in our smaller rivers, at such times will be found to lead to the mill, where these wanderers from the right course are liable to be netted, or else destroyed amongst the machinery. As passes must be erected over obstructions, in order to render all the farm accessible to the stock, so here, fences must be placed to prevent their straying out of bounds.

This can be easily and cheaply effected by driving a few stakes into the mill-dam at the point where it diverges from the main channel. These should be placed in a double row, arranged alternately, to guard the gratings from the effects of driftwood or other heavy substances which a flood may bring down. A few yards below this breastwork, the screen and netting must be fixed; the first to consist of slight iron rods set perpendicularly in a rough wooden frame. These bars need not exceed half-an-inch in diameter, nor should the interspaces be greater than an inch and a half, and beyond this, hardly any spent fish can pass. The principal use, however, of the screen is to offer a farther protection to the wire-netting placed ten or twelve inches behind it, which must be of a mesh sufficiently fine to stop all smolts in their perilous downward course. Each fresh brings with it more or less weeds, rushes, and such like; which, lodging against the safety screen, can, from the simple arrangement of the rods, be raked off as they accumulate.

A plan such as this effectually secures the safety of the descending Salmonidæ, and is as essential to the well-being of our farm as the uninterrupted ascent of the fish to the spawning-grounds; for if the assistance man affords these creatures to pass obstructions, and reach the ultimate tributaries, enables them there to sow the seed of a future crop, at least in an equal degree, his protection against dangers in their passage to the sea tends to the safe ingathering of the harvest.

It has been already observed that, very shortly after spawning, the mother fish commences her voyage to the sea. The males, however, remain longer on the roods, waiting the arrival of fresh females, and to this, probably, is to be attributed the well-known fact, that during the early winter our rivers contain so large a percentage of milters. By the end of December the majority of spawners have left the fresh waters, but at least six weeks more must elapse before the bulk of the males have quitted them; this brings us to the middle of February. In April the

smolts commence their journey, and their migration is nearly over by the middle of the following month. A knowledge of these facts will enable us to employ our protective powers to the best advantage. For example, whilst our river-police should jealously watch all obstructions in June, July, and August, they should be massed in September, October, and November about the spawning-grounds; whilst in December, and the five following months, their attention should be constantly directed to the dangers which beset the foul fish and fry in their passage to the ocean.

Enough has, perhaps, been said on the score of artificial dangers and impediments, as well as on the nature of the farm-work they necessitate; but before we absolutely take leave of this branch of the subject we must offer a few words respecting natural barriers.

These, as a general rule, are found in the higher parts of rivers, and consist almost exclusively of cascades, at the foot of which, alike in high or low water, the poacher has

effected, and can still effect, incalculable mischief. In the vast majority of these cases a slight study of the mode in which nature herself so often opens a road over such rocky barriers, together with a little gunpowder judiciously applied, will remove the difficulty, and add enormously to the value of the farm, by developing spawning-grounds hitherto unproductive.

We have now inspected our property from the sea nearly to the source, and have at length arrived at the head waters. We have noticed peculiarities that might have existed in or about the outfall, and have gained a just idea of the difficulties to be overcome, and the dangers to be guarded against. Whilst making the survey, all points of importance should be marked with red ink on "the Ordnance Survey," as spawning-beds, weirs, lodges, and the like, and this chart would probably prove as useful to English aqueculturists as similar ones have proved serviceable to many of my Scotch and Irish friends. The most important part of our

work, however, is still before us; for all that has yet been done will, in a commercial point of view, prove useless without our breeding-grounds, and to these we must now turn our attention.

In rivers of any given length, far less than half the extent will probably be suited for the deposition of spawn, yet if a stream possesses anything approaching an adequate stock, the salmon operate with wonderful uniformity on all the available spots, for the heavier fish rood on the deeper runs, whilst the smaller select the upper and lesser tributaries. This rule, however, is not invariable, for "all have a tendency to get into the most elevated rivulets in which they can swim and find shelter. On this question Thomas Ashworth, Esq., probably the highest authority on the subject, thus writes:—

"The smallest streams are found in area to be the most productive, even those not exceeding from three to six feet in width; and of such streams, in my own salmon-fishery at Galway on the west coast of Ireland, we have

thirty-three miles in length. Many of these in the summer seasons are not more than a few inches deep, with occasional pools, and in many places are overhung by brushwood, or banks of earth and stones, under which the young fish escape readily from sight, and into which larger fish do not go, as there is not sufficient water to cover them. Here the young fish, being beyond the reach of their more formidable enemies, who devour them when they can, remain in safety until they are about three inches long. As they increase in size they follow the stream into deeper pools, and thence migrate to the sea. I have in my fishery one stream divided into two tributaries of not more than from three to six feet in width, with springs at the head of it. This is a favourite resort for spawning fish; they will swim into this small stream with their backs frequently above the water, and where a boy with a stick might kill them with the greatest ease; and yet, when disturbed in their operations of spawning, they can only be driven away for a few minutes, when they

will return to the same gravel-bed to complete their work."

About a moiety of the roods in every fishery are ready made, and, for the sake of argument, may here be considered as beyond the reach of improvement; but the upper and more valuable beds are often capable of being not only altered for the better, but absolutely created. This power is of such importance that the mode of improving the old, as well as of making new ground, may well claim our careful consideration.

In all tributaries, rapid alterations in depth and volume of water are inevitable, and many spots, which in spates would form admirable beds, are useless, from being often wholly, or partially dry. Again, at other points, were not the current possessed of too great a fall, the ground would be all that could be desired. Now a little skill, and a small amount of labour, would obviate all these difficulties. The beds of such rivulets almost invariably abound with large blocks of stone, and if these were arranged at convenient intervals

as dams from three to four feet in height, dangerous changes in depth and excess of rapidity, would be equally avoided; and thus, whilst much spawn would be saved from perishing from drought, a still larger quantity would receive impregnation.

Again, the channels of mountain-streams, so dear to the salmon, are frequently encumbered with boulders to such a degree that the fish have no room for the successful deposition of the ova; but once roll these out of the way, a beautiful gravelly bottom either remains or is speedily deposited, in which case we have actually enclosed new ground of a quality more productive, probably, than any previously to be found on the farm.

These are some of the most important points which will claim attention whilst making a survey of our tributaries. Care, common sense, and skill, wherever exercised, make all the difference between failure or success. No man, in full possession of his reason, would expect a farm to pay if left to take care of itself, and the analogy between

land and water property, holds good here as elsewhere. Both will pay for cultivation, and, as a general rule, will yield a dividend in the ratio of the outlay; and happy would our agriculturists be if their expenses were no greater than those incurred by our water-farmers.

Constantly following a wandering life, our silvery friends encounter innumerable perils, are opposed by great obstacles, and meet with manifold enemies in their annual migrations. Against these dangers we have endeavoured to provide, by preparing the farm for their reception; and, if required to send in a report, might say, "Your committee have spent much time and thought on the foundations, which are sound, well cemented, and able to bear any strain that may be placed upon them; that they have made passages to enable the stock they are about to purchase, to wander freely over the entire property; that they have securely fenced all dangerous spots; that the company's servants are beginning to understand their business; that Imperial law

is favourable to the undertaking; and that our police will shortly be organised and ready for duty, as soon as their services can be wanted. Moreover, your committee desire to call your attention to so much of the history and habits of the animals they propose to rear, as shall be likely to exercise a beneficial influence on the concerns of 'this great joint-stock limited liability company,' and, in conclusion, beg to announce that at the next meeting they intend to read a paper entitled, 'The Natural History of the Salmon, with a View to its Practical Cultivation.'"

CHAPTER V.

OUR FRIEND'S HISTORY.

THE salmon has hitherto almost exclusively occupied public attention whenever the utilisation of our unproductive rivers has been under discussion.

Crowned long ago by acclamation king of fish, learning has done him homage; the splendour of his destiny has been the theme of modern prophecy; genius has shed her light upon him, and the skill of the engineer has been employed in his service. The natural history, therefore, of a creature of such importance, so far at least as it conduces to his practical cultivation, may here fairly claim our attention.

Of the 250 kinds of fish found in the rivers and seas of Great Britain, more is known of the genus *Salmo* than of any other.

When speaking of his family we shall deal with facts when we can, hypothesis where we must, and shall tell all that is yet known of his birth, growth, peculiarities, and anomalies; of his enemies and migratory habits, of his presumed fertility and real unproductiveness; and, in conclusion, endeavour to show their practical connection with our subject.

November is the month, *par excellence*, in which salmon take up their temporary residence on the gravelly fords of rivers for the purpose of spawning. Few sow their seed at an earlier period, whilst numbers are still on the roods during December and the early days of January. Indeed, considerable latitude must be allowed when any statement is made as to the time at which these animals are engaged in the dangerous office of re-production, for in the greater Blackwater I have often landed, through the whole month of March, two or three spawners per day, and these fish were exactly in the condition of those ordinarily, but unwisely, captured in the latter part of September

and during October. It has been already observed that the larger fish generally occupy the deeper fords, whilst the smaller ones push onwards to the ultimate and shallower tributaries. Whatever spot, however, may be selected, the mother fish, unless in some few exceptional cases, arrives in time to survey her nursery before using it, often, indeed, lodging close at hand for weeks and sometimes months before parturition. At length the critical moment arrives, and then the salmon, sailing out of some neighbouring pool, proceeds to plough two, three, or four furrows across the bed of the stream at an obtuse angle to the current. When these are finished to her satisfaction, she deposits her seed just as a gardener sows a row of peas. Over her precious deposit the male sheds the milt, partly filling in the gravel at the same time by the motion of his fins and tail.

The mechanical action of the stream is, however, the principal agent in covering the seed, as the force of the descending water

necessarily rolls the finer particles of gravel into the furrow till it reaches the surrounding level.

Weary with her labours, the female fish drops back to the nearest shelter, where she rests for two or three days. Again she returns to her labour, and again ploughs, sows, and wastes her substance as before. At length her work is done, and then she journeys leisurely towards the sea, leaving her husband and young family behind.

Meanwhile the seed continues to germinate, but, alas! it lives in hourly peril of death, for seven or eight remarkably ugly animals, with horny backs, an undue proportion of legs, and fearfully hard scientific names, pass their whole time in doing as much mischief as possible to the ova. A large proportion, however, survives the assaults of these deadly enemies, and in April a tiny fish creeps from each fertilised egg, and wanders about feebly, finding shelter under the edges of stones, his motions apparently impeded by the umbilical vesicle.

In about three weeks this bag is absorbed, and growth goes on more rapidly, though without any uniformity, some members of the same family attaining twice the size of others, though bred up under the same conditions of food, water, and temperature. In April of the following year, probably half the parr of each brood dress themselves in silver spangles, set out for the seaside, and three or four months later re-enter their own river as grilse, weighing from three to nine pounds each. These, like their mothers, spawn in November, again visit the ocean, and come back salmon, varying from ten to eighteen pounds.

Connected with the parr are many peculiarities, and not a few anomalies; the first which will probably strike the aqueculturist is the irregular growth of these little creatures. Suppose the pea of a ten-pound fish to have been hatched successfully, and that five thousand tiny fish are in the pond, it will soon become apparent that the rate of increase is very capricious. At the end of six months, whilst some of the fry measure three

inches, others will barely exceed one, and at twelve months the difference is even still more remarkable, a moiety, perhaps, of the young salmon attaining six inches in length with proportionate bulk, whilst others are scarcely larger than minnows. Nor is this produced by confinement, as a very limited amount of observation will show that the same peculiarity prevails whilst the animals are in a state of nature; and so far indeed is artificial rearing from arresting their growth, that some of the largest smolts I have ever seen were those that have been so bred.

The next thing to be noticed is the invariable regularity with which the grilse returns to the river from which it issued three or four months before, when a smolt. A knowledge of this fact first gave rise to a reasonable expectation of cultivating the salmon. All animals linger for a time around the spot where they were born; gradually stray farther and farther; and then cease to entertain any noticeable affection for it. But the Salmonidæ never voluntarily de-

sert the stream where they were hatched, and this wonderful instinct alone justifies the salmon-farmer in spending care, time, and money, on his aquatic property.

We cannot avoid mentioning one anomaly in our young stock, not merely because it appears to hold some relation to the irregularity of growth already mentioned, but also on account of its practical bearing; I mean what has been called by Mr. Russel, "the half-and-half theory," which is now known not to be hypothesis but fact. This deviation from a great natural law has been already alluded to, and is briefly this: That whilst at seventeen or eighteen months, about half the parr of any particular brood become transformed into smolts, the remaining moiety undergo no change, but pass another year of their lives in humble estate, side by side with their great silvery brothers and sisters, who, after a little sea-bathing, have returned splendid fish, from three to nine pounds each. How or why this mysterious condition obtains, we do not attempt to explain. At present

we must be content to accept the fact, and wait patiently for the explanation.

The salmon, besides numerous implacable enemies, has, in the natural state, great dangers to encounter. Passing over many of these, we will notice two important causes of waste, which have, however, no connection with each other. At least 25 per cent of the eggs are either washed out of the trench or dropped by the mother fish at the sides, to be swept away by the stream and devoured by a little cloud of small fry always to be seen hovering restlessly below, waiting for the banquet to which they appear to consider themselves regularly invited. Another percentage of equal amount probably fails to receive impregnation, and so it comes to pass that when the drills are closed after the day's work is over, a moiety of the good seed has perished.

Besides the dangers which attend our farm-stock in embryo, and the casualties which arise from the assaults of the larvæ of various flies, the race is constantly beset with perils.

During the earlier stages of independent existence, trout, perch, pike, and eels, each and all, display a dangerous fondness for our little ones; whilst ousels, kingfishers, and herons, share in the same fatal affection. No small injury used to be annually inflicted at a later period on the fry by juvenile anglers; happily this sport has now become penal, yet still I always observe that in April and May a passion for fly-fishing spreads like an epidemic amongst the boys of the only hamlet on my river, to the great disquiet of my water-keepers. The first fresh, however, which occurs, carries the smolts far beyond the reach of birds, beasts, and village-youths, only, however, to bring them within the sphere of marine enemies quite as destructive and more numerous. These, however, need not be enumerated here, because man's care, however applied, can exercise little influence over them.

The instincts and habits of the adult fish have already been shown to be full of dangers which need not be further insisted on in

this place. The apparent fertility, but real unproductiveness, of the animal deserves, however, some consideration, and we shall do well to listen to Mr. Ashworth. "In 1852 Mr. Buist and I, from the best information we then possessed, arrived at the conclusion that not one egg out of one thousand ever produced a marketable fish. In 1861 Mr. Ffennell and I came to the opinion that not one in three thousand ever became marketable."

If this be so, and there is no reason to doubt the accuracy of the calculation, what an argument does it furnish for the general adoption of artificial hatching. Before, however, we enter into details on this subject, let us very briefly endeavour to show how our salmon-farm may be advantaged from a consideration of the foregoing little historical summary. A knowledge of the season at which the salmon deposits her ova, and the circumstances attending the operation, show us when and where our river police should be massed; whilst the irregularity of the

time occupied in the process reminds us that protection must not be too hastily abandoned. The instinct which carries the fish to the highest tributaries teaches us the importance of improving and creating such nurseries. The certainty with which the salmon returns to its own river gives energy to our labour and expenditure on the farm. When we know the dangers which beset our young stock, we are often enabled to avoid them; when we are acquainted with the enemies which prey on them, we are able to destroy them; and, above all, when we learn that though the quantity of seed sown is enormous, yet that which ripens to harvest is very small, we are, as it were, irresistibly compelled to admit the system of artificial hatching to be one of the most important discoveries of the present century.

Left to their own resources, a pair of salmon produce perhaps only one marketable fish out of three thousand eggs, whereas, from the same number the pisciculturist can send one thousand smolts to sea. How many of

these will be destroyed in the next three months we know not, but if we suppose fifteen out of twenty perish, the result of art as compared with nature will still be about forty to one.

CHAPTER VI.

THE ARTIFICIAL SYSTEM.

"In 1852, we caught a trout in the spawning-beds," writes the earliest and best of our aqueculturists, "and squeezed 600 salmon ova out of its stomach." Again, whilst considering the destruction effected by aquatic insects, the same observer remarks, "As an instance of this, I may state that we once deposited 70,000 salmon-eggs in a beautifully clear stream for hatching, and that when the time arrived for vivifying, we found they had been eaten by the embryo of the dragon-fly; nor could we discover a single fish living out of the 70,000 ova deposited."

From these dangers, and many others, we can protect our young stock for fifteen months, and to a moiety of it we are able to offer nearly perfect security for twelve months

longer; to seek further evidence, therefore, in favour of artificial rearing would be mere waste of time. Moreover, it must be remembered that the farm we are bringing into order is, as regards the Salmonidæ, practically barren, and of necessity we must erect our breeding-boxes, purchase, or otherwise procure fertilised ova, and so stock the estate which is now ready for the seed.

There are several kinds of vessels at present employed for the purpose of fish-hatching, and these differ considerably in material, size, and shape. Those invented and used by M. Coste consist of a number of bars of glass set lengthwise in a wooden frame called a "grille," which in turn is made to fit into a glazed earthenware trough, in which the grille is supported on small projections, so as to ensure a constant and sufficient supply of running water passing over the upper, as well as along the lower surface. These water-baths are about 1 ft. 8 in. in length, 5 in. in width, and from 3 in. to 4 in. in depth. Three, four, or five of these

troughs are arranged each above, and beyond the one below, like so many stairs; a pipe conveying pure water opens into the upper box, and maintains a small but constant current, which runs into the tray beneath, either by a depression, or through a pipe placed at the opposite end, thus ensuring that a stream shall not only flow along the entire length, but also pass through each pan in succession. A rough frame of deal or common split fir is all that is required to support the troughs and complete our fish-hatching apparatus. Each grille will contain with ease 1000 salmon ova, which are placed side by side on the glass bars; then the water is turned on, and the process of artificial hatching commences. In England a more simple apparatus is used, composed of slate troughs. The same arrangement of pipes, however, is employed, and the same stair-like form followed, but the size is considerably larger, not only as regards each box, but also as to the number of such boxes connected together. Those at present to be seen at

the Horticultural Gardens, Kensington, are about 3 feet 2 inches long, 7 inches wide, probably 7 inches in depth, the steps being six in number, and the cost £5 sterling. These very efficient troughs are half filled with gravel, cleansed from the larvæ of insects by heat (that which I saw had been boiled), and on this prepared bed the ova are placed and the water turned on. So well does this method answer, that fully two-thirds of the eggs are safely hatched.

Many pisciculturists, however, employ modifications of the foregoing, differing slightly in form, size, or material; but so far as essentials are concerned, they are nearly identical. The number of boxes that must be required, and the heavy outlay which would be unavoidable, if operations were conducted on anything like a large scale, will probably lead to the substitution of cheaper and more simple machinery, such for example as is now employed at Stormontfield.

The breeding-establishment at Stormontfield having stood the test of thirteen years'

experience, may fairly be supposed to represent our most advanced opinions. Indeed, it is difficult to imagine anything better calculated to promote the end designed. Instead, therefore, of a verbal description, we will give a rough sketch of the nursery, over which Mr. Robert Buist has so long and ably presided.

Mr. Buist calls this nursery "an experiment," and considers "what has been done has scarcely been on such a scale as would justify the appropriation of a more pretentious title." Looking at the great extent of the Tay and its tributaries, the Stormontfield undertaking appears but a speck, for not more than one acre of ground was originally appropriated, and even this limited area is only now beginning to be fully employed. For the first eleven years there was only one feeding-pond, and this prevented the manager from hatching oftener than once in two years; now, however, a large additional tank has been constructed, and the entire works extended and improved.

We, who have learned so much from the labours and experience of others, can hardly appreciate the feeling with which Mr. Buist gradually found his scepticism melt away before facts. "I saw," he writes, "the seed of salmon deposited in the boxes, like peas sown in a garden, and I saw it come to life in like manner. With feelings of delight I traced the young fish from the egg to the smolt state; I saw them take their departure for the sea, and part of them return, during the same season, as grilses."

Although a pen-and-ink sketch has so far rendered words unnecessary, we have still something to say on the general principles which should guide the pisciculturist in his choice of a site for the breeding pens. There are two periods fraught with peculiar danger to the young of the salmon; the first during embryonic life, the second whilst the newly-born fish is encumbered with its umbilical vesicle. The statement made by Mr. Ashworth, that out of 70,000 ova deposited under circumstances highly favourable to

their development every one had been eaten by the larvæ of the dragon-fly, is sufficient to establish the truth of the first assertion, and as we know that nine-tenths of the food taken by fish is obtained from the smaller members of the family, and that none can be smaller, or more helpless, than the alevins, it may fairly be assumed that the destruction of these weak little creatures is great indeed. During each of these periods the artificial system offers nearly perfect security to the egg, as well as to the newly-born fish, and as there is every reason to believe four-fifths of the loss is incurred in the river, it is obvious that the less the fry have to do with it, the better it will be for the farm. The site chosen for the nursery, therefore, should be within two or three miles of the tideway.

The next point to be ensured is an unfailing supply of pure water, and this can be easily secured if ordinary care is employed. From what has already been said, the advantages of using a filter can hardly be over-rated, and need not be further insisted

on. The employment of the mill-lades at Stormontfield as a source of supply is well worth imitation, for whilst it ensures a constant flow, it reduces the danger of inundation to a minimum.

The cost of the ponds, sluices, and drains requires a few words. The little water-courses could easily be cut by two ordinary labourers in a few days, and the sluices made by any village carpenter. The present price of excavation, where no unusual difficulties occur, is one shilling per square yard—and if we suppose each tank to be 200 feet in length, by 50 feet in breadth, with a depth of 3 feet, the value of the work to be done may easily be calculated. One skilful man, aided by a boy, will suffice to manage the nursery.

To give an exact estimate of the cost of constructing a breeding-establishment is obviously impossible, as no two are likely to be built on the same scale. The size of the river to be stocked; the nature of the ground; the strength of the company; or the wealth and spirit of any individual proprietor,

will all affect the outlay. Moreover, some pisciculturists hatch under cover, whilst others leave their boxes open to the weather, and the erection of sheds would at once make a considerable difference in the correctness of any estimate that might be offered. Again, the cost of one set of troughs is at present £5; but a single apparatus will not accommodate more than twelve or fourteen thousand ova, and whilst one nursery may employ a dozen boxes, another may require five times that number. In some places stages would have to be erected for the hatching-boxes. In others, a natural fall of the ground would enable the manager to arrange them in a graduated series, such as we often see adopted in our watercress beds. It is, therefore, clearly impossible to determine absolutely what such establishments shall cost; but if we say that a large and thoroughly efficient one could be constructed for £300, we believe there will be a handsome margin to our rough estimate.

No terrestrial farm can nowadays be

reasonably expected to pay without barns, sheds, and machinery. If money is to be made, capital must be invested; and fortunate, indeed, are our aqueculturists in being able to construct works of such infinite value at a cost so insignificant.

Some difficulty seems to have existed at Stormontfield in procuring a sufficient quantity of eggs exactly in the state fit for impregnation; this has now been obviated by the simple plan of placing a requisite number of salmon in the mill-lades, where they are secured by gratings till ready for manipulation. Floods and other accidental circumstances may render the capture of ripe fish uncertain in rivers so large as the Tay, provided the take is required to be made near the tideway, but in smaller farms such a difficulty would be very unlikely to occur, as freshes soon run down, and spawners are sure to be found on the lower as well as the upper fords.

Connected with the rearing-establishment is a question of great interest. We have

briefly described the hatching-boxes, ponds, drains, and so forth, and have shown how an approximation to the cost of construction may be obtained; but, it may be asked, what results are reasonably to be expected from the outlay? The answer will be too important to be hurried over at the end of a chapter.

CHAPTER VII.

RESULTS.

A COMMON proverb tells us that cleanliness is next to godliness. Whatever influence this virtue may exercise on the sanitary condition of man, the practice of it cannot be over-rated in the management of our rearing establishments. Mud is a sad enemy to the fry in all stages of their existence, and should be excluded as far as possible from the ponds and drains. In the construction of these, therefore, attention must be paid to the bottom, which should either be paved with brick or flat stones. Gravel would appear the natural substance to employ, but being a collector of dirt, must be avoided; a little of it, however, may be used with

advantage. The pisciculturist's success will largely depend on the attention he bestows on minute points, and his gains will be in the ratio of his care.

Having provided against this source of loss, we will now consider the profit which may reasonably be expected to accrue from artificial breeding.

If what has been said be correct regarding the havoc committed on the eggs and alevins, little doubt can be entertained that a nursery is the water-farmer's road to wealth, as it protects the fry from dangers as inevitable as they are ruinous. Could we, therefore, arrive at anything like an approximation of the saving of life effected by the artificial system, as compared with the loss annually experienced from the natural, we should be enabled to show the profit to be placed to the credit of our breeding-establishment.

In the investigation we must appeal to facts and refer to figures; and in order that these may bear the seal of authority, we shall

examine the things which have been done, and quote from the books which have been kept on the Tay, as well as on the Galway fishery, the great centres of experiment, and the fountain-heads as it were from which most of our actual knowledge flows.

The time had arrived at which the smolts in the ponds at Stormontfield were ready for migration, and Mr. Buist, having received notice from the keeper, proceeded thither in the company of three distinguished friends to see that every fish was properly run off. One of these gentlemen selected sixty-four of the best-grown smolts from the few that remained to the last, and made a peculiar cutting in the dead fin of each, so that there might be no mistake as to the identity of the fish, should they afterwards be caught as grilse or salmon; and now let us carefully note the result.

Of the smolts thus marked on the 24th of May one returned as a grilse on the 16th of August, weighing nine pounds. Four

days after, a second was taken of five pounds. On the 23d of the same month, another was caught; and on the 26th (then the last day of the legal netting season), a fourth of the marked salmon was secured.

The angling, however, was not over, and on the 19th of September, writes Mr. Buist, "a friend caught a grilse with the fly, and sent me a cut of the fish, with the dead fin bearing the same mark." Subsequently four more were captured, making a total of nine. Commenting on these facts, Mr. Buist remarks, "It is to be regretted that only one of the tacksmen on the Tay has evinced any interest in the progress of the experiment, all of them invariably abstaining from giving us notice when any fish of our marking fell into their possession."

We must now pass for a moment from Stormontfield to Galway. "We will assume," writes the proprietor of the latter fishery, "that 20,000 fish of various sizes visited their breeding-ground the previous

year, and that one half were females, producing 7000 eggs each; in other words, that 70,000,000 eggs had been left in the river, and yielded in due season our 20,000 marketable salmon." There is so little hypothesis in this calculation, that it may be accepted as fact; if, therefore, we contrast the statements so modestly put forth by Mr. Ashworth and Mr. Buist, we shall have done much to answer the question proposed.

Out of the sixty-four smolts marked from the Stormontfield ponds, nine were known to be captured, three or four more may reasonably be assumed annually to have escaped net and rod, whilst it is impossible to doubt that at least two or three others fell into the hands of some of the many tacksmen renting fisheries on the river. If, therefore, we find that fifteen or sixteen smolts out of sixty-four visited the sea, and returned from it in safety, we are able to decide with considerable accuracy that the percentage of loss sus-

tained by our young stock during this period of their lives is three out of four, or 75 per cent.

But what is this when compared with the dangers which naturally beset them, when, from 70,000,000 of eggs, we are entitled to assert only 20,000 annually return from the ocean, the loss being in this case as 3500 to 1, or 350,000 per cent.

The proprietor of the noble Galway fishery has published a table of the number of fish annually captured by him during a period of twelve consecutive seasons—viz., from 1853 to 1864—and by it we find the increase, with one exception, as regular as it has been prodigious. From this most instructive account we will select five years by way of illustration :—

In 1853, the number taken was			1,601
In 1855	,,	,,	5,540
In 1858	,,	,,	9,639
In 1861	,,	,,	11,051
In 1864	,,	,,	20,512

In 1852, operations were commenced at Stormontfield, and at the same time the netting season was reduced by nineteen days, the results, as affecting the rental of the Tay, are shown in the table which follows:—

In 1853 it rose to . .	£8,715	17	6
In 1854 „ . .	9,269	6	5
In 1859 „ . .	12,884	14	0
In 1862 „ . .	14,080	12	0
In 1864 „ . .	15,000	0	0

In each of the fisheries so often alluded to the artificial system was followed, but at the same time, the most enlightened culture was bestowed on the bed of the Galway rivers; and to this policy, doubtless, not a little of the increase was due. If, however, we make the fullest allowance for the benefit produced by ladders, blasting, improving and creating spawning-beds, enlarging the close-time, and strict protection, we must still declare that to the hatching-boxes the triumph is principally due; and that nature, assisted by art, in the case of salmon,—at

least,—produces results incalculably important, not merely to the proprietor, but to the nation at large.

The fatuity and incredulity which has been exhibited by the owners of our inland waters seems truly wonderful. The experiment has been tried, in a greater or less degree, in many places; has failed in none; and has succeeded uniformly in the ratio of the scale on which it was conducted, yet men still talk of requiring further evidence. Such persons must, indeed, be hard of belief, and it seems difficult to imagine what amount of testimony would satisfy them. On the Dee, Messrs. Martin and Gillone are cultivating with marked success, their breeding-boxes, unlike those at Stormontfield, being all under cover. Then does not Arcachon supply all France with young fish artificially produced? Have we not an example at Huningue, and has not Germany already done much towards converting barren rivers into profitable water-farms?

Hitherto our Protestant proclivities have prevented fish from being an indispensable article of food, but the price of butchers' meat must, of necessity, inaugurate new tastes; in fact, all food that can now be raised is wanted, and is sure to find a ready market.

Again, we know that the cost of rearing and feeding our young salmon is only about one pound sterling per thousand, or a farthing apiece; and that the smolts thus reared, so far from being less fine and healthy than those naturally produced, are often actually larger, and in time become salmon of a quality and weight fully equal to any produced in the ordinary way. Breeding-boxes, like other manufactured articles, can now be obtained in any quantity, and of every size and pattern, whilst at least two-thirds of the eggs placed in them can be hatched.

What more can the proprietors of our inland waters require? They have facts in abundance; but, alas! deeds have not hither-

to kept pace with knowledge. Better times, however, are at hand; the period of discussion has nearly passed, and the day of action has commenced. "The home-farm," five miles from Perth, beautifully situated on a sloping haugh on the banks of the Tay, is called by Mr. Buist a speck, considering the great extent of water on which it is intended to act. Comparatively speaking, it is only a faint spark, but here and there over the land other lamps are beginning to glimmer, and the present generation will, in all probability, live to see a chain of such lights blazing at many points along the banks of the great majority of our rivers.

At the commencement of this century, money was far scarcer than at present, wages were lower, and our population more scanty; in short, less food was required, and moreover the people were not so well able to pay for it. Even then, thinking men believed that our land could not possibly support a larger population. Yet we know that high farming

has well nigh doubled the supply, *and that it pays.*

This principle applies as forcibly to the water as it does to the soil. Let us then hear no more of "further inquiry;" rather let us be up and doing, and manfully fight one great peace battle *pro aris et focis.*

CHAPTER VIII.

COLLECTING THE SEED.

Our engineering and architectural works are at length completed. We have constructed the farm, and finished the nursery with particular care, but the seed has yet to be collected; and as this is a delicate operation, we shall enter at length into some of the methods at present employed to obtain it.

The gathering of the seed commences early in November, and the first step is to run a net over the nearest spawning-bed. If the river possesses anything like a stock, twenty or thirty fish may be brought to land, but out of these not more than two or three will, in all probability, be found ripe. Having, however, procured a spawner and milter sufficiently matured, the pisciculturist proceeds to operate. In many places the female

fish is carefully and gently held in a perpendicular position over a tub, bucket, or other convenient vessel containing a little water, when the eggs, being entirely separated from each other, flow naturally, though slowly, from the oviduct. The hand of the operator is, however, always used to accelerate the process, which, of course, from a due regard to the life of the lady, must be very brief. The eggs are now lying at various depths in the water, and a moiety of the work is accomplished. The milter is next taken in hand, held in a similar position, and treated in a similar way; a very small portion of the milky fluid, however, is sufficient to vitalise the entire mass. Both the parents are, of course, returned to the river, and the contents of the vessel gently stirred by the hand, to insure that the milt and the water are so thoroughly mingled, that each egg shall receive its due proportion of life-giving matter. The success of the operation becomes immediately apparent, each egg assuming a pink hue.

This first haul of the net has, perhaps, produced thirty or forty thousand ova; but as this number will go but a very small way towards filling the boxes, other draughts must be made on the nearest fords. In the meantime, each bucket having been safely conveyed to the nursery, the spawn is placed in the boxes previously prepared for its reception; the tap from the filterer is then turned on, and hatching begins.

Experience has taught us many lessons, not only regarding the number of eggs to be placed in a single breeding-box of any definite size, but also the mode of arranging them, the rule being that out of any given number, success is in the ratio of the space allotted to them, and overcrowding has always been found to end in great loss and disappointment. During this month the pisciculturist must work with energy and perseverance on every available opportunity, for in November the weather is capricious, and floods will materially interfere with his harvest operations. If, through supineness or over-confidence, the

favourable opportunity is wasted, he loses what can never be regained. Time and tide wait for no man, and when he would be up and doing, the day of grace has passed, and no ripe fish can be obtained. Their seed has been already deposited, and for that season the artificial system, so far as he is concerned, is null and void.

This naturally leads us to observe the importance of building a lying-in hospital in every nursery, where immature salmon can be kept till in a state fit for use, and all uncertainty as to procuring ripe seed avoided. Nothing should be left to chance, and during the first and second weeks in November—if freshes do not stop netting—"the keeping-pond" should be fully stocked. We need not pause to describe it, as every reader will at once understand it must communicate either with the main river or some convenient stream possessing an adequate and invariable supply of water; and if the brook does not carry off the surplus water, an artificial cutting must be made, a strong grating be placed at its

inlet and outlet, and then the structure is complete.

In the early days of the Stormontfield experiments Mr. Buist suffered severely from the want of such a reservoir, and disappointment soon suggested the remedy to his fertile genius. So obvious is the advantage of such a storehouse, that in future it will—at least on our larger rivers—form a necessary part of each rearing-establishment.

The mode of collecting the eggs, hitherto described, may now, in the advancing state of our knowledge, be considered rather rough. The plan followed by Mr. Frank Buckland, whilst more refined, is probably also more efficacious. He recommends the use of oval tins, in size suited to salmon and grilse. When taken to the river-side these dishes are partially filled with water, and the fish being placed therein is held gently but firmly, in order to prevent her struggles; the hand of the accoucheur is next passed along the external surface of the abdomen in order to express the seed, and the lady is then

returned to the water. The milter undergoes the treatment before described, and the eggs are vitalised. The advantage of this plan seems to be briefly this, that the fish is delivered *in situ;* more time is given to the operator, and the eggs pass directly from the oviduct into their natural element.

It matters little, however, in what particular mode the ova is gathered, provided the manipulation be rapid, light, and easy. We will suppose, therefore, that the seed has been collected and sown in some of the many boxes now in use; there for a time it may be safely left, whilst we speak of the transmission of spawn to barren rivers, either at home or abroad.

This would appear at first sight a very simple matter; in practice, however, it has been found to be invested with many and great difficulties. In fact, the loss sustained in the carriage of the seed, as well as from the difficulty of obtaining it, has tended more than any other cause to retard the development of our inland fisheries; and whilst on

this subject it may not be out of place to remark that we labour under a difficulty not felt by our French neighbours.

Their fish-breeding establishments at Arcachon and Huningue send out annually millions of eggs, exactly in the condition in which they can be transported with the greatest certainty of success—namely, when the eyes of the embryo fish appear to stand external to the investing membrane, rather than within it. In this state the loss by transmission does not exceed five per cent, but at the same time it must be borne in mind that a large share of this success depends on the skill and care with which the seed is packed for the journey. The mode pursued in France is as follows:—A certain quantity has to be sent off. A box made of very thin wood, and about equal in size to the crown of an ordinary hat, is brought to the side of a range of hatching-boxes, in which the ova are exactly in the condition required. A layer of *living* moss is then placed on the bottom; on this the eggs, with

a due regard to space, are carefully placed. These are in turn covered with moss, more eggs are scattered on it, and the process is continued till the box is filled. We, however, at present do not possess the advantage enjoyed by our neighbours, as we have no public rearing-establishments. Parties at present engaged in fish-culture have few incubated eggs to spare, and are, therefore, necessitated to send off spawn which has been recently vitalised. Unfortunately this is the most unfavourable period at which it could be supplied to those who require it, for the delicate process then in operation is almost certain to be injured by motion, from which a new arrangement of particles probably takes place, and great loss is thereby sustained.

This state of things we are compelled to accept for the present. Hereafter, if not undertaken by our Government, the preparation of fish-spawn for transmission to distant points may become a lucrative commercial speculation to private individuals. Mean-

while, various plans have been proposed to obviate the difficulties which inevitably attend it on the road, none of which, however, have proved entirely successful. The two best are nearly as follows:—If the distance to which the precious freight has to be sent is short, fresh wet moss is the best medium in which to pack it; but should the journey be a long one, it is better to forward the seed in small wide-mouthed bottles, each capable of containing from six to twelve ounces of fluid. The moment before transmission, the spawn should be carefully bathed in fresh water, whilst a slight quantity, drawn from the filterer, must be placed in jars, and the mouths secured with pieces of calico tied over them. The bottles must, of course, be placed in a box, and so arranged as to avoid an upset. Such a freight is, however, too delicate and valuable to be trusted alone, and the recipient will act wisely if he sends a steady man to take charge of it during the journey.

All this appears plain, yet the mistakes

and disappointments which arise from the neglect of minute points of detail, are even now very numerous, and I may mention that a short time since a considerable quantity of eggs, packed in the last-mentioned way, were entirely destroyed by the over-zeal of the person who superintended the business. This man, all his life engaged on a salmon-fishery, having observed that gravel was always the nidus employed by the mother-fish, and wishing to be wise above that which was written—for full instructions were sent—after having conducted all the earlier stages with his usual skill, added a handful of gravel to each bottle; the act, though kindly meant, destroyed every egg, and left the hatching-boxes of my friend for this season without an occupant.

Having thus spoken of gathering, storing, and transmitting the seed, we shall next pass to the consideration of the number and cost of our farm-servants, present and prospective.

CHAPTER IX.

THE SEED GROWS. WORK AND WAGES.

THE reader has seen the vitalised seed deposited in its artificial bed; it is now in full growth, the early stages of which are not yet so generally known as to justify our passing over the subject without at least a brief notice. For the first fortnight after impregnation the eggs apparently exhibit but little change; within the next fourteen days, however, if the temperature be not unusually low, a marked alteration occurs, and two tiny black spots in each, afford unmistakable evidence that nature is doing her part in assisting the operations of art. These small specks are the eyes of the future fish, which become more and more visible, until the embryo bursts the shell, and commences independent existence.

The infant salmon on his first appearance in the world looks as unlike the future monarch of the stream as it is possible to conceive. Embarrassed by the umbilical bag, of which we have before spoken, it is probably the most feeble and helpless of created things. The stages and anomalies of its growth have been already mentioned, and need not be repeated here. There are two points, however, connected with its infancy which have not been spoken of; namely, space and food. As crowding the spawn has been shown to be injurious, so, as might naturally be expected, insufficiency of room is still more fatal to the young fry, and many of the disappointments which have embarrassed our early pisciculturists have been due to this cause. The difficulty, however, is so easy to overcome that it is unnecessary to carry the subject further. In young animals growth is rapid, and appetite proportionably vigorous, the former being in the exact ratio of the latter, nor do we doubt that the difficulty these helpless creatures experience in pro-

curing an adequate supply is a fruitful source of the enormous waste of life which occurs amongst them in our rivers and mountain-streams. In artificial hatching, however, we are able to supply food in a state exactly suited to their weak organisation and imperfect digestion. Like other babies, they require pap, and though farinaceous food in minute division might answer, animal matter, carefully rubbed down, has been generally employed, and this has usually been either bullock's liver well boiled, bruised through a sieve, and, with the addition of water, made into a sort of soup, or else eggs beaten up. Both these articles of nutrition, when thrown into the ponds which contain the fry, have been found to be greedily taken, and materially assist the nutrition and growth of the infant brood.

As a commercial speculation, the farmer finds the advantage of feeding his young stock as highly as possible. Nor must the pisciculturist forget that, if he desires his flock to thrive, he must supply food in such

proportions as his observation shows to be necessary.

Practical water-farming, to be successful, necessarily demands a close attention to details. These, as regards the preparation of the farm and the management of the infant stock, have been given at considerable length. This branch of the subject is now concluded, and we come naturally to the question of work and wages.

On the river we have selected as an exponent of practical water-farming, keepers were, of course, unnecessary for the first two years; after that time, however, they would be required. Such little works as we have executed were done cheaper, and probably better, by ordinary labourers, and the servants hitherto in our employ have been only the man and boy engaged in charge of the nursery. Water-keepers, henceforth, will be our servants, constables, rural police, and regular troops, all in one. They will assist at the capture, packing, and transport of our fish to the nearest station; will apprehend

such village-boys as destroy the fry, will keep under surveillance men given to poaching, and, during the early winter, watch the roods night and day to guard our frontier from the incursions of marauders.

It is obvious that a force required to discharge such important duties should be carefully selected, well taught, and sufficiently paid. We will say a few words on each of these heads. Character should be made a *sine quâ non* with each recruit. Often acting alone, with bribery and intimidation brought alternately to bear on his cupidity or his fear, without moral strength he must fall, nor can he so fall without serious loss to his employers.

Then, he should be instructed in his duty; taught what to do, and what *not* to do; when it is wise to act, and when it is prudent to be passive—over-zeal is often more injurious than mere supineness. On the Severn the water-bailiffs are furnished with a brief and plain summary of the law they have to enforce, and are, moreover, taught to under-

stand it; this plan is so excellent that it should be everywhere followed.

I have seen a good deal of these men, and believe them to be far more trustworthy than it is the fashion to suppose, and feel sure they err more often through ignorance than design. There can be no more fatal economy pursued by fishery proprietors than underpaying their staff. Such men are emphatically worth their wages—ay, and good wages too. The office is one of trust, vexation, and difficulty, and should by superior pay be made an object of desire. This would be ensured by raising the salary of these servants two or three shillings per week above the amount usually paid to farm hands in the neighbourhood. Such an advance in the labour market, if regarded as a mere commercial speculation, would prove a first-class investment, and fifteen or sixteen shillings per week to each water-keeper, would, in the great majority of cases, secure a grateful and honest executive.

The number of troops necessary to defend

our dominions requires a little consideration. In the spring and summer they may be reduced considerably, and during that moiety of the year one man to every six miles of river will generally be found sufficient. As the season advances, however, the force must be increased, and massed on or about the principal fords, at which time one keeper to every two or three miles will not be too much to ensure efficient protection.

The next chapter—in which four years are supposed to pass—will conclude the cultivation of salmon, and must involve figures; in fact, it will contain our balance-sheet, and we venture to promise, the document shall prove highly satisfactory "to the company."

CHAPTER X.

THE FARM THRIVES. RAISING FUNDS. OUR SECOND AND THIRD HARVESTS. BALANCE-SHEET. WE WIND UP ACCOUNTS, AND LEAVE THE COMPANY IN A PROSPEROUS CONDITION.

THE reader must suppose that four seasons have glided away since the first survey of our imaginary water-farm was made, and pardon us, if for the sake of brevity and clearness we speak of some things as actually *done*, which could with certainty *have been done*, under the conditions assumed. With regard to income, we repeat that the figures given below are less than those realised on a river of which we are one of the lessees, that has not only a course of seven miles shorter, but is *far* less perfectly cultivated than our model farm. But to resume.—Four seasons

have passed, but that time has done wonders for us; the ova first deposited in our boxes have long since become parr; these in due season were changed into smolts; the survivors returned as grilse from their visit to the sea; gained the head waters, and were permitted to commence housekeeping in the old-fashioned natural method, with the exception of about a score, whose eggs were employed to fill our breeding-troughs. Meanwhile the nursery has done its part, turning out each spring from 80,000 to 100,000 smolts. The water-police are organised, and with a little drilling have become efficient. Our small river, being one on which all the proprietors are bound in a common interest, presents few difficulties on the important question of finance, for from the source to the sea all are united for the general good. The entire length of our farm is assumed to be about thirty-two miles, and as the stream generally forms a natural boundary to property, and as the land on either bank is in different hands, we have a

clear length of some sixty-four miles. Each mile represents one share, and by an early and happy arrangement, powers were vested in the chairman to make a call on every shareholder to the amount of £5 per annum, which yielded an annual sum of £320 for working purposes. These calls were of course regularly responded to, and sufficed for construction and improvements; for the nursery, and incidental expenses.

On a stream cultivated so carefully as ours, proprietors would be fully justified in fishing for market during the fifth summer, nor would eleven tons of salmon be an overestimate for the season. If we suppose prices to be low, say eightpence per pound, the total value would amount to something about £821. In the sixth year, the returns might reasonably be expected to reach a higher figure; but, without further speculation, let us take the sum already mentioned, and see how the investment stands. From it the working expenses, £320, must be deducted, leaving an available balance of £501 to be

divided amongst the shareholders. We will suppose for the sake of argument that four calls of £5 each have been made, in which case the stock of each investor would represent £20, bearing interest at the rate of something very like £38 per cent. It must not, however, be supposed that our farm has reached its maximum of profit, or that it is by any means fully stocked; on the contrary, the nursery should be enlarged to twice its present productive capacity, and similar establishments be erected at suitable points along the river. In fact, it is impossible to say, with any degree of accuracy, to what extent a river may *not* be developed by the combined influences of art and nature. So far as our present experience goes, it is evident that the returns have hitherto been in the ratio of artificial propagation, improvements, and the number of its breeding fish. Indeed, there seems no limit to production, since the more smolts we send to the sea the greater will be the produce of the following harvest. The land, in the present state of

agricultural knowledge, can only give a certain return; but our salmon-streams own no such restrictions, for the ocean feeds and grows the crop we reap. There is no fear of our water-farms being exhausted by their production, for the king of fish employs them, not as pasture-grounds, but as highways along which he passes to deposit the treasure destined to feed and enrich mankind.

The future of salmon-farms will depend on the care, labour, and intelligence, bestowed on them. Enough has been said to show that such property offers a first-rate commercial speculation, but, like any other concern, it may be ruined by carelessness or incompetence. We, however, have pointed out how a barren river can be improved, how spawning-grounds may be multiplied, how a nursery should be built and managed; have spoken of various details necessary to ensure success; and have, in conclusion, presented our balance-sheet by way of illustration.

In point of profit, the salmon is incomparably the best fish to cultivate, whether its

intrinsic excellence or rapidity of growth be considered; but many waters of the United Kingdom are not suited for its successful production, and it is to these that we shall presently direct our attention, after the consideration of a few questions, which arise out of, and must exercise an important influence on, the artificial culture of the Salmonidæ.

CHAPTER XI.

GENERAL OBSERVATIONS.

It may well be asked why pisciculture has made so slow a progress in these kingdoms. That it has been neglected there can be no doubt, but it is equally certain that the apathy and suspicion with which it has been regarded, have existed in the face of evidence sufficient to show the science deserved at least serious consideration, if not unbounded confidence. The causes which have hitherto retarded its advance, may not, in a treatise like the present, be unworthy of examination.

From time to time, within the last few years, various partial and short-lived attempts have been made to improve water property. These attempts, however—seldom conducted on any definite principles—were

unsupported by perseverance or adequate capital. As might have been expected, they failed, from a combination of circumstances, hardly, perhaps, understood by those who conducted the enterprise. These abortive efforts proved more injurious to the cause than total neglect, since they furnished specious arguments to the indolent and unbelieving, and enabled them to throw discredit on a discovery that deserved investigation rather than disparagement. The science was a novelty, and with a great majority of proprietors took rank amongst the bubbles of the day. Here and there, however, *detached* parts of the new art were worked out with enterprise, perseverance, and skill, and the results made known. Gradually a change came over the public mind; water-culture ceased to be regarded as the visionary speculation of a few harmless enthusiasts; a reaction took place in its favour, and men became willing to be convinced, where they had hitherto been wilful sceptics. Henceforth, the system will be worked out according to scientific

knowledge and common-sense business principles. We see the difficulties that are before us, and feel that we can surmount them; we know what class of streams will pay with very small outlay, what rivers have little or no chance of achieving commercial success under existing conditions, and so forth. As we want no more failures, it is earnestly to be hoped that the enterprise now awakened will take wisdom for its guide, and make choice of waters in which disappointment is next to impossible, and success certain.

"Ladders" may be cited as one of the "partial attempts" alluded to, and as the question is one of great moment, we may be pardoned for discussing it. The *name* was in itself a misfortune, since it has, I believe, in no small degree, suggested many designs more curious than effective. These complex curiosities, faulty in construction, were often rendered absolutely useless by malposition; they were passes which no salmon could pass, and served only to bring into disrepute a

principle which, if correctly applied, would have been invaluable. Wherever they have been constructed on a gradient of 1 in 9—1 in 10 would be still better—they have answered admirably. But, unfortunately, we hear less of our few successes than our many failures; moreover, these ladders have been, and still are, made a kind of party question, chiefly, perhaps, because certain inventors in high places defend indefensible positions, and thus, so far as in them lies, help to perpetuate existing evils. This paltry vanity is below the dignity of genius. Rome was not built in a day, and early inventions may, without offence, be supposed capable of improvement. Projectors should rest satisfied with "the idea," if they fall short of perfection, and frankly own the merit of those who have improved on what they designed. Meanwhile the public are perplexed. When great fish-doctors disagree, how can they decide? If commissioners, instead of wrangling, would clearly explain the construction and position of

passes whose efficiency is acknowledged, they would do the state good service.

Whilst on this subject, we will lay before the reader an extract from an admirable letter recently published by Mr. J. H. Horsfall. "A weir 8 feet or 9 feet high would require a pass 64 feet or 72 feet long, to have a gradient of 1 in 7. Up such a pass no salmon *can ever* swim. It has been objected that a ladder with an easier gradient is more expensive, but the public may depend upon it, that money laid out on a ladder having a gradient of 1 in 10, will prove a much better investment, than money expended on a ladder having a gradient of 1 in 7. In salmon-passes, as in other things, that is not always the cheapest article which costs the least money. Colonel White is quite correct when he imagines that it would be possible to take salmon over the Falls of Niagara, if the passage for them was so constructed that the fish could *rest* on their journey up it. It is necessary, however, in order to accomplish this, to make the

floors of the chambers slope the reverse way to the incline of the ladder, for most surprising results have been obtained with ladders having the bed of the chambers sloping parallel with the incline of the ladder, and there is an improvement on this. The object to be attained is to reduce the speed at which the water flows; this is done by an easy incline, by the friction of the sides and bottom of the ladder, and also by regulating the volume of the stream above."

All this is sound doctrine, and we believe if Her Majesty's inspectors would call Mr. Horsfall to their councils, and order passes to be erected under the personal supervision of that gentleman, we should have more salmon, and less complaining. These are some of the causes which have hitherto retarded the progress of pisciculture; let us see what evidence can be advanced in its favour. Every year at Huningue and Arcachon, millions of eggs are regularly vitalised and transmitted over the Continent. In

London and its immediate neighbourhood, public bodies and private individuals are steadily demonstrating the infallible certainty which attends the artificial hatching of fish-spawn. At Galway and Stormontfield—in the establishment of Mr. Gillespie—on a smaller scale,—on a hundred lawns, and in many a study, the process is attended with unvarying success; nor does the evidence in favour of our art end here, for its economy is as evident as its commercial importance. These are facts, the value of which cannot easily be over-rated. We are not so Utopian as to assert that the final triumph of our rivers can be achieved without patience, skill, and money. In many of our smaller waters, as for example, in the highlands of Scotland, in the north and west of England, and in numberless streams in Ireland and Wales, the difficulty will be found trifling, and needs only to be grappled with to ensure success; but on our larger rivers, pollutions, mill rights, natural and artificial obstructions, together with indifference or selfish policy

amongst proprietors, offer at present serious obstacles.

That these will in time be overcome seems certain. Over the length and breadth of the land, men are now beginning seriously to consider the propriety of working mines of wealth, hitherto only explored. Objections, founded on the novelty of such undertakings, are daily losing force—doctrines, in themselves sound, are recognised and accepted—truth and error are clearly defined—half-measures and party-strife are alike condemned—money is plenty, and food dear—security for investment is needed—the uncertainty of speculation grows daily more manifest, and now the time has arrived when motives of prudence, patriotism, and philanthropy, equally urge us to cultivate the water as we have cultivated the land. Let a tithe of the money annually spent on the latter, be applied to the former, and we unhesitatingly affirm, that the returns shall convince the most incredulous, and satisfy the most exacting.

CHAPTER XII.

TROUT.

In the old mediæval days, ponds and stews, river and mere, were almost necessary adjuncts to monastic establishments, and the rearing and fattening of fish for the table was at that time well understood and actively followed. Necessarily this knowledge formed an important part of their farm management, and we may suppose that the good brothers, about the Lenten season, looked anxiously at many a corpulent carp, or golden trout, and speculated pleasantly on the joys of fasting. With the fall of the old faith, fish lost much of their commercial value, but now an increasing population and increasing wealth, have so far advanced the price of food that every aid to production is required, and anything which can be produced is certain to meet a ready sale.

In this altered state of things we once more look to our lakes, ponds, and streams, as sources of supply. These are as yet but in their infancy, and we must regard them rather for what they *will* be, than for what they *are*. Fish-culture at present is principally directed to our fore-shores and salmon streams, but we are not entirely without data as to the value to be derived from the commercial cultivation of trout.

At Heidelberg, and at other places in Germany, these fish are regularly prepared for market; but leaving Europe, we will for the present cross the Atlantic, and see what our American cousins can teach us, before speaking of the future utilisation of our bright English streams.

Mr. Francis, one of the most studious pisciculturists of the day, writes, "In Europe, Asia, Africa, and Australia, there seems to be a great interest displayed on this subject, and the idea appears to be gaining ground that the greater part of the human race have so far been only tillers of the ground, and have

neglected to cultivate one-half of the bounties of Providence, in not extending the same attention to the water." In India, at this moment they are engaged in the attempt to introduce trout; in Australia, eggs both of the salmon and trout, sent from the mother country, have been successfully hatched. New Zealand has followed in the footsteps of her elder sister, whilst all over Europe—in France, Germany, Italy, Norway, and Sweden —pisciculture is day by day becoming a more profitable calling. But it is from America that we must learn our first lesson, and our text-book shall be the *New York Tribune*, published January 28th, 1866. For the benefit of our readers we will epitomise the pamphlet. Near the town of Spring Water flows a small brook, in which, during the course of five or six years—without the aid of artificial hatching—trout have been multiplied to a degree almost incredible. These fish have increased not only in number but in size, so far as we can learn, merely from preservation, and the formation of larger pools

by the erection of dams; for it does not appear that food was directly provided, which might have been done easily and cheaply by collecting from the adjoining fields, worms, slugs, insects, and grubs. The trout, though what old Isaac calls "dainty meat," is by no means dainty in his diet; on the contrary, like the Rev. Dr. Gaster, he is omnivorous, and few things that can be eaten come amiss to him. The writer, whose paper lies before me, tells us, "I visited the ponds, three in number, by invitation last summer, with rod and line, and took trout from 1lb. to 2lbs. in weight almost at every cast. They were beautiful, fat, and healthy. The stream did not yield a volume of more than thirty square inches of water at the time I was there. This shows to what extent trout may be increased and grown by damming and screening small brooks." Passing from facts to figures, it may not be out of place to mention that this little water-farm was recently sold for 8500 dollars. Surely this ought to be sufficiently encouraging to English country gentlemen,

few of whom have not a brook of equal natural excellence and greater size, than that of Spring Water, flowing through their property.

But a greater inducement to the cultivation of our hitherto neglected streams remains to be mentioned. In Livingstone County, New York, are the Caledonian springs, the head waters of a brook which runs through the village of Caledonia. The entire length of this rivulet hardly exceeds one mile, when it unites with Allen's Creek, one of the tributaries of the Genessee. This wonderful stream, the most prolific probably in the world, from the source to its junction with the creek just mentioned, has a fall of about fifty feet, and flows through one of the richest and most thickly populated portions of the state. At the risk of being tedious we must be minute, as most of the facts which follow bear an intimate relation to the fecundity of "the springs," and will largely assist us in the practical farming of the fish of which we are speaking.

The brook, being dammed for the use of mills, occupies about six acres. The water is remarkably clear and pure; whilst the bottom is covered with small white shells and gravel—just such a bottom, in short, as is to be seen in ten thousand of our rivulets. As might be expected from its transparency, the water is rather strongly impregnated with lime, and is said, moreover, to hold sulphur in solution. The uniformity of temperature, however, probably exercises a greater influence on the productiveness of the stream than its chemical constituents, the average being 48 deg. the whole year round. And now we arrive at what is, in all probability, the secret of the marvellous fecundity of this small water-farm, for we learn that through its entire length, every stone, stick, weed, and blade of grass, is literally covered, summer and winter, with insect life. The first settlers found the stream absolutely filled with trout of great size. That it is still amply stocked at the present time, the following figures will show; and here I cannot do better than

quote from the paper before me:—"The fishermen tell me that at a low calculation there are 4000 trout taken from the stream annually, and they compute the number to-day at 320,000 of all sizes, from 4lb. to 5lb. to 4 inches or 5 inches in length." All this is sufficiently definite, but when the writer grasps his rod, and kills 110 fine trout in about three hours, he provokes us poorer brethren of the angle to break the tenth commandment, and covet our neighbours' stream, and our neighbours' trout, with other piscatorial blessings by him possessed.

Greater wonders remain to be told; about two years ago the springs were purchased for the purpose of rearing trout, artificially as well as naturally, by a gentleman who has since actively followed up the design. One more quotation and we have done with our transatlantic companion.* "He," the for-

* Tremendous as these figures unquestionably are, we can scarcely reject them. It must, however, be observed we do not give them on our own authority. The reader who refers to the *Field*, vol. 27, p. 213, will see more of the *New York Tribune* than has been transferred to these pages.

tunate Seth Green, Esq., "has one pond only 75 feet long, 12 feet wide, and 5 feet deep, that has 9000 trout in it, from 9 inches to 20 inches long, that will weigh from a quarter of a pound to three pounds each, all as fat as seals, and as beautiful as trout can possibly be, all caught with the fly by his own hand since he bought the creek, and all can be seen now any day, at one view, by any person who will take the trouble to call on him. Only think what a sight, 9000 such trout all in the eye at once. What a gigantic and magnificent aquarium." It seems incredible how so great a number could thrive in a space so small, but we are informed that the current which passes through it is sufficient to change the water every minute of the day, and that in this preserve the fish were fed.

Though much of the above may sound like "tall talking" to British ears, there appears no reason whatever to doubt its accuracy, nor, so far as we know, has its truth ever been called in question. On the contrary, the statements of the editor of the *New York*

Tribune have been accepted by his contemporaries in this country, and quoted, in good faith, by many of our best aqueculturists.

Instances might easily be multiplied to prove that trout cultivation offers no small inducement for commercial speculation. Enough has been said, however, to establish the position, and we will, for the remaining portion of this chapter, confine our attention to the small streams which in so large a proportion of the English counties flow pure and uncontaminated through every valley, and inquire generally how far they are capable of being made productive. What the brooks are in Wiltshire, they are in Hants, Somerset, Devon, Cornwall, and nearly every other of the fifty-two counties in England and Wales—namely, clear rapid rivulets, more or less wooded, now murmuring over the shallows, now falling into deeper pools, with a varying course of from three to ten miles. Amongst these I have passed a considerable portion of my life, and assert

not only that there is no inherent cause why they should not singly form productive water-farms, but that there is every reason to believe they would answer admirably. They seem, at least, to possess every element necessary to success. The water is generally extremely pure, and flows through meadows as rich as any in the world, whilst the rank vegetation along the banks ensures a large supply of insect food. Of course they will require damming and improving, but of this we shall say nothing here, as "construction" will form the subject of a subsequent chapter.

As the cultivation of our inland brooks, in so far as the public are concerned, is a *res nova*, and as example is better than precept, we have endeavoured to show what has actually been accomplished by our transatlantic brethren, and have pointed out that no reason exists why we of the Old World should not do likewise. In the next chapter we shall glance at the state of the com-

mercial cultivation of trout in Europe, and in the following one on this subject, point out in detail the steps necessary to be taken in order to make the brooks of England as prolific as any of their size in the New or Old World.

CHAPTER XIII.

TROUT.

EVERY one knows that the French Government has for several years past given the closest attention to the subject of pisciculture, annually sending out from Huningue and Arcachon millions of ova procured from various first-class fresh-water fish, to re-stock the impoverished waters of the Continent. Of course the largest quantity of this vitalised seed was sown in the rivers of France, which year after year continued to receive fresh importations of this precious commodity. All that skill and industry could do, was done. The scheme has been fairly tried, and we are justly entitled to ask what are the results.

It might reasonably be expected that the rivers of France, after such close and ad-

mirable cultivation, should, if there be any truth in the doctrine of aqueculture, now be fully stocked. Such, however, is not the case, and that the science may not suffer from misconstruction, it becomes necessary to account for the failure.

The ova sent was forwarded exactly in the condition best suited for transmission, five per cent only being wasted between the breeding-boxes and the river for which it was designed. In fact, the eggs prospered, and produced thousands and tens of thousands of young fish; but unfortunately, until the last season, there were no fishery laws in France to direct what sized mesh should be used in netting, or at what season fishing should cease. The consequence was, that the fish hatched were not allowed to come to maturity, and thus the only use derived from the artificial method, was the artificial production of vast numbers of fry, which, being killed as fry, in no way furthered the designs of the Government, and almost entirely neutralised the labours of Arcachon

and Huningue. Happily this can no longer be done, as a law was lately passed, based on, and nearly identical with, our present Fishery Act, which ensures that the seed henceforth to be sown, shall not only come to maturity but bear fruit, and thus contribute to the fertility of those waters which a wise legislation, having so ably fostered, has at length protected.

Having thus accounted for the practical failure of pisciculture in the rivers of France, we will proceed to notice briefly two or three continental establishments where the science *pays;* point out the importance of inland fisheries as a source of national wealth, speak of the produce and market-value of the trout in Loch Leven; and, in conclusion, say a few words on the fertility of the smallest of conceivable cottar water-farms, which, although entirely without cultivation—properly so called—yielded year after year an abundant harvest.

Near Heidelberg, at the village of Wolfsbrunnen, are beautiful trout-ponds, where

this delicate fish has a strictly commercial existence. The farm has been under cultivation for some years, and is still flourishing. We may reasonably infer, therefore, that it has proved a money success, as the works would not have been carried on at a loss. I hoped to obtain an accurate statement of the profits and outlay derived from, or expended on, these ponds, but have hitherto been disappointed, by the illness of an old and distinguished friend.

The establishment of M. de Galbert is probably one of the most important which exists in France. It consists of a chain of ponds with islands, canals, submerged rocks, and wire screens, to isolate the fish of different ages, whilst feeding is, of course, a prominent feature of the management. The works are situated at Buisse, on the south-eastern frontier, and comprise four ponds for fish in different stages of growth. These it is unnecessary to describe minutely. One point, however, demands notice—namely, that the streams which supply the ponds are

of an elevated temperature. It may be remembered, that when speaking of the prolific trout streams at the village of Caledonia, in the State of New York, the high temperature of the water was noticed, as exercising a considerable influence on production; and here again we find the same peculiarity on the banks of the Isere. These facts are well worthy the consideration of those amongst us who are about to cultivate their streams. That heat is agreeable, if not advantageous, to most fresh-water fish, the following anecdote will show:—Not five minutes' walk from my house runs a canal, which, like all such pieces of water, holds abundance of pike, perch, tench, roach, and other coarse fish. About seven years ago a steam-mill was erected on its banks, and poured, by means of a water-pipe, a nearly constant and considerable stream of hot water into the main channel. Previous to the erection of these works, for some unexplained reason, this portion of the water was held by the experienced in especial

disfavour; certain it is, that passing it constantly, I scarcely ever remember to have seen any person angling there. Now, however, "the swim" has risen enormously in public favour, and is probably the best spot for angling in the 110 miles which make up the entire length of the canal. A month since I saw a friend take three pike, by trolling, about twelve yards from the mouth of the pipe previously mentioned, at a time when it was pouring out a considerable quantity of hot water, which must have been of a very high temperature, if we could judge by the steam. We will return, however, for a moment to the farm of M. de Galbert. Here fish-culture is eminently a business transaction, and entirely successful.

The anxiety displayed by the French Government to make pisciculture one of the practical industries of the day is very remarkable, proving to a demonstration, that the astute monarch of one of the most intelligent races on earth sees his way to a

great success. Prior to the passing of the recent fishery law in France, the money value of her waters may be stated as follows, calculated in pounds sterling:—

Returns from rivers and canals	£28,000
Half returns from estuaries .	23,000
Private waters	2,680
114,889 miles of water-courses	148,000
Lakes and ponds	400,000
Total	£601,680

What will be the value of these waters when the new fishery laws have effected the improvement they inevitably will produce, it is difficult to imagine, but they must prove great indeed.

Much of the artificial cultivation of fresh water is carried on in France, Italy, and Germany, in ponds generally connected with some neighbouring river. With these, at present, we have little interest, since our earliest efforts at the cultivation of trout will be made on some of the countless brooks which, ready to our hands, meander through

every English valley. Instances of successful continental pisciculture, like that carried on at Wolfsbrunnen and Buisse, might, however, be easily multiplied, but enough has been said to show that labour in this direction is remunerative. That similar waters in this country are able to produce trout of extraordinary size, the rough picture of the fish grown in the Alresford ponds, and at present hung in the hatching department of the Kensington museum, proves indisputably. The weight of this corpulent monster is stated to have been fifteen pounds.

Twenty-two miles from Edinburgh is Loch Leven. We shall say a few words about this lake, not because it is more productive than a hundred others of the same size, but because the supposed quality of the trout has given it a high local reputation. Although, in consequence of the drainage of the lake in 1830, —at which time the water was reduced to a third of its former dimensions,—this boasted fish is said to have degenerated, it is still of considerable commercial value, since it cannot

be purchased in the Scottish Capital under two shillings per pound.

During the past autumn I visited this lake a few days after the close of the season, but was unable to obtain reliable statistics as to the weight taken. The lessee however assured me it was above the average. In former years, during the seven months which constituted the fishing season, from 15,000 to 20,000 pounds were annually captured. This estimate will, at the lowest calculation, give an annual money value of £1500 sterling. Nor is this all, since the revenue derived from angling must be very large, for a friend who fished the lake during the last summer assured me the terms, including, I believe, a boat and men, were £1 : 2 : 6 per day, and that numbers of persons are always ready to pay even this ridiculous price.

In speaking of these trout I have used the phrase "supposed quality," firmly believing that those of Belvedere Lake, Dereveragh, Lough Ouel, Lough Arrow, and a hundred others, produce fish of equal excellence. If

Loch Leven were cultivated, instead of being merely *preserved*, it would be a mine of wealth, and might serve to illustrate the value of the neglected lakes of Scotland and Ireland.

Half-an-hour's walk from the town-hall of the most beautiful city in the West of England, nestles a small green valley, to which we will give the name of Combe English. Through it tinkles the tiniest rill that ever held a trout. As its entire length does not exceed a mile and a half, the stream cannot have a productive course exceeding a mile and a quarter before it joins a larger tributary, which, meandering through a lateral vale, hurries on towards the Avon. Many a year ago I knew the locality well, and the old-world farmer whose meadows enclosed the little brook on either bank, from its source in a wood to its debouchment into the Preston river. My old friend the farmer had a son, "a sad dunce," he said, "who took to reading and fishing, and would never be fit for anything." This urchin, however, had his own

views of life, and for ten years angled and studied in and about the runlet before mentioned; his daily take in the paternal stream from March to September was, at a low calculation, six brace, and as each fish averaged four ounces, the weekly returns ranged from eighteen shillings to one pound sterling, giving an annual income of about £28. This little water-farm was in operation long before the modern science of pisciculture had been heard of; the acting agent was but a country bumpkin, whose only idea was to catch all he could. He never dreamed of breeding, feeding, or enlarging the pools, which, when I last saw them, ranged from the size of an ordinary hat to the dimensions of an average sized tea-tray, whilst the streams which connected them rarely exceeded twelve inches in breadth, by two or three in depth. Yet the rill, in ten summers, gave this boy £280, and started him in a literary life, in which he has already made himself a name. Had this puny rivulet been improved, as it doubtless would have been—had modern doctrines been

preached five-and-twenty years ago—its value might have been trebled.

We have told this story by way of preface to the following chapter, in which we shall deal briefly and practically with the cultivation of trout in our English brooks.

CHAPTER XIV.

TROUT.

THE brook we propose to adapt to the purposes of trout-cultivation has not merely an imaginary existence; on the contrary, it belongs to a friend, and by its banks I have whiled away many a happy hour. Every inch of it is well known to me, and from its source on a low green hill to its debouchment into a river that will one day take its place amongst our salmon-streams, I could tread its margin blindfold. There is nothing remarkable about it; nothing unusually favourable for the ends we have in view. It is clear, of average purity and moderate volume, with a course of nearly four miles—in short, it is nothing more than an ordinary brook, such as may be seen in almost every English valley. Yet out of this we propose to con-

struct a small water-farm. The systematic cultivation of our rivulets is yet *in futuro;* indeed, so far as we can ascertain, there is no instance in which it has been attempted. As we cannot therefore appeal to facts, we must resort to hypotheses, and beg the reader to imagine that in the autumn of 1861, the writer was requested to undertake the cultivation of the stream in question. In the details, however, about to be given, it is earnestly insisted on, that there is neither speculation nor uncertainty.

The agriculturist, when he has prepared his land, and sown good seed therein, will not be deemed a visionary because he calculates on the coming harvest with certainty. Time, custom, and experience plead for him, and were he pressed for cash, he could raise money on the growing crops, as on any other first-class security. The pisciculturist possesses none of these advantages, time has done nothing for him, "yet truth is great and will prevail," and his art, which the public now regard with suspicion

as a theory, will ere long be accepted as a fact.

This, however, is a digression. We have undertaken to convert a barren rivulet into a profitable little water-farm; and when we have shown the mode in which it ought to be stocked, nursed, and worked, we will, in conclusion, lay such commercial results as we have a right to calculate on, before the reader. At present it is a wilderness containing only *feræ naturæ* of very indifferent quality—comparatively valueless as property. The first step to be taken in the way of improvement is to enlarge and secure the safety of the pools, which will hereafter form pastures for the new stock we intend to introduce. This must be done from one end of the rivulet to the other, so that if possible no part shall be unproductive or unprotected. As one pool will resemble another, we need only describe the mode of constructing the first, premising that as we descend the stream, each will be somewhat larger than the one

above—that is to say, in the ratio of the increasing volume of water.

Commencing at the head of the brook, we will erect the first dam and enlarge the first pool, at a point where the natural channel is about two feet in width;—the alders and hazels which fringe the stream furnish ample materials for our work. The reader must suppose that we are accompanied by a couple of ordinary agricultural labourers, armed with hook, mallet, and spade; and these form for our purpose an ample corps of sappers and miners. Ten minutes will suffice to cut down and tie up two faggots of the required length—say about 5 feet. This will allow 12 inches at each end to be inserted into corresponding niches on either bank. A short stake driven through the extremities will prevent the possibility of their removal by floods or other accidents, and a few shovelsful of stone and gravel, together with a layer of sods, complete the work, and make a dam so effectual, that it will last for ever; in fact, the winter-freshes—by adding

sand, dead leaves, twigs, and such like—tend to keep it in continual repair. We have now erected our first weir, and by taking an acute triangular strip of turf, 12 inches broad at the base, from each side *above* the barrier, have doubled the width of that portion of the stream, converting the original channel of 2 feet into 4. The next point is to construct a pond *below*, which we make about 5 feet wide, 10 feet long, and 3 feet in depth; gradually, however, becoming shallower as it approaches the run below. Having thus enclosed what may be called the first pasture in our small farm, the next thing to be done is to insure the security of the stock we propose placing therein. To effect this, two stones of about a hundredweight each should be set in the centre of the pool, at a distance of 3 feet from each other, and over these a flat slab must be laid. This structure, resembling a subaqueous bridge, possesses two advantages—namely, affording shelter to the fish in hot weather, and protecting them almost absolutely from the assaults of night

poachers. Descending the stream, we repeat the process about 50 yards below, and continue to do so at similar intervals till we reach the main river. This work might easily be effected by two labourers, under judicious direction, in three weeks; and two or three days more might be occupied in a careful inspection and improvement of the various pools and dams: such, for example, as increasing the height of the falls, by adding an additional faggot to some of the weirs, and raising a light turf embankment on either shore, 10 or 12 inches in height, so as to correspond with the additional elevation given to the edge of the dam. We will therefore suppose this portion of our work completed, and we may here repeat, that if executed according to the directions given, such work will last almost for ever.

In grazing-farms the success of the agriculturist depends greatly on the quality and quantity of the fodder he is able to furnish for his live stock; the same rule holds good in the case of the pisciculturist. In all brooks

such as the one in question, the crawfish thrives admirably. The introduction of this small crustacean, whilst directly increasing the commercial value of the property, furnishes an excellent and abundant supply of food for our stock.

It should have been mentioned, that the stream we are supposed to be improving, holds a considerable number of small white-fleshed trout, which we believe by judicious feeding might have been converted into the delicate pink article so highly prized at our dinner-tables. It is unnecessary, however, to discuss this question, since no water-farm should exist without a nursery, and our hatching-boxes can readily be supplied with vitalised seed from the fine red trout to be obtained from the Kennet, or any of the Hampshire rivers.

Most of our British fishes have strong cannibal propensities, and as none are more voracious than the common trout, the reader may suppose we did our best to eradicate the original unprofitable denizens of the water,

and thus were able to send to market more than sufficient to pay the cost of construction twice over. At this moment, therefore, our farm is without stock of any kind, if we except the few hundred crawfish which have been placed in it to breed and multiply for future use.

The reader must be kind enough to imagine that we have been busily occupied in hatching from the best-known species of trout; turning each year's brood into the stream, when sufficiently strong to take care of themselves. Attention, however, must not be confined to the nursery, as inspecting the farm and feeding the young stock should form part of each day's business. The inspection need not occupy much time or give much trouble, the principal point being to ascertain that the ponds and dams are sound, and show no signs of having been robbed.

Feeding, however, is not only a more important, but a more troublesome duty. As soon as our first brood attains the weight of

5 or 6 ounces, it becomes needful to supply them with ample means of rapid growth; to ensure this, four children will be sufficient to collect snails, slugs, worms, grubs, and larvæ of all kinds. These should be delivered about noon each day at the nursery, where they could be prepared for use, and then divided amongst the collectors, each of whom would have to distribute his portion equally between the dams and pools contained in the mile of water placed under his care. This simple plan will be found to answer admirably, and ensure the rapid growth of the fish. Four years must be supposed to have passed, and to have given us fine healthy trout averaging nearly one pound each.

Having brought our management to this point, we will epitomise and take a rapid glance at our improving property. A small stream, scarcely four miles in length, has been altered (on paper) to suit the requirements of fish-rearing. Three hundred and forty-eight ponds and dams have been cut, and have thus increased our available space enor-

mously; one set of hatching-boxes has proved amply sufficient for our wants; and being carefully put up, have since continued in good working order, giving us 6000 or 7000 fry each spring.

Meanwhile, our first hatch spawned in their season, and the produce added largely to the number of the fry artificially raised; in fact, our small farm by this time contained a stock as large as it could support. Our plan for feeding being based on principles as natural as economical, the fields, lanes, ditches, and hedgerows, yielded an abundant supply of food, and our small collectors have not been ill paid at 3s. 6d. each per week.

Had these results *really* been attained, in May 1865 we should have been enabled to fish the pools and dams for market, and during the summer, might have disposed of about 2000 trout, averaging a little over one pound each, which would have produced about £103. And now, in conclusion, let us glance at the expenses of our farm. Let us suppose the construction cost £15; the hatching-boxes,

with fittings, £6; and wages for portions of three years' feeding, £70; this will give £91 as the total outlay.

We will assume, therefore, that something about the sum of £100 has been sunk on this petty water property; that the annual expenses are £50; and that its yearly production equals £100. Even at this rate, the farm would yield a clear annual interest of 50 per cent on the outlay. But are we warranted in believing this to be the maximum of its produce? We think not; nay, we are confident it could be raised to a higher figure—for the number taken from each pond, about five, was very insignificant in comparison to what they might easily have spared. How trout, grayling, and other fresh-water fish, can be increased both in size and number by mere preservation, many streams in Wiltshire, Hampshire, Shropshire, and other English counties, prove. But preservation is only one amongst the ninety-nine points of good water-husbandry. If the science was applied in its entirety, what might *not* reasonably be expected from it?

Surely these things are worthy the attention of our landed gentry. It needs but some one, systematically and steadily, to cultivate a farm such as we have spoken of, to demonstrate the truth of what has been advanced.

Who will lead the way?

CHAPTER XV.

POND FISHES.

In the present chapter we propose to speak of carp and tench, fish which, though thriving well in rivers of moderate current, are capable of being domesticated and cultivated with advantage in pieces of artificial water.

The genus Cyprinus, as now restricted by modern systemists, contains the common carp and allied species, which are distinguished from those of kindred genera, by a small mouth devoid of teeth, scales of a large size, and the second rays of the dorsal and anal fin, large, bony, and more or less serrated. The common carp (*Cyprinus carpio*) was introduced into this country probably between the 14th and 15th centuries, but neither the date nor the country from which it was originally imported can be accurately determined. In

Jenyn's *Manual of British Vertebrate Animals*, it is said to have been originally acclimatised from the central portions of Europe, and since it still thrives better in those districts than elsewhere, the statement is probably correct. At present it is found over the greater part of Europe, and may be considered a citizen of the world; in many places its growth is much attended to for the purposes of traffic.

When in a state of nature, the food of the carp consists almost entirely of vegetable substances, which are masticated by means of the flat teeth situated on the palate. These are strictly analagous to the molars of our ruminant animals, and are employed to bruise and mash up the aquatic vegetables on which it principally depends for subsistence. As regards the size and weight to which this fish can attain, we extract a few lines from Mr. Yarrell's valuable work. "Though not very rapid in growth," says this author, "carp usually attain 3 pounds weight by their sixth year, and 6 pounds weight by their ninth

year." The largest we can refer to are noticed in Daniel's *Rural Sports*. Mr. Ladbroke, from his park at Gratton, presented Lord Egremont with a brace that weighed 35 pounds, in order to ascertain whether Surrey could not vie with Sussex in the production of carp. In 1793, when a large piece of water at Stonehead was fished, 2000 carp of large size were taken, and amongst these was one of the following dimensions—length 30 inches, breadth 22 inches, weight 18 pounds. At Weston Hall, in Staffordshire, the painting of a carp can still be seen, which weighed 19½ pounds. This handsome fish is in season for the table from October to April, a period when most other fresh-water fish are no longer in a condition for food.

From what has been already said, several points appear to be established; first, that the carp attains a great weight in confinement; secondly, that artificial feeding, though always advisable, is not a necessity; thirdly, that it has long been domesticated in Europe, and prepared like any other farm-stock for market;

and lastly, that it is not only inherently good for food, but doubly valuable as being in the highest condition when most of our other English fresh-water fish are out of season.

A general statement has been made, that the carp has long been domesticated in Europe; in a practical treatise like the present, it is desirable to be a little more definite on this point. Formerly there were, and doubtless at the present day are, large ponds in Prussia, Saxony, Bohemia, Mecklenburgh, and Holstein, employed solely for the rearing of carp; which we are told "were brought to market with as much regularity as if they had been so much fruit or vegetables," and as this branch of commerce has been long established, we can hardly hesitate to accept its continuance, as evidence of its success. Passing from the Continent to England, we have the authority of an eminent fish-salesman for stating, "that almost any quantity of carp could be disposed of amongst the Jews and Catholics of London alone, and that could a

regular supply be obtained, an unlimited amount might be sold for 6d. a pound."

Having thus spoken of the carp, we will now turn to the tench, which, whether considered naturally or scientifically, is closely allied to it; being, in fact, the *Cyprinus tinca* of Linnæus. This fish, therefore, belongs to the carp family, and is separated from it generically on account of the size of the scales with which the body is covered, as well as by the small antero-posterior extent of the dorsal and anal fins, both of which are, moreover, destitute of the anterior bony spine.

The tench inhabits most of the lakes throughout Europe, and in this country is found in many of our sluggish rivers. There appears to be a doubt whether, like the carp, its origin is not foreign, and whether the streams that now contain this fish are not indebted for its presence to an accidental escape from neighbouring ponds. Cuvier observes that the tench inhabits stagnant waters by preference, and Mr. Yarrell remarks, "that rivers being an unnatural

habitat for the fish, will account for their being less prolific in such situations." We are by no means disposed, however, to admit the truth of this statement, inasmuch as we are acquainted with several small and sluggish streams in the west of England in which this fish not only abounds, but attains considerable size. The tenacity of life exhibited by the tench is very remarkable; a peculiarity which must give it additional importance in the eyes of the pisciculturist. Recent experiments have shown that it is able to breathe when the quantity of oxygen is reduced to a 5000th part of the bulk of the water it inhabits, ordinary rivers generally containing 1 per cent of this gas. Like the carp, the tench is a vegetarian, though it by no means objects to the larvæ of insects or small worms. It spawns about the middle of June, and deposits its ova on weeds. Each of the fish which we have mentioned is remarkably prolific; and it stands on record that no fewer than 700,000 eggs have been found in a carp weighing 10 pounds.

Having thus spoken of the inhabitants, we must devote the remainder of the article to the consideration of their artificial residence. The construction, as well as the management of ponds for the rearing of fish, was formerly much better understood in this country than at present; in fact, during the last hundred years they have fallen almost entirely out of use. It is necessary, therefore, to enter somewhat into detail as to their formation. A number of small ponds are far better calculated to ensure successful cultivation than two or three larger ones, containing the same area, as cleanliness is an element essential to success. This can only be accomplished by letting the water off about every sixth year, and exposing the bottom to the action of the weather, as well as to such mechanical agency as may be necessary to remove the mud, which is apt to accumulate in such places. A suitable site being chosen—the higher, more open, and more exposed, the better—a chain of ponds should be made, connected by water-courses, but separated by flood-gates.

Each of these sheets of water should not, in our opinion, exceed 80 yards in length, 30 in breadth, and 6 feet in depth. Such an excavation, at 9d. per cubic yard, would cost about £180. It by no means follows, however, that even this outlay is necessary, as natural depressions in the ground—old marl or gravel pits, and such like—could be made to answer the purpose equally well, at a price infinitely less for the same area. Every estate contains more or less poor land, and it will frequently happen that such comparatively valueless property is well suited for the purpose in hand. When the pools and connecting canals have been cut, and the flash-boards erected, the bottom must be suitably finished, and this is best done by roughly paving the excavated surface with flat stones, over which a layer of gravel should be thrown. A few heavy blocks must be placed on the bottom, and if two or three strong iron crooks are inserted in each, poaching will be an impossibility, and the stock we are about to introduce will be safe from aggression.

In considering the eligibility of any particular site for the formation of ponds, the proximity of a small stream as a feeder to the water-farm, is of course implied. We must now suppose that everything is ready for the introduction of the stock—6 or 7 brace of good-sized carp, say of 4 to 5 pounds each; as many tench, of 1½ pound each, and a few dozen brace of fish of the former season, will be amply sufficient for one pond. Operations having arrived at this point, the pisciculturist must be content to wait five years for his first harvest. It is not, however, implied that his work is over, for all stock of what kind soever, whether terrestrial or aquatic, will thrive in proportion to the amount and suitability of the food given to them. Dog-biscuits, soaked in water or skimmed milk, and mixed with coarse flour, grains, chopped garden-refuse, cold boiled potatoes, bran, and such like, worked together into a sort of paste, and then subdivided into small pellets, will answer admirably for the purpose, and would not occupy the gamekeeper or gardener one hour a-day in their preparation and distribution.

In the autumn of the fifth year, the first harvest may be reaped, and as each of the ponds we have described might, with the aid of feeding, conveniently contain 1000 fish, such harvest would, at a moderate calculation, yield 250 fish averaging 4 pounds each. This quantity, at 6d. per pound, would give the proprietor £25 for a single pond; and if we suppose the chain to consist of six, they will collectively produce an income of £150 per annum, an amount immeasurably greater than a similar surface of poor land could by any possibility be made to yield, if employed in any other way.

It need hardly be pointed out that such ponds may be multiplied *ad infinitum*, or that the income to be derived from them will be in proportion to the extent of water. Enough has been said to show that there is a ready market for as much of this class of food as is likely to be produced for many years to come, and that pond-farming will hereafter take rank amongst our profitable investments.

A few days since, whilst on a visit to a friend

in Shropshire, conversation turned on pond fishes, when our host came out in great and unexpected force. He was a cultivator and gastronomic admirer of tench, and gave me many interesting details respecting his mode of management, one or two of which I shall borrow for the benefit of the reader. My friend had two small keeping-ponds into which, when the autumn arrived, he placed as many fish as he wanted, being careful to separate the males from the females. On this inhuman arrangement he laid great stress. With respect to their rate of growth (a very important question) he assured me that tench of half-a-pound each, deposited by him one autumn, ordinarily attained a weight of 1½ pound by the following season. He did not feed his fish; had he done so, his success would have been greater. My friend's favourites had yet to be prepared for the cook. The method employed in their purification was as follows:—A certain number being taken from the pond were placed in a stone trough, through which a strong stream

of spring-water flowed. Here they were kept for three or four days and were then considered "excellent meat." Treated in this way, he assured me the flesh was as good, and very similar to that of the turbot.

CHAPTER XVI.

PIKE AND PERCH.

In the previous chapter, carp and tench, the most harmless of fishes, have been associated. In the present, pike and perch, the most quarrelsome and aggressive, may, for practical purposes, with equal propriety be grouped together.

The *Esox lucius*, or common pike, is found in nearly all the fresh waters of Europe; it occurs also in the great Lakes of North America, where, however, two other species are met with. It is probably indigenous in Britain, though generally supposed to have been introduced during the reign of Henry VIII.

Endowed with a prodigious appetite, the pike exhibits extraordinary rapidity of growth, its increase of weight being stated by the

highest authorities to be at the rate of 4 pounds a-year. Innumerable anecdotes have been related regarding the voracity of this fish. Mr. Jesse, in one of his works, says "that a pike of 8 pounds has been known to eat 100 gudgeons in three weeks;" and Mr. Stoddart tells us that in the Teviot, a tributary of the Tweed, this fish exhibits so fatal a partiality for the salmon fry, that "in a stretch of water 10 miles long, where there is good feeding, there will be at least 1000 pike, and that during a period of 60 days, they will consume a quarter of a million of smolts."

In the dawn of domestic agriculture, beasts of prey ravaged our flocks and were exterminated. It is much to be regretted that "the fresh-water wolf" is not more systematically hunted in our salmon-streams, and as far as possible destroyed. When the fry have reached the smolt state, their dangers are comparatively over, about a fourth or fifth of the entire number returning safely to the rivers. Fifty thousand grilse destroyed in six weeks by one hostile race! what outlay would

not have proved almost immediately remunerative to the lessee of a salmon-farm, if employed for the purpose of keeping down such destructive foes?

The flavour of fish, like that of terrestrial animals, depends largely on the quality and quantity of its food, and from the various stories that have from time to time been related regarding the exceptional diet of the pike, some persons entertain a prejudice against its use. This, like many other prejudices, fades before experience, for the fact is, that the pike, as an article of food, is equal to any of our fresh-water fish, salmon, trout, and grayling, excepted. It is white, firm, and flaky, and when fried, or stuffed and roasted, is, as old Isaac says, a dish fit only "for anglers and honest men."

Without absolutely accepting the extraordinary rate of growth given above, it is at least certain that no native of our English waters increases with the same rapidity, and this, to the pisciculturist is no mean recommendation. Each year introduces into our best markets

some fish not previously held in high estimation for the table, and increasing necessity will probably annually add to the list, in which case we may reasonably expect the pike to claim a larger share of public attention.

The fact is, we can no longer afford to be nice. How to increase the supply of food is one of the most prominent and important questions of the day. On its solution does not hinge merely "the bone and sinew of the country;" considerations far higher are involved in it. The wealthy, as a body, little know how bitter a thing is poverty, with its daily struggles—so necessary—yet so vain to make both ends meet; but men must be fed, pale half-famished children cannot be allowed to die of semi-starvation; and so it comes to pass, that our poor spend their lives in dwellings a thousand times more injurious, as to the effects produced on soul and body, than those which exist in the kraal of the Caffir, or the wigwam of the red man. Hunger and rags are *not* eloquent preachers of law and gospel, and want is a terrible

tempter. We send missionaries "over sea and land to make one proselyte." How many might be made at home could the masses be more cheaply fed? At the present high price of food, what sum can remain at the week's end for decent clothing or wholesome tenements? Little, indeed!

We are not so Utopian as to imagine capitalists will embark in hopeless schemes, merely from philanthropic motives; investments must show a reasonable prospect of remuneration. But fish-farming offers something more—the almost certainty of success: and beyond this will confer on our poor a moral and social benefit, the extent of which cannot be easily overrated. This, however, is a digression, and we must pass from ethics to business.

Having already spoken briefly of the size and excellence of the pike, of its quick growth and applicability for pond life, we will, before entering into detail on its cultivation, say a few words about the perch. This fish, probably more in favour for the table, is equally

hardy and equally adapted for artificial pieces of water. Without discussing the question of acclimatisation, we may mention that the *Perca lates,* a genus closely allied to the common perch, is well worth the attention of pisciculturists, as the members of this sub-genus are of large size and excellent quality. Though at present chiefly found in the rivers of the warmer parts of the old world, there seems little reason to doubt they would thrive in our own temperate climate; and here it may not be out of place to remark also, that the black bass, a native of Lake Huron, and one of the best-flavoured fishes in the world, is a perch known to naturalists under the title of *Perca huro.*

In the days when ancient Rome exchanged conquest for luxury, the perch was assiduously cultivated for the table, and was thought to be equal to the mullet in flavour. Tastes are proverbially said to differ, but a friend* (who may be considered an unexceptionable authority) declares them equal in

* H. Cholmondeley Pennell, Esq.

excellence to the whiting, as indeed in our opinion they are. Perch taken from rivers are thought to be superior to those whose lives have been passed in ponds. But this is an accident, not a necessity, and results from the neglected condition of our meres, where mud has been allowed to collect to a degree quite incompatible with the perfection of animal life. These fish do not usually attain any great size, the largest on record being one taken in the Serpentine, which weighed 9 pounds. Perch of 3 or 4 pounds are by no means rare, and 1 pound is a common weight.

In the lakes of Westmeath, as in Dereveragh and Lough Ouel, for example, this fish thrives admirably, attaining a size of 4 or 5 pounds, and possessing a flavour and firmness not easily surpassed. This has been mentioned, to prove how perfectly the perch can thrive without access to running water. When speaking of the cultivation of carp and tench, a chain of small ponds was recommended in preference to two or three sheets

of water of their united extent, but this does not hold good in the case of pike and perch, which, being predatory animals, require greater space. We should therefore advise a series of ponds to be constructed of about half-an-acre each: these must be well puddled with clay, coated with gravel, and defended by rocks and stumps of trees from the attacks of poachers. The necessity which exists for coating the bottom with clay, will necessarily restrict the formation of these pieces of water to such districts as produce this material, since its carriage would prove so costly as to neutralise all reasonable hope of profit. A suitable site having been found on poor land, the first step to be taken is to provide good and sufficient food for our stock, for without this their growth will be slow and their quality bad. No fish thrives better in confinement, or breeds more rapidly than the roach; and as it happens to be a great favourite both with perch and pike, it will probably answer better than any other that can be introduced.

It has been already stated that the growth of the pike is wonderfully rapid: the advantage of this is obvious, as it enables the proprietor of the farm to send his produce to market at the expiration of the first year. Custom exercises a great influence on gastronomy: men eat and value what they see others eat and value. Hitherto the food of which we are speaking has been rarely found in our markets, except in a few districts, and even in these the supply is extremely irregular. Our own neighbourhood abounds with coarse fish, such as roach, dace, and chub, which are anxiously sought for and eagerly purchased by the poorer classes, at threepence per pound; and, in fact, during the summer and autumn constitute one of their principal luxuries. If fish of this inferior quality finds a ready sale, we may reasonably infer that animals so excellent as those which form the subject of this chapter, would obtain a still better market.

All water-farms such as we are now considering, should consist of a chain of ponds, to enable the proprietor not only to examine

the condition of his stock, but to select the best fish for market, and clean the bottom once in eight or ten years. We have already advised that these ponds should be half-an-acre each, and a series of six would therefore represent a space of three acres.

It is by no means necessary that an area so large should be excavated. In many places the formation of the ground is so favourable, that embankments are alone needed to make admirable ponds. Mill-dams are always available; railway excavations might be profitably employed, and meres and pools, now probably nearly useless, might be cleaned, enlarged, and improved.

It must be remembered, however, that the outlay on terrestrial farms *annually* represents a large sum, whilst our water enclosures cost little to maintain, and *once* made are made for ever.

Each pond such as we have described, might easily yield 300 pike annually, averaging 4 pounds, which at sixpence per pound would produce £30. It might also ad-

vantageously spare 500 brace of perch which, if amounting only to six hundredweight, would be worth £16 : 16s.; and £46 : 16s. may be considered no mean annual interest on a capital comparatively small. But besides these fish, eels of necessity would be produced, and as these sell well, we are entitled to assume they would raise the income derivable from each pool at least to £50, which would give for three acres of poor land receipts to the amount of £300 per annum.

Such statements are patent, nor can it be long before men acknowledge their truth by reducing what may now be considered theory, to the test of practice.

CHAPTER XVII.

EELS.

THREE, if not four, species of the genus *Anguilla* are found in this country—namely, the sharp-nosed eel, the broad-nosed eel, and the snig.

The sharp-nosed species may be distinguished, as Yarrell tells us, by a comparatively narrow muzzle and compressed head, as well as by its dark olive-green back and silvery belly; the colouring, however, varies according to the nature of the water in which the animal lives. This rule, it may be observed, holds good with respect to all fishes; those in clear streams being bright, whilst those found in muddy waters are pale or dusky.

The silver eel is common in rivers and lakes throughout the country, and is by far the most valuable of the species known in

Great Britain. Like the salmon its habits are migratory, though the causes that regulate such migrations are entirely different.

The eel is supposed to dislike cold, and in the autumn spates—under cover of the night—passes down the rivers to gain the warmer brackish water, where it spends the winter and deposits its ova. In spring, the fry may be seen working their way against the current with marvellous patience, and in extraordinary numbers; scaling rocks, and struggling through rapids, that might well be deemed barriers to their further progress.

Without entering farther into the natural history of this interesting animal, we will proceed to regard him from a commercial point of view, and speak very briefly of the principal sources from which our markets are at present supplied; see what is to be learned from Comacchio; glance at the capabilities of our own rivers; and lastly, say a few words on one or two obvious means whereby the quantity annually taken might be increased.

The London markets, though largely

supplied from Holland, receive, at certain periods of the year, a considerable number of eels from the midland and western counties of England; such districts being able to furnish infinitely more, if the rivers were properly prepared for the reception of the fry, and furnished with such cheap appliances as might be necessary to intercept the adults in their passage towards the sea during the autumn floods. Ireland and Scotland are better adapted by nature than either England or the Low Countries for eel-cultivation, and, were it not for the mischievous prejudices which exist in those countries, might supply with ease the existing demand.

Although Italy does not send any of these fish to British ports, the eel-farms in the Papal States are sufficiently instructive to claim our attention for a few minutes, and are interesting from their antiquity, the perfection of their management, and their value.

Hitherto our ideas of cultivation have

been limited—in these Islands at least—to agricultural operations, the nomenclature of which has only recently been applied to the infant science of aqueculture. But long ago it appeared so natural to the people of Comacchio to consider their various water-enclosures as farms, that they have from a very early period spoken of them "as fields." Of these there are about 400, the most valuable belonging to the Papal States, the remainder being in private hands.

With the commencement of autumn, the migratory instinct of the eels begins to be fully developed, and at this time the harvest is ready for the gathering. The mode in which it is collected is eminently simple. At either end of each pond are flood-gates. Above the one designed to carry off the surplus water, a series of long funnel-shaped enclosures are erected, at the apices of which are placed smaller chambers. As soon as the salt water is introduced by the upper sluice, the fish prepare for their migration, the fences being so arranged that

their course necessarily conducts them to the base of the enclosures before mentioned, along which they pass in the direction of the current; resolute to reach the sea, they hurry down the narrowing passage, and at length find themselves lodged in the trap from whence there is neither return nor escape, and in which they are preserved alive till required for market. This plan of capture, as will presently be shown, is substantially the same as that employed in the Irish rivers.

One of the most interesting objects in Comacchio is the great kitchen where the fish are prepared, one of the peculiarities of the place being, that a large portion of the eels are cooked before they are sent to market. If the reader will imagine an extensive building in which are arranged a series of gratés larger than those at Christchurch, Trinity, or the Dublin University, with mighty frying-pans suspended above, and rows of spits arranged in front of each, he will gain a tolerable idea of the kitchen at

Comacchio. When the eels are fried to perfection, or roasted to a turn, they are placed in baskets to drain and cool—are subsequently packed in barrels of various sizes, when a mixture of vinegar and salt is added. Previous to exportation, the barrels are branded to show the size and quality of the contents. We can well imagine one of these fish would form no mean addition to our breakfast-tables.

Besides these methods of preservation, the eels are salted like cod, or dried like Finnan haddock, and yet when all this has been done, a barrel weighing 150 pounds can be purchased for little more than 97 francs, or about threepence per pound. The value of this fishery is great. Towards the end of the 16th century the annual income, derived from eel-breeding in the lagoons, amounted nearly to £12,000. No recent statistics have been made public, but there is every reason to believe that the sum has not diminished. In the year 1580, £12,000 was an amount far different from that expressed by a similar sum at the present time, and if

we consider the altered value of money, we may readily imagine the revenue derived from the Italian fisheries must now realise something like £50,000 or £60,000 per annum.

Having now seen how the eel is caught, cooked, and sold at Comacchio, we will next inquire into the productiveness of our own rivers. The eel-fisheries in Ireland may serve to throw some light on this point. The river Bann, separating the counties of Antrim and Londonderry, affords an instance of the annual income derivable from the capture of this fish. The stream in question is divided by Lough Neagh into the upper and lower Bann, the former being one of the feeders, and the latter the only channel through which this mighty lake discharges its surplus waters into the sea. At various points in the course of the rivers which feed the Lough, eel-weirs are placed, the annual value of which is known to few except the owners and lessees. We may infer, however, that they take a fair proportion of the fish reared in their several waters. Between the lake and

Coleraine, the autumnal harvest of eels is said, on very good authority, to be worth considerably above £2000; and there is little doubt that the upper waters collectively produce a larger sum. Great as this income appears to be, it is nothing to what this chain of lake and rivers would yield, if properly cultivated and carefully fished. Here and there, by the side of some fall or rapid, a loose rope of straw is placed to enable the ascending fry to overcome difficulties otherwise insurmountable, and this forms the Alpha and Omega of the cultivation bestowed on this valuable property. Then, again, in most of the Irish eel-weirs with which I am familiar, there is usually something wrong. A portion of the lines of wattling, which converge towards the apex, may be imperfect; the flood may come down an hour or two sooner than was expected; or more frequently, "the cockle" or long funnel-shaped net—employed to close the only outlet—gives way from age or infirmity, just when it should not. From either or all these causes combined, the eel-

fisheries, at least on the generality of Irish waters, are infinitely less productive than they ought to be. Under these disadvantages, however,—and we do not suppose the Bann exempt from the common lot—we have seen that the annual income is between £4000 and £5000; what it might easily become, would involve a very different arrangement of figures. It has been stated in an earlier part of this chapter that eels "dislike cold;" this may perhaps be true, but is certainly not the cause of their annual migrations, which we believe is solely referable to the instinct that leads them to spawn either in salt or brackish water. In the *Field* of Nov. 23, 1867, there is an interesting article which we make no apology for quoting, since it mentions the eel-fisheries on the Bann, and also touches on many important points connected with the subject:—

"I remember on one occasion 40 tons of eels having been taken in *one night* in the river Bann in the north of Ireland, and I suppose as many more escaped, for they

came down in such numbers that nearly all the nets on the eel weirs were burst. This is one of the finest salmon rivers in Ireland, and it is rather remarkable that in most of the fine salmon rivers in Ireland, very valuable eel-fisheries exist, which would, to a certain extent, prove that the eel is not so injurious to the salmon as some appear to imagine. Valuable eel-fisheries exist on the Shannon, the Bann, the Ballyshannon,* and other rivers, and these are all first-class salmon rivers. The Ballyshannon, with the right of netting in only a few miles of tide-way, sold the other day for £45,000. The eel-fisheries are, by means of V weirs in the fresh water, only carried on at night. All this may be very well known to most of your readers; to some, however, it may be interesting. The breeding of eels remains the great mystery to be solved; not, I think, their torpidity."

Ireland is a land of lakes and streams. Scarcely a square mile of the country but has

* The river which flows through the town of Ballyshannon is called the "Erne."

connection with some water communicating with the sea; and wherever such water exists, there the silver eel is to be found. As an instance of the fertility even of the smallest streams, it may be stated, that close to a fishing-lodge belonging to the writer, in the county of Antrim, there is a little brook or drain whose extreme length, from a neighbouring bog to the sea, is less than half-a-mile. In the early autumn freshes we have often placed a suitable net across it, and taken a couple of bushels of fine fish in the short interval between sunset and darkness. Few fish afford more nutrition than the eel—none could be obtained more cheaply, or in greater abundance; whilst the price at which they are sold, proves the estimation in which they are held. Although it is hardly possible to offer any satisfactory estimate of the collective productiveness of Scotland and Ireland, it may be stated, without fear of contradiction, that they are capable of yielding a supply of eels fully equal to any demand likely to be made on them.

Nor does the production of so great a mass of excellent animal food pre-suppose a large expenditure of capital. On the contrary, the character and habits of the fish render preservation almost unnecessary, and its capture easy. A few straw ropes, placed at the sides of difficult falls and strong rapids, are sufficient to enable the fry to spread over all the tributaries; whilst well-constructed lines of wattling, and a few small but stout funnel-shaped nets, suffice to gather the grist which the autumn spates bring to the mill.

We are well aware that the eel is said not to be a favourite food with the great body of our countrymen. This is referable to a variety of causes, amongst which, irregular supply,—bad quality when the article happens to be cheap, and high prices when good, probably hold prominent positions. New articles of food, however, are constantly finding their way into our markets, so we may reasonably hope that our old friend the eel will float on the current of public favour, and take rank with the best.

CHAPTER XVIII.

OYSTERS AND MUSSELS.

CAUSES WHICH LED TO THE DECLINE OF OUR OPEN OYSTER-BEDS—PUBLIC ATTENTION IS AROUSED—PRIVATE ENTERPRISE STEPS IN, AND IS AIDED BY LEGISLATIVE ENACTMENTS.

THE majority of my readers doubtless remember that pleasant time when the oyster presided over suppers, and was with many of us quite *l'ami de la maison*, dropping in almost as a matter of course, to luncheon or dinner. Alas, that it should be said so close a companion has grown almost a stranger. It is unjust, however, to blame an absent friend, especially one who has received such grievous wrongs at our hands,—we have suffered for our misdeeds; have seen the error of our ways; have repented, and are now anxiously

seeking reconciliation in a hearty, liberal, and constitutional manner; may we not confidently predict that we shall soon welcome him—who has been so long an absentee—once more to our hearths and homes?

Though old as Imperial Rome, oyster-culture, in these kingdoms at least, may be called a new art; since it flourishes under new laws, is watched over by a body of men recently appointed to the office, stretches forward with higher aims, and day by day gains larger proportions. Science lends it her aid, wealth gives it power, and the public regard it with interest; in a word, it is *wanted*, and will achieve success.

In the mouth of the Thames and its tributaries, and in a few other estuaries, oyster-parcs—more or less artificial—existed, where the fish were brought from natural beds to fatten on a more congenial soil. But this is widely different from the art of to-day, which aims at nothing less than filling our foreshores with broods of their own producing; improving the stock on principles de-

duced from a knowledge of the habits and instincts of the animal; and perhaps at no distant date, to the restoration of our natural but exhausted ocean-beds, from the abundance it has created.

In treating this subject, we shall offer a slight abstract of the acts of 1866 and 1867; glance at the Board of Trade regulations, and see what is to be gathered from the first report of their Commissioner. We shall say a few words on the natural history of the oyster; notice the situation and extent of the new parcs; endeavour to ascertain their prospects; and, in conclusion, lay before the reader the principles on which the cultivation of this valuable bivalve is at present carried on. The causes which so nearly produced the total ruin of our natural oyster-beds are easily explained; nor are they uninstructive, since the reckless mismanagement which proved so fatal to one branch of our fisheries must, if continued, be equally injurious to all others.

Till within the last few years, the increasing

scarcity of the oyster was balanced by the greater exertions made for its capture, and supply made a spasmodic attempt to keep pace with the demand. This process, however, could not long continue; indeed, when once the existing stock on the beds was nearly dredged out, every fresh effort only made the final exhaustion more inevitable and complete. We were creating a fictitious income, by spending interest and capital together. As might naturally have been expected, this suicidal policy soon brought the fisheries to the brink of actual beggary, and for the great mass of consumers the oyster had practically ceased to exist; then it was gravely asserted that for years there had been no spat; whereas the truth is, the stock of breeding oysters had been so greatly reduced, that anything like a successful breeding season was impossible.

Things had thus come to the worst, and according to the popular proverb, might be expected to mend. The exigency of the case roused public attention; the press took up

the question; theory produced practice, which in return gradually established the truth or exposed the errors of new doctrines. The first step was made by Mr. Cholmondeley Pennell, the present Inspecter of Oyster Fisheries, and Mr. Frank Buckland, who obtained from parliament, in 1864, the grant of a portion of the flats off Herne Bay, for the purpose of ostreaculture. Several other companies followed this initiative, and eventually the general importance of making public grants to private companies was recognised by Government and by Parliament, who passed a bill in 1866, entitled "The Oyster and Mussel Fisheries Act," for facilitating and systematising fishery-grants on the principle above indicated. Meanwhile, several companies and individuals had commenced, with more or less success, the artificial cultivation of the oyster as followed at L'ile de Rhe and Arcachon. As The Oyster and Mussel Fisheries Act must be considered the basis of modern English oyster legislation, and is destined henceforth probably to play an all-

important part in the resuscitation of our exhausted fisheries, it may not be out of place to offer a brief abstract of its provisions.

29 & 30 Vict. cap. 85, empowers the Board of Trade to allot, with a few exceptions, any portions of the shore and bed of the sea, of estuaries and tidal rivers, in England and Scotland, for the establishment or improvement, and for the maintenance and regulation, of oyster and mussel fisheries, to any person, persons, company, or body, desirous of obtaining such an order. If, on consideration of the memorial, the Board of Trade think fit to move in the case, the applicant must give such notice to all parties interested as the Board shall think fit. The Act next proceeds to determine how conflicting claims between the promoters and parties asserting opposite interests shall be dealt with. "The inspector shall proceed to make an inquiry concerning the subject-matter of the proposed order, and for that purpose to hold a sitting, or sittings, in some convenient

place, in the neighbourhood of the portion of the sea-shore to which the proposed order relates, and thereat to take and receive any evidence and information offered, and hear and inquire into any objections or representations made respecting the proposed order, with power from time to time to adjourn any sitting; and the inspector may take evidence on oath or otherwise, as he thinks expedient, and may administer an oath, or take any affidavit or declaration for the purpose of the inquiry, and if any person wilfully gives false evidence in any examination, on oath, in any such inquiry, or in an affidavit, to be used in any such inquiry, he shall be deemed guilty of perjury."

After the Act has provided that all expenses connected with the scheme shall be defrayed by the promoters, it defines the privileges vested in owners, and the penalties which follow any breach of trust. The persons, company, or owners of any private oyster-bed, lawfully formed independently of this Act, and their respective agents, servants, and

workmen, may at any season dredge for and take oysters from any natural public oyster-bed for the purpose of supplying, or replenishing therewith, any oyster-bed made under the order, or any such private oyster-bed (as the case may be), and may apply the oysters so taken accordingly. But if any person applies or uses, or any persons, company, or body, knowingly authorise or permit to be applied, or used otherwise than in manner authorised by this section any oysters so taken; such person, or such persons, company, or body (as the case may be), shall be liable to all the like penalties and consequences, to which he or they would have been liable if this section had not been inserted in this Act.

Nor are the rights of property less clearly set forth. All oysters or mussels being in, or on, an oyster or mussel bed, within the limits of any such several fishery, shall be the absolute property of the grantees, and in all courts of law and equity, and elsewhere, and for all purposes, civil, criminal, or other, shall be deemed to be in the actual possession of the grantees.

It shall not be lawful for any person, other than the grantees, their agents, servants, and workmen, within the limits of any such several fishery, or in any other part of the space within the same, described in this behalf in the order, knowingly to do any of the following things:—

To use any implement of fishing except a hook and line, or a net adapted solely for catching floating fish, and so used as not to disturb or injure in any manner, any oyster or mussel bed, or oyster or mussels, or the oyster or mussel fishery.

To dredge for any ballast or other substance, except under a lawful authority for improving the navigation.

To deposit any ballast, rubbish, or other substance.

To place any implement, apparatus, or thing prejudicial, or likely to be prejudicial, to any oyster or mussel bed, or oysters or mussels, or the oyster and mussel fishery, except for a lawful purpose of navigation or anchorage.

To disturb or injure in any manner, except as last aforesaid, any oyster or mussel bed, or oysters or mussels, or oyster and mussel fishery.

And if any person does any act in contravention of this section, he shall, on summary conviction, be liable to the following penalty—namely, to a penalty not exceeding £2 for the first offence, and not exceeding £5 for the second offence, and not exceeding £10 for the third and every subsequent offence; and every such person shall also be liable to make full compensation to the grantees for all damage sustained by them, by reason of his unlawful act; and in default of payment, the same may be recovered from him by the grantees, by proceedings in any court of competent jurisdiction, whether he has been prosecuted for, or convicted of an offence against this section or not. These penalties do not of course interfere with those enacted by the general law of the realm against oyster-theft.*

* *Vide* "Larceny Act."

The twenty-first clause limits the period for which grants shall be made to sixty years.

Such are the principal provisions of this Act, which, however, does not apply to Ireland; powers more ample, no law apparently could give, or define rights and privileges more exactly, whilst it grants the clearest of all possible titles to property; yet, on the 3d of May 1867, an act for the preservation and further protection of oyster-fisheries was passed, in order, it would seem, to make assurance doubly sure.

The Board of Trade, to whom the administration of the above Act has been committed, issued regulations for the purpose of facilitating applications for grants under its provisions. This document gives full information on three points:—

1*st*. General principles on which exclusive rights of fishing will be granted.

2*d*. Title to soil.

3*d*. Form of procedure in applying for a grant under the Act of 1866.

The general principles upon which it

appears all grants will be made by the Board of Trade are two :—

1*st.* That, in every case of concession of exclusive fishery-rights, a fair probability should be shown, that the supply of oysters will be thereby materially increased, and the public correspondingly benefited; and

2*d.* That the fishery granted shall not be more extensive than the grantees, whether corporate or individual, possess the means of properly cultivating.

These fundamental rules, and the other minor regulations, have in our judgment been carefully and judiciously framed for the attainment of their object.

With regard to the "Title," it may be sufficient to state that, by the Crown Lands Act 1866, the administration of crown rights over the foreshore and bed of the sea is, with a few exceptions, transferred to the Board of Trade, and the title given by them, therefore, is in effect a grant direct from the crown as well as from parliament.

In dealing with the proprietary rights of

the crown, the Board propose to reserve for the public purse such share of any ultimate profits as may fairly belong to the owner of such rights, at the same time expressly declaring, "they will carefully abstain from throwing obstacles in the way of public improvement, and will be averse to imposing any such terms as may impede or delay its progress." In this spirit, therefore—and it is one which contrasts very favourably with that of the former guardians of the foreshores, "the Woods and Forests"—they will consider favourably, proposals founded on the basis of determining the rent or royalty, according to the profits actually made.

It is needless to trouble the reader with a detail of the form of procedure necessary to be followed in all applications for grants under the Act in question, since this portion of the business must almost of necessity devolve on the solicitor of the applicants. It should be stated, however, that the procedure is simple and efficient, and that the expenses need not exceed £40 or £50.

Companies may, of course, expend as much as they please in preliminary inquiries, by engaging expensive counsel and so forth; but such steps are totally unnecessary, since the government employs a commissioner of large practical knowledge, perfectly able to judge of the facts of each case for himself, on purpose to obviate the necessity of any such outlay. Two orders—one for the river Humble, Hants, and one for the Essex Blackwater—have already been granted, whilst several others are in the preliminary stages.

Our reconstructive policy has commenced; we have only, as it were, sown the seed, but it has taken root, and in due season will produce "first the blade, then the ear, after that the full corn in the ear."

CHAPTER XIX.

OYSTERS AND MUSSELS.

STRUCTURE AND HABITS OF THE OYSTER—GENERAL OBSERVATIONS — EXTRACT FROM THE REPORT OF THE SEA-FISHERIES COMMISSION.

FEW of the inferior animals have occupied so large a share of scientific and practical attention as the oyster. Innumerable papers have recently appeared, describing his organisation as revealed by the microscope; and theories, hereafter to be rejected as erroneous or accepted as facts, have been promulged as the immediate consequences of such investigations.

With these we shall not trouble the reader, as at present they can scarcely be considered essential to *practical* water-farming, and shall only touch lightly on a few points

relative to the structure and habits of the animal.

Formed of two unequal valves, and connected by a hinge of simplest character, the shell of the *Ostrea edulis* presents externally a coarse and dirty appearance. This bony covering, admirably contrived for the protection of the soft gelatinous mass within, is composed of innumerable laminæ folded irregularly on each other. In some species, however, it is smooth, in others striated, tuberous, or prickly, the lower shell being always the deepest. Nothing can be more rudimental than the formation of the oyster, yet this simplicity is sufficient for all purposes of life and comfort, and, like man's more perfect organisation, has been pronounced "very good." No vestige of a foot is to be found. Four rows of lungs are placed at a little distance from the fringed edge of the mantle. The abductor muscle is fixed near the centre of the body; and around it lies the circulating system. The mouth may be seen beneath a kind of hood, formed by the

edges of the mantle, whilst the beard, performing the office of a hand, grasps and distributes its food.

Many curious discussions have arisen as to whether oysters possess the faculty of locomotion. Recent observation, however, shows they can move from place to place by rapidly closing their shells, and thus, ejecting the water contained between them, create a force sufficient to propel themselves backwards, or in a lateral direction.

The principal breeding-season of our common oyster is in April and May, at which time the spat is cast; this—for about forty-eight hours—floats, and resembles minute specks of grease. After a brief period of involuntary wandering, the young oyster fastens on some fixed substance, and then commences what may be termed its normal mode of life.

In the cod, salmon, herring, and other similar fishes, a given number of ova by no means implies the same number of fry, for imperfect vitalisation is one of the principal

causes of the enormous waste that occurs; but in the oyster the powers of multiplication are indeed wonderful, since the dual sex of the animal insures that a million of spawn shall equal a million of living creatures.

It has been asserted that in twenty weeks the oyster attains its full growth; unhappily this is but a pleasant fiction, as any person who has visited Hayling Island well knows. At the age of twelve weeks, the young mollusc is hardly bigger than a split-pea, and in this country fully four years are required to fit it for the market. The parcs springing up round our coasts will soon teach us how far feeding, climate, and soil, can shorten this period. That these agencies will affect the oyster beneficially we cannot doubt, since it is but the old agricultural rule applied to a new description of stock. In some places the brood becomes saleable (for laying down) in about two years, whilst in others it requires three, but whatever may be the rate of growth from local circumstances, the cultivator may calculate on the

young becoming articles of market value long before they attain their full development.

It is frequently asserted that oysters have not spawned extensively during the last few years. It would probably be more correct to say that a series of cold and stormy seasons injured the spat, which doubtless fell as regularly as the seed of the sower in spring. Warmth and quiet, it is believed, exercise great and beneficial influence on the spawn during the first few days of life, and consequently strong winds, currents of exceptional force, or rough water, are highly injurious, carrying it far from the parent beds, causing it perhaps to fall on sand or mud, where its destruction is inevitable. From these and other less recognised causes, the loss to the spat is so enormous, that a loose statement prevails that not more than a single oyster out of each million comes to maturity. The practical importance of some of these points must hereafter be considered when we treat of oyster-culture. Meanwhile, a brief account of the revival of this ancient branch of in-

dustry may not be without interest and advantage to the reader.

It was in France that Joseph Remy hit on the felicitous idea of hatching fresh-water fish by artificial means, and to France also belongs the credit of cultivating her foreshores. Twenty years ago there was scarcely an oyster to be found on her coasts. At Rochelle, Rochfort, St. Brieuc, over-dredging had ruined the beds. In this crisis M. Coste thought of restoring by artificial means what man's improvidence had destroyed. Directed by his government to examine the shores of Italy and France, and having inspected the bay of Aiguillon, and the parcs of Lake Fusaro, he placed the result of his observations before the public. In order to settle the question whether the system followed at Fusaro was applicable to the open sea, it was determined to renew the old oyster-beds in the bay of St. Brieuc. The attempt was made; fascines placed to intercept the spat were soon covered with it, and within six months the "idea" became a great success.

At the Isle de Rhe, oyster-rearing soon obtained the lead. It was commenced in 1858; now there are above 4000 farms on its shore, some of which are supposed to yield 1000 per cent on the outlay. If the reader will imagine a vast extent of sea-beach, laid bare by the ebb-tide and divided into manifold small enclosures by low dikes or fences, the interspaces paved here and there with stones, faggots, tiles, or old shells—if he will people these small holdings with busy labourers, clearing away mud, laying down brood, or collecting oysters for the market—he will be able to form some idea of the parcs at the Isle de Rhe.

Previous to the year 1858, the foreshores at the Isle de Rhe were but profitless mud-banks. At this date, Mr. Bœuf, a poor mason, made his first enclosure of some twenty-five yards square, and in the following season, the stones and faggots he had laid down to intercept the spat, were covered with young oysters. His neighbours required no better evidence that a new and profitable branch of

industry had been discovered. Two years later the beds probably amounted to nearly 1000, and produced, from sale of brood alone, a sum equal to £500.

Referring to what has been effected subsequently on this island, Dr. Henry Lawson, late editor of the *Popular Science Review*, says—"Five years since, its shores were barren and uncultivated, now they give employment to 3000 men."

The annual crop of oysters has increased very considerably since Dr. Lawson wrote, yet even at that date, the equivalent for wages must have exceeded £40,000 sterling.

That which has been done on the mud-banks of the Isle de Rhe may be done on a thousand points of our coasts. We shall presently show what British energy is in the act of accomplishing; but, before entering into the more practical portion of our subject, we will offer a few general observations as to the grounds most suitable for the growth and fattening of the oyster, and give some statistics from the last report of the Commissioners

of the Sea-Fisheries of the United Kingdom, illustrative of the commercial value to be derived from the cultivation of this molusc.

Hitherto we have trusted to the deep sea for our supply; henceforth, we must rely principally on our foreshores, and it is most satisfactory to find that the oyster thrives and multiplies as well in shallow as in deeper water. This is a most important fact. At twenty or twenty-five fathoms, however, few or no currents are found, whilst they increase in force as the shore rises. Calm water, therefore, has been selected by the oyster as his proper habitat, and man, by dikes and dams, must afford him a home suitable to his wants. It is only very recently that the importance of this fact has been practically recognised. A mixture of rock and stones forms the best *nidus* for these fish, as such ground affords a sufficiency of food, and ensures good anchorage. The adult oyster fattens very quickly on muddy shores, but the young require cleaner ground. Marl, so far as our experience goes, seems the

best soil for its most perfect development, the value of such hints needs no comment.

Previous to the publication of the reports of the Sea-Fisheries Commission, the public possessed few data on which to found an opinion of the money-value of our oyster-beds.

From a mass of documents now before me, I select at random two extracts, both being taken from the records of the Whitstable Oyster Fishery.

WHITSTABLE OYSTER FISHERY.

No. 28.

Year.	Quantity of brood from Flats and Essex.	Total cost.
1852-53	63,853¾	£15,240 0 5
1853-54	55,907	16,200 4 0
1854-55	44,101½	15,969 8 3
1855-56	30,004	10,322 8 11
1856-57	40,704	11,250 5 6
1857-58	77,844	21,057 4 3
1858-59	134,878½	28,711 0 2½
1859-60	83,481	19,839 1 1
1860-61	49,709	16,033 4 5
1861-62	84,937	36,713 9 10½
1862-63	22,499	13,389 9 10
1863-64	15,234	14,553 19 2
1864 to March 1865	2,683½	1,945 8 10
Do.	2,500	2,625 0 0

No. 28—*continued.*

Year.	Price paid for labour, from August each year to May in the next year.			Total expenses for each year from August to May in the next year.		
	£	s.	d.	£	s.	d.
1852-53	16,793	9	2	48,484	11	1
1853-54	17,822	5		45,427	1	5½
1854-55	14,154	15	0	45,994	1	11
1855-56	14,166	11	6	36,715	9	3½
1856-57	14,131	8	8	42,336	13	4
1857-58	19,415	6	11	58,887	2	11½
1858-59	20,445	13	9½	65,948	10	9½
1859-60	20,531	18	6	64,286	12	7½
1860-61	16,713	4	4	45,745	1	6
1861-62	27,641	18	9	74,354	18	1
1862-63	43,731	14	4	97,794	2	1
1863-64	46,609	10	8½	79,860	0	7½

Such are the figures presented by a single company. It must, however, be remembered that these were largely obtained at the expense of the natural beds in the Thames, and that the outlay nearly ruined them. Henceforth our stock must be sought from other sources, and a few years only can elapse before the modern system of oyster-culture will ensure a supply fully equal to the home and foreign demand.

CHAPTER XX.

A GLANCE AT BRITISH OYSTER PARCS—THEIR PROSPECTS.

THE most successful instance of the production of an artificial spat on our coast during the present year, occurred in the same locality in which it appeared during the summer of 1866—namely, at Hayling Island, off the Hampshire coast, where an enclosed area of water, eighteen acres in extent, and from five to six feet in depth, may now be said to be literally covered with young oysterlings, the growth of the present season.

The natural capabilities of the Hayling Island creeks, for the artificial cultivation of oysters, led in 1865 to a private and successful attempt at raising spawn, and afterwards to the formation of a company, to ensure the work being carried out on a larger scale.

The first great experiment was made on the site of some old salterns at the south-east extremity of the island, the entire water area being about three acres and a half, and the result of which was perfectly satisfactory. In the spring of 1866 two nurseries were prepared for the old oysters; one on the plan pursued at Lake Fusaro in Italy; the other on the French model followed at the Isle de Rhe. The depth of the Fusaro bed was about three feet, which might be considered as still water, the tide being only admitted at the springs, through a sluice from the harbour outside the bank, of the oyster-farm. The bottom of this parc, consisting of deep, black, and almost fetid mud, was partly covered with shingle, on which, in April, 50,000 oysters, brought from deep-sea beds, were laid. Light hurdles, formed of hazel and brushwood, were pegged down horizontally over them in mid-water by stakes, driven through the hurdles into the bed of the pond. The other nursery, on the plan of those at the Isle de Rhe, was covered

with shingle, and had a constant, though gentle stream of water passing over it. Instead of hurdles, tiles were laid down to collect the spat. The parcs were connected by a narrow causeway. Although no difference existed in the kind of oysters, as will be observed, there was some variation in the time of laying them down. There is also a reasonable probability of a considerable difference having existed in the quality of the water in the two parcs, inasmuch as the Fusaro parc was merely, we believe, an unused salt-water pond or lagoon, whilst that laid out on the Isle de Rhe system, was constructed on the site of some old salterns or salt pits, and as such, probably very highly impregnated with saline matter. Whether, as the result of these different circumstances, or from some other cause, the fact remains, that at spawning time the hurdles on the Fusaro parc were thickly covered with spat, whilst the Isle de Rhe pond held none, nor was any thrown off subsequently. The difference which existed in the time of deposit will, we

believe, help to explain this, for in the latter, the oysters were not laid down till the 16th of May, whilst in the former they were deposited on the 1st of April, nor can we doubt, that long interval of six weeks, at a season so critical, tended largely to the failure of the Isle de Rhe experiment.

Late in the autumn I visited Hayling, and was shown over the works by my friend Mr. Hart, the able manager and laborious scientific observer of the farm. The hurdles were still *in situ*, and were *literally covered* with young oysters. Millions on millions were there, thriving and healthy; the rest shall be given in Mr. Hart's own words. "Unfortunately for this supply, magnificent by reason of their numbers, and the manner in which they had grown by the beginning of the following September, it was determined, contrary to the advice of the company's manager, to allow the young fish to remain attached to the hurdles in their original position for a certain time, until they had attained a larger size. The consequence

was, that they grew *round* the sticks, and in subsequently removing them, the under shell was broken in three cases out of five, and seventy-five per cent were thus destroyed. The oysters that escaped destruction are flourishing amazingly, and now measure from the minimum of an inch, to a maximum of two inches in diameter, and in September 1869 will be in the market."

Since my visit, one parc of eighteen acres, and another of seven, has been enclosed and stocked. Ten acres besides, are being laid out in parallel beds, with clay and chalk walls, and a feeding reservoir of five acres, whilst 800 adjoining acres remain for any further extension that may be found requisite.

This account, slight as it is, may serve to show the extent of the South of England Oyster Company's operations; at present, the most important of those now in progress round our coasts.

It is time, however, to return to the 18-acre-field alluded to in the commencement of the

chapter. This parc and the adjoining one of seven acres were stocked during the spring of the present year. The conditions in both were similar, the oysters being taken indiscriminately from one lot, and deposited in the ponds at the same time. In each, the water ranged from five to six feet in depth, whilst hurdles or fine twigs were placed as before described. On the 1st of June, the presence of oyster-spat was discovered in the 18-acre enclosure, and by the 6th of the month, the birth of what Mr. Hart calls the "baby hosts," was evidently brought to a close for the season. Sixteen thousand hurdles were staked over the beds. These are now (October 10th) being taken up, and the young fish removed, together with the *bark*, from the larger sticks, the smaller twigs being cut into short pieces of four or five inches. Taking the lowest estimate, each of these hurdles holds at least 5000 little oysters, giving a total of 80,000,000 as stock for market in 1870-1.

In 1864 it was estimated that about 700,000,000 of oysters were consumed in

London, and more than that number in the provinces, so that, it appears, eighteen acres of previously profitless fen or mud-land, are capable of supplying an eighth part of the present metropolitan demand; we say "present," advisedly, for as prices fall, consumption must inevitably increase.

Each year a spat has been obtained at Hayling Island, but, strangely enough, not from the same pond—as the Fusaro parc, which gave such enormous returns in 1866, yielded nothing the following season, though all conditions essential to the success of the former year were supposed to be faithfully observed in the following one. Whether the breeding oysters in the Fusaro parc were left unchanged, we have no information; but supposing this to be the case, is it not possible, that by their long confinement in comparatively stagnant water, their constitutions may have become enervated, and perhaps unfitted for the procreative functions.

That the oyster spawns each year we do not by any means believe, but we feel sure that

under normal conditions, out of any given number, a certain percentage will always do so; when, therefore, no single fish in 40,000 or 50,000 produced any spat, we are compelled to believe, that some important, though apparently slight condition necessary to success was wanting. It has been calculated that an oyster produces about 2,000,000 of young at one birth; supposing, therefore, only three per thousand spawn annually, we may expect 6,000,000 from every thousand laid down, and as, in our artificial beds, care is taken to exclude "five-fingers," crabs, and other enemies to the race we foster, we may reasonably hope hereafter to send a large proportion of the amount raised, safely to market.

One great fact should always be remembered "that spat never fails at Arcachon." It would therefore be wise in our ostreaculturists, to send one or two fit persons there, during the breeding season, to take careful notes of the conditions of atmosphere, water, soil, etc. etc., that we may have some standard by which to

compare our own successes or failures. This suggestion occurs in an admirable article contained in the *Field*, Oct. 19, 1867, a portion of which we cannot help introducing.

"That it is quite possible to obtain spat upon a large scale—at any rate upon our southern coasts—is certain; for we have not only the two instances of success on the part of the Hayling Island Company, but we have lately seen an account of a plentiful spat having been obtained at Lymington by artificial means, and we have also been informed by one of the directors of the Isle of Wight Oyster Company, that the Company has also succeeded this season in obtaining a fine spat in their artificial oyster-ponds; so that it is quite certain that a very large supply can thus be calculated upon; and the results are so considerable and so very remunerative when a spat is obtained, that it may fairly be assumed, that if in such undertakings, a spat can be gathered once in three years, it would pay very handsomely. The great difficulty, however, in inducing persons to

come forward and support companies for this purpose on a large scale, would seem to be the length of time which must elapse before any return can be obtained for the money invested, combined with the uncertainty of the return. Many persons, however, are taking up the speculation, and no doubt, ere another year or two is past, we shall be able to calculate upon such undertakings much more in the light of a certainty, than we are able to do at present."

As the South of England Oyster Company is at present the most important artificial breeding company in the kingdom, we have dwelt at some length on the subject, designing to make it an exponent of others, which will therefore pass more rapidly in review before us. Before quitting this locality, however, we should observe that there is also a smaller undertaking of the same kind at Hayling, "The Hayling Island Company."

At Emsworth, on the same coast, a small company has been established about two years. They have eleven acres under cultiva-

tion, and obtained a moderate spat on hurdles in the spring of the present year. After spatting time, they use the ponds for fattening oysters procured by dredging, and from this source paid a dividend of eight per cent, in the eleventh month of the company's existence. The nominal capital is £20,000, only £7000 of which has been called up. The works were commenced in the early part of 1866.

On the opposite coast there are also two artificial parcs belonging to the Isle of Wight "Oyster Fishing Company (Limited)," established in April 1866. One of these called Somerton Parc, on the river Medina at Cowes, contains about seven or eight acres, and was only commenced in the spring of the present year. From a letter of the manager (Captain Johnstone) to a friend, we are happy to find "there is plenty of spat on the hurdles." So far as construction is concerned, this parc is a great money success, the total cost, exclusive of stock-oysters, being only £400. The other farm, some miles distant on the river Newtown, covers about seven acres. The site occupied

was originally a creek dry at low-water. The embankment necessary to retain the water in this parc having given way, the works are suspended till the coming spring.

At Poole, in Dorsetshire, there is an establishment conducted by M. Gillardie, a native, I think he told me, of Arcachon. Together we paddled over the mud, saw the oysters—which he told me had improved greatly—laid out in long symmetrical beds, but, I regret to say, I observed no signs of young fish. This parc is situated at the mouth of the harbour, where strong tides prevail, which I imagine make the securing a successful spat a matter of considerable uncertainty.

At Herne Bay, the company formed a small experimental tank during the previous winter, and were fortunate in obtaining a spat on hurdles. Another farm has been established about two years since at Exe Bight, on the mouth of the river Exe, Devon. The Company rent a large part of the estuary from Lord Devon, and have also a salt-water lake of

many acres, on a warren, which, extending almost across the estuary, guards it from the effects of the winter gales. This lagoon is now converted into an artificial parc, and it is difficult to conceive any natural piece of water, better suited for the purpose. As might have been expected, the company obtained a highly satisfactory spat this last season. The large extent of ground, its natural productiveness, and the warmth of the climate, will probably eventually render the farms of the Exe Bight Company, the most important in the south of England, since they are not only fortunate in the possession of the natural lagoon already mentioned, for artificial breeding, but have also a large extent of admirable fattening ground in the mouth of the river, producing a natural breed of natives, which have always held a high reputation in the surrounding counties. Several other companies have been formed, and are on the point of starting into active life, one of which, the Fish and Oyster-Breeding Company (Limited), has lately—as already

stated—obtained a grant under the Oyster and Mussel Fisheries Act (1866), of several hundred acres, of very valuable ground, in the river Blackwater, Essex. In Ireland and Scotland also, a few parcs have been established which have succeeded, more or less satisfactorily.

We may fairly say then, that there can hardly be two opinions respecting the prospects of our British oyster-fisheries. Scientific cultivation is yet in its infancy. A very few years ago we had everything to learn, but during that time experiments, though often falling short of complete success, led to more matured efforts, which, in turn originating a fresh series of attempts, brought us still nearer to fixed ideas and assured prosperity. Time, however, is required for their full development; and as in these kingdoms the fish require one year more to arrive at maturity than in Italy or the French claires, they have not yet lived sufficiently long in their new homes to attain their majority; still, wherever proper methods have been

pursued, spat has been attained. This is all that oyster-growers need; time and care will inevitably do the rest. The future can rarely be calculated on with certainty, but with the ostreaculturist a present spat is equivalent, at no distant date, to a splendid interest on the capital expended. All the new parcs and claires prove this; they only repeat the old experiment of reclaiming lands, by nature comparatively unproductive. Labour is man's destiny and his reward. His task has been to replenish the earth and subdue it; he who does so becomes more than a conqueror—a blessing and a benefactor to the age he adorns.

CHAPTER XXI.

PRINCIPLES OF OYSTER-CULTURE—A WORD ABOUT MUSSELS, COCKLES, AND PERRIWINKLES.

We must now turn to the practice of oyster-culture, which, having passed through various stages, may be said to rest on tolerably definite principles. The first step taken is to obtain a site for the future farm. This is usually placed in some creek or estuary; the great object being to secure quiet water, well supplied with *infusoriæ* and the *sporules* of marine vegetation. In places where a considerable extent of foreshore is diurnally exposed to the action of sun and air, these are almost sure to abound. Nearly all the new companies have started with two grand designs—namely, fattening and breeding; we must say a few words on each.

As raising a stock and bringing it to maturity takes about three years, the ostrea-culturist naturally desires to see some earlier return for his capital, and endeavours to obtain it by fattening deep-sea oysters for market. It has already been noticed that mud-lands are well suited for the purpose, and that adult fish, laid down in such localities, thrive admirably, becoming more plump, tender, and succulent; whilst the shell, sharing in the improvement, grows more smooth and uniform.

On the farm in Poole harbour, fattening has hitherto, I believe, been the main business of the manager, M. Gallardie; and we may well believe his system inferior to none. The stretch of mud-land occupied by the company is an oblong, extending from east to west, and this is laid out in beds and walks, with the regularity of a Dutch garden; the former, about four feet in width, being planted with innumerable oysters, and the intervening paths fenced with brush, during the spatting season. Here each, calmly

reposing on its under shell, fattens on the rich ouze, and I am enabled to state from personal experience that finer, or better fish never crossed a gourmand's palate. It need hardly be said that the oysters were closely arranged side by side, and only in a single layer. The reader will observe that in this establishment there are no artificial works as at Hayling or Exe Bight; the flats have simply here been utilised. This arrangement, whilst it avoids the expense incidental to construction, must, I fear, labour under the disadvantage of very precarious spats, which have hitherto, in this country at least, been most surely obtained in tanks and ponds protected from tidal currents, and where hurdles and brush, being placed at a certain distance *above* the beds, mechanically intercept the spawn as it rises.

The method followed by M. Gallardie, is rather that pursued in France than in England. Like those at the Isle de Rhe, these beds are exposed to the action of strong tides, and in spite of care, the spawn must

always run a great risk of being swept away. Mud, too, is in excess at Poole, as at the Isle de Rhe, and requires constant labour for its removal; still the profits—though infinitely less than will hereafter be obtained from more artificial, but at the same time more expensive works—may well repay both capital and labour.

"It is not surprising," writes Mr. Hart, "that a far greater amount of attention has been paid by ostreaculturists to the growth and fattening of oysters purchased from coast-dredgers, than to raising spat from old fish. The acknowledged result of this course has, however, been to denude natural breeding-grounds on both coasts, of fish old and young; and it has only been the almost insurmountable difficulty met with for several years now past, in procuring oysters suitable for fattening-beds, that has turned the attention of people in the direction of breeding, as well as fattening oysters for the table."

We must return once more to Hayling.

Here the spat, as before observed, is obtained from ponds—in fact in calm water—where it cannot be drifted away, and this isolation is one prime element of success. But in the experiments carried out at Hayling, it will be remembered, that whilst the Fusaro pond proved a mine of wealth, the Isle de Rhe pond failed *in toto*. Can this be accounted for? We think it can in a great degree.

Besides the points adverted to in a preceding chapter, it may be observed that in the former enclosure, hurdles were placed *over* the mother fish; in the latter, tiles only were laid down. We do not say no spat can be obtained under the latter conditions, far, very far from it, but we believe the super-imposed hurdles *must* arrest it, whilst any other kind of clutch is more or less uncertain in its action. There appears, moreover, to have been a constant though gently running stream passing through the Isle de Rhe pond, and this, too, probably contributed to its failure. In the small experimental tank made at Herne Bay during the winter of 1866-7, the company

obtained a spat on hurdles, a formation similar to that of the Fusaro pond, producing similar results. These facts are well worth attention. We are studying a new art, and must learn alike from failure, as from success. The points most worthy of imitation are isolation and super-imposed impediments to the escape of the spat during the brief period of its wandering life. It is one thing, however, to obtain spat, but another to utilise it. We have already seen how seventy-five per cent of the great oyster-harvest at Hayling was lost by the process of detaching the young fish from the hurdles. This was partly due to the period at which the operation was performed, for had the oysters been allowed to attain a larger growth, they would have suffered less, whilst the deformity would, during subsequent development, have passed away in a great degree. Such an accident is not likely to occur again, since it can be obviated by the simple plan of peeling the bark from the hurdles, and thus ensuring that a level

surface shall destroy all chance of curvature.

Time is money, says the proverb, and it would effect no small saving to the oyster-farmer, if he could send his stock twelve months earlier to market. On the coast of England the fish require nearly a year more to reach maturity, than they do in the warmer waters of France; but it remains to be seen whether artificial feeding cannot be made to neutralise the effects of climate. We know how large an influence it exercises on terrestrial farm-stock; and, judging from analogy, there appears to be no reason why a similar process, judiciously modified, should not succeed equally well when applied to animals of inferior type. So far as we know, such a plan has not yet been tried at all—certainly not on any considerable scale—by our ostreaculturists.

In a former chapter,* a statement from the report of the "Sea-Fisheries Commission" was given, regarding the sums expended in

* Chap. xix. pp. 209, 210.

oyster-culture by a single company. We will now give a few figures from a work of Mr. Lobb, which will be satisfactory, as showing the profits made, and anticipated, from two of the fields of oyster enterprise so often mentioned. "My visit to the bed," writes this gentleman, "took place upon 10th of July 1866." M. Chaumel was his conductor, and probably furnished the following statistics :—

The expense of making the bed Lahillon* was	£112
Purchase of oysters	808
Purchase of boat	40
Guard	104
Extra labour	60
Tiles	16
	£1114
The results are as follows :—	
Returns from sale of oysters . .	8000
Deduct expenses	1114
Profit realised	£6860

So much for oyster-farming at Arcachon.

* "Lahillon" is a narrow strip of sea-bottom, in the Bay of Arcachon, 2700 metres long by 180 broad. In 1860, M. Chaumel—commandant of the brig Leger, the

The following facts and figures are also given by Mr. Lobb of the cost and anticipated profits of the Hayling Island Company :—

Purchase of salterns .	£500	0	0				
Labour in preparing the same . . .	300	0	0				
Hurdles . . .	3	3	0				
Cost of 50,000 oysters to breed . . .	50	0	0				
				£853	3	0	
Wages for two years, for four men . . .	£400	0	0				
Directors' fees, salaries, interest, etc. . .	150	0	0				
				550	0	0	
				£1403	3	0	
5,000,000 oysters at 10s. per tub				£2500	0	0	
Deduct the expenditure of two years				550	0	0	
Estimated profits . . .				£1950	0	0	

Which would yield an annual dividend of more than cent per cent on the capital,

guard-ship on that part of the coast—was directed by the Minister of Marine to carry out M. Coste's recommendations as to oyster-culture. The reader will see the success which attended M. Chaumel's efforts, under the orders of his government. The receipts for the year 1866 do not appear in the account, as "the return" was not made whilst Mr. Lobb's work was in the press.

£853 : 3 : 0. Mr. Lobb's volume was published at the end of 1866; since that time the works at Hayling have grown alike in expense and fairer prospects. Here we will leave the subject, and whilst bidding it adieu, may be pardoned for expressing a hearty wish that the company whose fortunes we have so long followed may soon reach the culminating point of oyster prosperity.

As the Oyster and Mussel Fisheries Act, has in a great degree placed the future of our foreshores in the hands of the Board of Trade, we may well inquire in what spirit they have discharged their high duties.

Unfortunately, the first applications were rejected; we say "unfortunately," since such rejections gave an opening for those whose passions or prejudices were opposed to the workers, or the working of the Act. It may not, therefore, be out of place to say a few words on the causes which led to the rejection of some of the earlier applications. Amongst the first of these were two of no ordinary pretensions, since the one sought to

obtain a grant of the entire Solent, whilst the other, with less ambition, desired to possess a moiety of the same. Had these claims been granted, many existing rights must have been crushed; nor did it appear either that the claimants could effectually have cultivated so large a tract, or that the public would have received any benefit. Under these circumstances, where neither public nor private interests could have been advanced, the Board had no alternative but to reject the applications. The best evidence, however, of the earnest desire of the Board of Trade to discharge their difficult duties in the most conciliatory spirit, is to be found in the appointment of Mr. Cholmondeley Pennell, as Her Majesty's Commissioner. In this gentleman, are united practical knowledge, independence, and rare tact, together with great temper, courtesy, and patient investigation. Constantly called to decide between conflicting interests, he has already won "golden opinions from all sorts of men," and hereafter, when the history of Act

and Board shall be written, we believe the utility of the one, and the public appreciation of the other, will be acknowledged to have been due in a great degree to the judicious appointment of Mr. Cholmondeley Pennell.

We must now say a few words about mussels and cockles; did space allow, it would be important to inquire fully into the habits and mode of cultivating these edible molluscs, with the view of bringing them into more general use, but as a systematic treatise is impossible, we propose merely to offer a few general remarks on the subject. "There are special reasons," says a most able writer, "for seeking new food amongst molluscs and shell-fish. They can be confined to localities and preserved; their habits, their wants, their peculiarities, can be studied, and from careful observations, deductions can be drawn, which may lead to a regular and scientific system of culture. The experiments tried with so much success at the Isle de Rhe, and more recently at Hayling Island, have shown that the oyster can be as systematically

cultivated as corn can; and there seems to be no reason—at the first glance certainly—why other stationary creatures of a kindred kind should not also be brought into farm.

"There would not seem to be any reason why enormous aquaria should not be established in the many favourable estuaries around the coasts of the kingdom, in which not only oysters might be cultivated to a much larger extent than is now done, but other molluscs and conchifers might be farmed for the public good, and for private advantage."

For our present purpose the edible mussel *Mytilus edulis* need only be mentioned. *De gustibus non disputandum est*, is a rule universally accepted, and as regards the mussel, admits the broadest interpretation; for by some persons it is called "the most agreeable of all shell-fish," whilst by others it is held scarcely fit for human food. In Scotland the fish is largely used, about 100 bushels being eaten annually in Edinburgh and Leith alone. An extensive prejudice,

however, exists that mussels, at least during certain seasons, are unwholesome; probably it would be more correct to say, the unfavourable symptoms occasionally manifested after eating them, are due to their having been taken from unwholesome localities, or used at improper times.

The edible mussel abounds on the whole sea-board of Britain, but at present is not cultivated, at least in the proper acceptation of the term, in any part of the kingdom. Her Majesty's Commissioner, however, informs me one application is already before the Board. Hitherto it has been deemed a kind of common property, and has been used more as bait than for food. In France, however, it is extensively cultivated for the table, and who that has seen the countless myriads produced in the bay of Aiguillon, can forget the number, size, and quality, of the fish. Over the bay, a large portion of which is dry at low water, long rows of stakes are driven into the mud, and interlaced with brush. On these the spat fastens, grows, and in due

time is thinned, transplanted, and finally sent to market. This farm has existed above seven centuries, and proves at least two points conclusively; first, that the mussel, if properly prepared, and eaten at the right season, is not unwholesome; secondly, that such a farm can be made to pay: otherwise we should not see a concern, established about 1130, flourishing in 1867.

It is much to be wished that one or more of the Scotch Firths may imitate the industry carried on at Aiguillon.

Like the mussel, the cockle appears to be regarded in this country as common property, or at least the right to gather them seems very loosely defined. As they have hitherto been protected by no law actively enforced, and are still very numerous, it may fairly be asserted that their hardiness and fecundity are of no mean order. With our countrymen, the cockle is held in higher estimation than the mussel, and with a little care in the selection of suitable grounds, and a moderate close-time, might be multiplied *ad infinitum*.

The scollop commands a higher price in the market, but has never yet been cultivated so far as we know. It abounds in Dublin and Carrickfergus bays, where it is actively dredged; the smaller fish being used for bait, whilst the larger are highly esteemed for the table. There is a growing demand for limpets and periwinkles. The quantity of the latter sold in London alone is enormous, as the following extract from "the minutes of evidence taken by the Sea-Fisheries Commission" will show.

"With regard to periwinkles: do you sell any large number of them?"

"Yes; the supply comes from the Orkney and Shetland Islands, and all round the Scotch and Irish coasts."

"Has the price fallen?"

"No; it is more than it was. I remember a circumstance that took place about twenty-four years ago, which will give you some idea of the increase. On Whit-Monday, there were only 50 bushels in the market, and it took two days to sell them; now we sell from

300 to 500 bushels in the same time, and at quite as good a price. They are used by all classes, and are sold in almost every street in London."

These and many other inferior species of shell-fish might be largely increased, and greatly improved by art. There is a market for all; a remunerative price for all. With plenty of consumers, it is to be hoped that cultivators will not long be wanting.

CHAPTER XXII.

LOBSTERS AND CRABS — PRAWNS AND SHRIMPS — GENERALITIES. — DE NECESSITATE.

First in value as in goodness comes the lobster, an animal once numerous, and even now not scarce round our coasts. His home is in the purest water, beneath which he walks through brown and tangled forests of palmy weeds, a warrior in full panoply, ever ready to do battle with all comers. In these pages, however, he must not appear in a poetic, but prosaic aspect. If we consider him scientifically, it will be to determine his value as a domestic animal; even if we inquire into his gastronomic tastes, it will be from the wish to learn how to feed him; and if we visit his home, it will be with the design of learning how to fit up a house in some degree resembling that from which

he is sure to be kidnapped. With these selfish ends in view, we will see what science tells us.

Passing over the general anatomy of the lobster, we may observe that the ovary or place in which the spawn is produced, is situated towards the tail, where a red coral-like substance may always be found. This mass, composed of atoms closely adherent, is in fact spawn, too crude for exclusion. From this receptacle proceed two canals, which, opening through the integuments on either side the mesian line, allow the fish to place her eggs under the protection of her over-arching shell, where they advance gradually to maturity, like the young of the terrestrial marsupials.

Although the procreative functions of the lobster are of a high order, the fecundity of the female is very great, since she produces from 20,000 to 25,000 eggs each season. We need hardly pause to remark how much this faculty enhances the value of the lobster as a domestic animal.

The spawn is carried by the mother till

nearly fit to commence independent life, and when cast off soon gives birth to the young crustacean, which grows rapidly, but passes through many changes before it assumes the form, size, and colour, with which ordinary observers are best acquainted. During the early period of growth it necessarily casts its shell frequently—in the second year, every two months; but as size increases, a new dress is less often required, till at last, when arrived at the fulness of physical dignity, its armour grows as it were rusty, and becomes coated over with parasitic shells.

As is now well known, the lobster only increases in size during the short period of "moulting," but this increase is so great, that it is almost as difficult to believe the cast-off clothes ever fitted the large fleshy mass lying languidly beside them, as that the gigantic geni ever came out of the jar, the lid of which had been in an evil hour removed by the Arabian fisherman.

Delighting in rocky ground, probably for the fastnesses such localities afford to a

creature so frequently defenceless, he feeds chiefly on the weeds which surround him, chopping up his salad with the large claw like any other epicure.

For all practical purposes, so far at least as fecundity, food, and habits, are concerned, the foregoing remarks apply to the crab, who enjoys an amount of popularity almost equal to that held by the lobster. The consumption of these fish is enormous, and as prices are high, they are sought with a ruinous industry which bids fair to exhaust the mine. Every headland and reef on the English, Scotch, and Irish coasts, is diligently fished. On every fiord of the stormy Orkney and Shetland Isles, long rows of corks are dancing on the waves. Hardy Antrim men push their light dronthens* from an iron-bound shore; steer across the dangerous North Channel, and pass from island to island through the long and howling winter. Such unremitting pursuit, as might be expected, has told heavily on the

* Gigs of about 23 feet keel, and 6 feet beam, originally copied from the Norwegian Dronthen, a boat whose qualities, in a heavy sea, cannot easily be over-rated.

number and size both of lobsters and crabs. My experience is tolerably extensive, and I am convinced that a long range of coast may easily be swept clean by over work, or, at any rate, left so bare of these fish, that they no longer pay for gear and labour. A few years since, I sent a boat's crew to report on the productiveness of the headlands and bays along the north-west of Ireland. They spent a summer in their little voyage of discovery, and the details they gave relative to the ease with which even favourable localities could be exhausted, are not without interest and instruction. The portion of coast visited by the crew in question was new ground; so far as the crustacea were concerned, it had scarcely ever been fished except at rare intervals, and even then with very little skill. The first attempt was made in bright settled weather, conditions not favourable for lobster catching, yet the success of the party was wonderful—two dozen creels often taking as many as 300 fish in one day, a large proportion of which ranged from 4 to 6 pounds each.

After a week's labour the sport gradually declined, and at the end of a month necessitated a change of place. Here, again, fortune smiled on them as before, till decreasing captures once more warned them to seek "fresh fields and pastures new." Through the entire summer the same gradual falling off in the numbers captured showed how easily even good spots might be fished out, and proved indisputably that over-creeling would be as destructive to the lobster, as over dredging has been to the oyster. A few years before, the same results followed the exertions of the first pioneers in the out islands, many of whom I knew well. When they visited the Hebrides the lobsters seemed inexhaustible; yet after two or three winters their gains did little more than pay moderate wages and expenses. These facts throw us back, as it were, on practical water-farming, and lead us to inquire whether the valuable crustaceans we have been considering cannot be advantageously cultivated.

The only experiment in this direction with

which we are acquainted, was made in 1866 by Mr. Hart at Hayling Island, who, early in that year, placed about two dozen lobsters in a small pond, supplied at spring-tides with water from the neighbouring estuary. I visited the nursery in the autumn, where I saw thousands of infant lobsters. From causes with which we perhaps are not acquainted, the brood perished during the winter. Mr. Hart was perfectly aware that the experiment could hardly have been tried under more unfavourable circumstances. The pond seemed to want all that we are accustomed to consider essential to lobster life; yet the old fish spawned, the young ones grew, and all promised fair, till either the frost or the want of some indispensable conditions killed them. But who can say this attempt has been in vain? Unquestionably it fell short of success, yet it proved that lobsters can be domesticated, and has left no doubt on our minds that under more favourable circumstances lobster-farming will prove a great success.

Let any aqueculturist who desires to embark in this branch of industry, inspect the larger pools laid bare by the ebb. There he will find a submarine forest, pure water, and a rocky irregular bottom; in short, all the requisite normal conditions. Why should not these natural aquaria be utilised? Grants of foreshore, fit for the culture of these crustaceous animals, could be obtained from the Board of Trade, and what a saving of life and property might be effected! If suitable pools were stocked, fenced with iron gratings, and the lobsters fed with coarse fish or offal, a more regular supply would be obtained, the risk to gear avoided, and many valuable lives annually saved. But cultivation need not be limited to rock-pools; advantage might be taken of the heads of numberless narrow fiords, such as may be seen almost everywhere along the Highland coast and the out islands; nor is there any reason why artificial ponds, roughly paved with rock, and well supplied with pure water, should not be constructed and worked with profit.

If the experiment at Hayling Island—notwithstanding its great local disadvantages—so nearly succeeded, may we not believe that any or all of the plans at which we have hinted might reasonably be expected to answer?

The smaller crustacea, such as prawns and shrimps, might be similarly treated in localities suited to their habits. There is hardly a limit to the demand for these small dainties, which in quiet waters—where a happy mixture of sand, rock, and weed, existed—would be certain to yield full returns.

Whilst glancing at the cultivation of our foreshores, we do not desire to embark on the sea of hypothesis, or we might speak of the utilisation of inlets, salt-water lakes, and lagoons, as parcs for plaice, dabs, flounders, mullets, and the like.

Any one who is conversant with the brackish streams on our coasts, must have observed the multitude of small flat fish constantly to be seen in the mouths of such

waters. They are the fry of migratory flounders (*Pleuronectes flesus.*) Whether they wander far, or hover near the place where they are bred, is not yet determined, though there is reason to believe they do not stray to any distance. Might not the experiment of breeding these creatures be tried, with reasonable hope of success?

With our present views, the sea is an *aqua incognita;* we have a glimpse, and a glimpse only, of reclaiming this vast region. Except in a few cases our ideas are vague, and our plans undefined. Even its food-riches, though generally admitted, are not fully estimated. Considerable light, however, has been thrown on this point by the Report of the Sea-Fisheries Commission, from which we extract the following important passage:—

"The great importance of fish, as an article of food, may be clearly shown by a comparison of the total supply of fish and beef to London in the course of a single year. Neither in the case of fish nor of beef is it possible to give accurate statistics; but it

has been roughly estimated that London consumes 300,000 fat cattle annually, which, at an average weight of 6 cwt. each, would amount to 90,000 tons of beef. At this moment there are between 800 and 900 trawl-vessels engaged in supplying the London market with fish; and assuming the average annual take to be 90 tons, this would give a total of some 80,000 tons of trawl-fish. This is irrespective of vast quantities of herrings, sprats, shell-fish, and other kinds of fish, which are supplied by other modes of fishing. The weight of fish and of beef annually consumed in London is thus in no great disproportion.

"The produce of the sea round our coasts bears a far higher proportion to that of the land than is generally imagined. The most frequented fishing-grounds are much more prolific of food than the same extent of the richest land. Once in the year, an acre of good land, carefully tilled, produces a ton of corn, 2 or 3 cwt. of meat or cheese. The same area at the bottom of the sea, on the

best fishing-grounds, yields a greater weight of food to the persevering fisherman every week in the year. Five vessels belonging to the same owner, in a single night's fishing, brought in 17 tons weight of fish, an amount of wholesome food equal in weight to that of 50 cattle, or 300 sheep. The ground which these vessels covered during the night's fishing could not have exceeded an area of 50 acres.

"When we consider the amount of care that has been bestowed on the improvement of agriculture, the national societies that are established for promoting it, and the scientific knowledge and engineering skill which have been enlisted in its aid, it seems strange that the sea-fisheries have hitherto attracted so little of the public attention."

The high price of food occupies the serious regard of thoughtful men. Corn has risen so rapidly that an advance of 10s. per quarter has been established during the last month, whilst meat has by no means fallen in proportion. It is to be feared all

common articles have an upward tendency; in fact, there is a hard race continually going on between demand and supply. While free trade is opening fresh markets, the natural increase of population is opening fresh mouths, and good wholesome living, remarks the *Times*, "enters into the expectation of classes who had no such expectation thirty years ago. Every fresh supply, however, is attended by some fresh demand. The cheaper wheat becomes, the greater is the consumption of bread. Exactly in proportion to the cheapness of meat will be the increase of customers to the butcher's shop. Once, however, let supply equal demand, and food will cease to hold a fictitious value." The question is, where is it to come from? We trust "Practical Water-Farming" may, in some measure, furnish an answer. The art of submarine cultivation, however, is new; thought, care, and experiment, are all needed to bring it to perfection; but then, in what scheme for man's advancement are they not required? We know of none; but this we

do know, our wants are great; food, once deemed a necessity, is fast becoming a luxury, and the most direct means by which it can be supplied, is from a large development of our fisheries in salt and fresh water.

FINIS.

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