THE CONDITIONS FOR SUCCESSFUL

OYSTER CULTURE

Being the Substance of a Lecture delivered at the Cornish Fisheries Exhibition, 1893.

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LONDON:
DULAU & CO., 37 SOHO SQUARE, W.
1893

PRICE FOURPENCE.

The Department of Agriculture and Technical Instruction for Ireland issue this publication entitled "The Conditions for Successful Oyster Culture," because they believe that it contains much useful information; but they do not hold themselves in any way responsible for the views set forth therein.

OYSTER CULTURE.

NO apology is necessary on my part for the subject o to-night's lecture; there are, unfortunately, but few people who do not appreciate oysters, and here at Truro there are valuable beds in the immediate neighbourhood. But I feel that I owe you some explanation of the apparent presumptuousness of the title which I have selected for my lecture. So many attempts at oyster-farming in England have resulted only in failure that a discourse on the Conditions of successful Oyster-farming may at first sight appear a mere impertinence. But even in England, and to a much greater extent on the Continent, enough success has been attained to enable a careful student to understand the chief causes on which this success depends, and it is these which I propose to lay before you to-night. The details which are apparently of less importance, and which are certainly less clearly understood, require to be investigated separately in every river in which it is proposed to cultivate oysters, and need for our purposes be only briefly mentioned.

By oyster-farming I mean the breeding and rearing of oysters for the market, not merely the relaying of imported foreign oysters to fatten. This fattening industry is no doubt commercially of very great importance; but, since it is far easier than the breeding of oysters, its success depends upon some of the same conditions as those for successful oyster-farming, and it is not practised to any great extent

here in the West, we may omit its consideration in favour of the more difficult, and, I may add, the more remunerative, industry of breeding and rearing the oyster.

Naturally enough, success is most likely to be attained in a river, estuary, or harbour where a local oyster-bed already exists, or has been known to have existed till a comparatively recent date; but even here it is most advisable to make careful experiments before commencing cultivation, in order to ascertain that none of the conditions under which oysters previously thrived have become in any way altered; the water may have become fresher, or fouled by impurities; the food may have become scarcer; in various ways a river that once produced oysters may have become unfitted for cultivation. There is another and a very important question to be considered: Are the conditions of the river so favourable that as many oysters can be reared there every year as are required to make the beds pay? In a very large number of cases of the depletion of oyster-beds, their failure has, no doubt, been due to neglect of the first principle of oyster-culture, viz., that *the average number annually dredged must not exceed the number annually bred and reared to a marketable size.* The question for the oyster-farmer therefore is, Can he rear annually a number of oysters equal to that which he has to sell in order to pay his expenses? The actual answer can only be given after cultivating the beds for about five years; but a careful investigation of the beds beforehand will show whether this is likely to be favourable, or the reverse.

We will suppose that a man wishes to start oyster-farming, and desires to know whether the river that he has selected is suitable or not for the purpose. His first care should be to inquire into what may be classed as the physical conditions of the river, and find out how much nature is prepared to do for him.

1. Perhaps the most important physical condition is **the movement of the tide**, and the manner in which it is affected by the lie of the land. This is a point which has been greatly neglected, and yet it is beyond doubt the key to the extinction of oysters in many English rivers. Where the ebb-tide is strong, and lasts a long time, a river empties itself almost entirely, and the ebbing water carries out to sea with it the young oysters, or spat, which are floating at its surface; when the tide turns, the drops of water that were in the river at flood do not by any means all return to it, but other drops of water from further along the coast take their place to a great extent, so that much of the oyster spat which has been swept out by the ebb is not brought back on the flood, but is lost at sea. A river such as this is unfavourable for breeding oysters; but the great oyster-breeding grounds of Europe—Arcachon in France, the East Scheldt in Holland, the Essex rivers of England—owe their success, in the first place, to the fact that the tide is kept up in them either by the narrowness of their outlet, or by the presence of bars and banks at the river mouths; in these cases the ebb is of long duration, as there is more water in the river than can get rapidly out; long before the river has emptied itself the tide outside has turned, and thus a great deal of the water in the river, carrying with it the precious oyster spat, never gets outside at all on an ebb-tide.

I said above that in this configuration of the land and its effect upon the tide there lay the key to the depletion of the oyster-beds in many English rivers. You have probably all heard of Mr. Darwin's phrase, 'the struggle for life,' by which he referred to the now well-known fact that every race of animals was perpetually fighting against natural disadvantages, and against other animals, for life and food. Further, as you are also probably aware, one of the con-

sequences of this struggle for life is that all animals produce a much larger number of eggs and young than ever grow up to maturity. In the case of the oyster, for example, the mother produces about a million eggs, of which very few ever grow up.

Let us imagine a river with a hundred oysters in it, producing on an average five young oysters a year which reach maturity, the remaining eggs and embryos having been eaten by other animals, or swept out to sea, or otherwise destroyed; as long as that bed is left undisturbed, it can just make head against nature and its other enemies, and will very slowly grow into a large bed. But then suppose a dredgerman discovers it, and takes six oysters a year from it—takes one more oyster yearly than is produced—then that bed is doomed to extinction. And this appears to be the melancholy history of many old oyster-beds in English rivers; they could just make head against their general natural disadvantages, and this great disadvantage of a strong ebb tide in particular, so long as they were left alone, but when they had to fight man as well as nature they were beaten.

2. **The character of the water** is the second physical condition which requires consideration. It must be pure, it must not be too fresh, it must contain a certain quantity of lime in solution, for the oyster to build into his shell. It must also, of course, contain the appropriate food of the oyster. Unfortunately we do not yet know exactly upon what conditions the abundance or the scarcity of this food depends; we know that it consists largely of minute plants, but no one has as yet seriously studied the matter.

As regards the depth of the water, oysters will live and thrive at very considerable depths, but shallow water is obviously best adapted for oyster-farming, as being so much easier to cultivate than deep water; up to a depth of five fathoms it is easily worked.

3. With regard to the **character of the ground** forming the bottom of the river, a naturally clean ground, free of weed, is of course very desirable; it should be firm, but not too 'cold;' a light shingly marl, for instance, forms a capital ground. Sand, so long as it is a firm, rich sand, is also good, but shifting sand and shifting mud are most deadly. Many splendid oyster-grounds on the Essex rivers, and in France, are in the first instance composed of soft mud, and require an enormous expenditure of trouble and money in order to bring them to the requisite condition of firmness.

4. **The climate,** including under this head the seasonal temperatures and the weather, forms also a physical factor in oyster-farming of very great importance, although, perhaps, too much has been attributed to it in recent years. Hot, calm summers, and mild winters form the ideal climate of the oyster-farmer, but are unfortunately not the rule in England. In cold tempestuous weather during the summer months the oyster-spat is unable to settle; in hard winters the stock of mature oysters is sadly diminished by frost. For example, during the winter of 1890–91, nearly 60 per cent. of the oysters in the Scheldt were killed. It may be noted in this connexion that the presence of large ebb-dry flats in the river is found to raise appreciably the summer temperature of the water, as they become very hot, and warm the water as it rises over them on the flood-tide.

Given a river, or estuary, with all these favourable conditions, with a weak and prolonged ebb-tide, clean shallow water, a firm bottom, and a warm climate, the next thing to consider is the **stock of oysters.** This should be larger, much larger than would at first sight seem necessary. There are people who say, 'Oh, you can't dredge the last oyster off the bed, and one oyster will give you spat enough to stock the whole fishery!' Both these statements are perfectly true; but the conclusion which is generally drawn

from them, that it is impossible to overdredge a bed, i most untrue, and takes no account of the struggle for life In the first place, out of every hundred oysters in the breeding season, about forty are females, about fifty are males, and ten are not breeding at all—that is to say, only about four in every ten will give out spat, or young oysters. In the second place, on a cold, rainy, windy day, probably not one spat will be able to settle down and start life for himself. Thirdly, even on a calm, hot day the little spat has innumerable foes to contend with. *There should be so many parent oysters on the bed as will keep the water full of spat during the whole breeding season*, for there may be only one good spatting day in the whole time, and there can be no doubt that the more parent oysters that there are on the bed the greater are the chances of success.

This brings us to the question of **Reserves,** of a stock of oysters not used for market, but left undisturbed for breeding purposes. It has been suggested that on the river Scheldt in Holland, where no one is allowed to dredge near the great dykes or sea-walls which protect the land, the oysters on these dykes serve as a breeding stock, to which a great part of the spat is due. On public, or semi-public, grounds such a reserve is doubtless of extreme value, but on private grounds an owner with some capital may be trusted to maintain a sufficient stock for breeding purposes.

The next question to settle is, **What kind of oyster to lay,** and it is a question not easy to settle authoritatively. If there are already oysters in the river, there is no doubt that it will be best to stick to them; it is their home, and they have adapted themselves to it. If they have become extinct, and there are still oysters in a neighbouring river, it would probably pay best to try these; but, so far as I know, the experiment has not been tried Failing these, there seem to be only two striking alternatives, to lay in a

stock of either the cheapest or the best oysters available. The cheapest are those of Arcachon in France: these have been bred successfully in England, but very rarely; remarkably rarely, when one considers the enormous number of French oysters annually laid down in England to fatten. With regard to laying down the best oysters, it is impossible to say what their children will be like after being transplanted to a different river. The various kinds of oysters found in English rivers are what are termed by naturalists varieties of the same species, just as there are varieties of sheep and cattle; but, unlike sheep, if they are transplanted to another river, their children will, at any rate sometimes, grow up into a new variety.* If it were necessary to import oysters from a distance, it would probably be better to select oysters from Holland, where the climate is much the same as our own, rather than from the South of France, where the temperature is higher. In any case, they should lie on their new beds for some months before spatting time.

I propose now to speak briefly of the **development of the oyster-spat from the egg** before describing the methods adopted for catching it.

In a plan† of the oyster the reproductive organ is seen to form a branching mass occupying a considerable area. In the case of a female oyster this produces eggs; in the case of a male oyster it gives rise to minute bodies called spermatozoa; these are provided with a long tail by which they propel themselves through the water. When ripe, these spermatozoa leave the parent and swim in all directions. An oyster, when open, is continually taking in water in order to breathe and feed, and some of the spermatozoa are swept in between the shells of a mother

* Specimens illustrating these points may be seen in the Exhibition.

† The descriptions were illustrated throughout by lantern slides, models, and specimens.

oyster by the current thus created. If one of these spermatozoa meets and combines with an egg, then, and only then, can that egg develop into a little oyster; and from this we learn, for the purposes of oyster-culture, that *there must be so many oysters on the ground as will ensure the water being full of spermatozoa during the early part of the breeding season* in order that all eggs may be fertilised. When this union between spermatozoon and egg has occurred, the egg, which is a single little brick of living matter, a cell, as it is called by naturalists, falls apart into two cells, then into four, and so on, the bricks out of which the little oyster will be built up gradually increasing in number. Soon there appear on its surface two little depressions, of which the one will give rise to the intestine and stomach, the other forms the temporary shell. By the next stage, which is known as white sickness or white spat, the stomach and intestines have appeared, as has also a muscle for closing the two valves of the shell; this muscle, like the shells which it closes, is only a temporary structure. At the next stage, which is considerably larger and darker in colour, and which is termed black spat, the intestine has become more complicated, and the liver has made its appearance. The black spat is now emitted from between the shells of the mother; and I have seen it stated, although I have no knowledge of the fact myself, that this happens chiefly on a rising tide. Thus turned out into the world, the little oyster floats at or near the surface of the water for some time; it may be only for a day, it may be for a week, according to circumstances. It is now exposed, a helpless and tender morsel, to numerous hungry enemies; if the weather be cold and rough, it will perish miserably; if the ebb be strong it will be swept out to sea to meet with new foes, and to find itself in deep water and strong currents, against which it cannot contend; but in

hot, calm weather, if it be gently carried into a quiet corner by a weak current, it will sink to the bottom, and then, if it finds a suitable object to which to attach itself, it will settle down for life. This attachment is effected by a protrusion outwards of the mantle or membrane lining the shells, which secretes a horny cement.

The oyster-farmer cannot, unfortunately, make calm hot days to order, but he can provide, what is equally important, a clean hard surface, free from weed or slime, to which the little oyster may attach itself; and this brings us to the question of the various artificial methods adopted in various countries to catch the spat.

Cultivation in North Germany, and natural beds.—In a natural bed of oysters the spat adheres to stones and to old oyster-shells. The most prolific of these beds at the present time is probably that of the Wattenmeer, or shallow sea, which lies between the west coast of Schleswig-Holstein and the North Frisian Islands. Here there is no great attempt at cultivation; the oysters are dredged as required for market, and young, unmarketable oysters thrown back, but no attempt is made to catch spat by means of special collectors. In England similar beds have been in many cases, by the rapacity of dredgermen and dealers, so far reduced in number that, as I have explained before, they can no longer make headway; they do not even increase sufficiently in numbers to make it worth the men's while to dredge for them. In the Wattenmeer, on the other hand, I am informed that the beds are leased by the German Government to one firm, and that great care is taken to prevent more oysters from being sold off the beds than are annually raised to maturity. The spat is, however, left to attach itself to anything handy, and the bed is practically in a natural state.

The first improvement upon this natural condition of

things is, of course, to supply in large quantities clean shells and stones such as the little oyster desires; this may be termed the 'natural' system of cultivation, and is practised greatly in Essex rivers where the real 'natives' are bred. The Essex system will be described in some detail later, and is here merely mentioned as the first step by which man improves upon nature.

Cultivation in Lake Fusaro, Italy.—Even the Romans, 1800 years ago and more, had devised a system of supplying artificial surfaces to which the spat might adhere. This has apparently been but little altered in the course of centuries, and is still practised in Lake Fusaro, a land-locked lake in Italy, communicating with the sea by a canal, and about three to six feet in depth. Here the parent oysters are laid on little banks of stones, each little bank surrounded by closely set wooden stakes; at other points in the lake, bundles of brushwood or fascines are suspended from a cord stretched between two stakes. The spat adheres both to the stakes and to the fascines, and can be picked off as required. This ancient industry, however crude, forms a distinct step in advance, by supplying a clean artificial surface of wood for cultch.

Cultivation in France.—About 1858, when the once prolific oyster-fisheries of France were beginning to show signs of exhaustion, Napoleon III. commissioned M. Coste, then a professor at the Collège de France, to report upon the possibility of applying methods of artificial production to fish and oysters. His first experiments were made on lines suggested by the Lake Fusaro method, and were a triumphant success. He anchored bundles of brush-wood or fascines, sixteen feet long, over the bottom of the Bay of St. Brieux, where a large stock of parent oysters had been previously laid down. Upon one fascine 20,000 oysters were counted. In the face of this experiment, it

remained only necessary to find out how the cultivation could be most cheaply carried on as a commercial under-taking; and although, after the first, the system met with great difficulties, and M. Coste died in poverty and neglect, it is to him in the first instance that the enormous oyster-industries of France and Holland owe their existence. He also advocated the use of planks, stones, and of tiles as collectors, all of which are at present in use in France.

The methods of laying the tiles at first adopted were very simple, and the number of brood oysters killed by their removal from the tiles was considerable. An experience, however, of thirty years has produced great improvements in the methods; the tiles are now stacked to a considerable height (three feet), thus exposing a much larger area to the spat, and are coated beforehand with cement, as are also the plank and stone collectors. When the brood oyster is to be removed from the collectors, instead of the adherent shell being damaged, it brings away a little patch of the crumbling cement with it, but remains uninjured itself, and the destruction of the brood is in this manner reduced to an insignificant percentage.

In most of the centres of oyster-farming in France, dredging on the natural banks is permitted only on one or two days in the year, the Government maintaining them as reserves for the supply of spat. The oyster-grounds, whether on the foreshore or in deep water, are leased by the Government to companies and individuals, and are watched by police. By the end of June each man has carefully cleaned his ground, and prepared his collectors. The moment that the black spat is seen the collectors are all laid out; if set out too soon, they become coated with slime and weed, and the spat is unable to adhere to them. About October the collectors are taken inshore; the little oysters are flaked off from the cement, and laid out in

hospitals. These are shallow boxes with galvanised wire top and bottom, which stand a few inches above the ground in enclosed ponds or parks on the foreshore, where they are hardly uncovered on the ebb-tide. In them the little oyster, protected from enemies, lifted out of the reach of mud and sand, and abundantly supplied with food, makes rapid growth; when of a good size and strength, it is sown out on the bottom of a similar park, and finally, in the more elaborate farms, it is relaid in a very shallow pond dug in the adjacent salt-marshes, and termed a claire. Into these claires, which are only about a foot in depth, water is but rarely admitted; their extreme shallowness allows them to be easily warmed by the sun, and produces an exuberant growth of the plant life on which the oyster feeds. It is hardly remarkable, therefore, that the oyster, in a few weeks, grows and fattens amazingly. It is also in the claires that the greenness of the oyster, so much dreaded in England, so much prized in France, is obtained; it is due to a microscopic plant on which the oyster feeds, the bluish-green colouring matter of which is taken up by some of the cells of the oyster.

The remarkable features of the French system as compared with others are, firstly, that practically the whole of the spat reared and sold every year is the produce of Government reserve beds; and, secondly, that it is during its whole life in artificial conditions.

The cultivation in Holland, although founded upon the French system, has been modified to suit the different conditions. While in France there are a number of places round the coast where oyster-culture is practised, in Holland it is almost confined to the east arm of the River Scheldt; this was, about thirty years ago, converted by a railway dam into a great land-locked lake, and the mud and fresh water coming down the river was thus

retained in the western arm. The ebb-tide is strongly blocked by banks at the mouth of the river, and experiments have shown that it certainly requires more than one tide to take spat from the head of the river to the sea.

A Dutch oyster-farm of the more elaborate kind, consists of three sections: ground on the foreshore for laying tiles, deep water grounds for laying out year-old oysters, and what may be termed the home farm, where a store of marketable oysters is maintained, and where the little oysters are first stored. As in France, the oyster-grounds are leased from the Government, often for large sums.

After trying all forms of collector, the Dutch have decided in favour of tiles, of which about 11,000,000 were laid out in 1891. The tiles, which are all cemented, are simply laid on their edges on the ground, since soft mud or shifting sand are not so prevalent as on the French grounds. The tiles are gathered in about September, and are laid in pits about four feet deep on the home farm. Growth is slower than in France, and the winter more bitter; the oysters are therefore not removed from the tiles till about April, and are then laid in hospitals till about August, either in pits or on the foreshore. They are then sown out on the deep-water banks for two or three years till required for market.

The chief points in which the Dutch system differs from that in use in France are the simpler and cheaper arrangement of collectors owing to the comparative absence of mud; the length of time during which the brood oyster is left on the collectors, owing to the slower rate of growth; the use of deep pits excavated on land instead of shallow pits on the foreshore, due to the greater cold of winter; and the sowing out of the year-old oysters on deep-water layings instead of rearing them in parks or claires. In Holland, as

in France, there is reason to believe that the spat is mainly produced by a Government reserve, an accidental result of the regulation which prohibits dredging within 547 yards of the dykes or sea-walls which protect the country.

The cultivation in Essex, the part of England which produces the true native oyster, appears at first sight to be more simple than in foreign countries, but it is doubtful whether the general system is not the one best adapted to the special conditions prevalent; at the same time, in some respects its details are capable of improvement. The methods adopted are, briefly, to lay out cultch of oyster and cockle-shells on the foreshores just before the spatting season, and to strip the brood from the cultch during the summer of the next year. All oysters (ware or marketable, half-ware of two and three-year-olds, and brood) are dredged up in the autumn, and laid in pits about two feet deep near high water-mark; here they remain till the following March or April, and are then sown out again in the rivers.

The Essex cultivators are hampered in various ways as compared with their more fortunate competitors abroad. In the first place, no reserve is maintained for spatting purposes, the marketable oysters in the river being supposed to serve. Now, what little evidence is available on the matter, tends to show that this artificially fattened oyster, constantly moved from place to place, is not so fertile as an undisturbed oyster on a reserve; and, for another thing, in some places there are not always enough oysters to fulfil the canon laid down above, that there should be enough oysters on the ground to keep the water full of floating spat all through the breeding season, since there may be only one good spatting day in the whole time. Another great disadvantage in the Essex rivers is

the shifting mud, which stifles the oysters and covers the cultch with slime, necessitating the constant use of harrows and rakes, and an enormous expenditure on shell and gravel to make a good bottom; this further renders the use of artificial collectors difficult. A third hardship with which the 'native' growers have to contend is the ice-cold water which comes down the rivers in winter from the melting of snows; this is most fatal to oysters, and is a principal reason of their being taken into pits during the winter and spring. This snow water, and the constant cleaning which the ground requires in these rivers, militate against the establishment of a reserve for breeding beds.

This is not the place in which to suggest improvements in the Essex methods, but I have no doubt that, in some points, Continental methods might be adopted with advantage, or modified to suit the peculiar conditions of the rivers.

Having thus briefly discussed the various methods adopted in France, Holland, and Essex, for the collecting of the spat, we may now return to the general principles of oyster-farming.

The kind of collector which will give the best results in any river can only be determined on inspection of the river, no hard-and-fast rule can be laid down. It will depend largely upon the strength of the current, the character of the bottom, the amount of traffic in the river, and the local prices for shells, tiles, slates, and wood. Whatever kind of collector is adopted, it should be set out as soon as possible after the appearance of black spat; and, with the exception of shell cultch, it should be cemented, in order to allow of the easy detachment of the brood. It is hardly necessary to add that the collectors should be set thickest where experiment has shown that

spat falls most plentifully, owing to the presence of back-waters or other favourable conditions.

The after-treatment of the brood, again, must depend upon the character of the river. If growth is rapid, it can be detached when a few months old; if growth is slow, it must be delayed till the next year. In either case I am unable to conceive of any conditions under which the foreign system of hospitals would not prove of distinct benefit, both as diminishing loss and as promoting rapid growth; by this system enemies of all sorts are kept away from the brood, and arrangements are made to allow of the easy access of food. For the same reason, where it is practicable, the gathering of the collectors into suitable pits which are unaffected by rough weather, mud, and enemies, must reduce the percentage of deaths very considerably.

In any river some grounds will be found to give rapid growth, others to be best adapted for fattening purposes, and the judicious oyster-farmer will shift his oysters accordingly. But all grounds, whether for spatting, growing, or fattening, must be constantly worked; if they are muddy, the oysters and cultch must be constantly raked and harrowed out of the mud; if there are strong currents, and especially after bad weather, the oysters will drift into banks and ridges which the dredge will not touch, and which must be harrowed out; all drift weed must be removed as fast as it is deposited, and all the numerous enemies of the oyster killed or taken ashore. Except for a few weeks during the breeding season, when it is best to leave the cultch alone, the grounds should be worked the whole year through.

The enemies of the oyster, to which I have just referred, are a more serious matter than is generally supposed. In some rivers one set of animals is found

to be most detrimental, in others another. They may be roughly divided into two classes: those which actually attack the oyster, and those which affect him indirectly.

Among the animals which actually attack the oyster, the five fingers (*Asterias*), the star-fish (*Solaster*), and the burr (*Echinus*), all belonging to the class *Echinodermata*, have the same method of attack. They wait till the oyster opens in order to breathe; they then evert their stomachs between the valves, and digest him in his own shell. These animals should be taken ashore, where they are found to make capital manure. The whelks, the dog-whelk (*Purpura*), and the rough-whelk (*Murex*) have a different method of attack. They bore a small hole in the shell, and then lick the oyster out, probably by means of the long toothed tongue which they possess.

Crabs (*Carcinus* and *Portunus*) are particularly deadly to brood oysters, the delicate shells of which they break open with their claws. These and the whelks should be killed whenever met with on an oyster-ground. Among indirect enemies, the boring-sponge or yellow-rot (*Clione*), and a small worm (*Leucodore*) attack the shell, and weaken it to such an extent, that the energy of the oyster is often absorbed in thickening the shell, instead of growing and getting fat. The *Clione* can be cured either by standing the oyster in the sun for a time, or by placing it in fresh water for three or four hours, and I think the *Leucodore* could probably also be cured by the fresh water, but have made no experiments on the point. All stones and dead shells infested with these animals should be taken on shore in order to prevent them from spreading. Quats or pock (*Styela*), blubber or squirts (*Ascidia*), crow-oysters (*Anomia*), nuns or chitters (*Balanus*), hard-ross (*Serpula*), and hassocks (*Sabella*) affect the oyster in various ways. They take

up its food, some of them probably eat any floating oyster-spat which comes near them, and they take up space which ought to be left clear for the adhesion of the young spat. They should all be scraped away and taken ashore, except the crow-oysters. These appear to be killed by being separated from the shell or stone to which they adhere, and may be thrown back to serve as cultch. Special dredges and harrows are required for this work of cleaning the ground.

Mussels also inflict serious injury on oyster-beds. They spin up the young oyster with their threads or byssus, and compete with the oyster for lodging and food. Being hardier than oysters, there is always a danger that they may supplant them. In places where they cannot be sold for food, for bait, or for manure, it is best to kill them, but they can sometimes be cultivated on muddy lands where the oyster will not grow, and utilised for food.

A point still remaining for discussion is **the breeding of oysters in enclosed ponds.** The obvious theoretical advantages of this method are: that no spat is lost by being washed out to sea; that its enemies can be reduced to a minimum; that an enclosed body of water becomes hotter, and is less disturbed by bad weather than does the open river. A fall of spat has been achieved in such ponds in England, Holland, and France; but, so far as I am aware, it has nowhere proved a great commercial success, for the obvious reason that it is extremely difficult and very costly to maintain the water in its natural condition. Here I can only briefly indicate the points which require special attention. In the first place the aëration of the water, the keeping the water charged with oxygen for the oysters to breathe, is a great difficulty, which is best met by making the ponds very large and rather shallow, so as to expose the

largest possible surface of water to the air. The pumping of air into the water, and the driving it in by fans, worked in both cases by steam power, have been tried, but are necessarily costly. Secondly, absolute cleanliness is even more necessary in enclosed ponds than on ordinary rivers, for the parent oysters are bound to foul the water to some extent, and any further impurity is most dangerous. To obtain this cleanliness the pond should be drained early in the year, say about February, and should stand empty for a couple of months; the bottom should be ploughed, if possible, when dry on the surface, in order to turn up to the air and sun the decomposing matter below. Water should be admitted about April, and allowed to ebb and flow for a week or more, and the parent oysters should then be put into the pond. Thirdly, in rivers where a good deal of sediment falls, the parent oysters and all the collectors should be raised a little above the bottom; the water may ebb and flow in the pond till black spat is seen, the sluices should then be at once closed and the collectors put in. In case of a heavy fall of sediment, the collectors should be occasionally raised and shaken in the water. Fourthly, a very careful watch must be kept on the density of the water; springs in the ground and rain water may make it too fresh; evaporation under wind and sun may make it too salt; and water must be added to correct these alterations. Lastly, the utmost care must be exercised in rearing the spat. As a great oyster-farmer remarked to me, oysters reared in enclosed ponds are like hot-house plants; they must be most gradually 'hardened off,' accustomed to the colder waters and rougher weather by degrees, otherwise the bulk of the crop will die in their very first winter.

Personally, I am of opinion that to grow oysters in enclosed ponds can be made extremely profitable; but in

this, as in every form of oyster-culture, the motto should be 'Festina lente,' or, in homely phrase, 'Go ahead easy.' Experience should be gained on a small scale before extensive works are undertaken and capital irretrievably sunk. Nor must the oyster-farmer despair easily upon the failure of one or two crops in bad seasons; for, if reasonable precautions are taken in the first instance, skill and patience are bound to produce a harvest in time.

LONDON:
Printed by STRANGEWAYS & SONS, Tower Street, Cambridge Circus, W.C.