*Oysters
and all
about Them.*

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OYSTERS,

And all about them.

BEING

A complete history of the titular subject,
exhaustive on all points of necessary and
curious information from the Earliest
Writers to those of the Present Time,
with numerous additions, facts, and
notes, by

JOHN R. PHILPOTS,

L.R.C.P. & S. Edin., J.P., &c.

VOLUME II.

JOHN RICHARDSON & Co.,
Medical Publishers.

LONDON: 6, Great Russell Street, W.C.

LEICESTER: 10, Friar Lane.

1891.

MBL 4147-1788

CHAPTER XXVII.

During the progress of Printing, the accumulation of new matter has so far exceeded the number of pages originally intended, that the book has, for convenience, been bound in two volumes, although paged throughout as one.

tells us that at the German coast (in the neighbourhood of Nordeney, &c.), and at the Sleswick coast, it has been repeatedly tried to introduce French oyster culture, but without any success. Mœbius, a well-known authority for all that regards the oyster and oyster-culture, believes that it is the low temperature of the water in winter, and

CHAPTER XXVII.

OYSTER CULTURE IN GERMANY.

GEOGRAPHICAL ADVANTAGES FAVOURING FISHERY CULTIVATION—
UNSUCCESSFUL ATTEMPTS TOWARDS THE FRENCH METHOD—
MÖBIUS ON THE CAUSE THEREOF—HIS SUGGESTED REMEDY.

THERE are many advantages in the geographical position of the German Empire which considerably favour fishery and its cultivation. The vast extent of the south coast of the Baltic, with its multitude of useful fish, which abound still more towards the south-west, wholly falls within the limits of the German Empire; while the coasts of Schleswig-Holstein, Hanover, and Oldenburg, afford a considerable seaboard on the German Ocean.

Yet with all these advantages, and many more unnecessary to mention here, the oyster industry has hitherto been unsuccessful.

In his Prize Essay on “Oyster Culture,” Dr. Hoek tells us that “at the German coast (in the neighbourhood of Nordeney, &c.), and at the Sleswick coast, it has been repeatedly tried to introduce French oyster culture, but without any success. Möbius, a well-known authority for all that regards the oyster and oyster-culture, believes that it is the low temperature of the water in winter, and

the violence of the waves during high spring-tides, increased by tempests, which oppose themselves to oyster culture after the French method. According to him, at the south-eastern shores of the North Sea, the lowest tides always occur when the coldest winds are blowing, and a low temperature of the water is much more dangerous for oysters placed in shallow than for those found in deep water. Mœbius therefore thinks that the oyster production of the German waters cannot be augmented by culture, but that this can be effected in the first place by keeping a sufficient stock of full-grown oysters on the existing oyster-beds, and in the second place by ameliorating and enlarging the places fit for the fixing of the oyster-spat.

“In the Baltic the percentage of salt is too low for the oyster to live in. Of course there can be no question of oyster culture there.”

Here and there, in this book, the name of Mœbius has been rendered familiar to the reader, and perhaps aroused some curiosity as to its owner from the fact of the late great German scientist being respectfully quoted by such celebrities as Professor Huxley, Dr. Brooks, Lieut. Winslow, Dr. Hoek, Professor Hubrecht, M. Bouchon-Brandely, &c.; and I have now great pleasure in introducing him to my reader through the medium of quotations from Mr. J. H. Rice's translation of his celebrated pamphlet, entitled “The Oyster and Oyster-Culture,” (a) trusting that the acquaintance may tend towards a due

(a) *Die Auster und die Austernwirthschaft*, von Karl Mœbius, Professor der Zoologie in Kiel. Mit einer Karte und neun Holzschnitten. Berlin, Verlag von Wiegandt, Hempel & Parey. 1877. Small octavo, p. 126. Translated by H. J. Rice, B.Sc., by permission of the author.

appreciation of the famous ostracultural Professor's merit in his valuable scientific work, and the profoundly instructive lessons contained therein, the first chapter of which, treating on German Oyster Culture, gives the following information under the heading—

THE SEA-FLATS.

Among those oysters which are produced in the waters of the west coast of Europe, the Holstein oyster has, for more than a hundred years, maintained a well-merited celebrity. The beds which furnish them lie along the west coast of Schleswig-Holstein, in a territory only 74 kilometers long by 22 broad. The most and the best oysters are found on the east side of the island of Sylt and in the neighbourhood of the islands of Amrum and Föhr.

Along the northern boundary of the German oyster-territory, near the island of Röm, and along the southern boundary, near the islands of Pellworm and Nordstrand, opposite the city of Husum, there are only a few insignificant beds. And since the flavour of the oyster is entirely dependent upon the quality and quantity of food in the water in which it grows, it becomes necessary, first of all, to examine into the character of the soil and water of the Schleswig-Holstein Archipelago. In comparison with the open North Sea, this portion of our coast is a very shallow division of the ocean. Along the entire southern portion of the open North Sea, between Germany, Holland, England, and Scotland, the general depth is from 35 to 45 meters. In no place in the Schleswig-Holstein Archipelago is the water as deep as this, the greatest depth being 15 to 20 meters, and this only in the channels which connect it with the open sea. The floor of this archipelago

is raised above the deep bottom of the open North Sea, very much like a high table-land. In this table-land valleys, varying in depth and width, have been cut out between the islands and the mainland. At high water the entire floor is covered, but at the end of the ebb tide very much of this table-land lies dry above the surface of the sea. These stretches of sea-bottom which thus become dry are termed "Watten" (plains or flats), and from these "Watten" this archipelago has received the name of "Wattenmeer" (sea-flats). The water, which during the ebb tide runs off from the flats, flows in both shallow and deep channels, called by the sailors "Leien" and "Tiefen," partly in a northerly, partly in a southerly direction, into the open sea, until the incoming flood-tide, which flows in from both sides twice daily, stops the ebbing water and turns it back. The water now rises once more. The Leien and Tiefen can no longer hold it, and it pours over their banks and over the flats, finally flooding them to such a depth that small vessels can pass over places where only a few hours before men and waggons might travel with perfect safety.

. . . . Along the entire German coast, from Röm in the north, upon the Danish border, to Borkum in the west, near the islands of Holland, the sea is of a similar character. Thus, before the mouth of the Elbe, from Cuxhafen to the island of Neuwerk, the sea-bottom is laid bare with every ebbing of the tide, for a breadth of 7 to 8 kilometers. At such times one can reach the island on foot, on horseback, or with a waggon. In passing over this flat one finds himself at such times on a level with the sails of vessels which are passing by upon the sea, and along the border of the retreating waters and the emerging sea-bottom one sees scattered flocks of sea-birds hunting

the uncovered worms, mussels, and crabs, before they withdraw into the earth. When the flats, at the time of the lowest ebb, are lying, dry and silent, above the water, one can already hear in the distant depths the roar of the incoming flood. First it comes in slowly, then faster and faster, and finally more slowly again, until at the full flood the water stands over the northern portion of the flats nearly two meters higher, and over the southern portion, out from the mouth of the Elbe, nearly three meters higher than at the ebb.

The tide generally attains three-fourths of its entire height about three hours after turning. In this short time immense masses of water move towards the coast, and in many places currents are formed as swift as the current of the Rhine between Coblenz and Bonn, the rate of which is from 1.5 to 2 meters per second. Yet the ebb-currents are nearly everywhere stronger than the flood-currents since they not only carry off the sea-water which has been brought in, but also the fresh water from the land, which was checked in its flow during the flood.

Hence the ebb-currents bring about much greater changes in the soil of the sea-flats than the flood-currents, and they displace and transport the constituents of the flats in the most powerful manner, wherever great fresh-water streams enter the sea, as at the mouths of the Eider, Elbe, Weser, and Ems. Here the floating buoys and the implanted buoy-stakes (Baken), which indicate navigable water for vessels, are changed nearly every year because of the changes in the channels.

The principal ingredient of the bottom of this changeful sea is quartz sand. In many places there are accumulations of mud, which is very slimy and sticky, and contains much organic matter. This mud is found along the shores

of the mainland and on the east side of the island of Sylt, principally at those points where, after the changing of the currents, the water does not flow fast enough to carry away all of the muddy material which was deposited upon the bottom as the tide ran out. Along the slopes which lie between those portions of the flats, which the tide leaves dry, and the deep channels are long dry stretches of soil where the ground is covered with coarse sand, small and large stones, and shells. At such places colonies of oysters, so-called oyster-beds, are found, along with many other sea-animals.

OYSTER-BANKS AND OYSTERING.

By far the greater number of our oyster-beds are never exposed to view, on account of the muddiness of the water of the sea-flats, from the continual stirring up of the sediment upon the bottom. Only when, during the lowest ebb of the spring-tides, easterly winds drive off a great deal of water from the land, does the sea along the border of many beds become so shallow that the oysters can be seen, and even taken up with the hand. This state of affairs occurs upon the oyster-beds which are numerous along the east coast of the island of Föhr, and in one autumn as many as 20,000 oysters could be gathered from these beds by hand, and transplanted into deeper waters.

Generally one is obliged to use measuring-sticks or dredge-nets, in order to tell when he is over a desired oyster-bed. The measuring-sticks are poles, five to six meters long, with the lower half divided off, by different colours, into feet. They are used from vessels, in shallow portions of the flats, in order to ascertain during the journey whether the depth increases or diminishes, so that the vessel may not run aground. The measuring-rod is pushed

down to the bottom, and one can thus easily tell whether the bottom is composed of soft mud or pure sand, or whether it is covered with shells.

The dredge used by the oyster-men . . . weighs from 50 to 60 pounds.

The older oyster-dredgers know the position of all the oyster-beds with great precision, and they guide their vessels to the desired places by reckonings from high-lying points of the coast and islands, from light-houses, churches, windmills, and houses. Their vessels are yacht-like, with a capacity of from three to six tons. Each one generally carries two sailors, in addition to the owner.

Upon the Schleswig-Holstein banks there are fourteen vessels engaged in the oyster business.

. . . . Generally the net (or dredge) is allowed to drag from five to ten minutes; then it is drawn up by two or three men, and the entire contents of the bag emptied upon the deck. . . . From this heterogeneous heap all the matured oysters are now picked out. As they pass singly through the hands of the fishermen, the coarsest of the foreign material is cut and scraped from the shells with a knife, and then the oysters are thrown into baskets. In these they are shaken about, in order to get off any material which has escaped the knife. Ropes are then fastened around the baskets, which are put overboard, and raised and lowered in the sea until all dirt is completely washed from the oysters. They are now for the first time in the condition in which they appear in commerce. Despite these manifold cleansings, many oysters, when they are exposed for sale, are covered with dead and living animals, and the peculiar odour which oysters have when carried into the interior, arises from the death and decay of the organic material upon the outside of the shells, and

does not pertain to the living oyster itself. In no place upon the sea-flats do oysters grow upon rocky bottom. They grow best where there is a substratum of old oyster and other shells. The most of them lie singly, and they are seldom found growing together in clumps or masses. The wide-spread notion that they are found growing firmly attached to the sea-bottom, and piled upon one another, layer upon layer, is accordingly false. Upon the best of the Schleswig-Holstein beds, the dredge must drag over a surface of from one to three square meters, and often over a still greater distance, in order to secure a single full-grown oyster. Over the Schleswig-Holstein sea-flats there exist 50 oyster-beds of very different sizes. The largest is not far from two kilometers long, but the greater number are shorter than this. . . . There are no beds upon our sea-flats which have a greater depth of water over them than from six to nine meters. Although all the beds lie within an area 74 kilometers long by 22 broad, yet the nature of the oysters, and especially the form and solidity of the shell and the flavour of the animal, differ very greatly. Upon two beds inside of the south point of the island of Sylt are found oysters which in fullness and delicacy of flavour are not inferior to the best English "natives."

WHY ARE OYSTERS NOT FOUND OVER ALL PORTIONS OF THE SEA-FLATS ?

It is now clear that the fruitfulness of the oyster is extraordinarily great, and that the extension of oyster-beds over the entire surface of the sea-flats does not fail of being accomplished from a lack of young oysters, but from other causes. It then becomes our duty to investigate into the characteristics of our sea-flats, in order to determine

whether some portions are more suitable for the growth of oysters than others ; and whether the saltness, temperature, and movement of the water, the amount of food which it contains, and the nature of the ground composing the oyster-banks, differ in any respect from these same features as observed in other places over the bottom.

The saltness of the upper layers of the waters of the open North Sea is from 3·47 to 3·50 per cent. The water of the sea-flats is slightly less salt, being only from 3 to to 3·3 per cent. Here upon our sea-flats, and in other European coast-seas, where the water is less salt, the oysters acquire a much finer flavour than upon the ground of the open North Sea, (*b*) where they live in water 35 meters or more in depth, with a percentage of salt of about 3·5.

That coast-water is, then, the most desirable for oyster-culture which contains about 3 per cent. of salt ; and since not only over our oyster-beds, but over our entire sea-flats, the water possesses this degree of saltness, neither a lack nor an excess of salt can hinder the extension of the beds over the whole area. Even less can the

(*b*) Many oysters are taken north of Germany and Holland, east of England, and in the channel between England and France. The German fishermen of Blankenese and Finkenwärder, near Hamburg, who fish with great dredge-nets for flounders, turbot, and soles, out from the mouth of the Elbe, often dredge oysters along with their fish. . . . Fishermen from Holland and Germany dredge for oysters here (the North Sea), especially during the months of August, September, and October, and often catch, at a single drag of the dredge, as many as 1000 oysters. Sometimes great bunches of oysters, growing attached to one another, are gathered into the net. . . . (S. Metzger's Beiträge zu dem Jahresbericht d. Commiss. zur Unt. d. deutschen Meere, 1873, p. 171, u. 1875, p. 252.)

temperature of the water hinder their extension, for the variation is the same over the oyster-beds as at other points, and it fluctuates, during the course of the year, from 20° C. above zero to 20° C. below. Nor can a lack of motion of the water, or of nutriment, be the cause why the oyster-beds have not, during the past hundreds of years, extended themselves beyond certain definite limits, for floating everywhere, in the ebbing and flooding water, are microscopic plants and animals, and much dead organic matter, which would nourish large numbers of oysters, just as they do multitudes of soft clams (*mya arenaria*), edible mussels (*mytilus edulis*), and cockles (*cardium edule*). There remains, then, as the single natural hindrance to a further extension of the oyster-beds, the unfavourable condition of the ground over the greater portion of the sea-flats. Oysters cannot thrive where the ground is composed of moving sand, or where mud is being deposited, and one of these conditions or the other is found over the greater part of the sea-flats. The number and size of those places where, notwithstanding the daily ebb and flood currents, the ground remains unchanged and free from mud, are very limited. Only along the slopes of certain channels to the north of the mouth of the Eider do we find united all the conditions favourable for such places, and only within these limited districts can young oysters grow to complete maturity.

CAN THE FRENCH SYSTEM OF ARTIFICIAL OYSTER-BREEDING BE CARRIED ON IN THE WATERS OF THE GERMAN COAST ?

. . . . As regards the saltness of the water, the currents, the food, and even the composition of the soil, our sea-flats will compare as favourably for the artificial

gathering of the young broods and for the raising of the same as the Bay of Arcachon, but not as regards temperature and the depth of water.

In the Bay of Arcachon the difference between ordinary high and low tide is 4.5 meters, and during a storm a meter more. But along our North Sea coast during a storm the water rises with the tide even more than twice as high as during ordinary flood-tide. The power of the water during a storm, as compared with the power of the water during an ordinary flood-tide, is much greater along our coast than in the Bay of Arcachon. Hence, we would be obliged to give to our oyster-beds a much greater firmness than the French breeders have to give to theirs. We would also be obliged to place them so far out in the sea that they would be entirely covered with water, even at the lowest ordinary tide, and also give them sufficient stability to withstand, during a storm, a rise of water of from 2 to 2.5 meters, as well as the great and powerful force of this water-mass. Beds thus laid down would cost much more than the ditched and planked ones of Arcachon. But even if they were so placed as to bid defiance to the most severe flood-storm, they would indeed hardly suffice to protect the breeding oysters from being covered with mud and sand; and thus one flood-storm, or storm in connection with a flood-tide, might destroy the accumulated oysters of many generations.

. . . . If the situation of the free sea-flats is not suitable for the formation of oyster-beds, perhaps there is still a possibility of artificial oyster-breeding being carried on inside of the dykes which protect the fertile marsh-land along the German coast from the encroachments of the waters of the North Sea. For this purpose basins would have to be dug out inside of the dyke and placed in

connection with the sea by means of canals. Where these canals cut through the dyke it would be necessary to build a gate, in order to prevent the sea-water from passing in during high tide. Then, oyster-beds could not be laid down in the neighbourhood of this gate, because it would serve not only as an inlet for salt water, but as an outlet for the fresh water from the marsh-land, and so fresh water instead of sea-water would cover the oyster-beds.

. . . . (In these beds) It is certain that they will not receive as much food as in the open sea, since they cannot have nearly as much water as will pass over them upon the natural beds; and the quantity of nourishment varies in proportion to the amount of water which passes over the beds. In these beds the oysters would also be in danger of being buried in the deep mud, and in order to prevent this they must either be changed very often into clean beds, or else a cleaning pond must be formed beside the breeding pond. But while the water is rendered clear by being allowed to stand quiet, yet by this means a large amount of organic matter which serves as food for the oysters is taken from it. Especially dangerous, however, to oyster beds within the dykes would be the cold during winter weather, for along our North Sea coasts the water is lowest during an east wind, and at the same time such a wind is accompanied by the lowest degree of temperature. Hence, at such times, when a great depth and a constant change of water over the beds would be the best protection from freezing, we cannot have high water, nor can the water then standing over the oysters be constantly changed; thus during every cold winter, a large number of oysters would be sure to perish in their beds.

. . . . In cold weather slime collects upon the gills and mantle-lobes of the oyster, the power of the

muscles and cilia being weakened by the cold. Accordingly, the oyster is no longer in a condition by means of its rapidly-moving cilia, and the quick closing of the valves of its shell, to drive out the particles of slime brought in with the water. But the power of the cilia and the elasticity of the muscles are again restored as the water becomes warmer, providing the cold has not lasted too long. The gills become clean once more, and respiration and nourishment, which have been disturbed by the sliming, proceed again as before. If the cold spell is prolonged, then, in addition to the sliming of the gills and mantle, there are yet other pernicious results. The shell-muscle becomes so soft that it can no longer close the valves. The cilia move slower and slower, and finally, when the shell-muscle has allowed the valves of the shell to gape wide open, cease moving altogether. The mantle and gills become pale in colour, infusoria nest in them and hasten their destruction, and soon their ciliated layer separates and disappears. The softest portions of the body, the generative organs, the liver, and the stomach quickly vanish, probably consumed by snails, crabs, worms, and star-fish as soon as they can make their way unhindered into the open shell. The last part of the mollusc which is to be found in the shell is the shell-muscle. It remains free between the two valves, or attached to only one of them, until finally but a trace of its fibres is to be seen at the points of attachment, the so-called muscular impressions.

. . . . I have frozen the mantle and gill lobes of oysters in North Sea water and allowed them to remain inclosed in ice for an hour at a time, with the temperature of the water varying in degree from 4° C. to 90° C. below zero. When the ice had melted, the cilia began to move feebly,

and four hours later, when the temperature of the water had risen to 50° C. above zero, their movements were once more fully established. Other gill and mantle lobes which had been three hours in water of a temperature of 1° C. to 2° C. below zero moved quite lively on the following day. This recalls to me a very weighty difference between fresh and salt water, which is often overlooked.

It is generally known that fresh water is densest and heaviest at a temperature of 4° C. above zero. When any portion has arrived at this temperature during freezing weather, it sinks to the bottom of the body of fresh water, where it remains until the entire mass above it is of the same density. That portion which first becomes lower in temperature than 4° C. then expands, rises to the surface, and stiffens into ice as it reaches the temperature of 0° .

The fact is less known that with sea-water the lower the temperature the greater the density and weight of the water. Therefore, it also sinks to the bottom until it has reached the temperature at which it forms ice, which, when it holds 3 per cent. of salt in solution, is 2.28° C. below zero. It is evident, then, that water may be found at the bottom over the sea-flats of a temperature of 2° C. below zero, while, during the most severe cold, water at the bottom of the lakes and deeper rivers of North Germany is found to be constantly several degrees warmer than this. When, finally, the sea-water, from the surface to the bottom, has reached its freezing point, it does not become solid ice for the whole thickness, but thin layers of ice, at greater or less distances apart, are formed in it. These layers, which are crystallized from the salt water, are free from salt, are hence lighter than the surrounding water, and accordingly ascend to the surface; consequently, those

animals which live upon the ground of the deeper portions of the sea-flats remain surrounded by water whose temperature is 2° C. lower than the freezing point of fresh water.

. . . . Our investigation, then, has led to the grievous conclusion that profitable artificial oyster-breeding, according to the French system, is not possible along our North Sea coasts. Whoever should attempt to carry out this system, despite the unfavourable conditions of our waters and climate, would be certain to find that his breeding oysters were more costly than many English oyster-breeders have found theirs to be; for upon the English coasts the difference between ordinary high tide and the tide increased by a storm is much less than upon our sea-flats, the lowest water does not occur simultaneously with the coldest winds, as along the south-east shore of the North Sea, and the climate there is milder than upon our coasts.

CAN NATURAL OYSTER-BEDS BE ENLARGED, AND CAN
NEW BEDS BE LAID DOWN, ESPECIALLY ALONG THE
GERMAN COAST?

It will thus be seen that the German oyster industry remains dependent now, as ever, upon the natural oyster-banks of our coast-seas, where oysters have lived for thousands of years, and where they exist to-day fruitful and well flavoured. And in regard to these beds we have now to consider the important questions:

First. Is it possible to increase their size?

Second. Can we still farther increase the surface of our oyster-territory by laying down new beds?

The water in the neighbourhood of the banks, and over all the stretches between them, has the same character as over the banks themselves. All that is

necessary, then, in order to increase the size of these beds is to render the sea bottom between them habitable for oysters. Old beds increase naturally in size whenever the shifting and slimy sea bottom which borders them becomes changed into stable and clear ground. This can take place if changes occur in the force and direction of the ebb and flood currents. In such cases the extension can be hastened artificially by placing upon the newly forming ground shells of oysters and other molluscs, in order to furnish just outside the borders of the old bed the most judicious objects of attachment for the young broods as they swarm out from the mother oysters.

For the establishment of new beds, within the limits of the German sea-flats, in places where no oysters are found at present, it will be necessary to find stretches of sea-bottom which are free from mud, where the soil is not being constantly shifted about by currents, and where the ebb-tide will leave at least one or two meters in depth of water over the beds. But nearly all such places are occupied by oyster-beds.

. . . . Over the entire German sea-flats lying south and south-west of Schleswig there can hardly be found a single place which is suitable for the formation of a profitable oyster-bed ; for in front of the mouths of the Eider, Elbe, Weser, Jahde, and Ems the sea-bottom is so covered with mud, or so subject to change, that oysters could not live and multiply there.

. . . . Whoever, therefore, would establish new oyster-beds along the German portion of the coast of the North Sea, between the Eider and the mouth of the Ems, must begin his difficult work by changing the ebb and flood currents in the southern portion of the North Sea, in

order to prepare a surface upon which oysters can thrive ; for to attempt to adapt oysters to a bottom of shifting sand or mud is not natural, nor is it conducive to an industry which is to last for a hundred years. For thousands of years innumerable young oysters have been scattered from the oyster-beds over changing mud and sand-banks, and yet not one has so altered its organization as to become adapted to such a bottom and transmit its new nature to its progeny ; they have all been destroyed.

. . . . Along the German coast, in the East Sea, the sea-bottom, over many extensive tracts, is firm, and also free from mud. These places possess then, in this respect, one of the most important conditions for the successful formation of oyster-beds. Yet several attempts to plant oysters in the Baltic have proved entire failures. . . . The much talked-of attempt at oyster-breeding by Coste gave a new impulse to the question of planting oysters in the Baltic. . . . The water of the Baltic is not salt enough for the propagation of the oyster. East of the island of Rügen the water at the bottom contains only 1 per cent. of salt, and near the surface still less, since the rivers bring in much fresh water. West of Rügen, south from the Great Belt, to near the coast of Mecklenburg, the water at the bottom contains, indeed, as much as 3 per cent. of salt, but here also the surface-water everywhere contains a less degree.

The young oysters, as soon as they had left the mother oysters, would then ascend to the surface, and thus come into water which throughout the entire southern portion of the Cattegat contains less than 2 per cent. of salt, while they need water with at least 3 per cent. of salt. This I infer from the fact, that such a degree of saltiness is to be

found at all places along the European coast where natural oyster-beds exist. There are two other conditions of the Baltic besides the low percentage of salt, which certainly hinder the growth of the oyster—the long-continued low temperature of winter, and the lack of regular tidal-currents, the oyster, which is a stationary animal, will receive daily a greater quantity of oxygen and food in the water brought to it than it will in an interior sea, where the water is in less regular motion. These chemical and physical differences between the North and East Seas render it not only impossible for the oyster to live in the latter, but also for many other North Sea animals, of which I will mention only the lobster, the larger punger (*platycarcinus pagurus*), and the edible sea urchin (*echinus esculentus*). . . . Nature has already made frequent efforts to introduce not only oysters, but other North Sea animals, into the Baltic. Nearly every year fish and other animals from the North Sea appear in the Baltic, but they are not permanent, and soon disappear again from our fauna.

CONCERNING THE PRICE OF OYSTERS.

On the 21st of September, 1740, the first hundred fresh Schleswig-Holstein oysters sold in Hamburg for 1.42 marks (about 35 cents) of present money. Later the same day 900 were sold at 1.20 marks (30 cents) per hundred; then 3400 at 15 cents; and finally, 10,800 at 7½ cents per hundred. On the 15th of October of the same year, and at the same place, the first hundred fresh, newly-arrived oysters, sold for 2.40 marks; the second hundred for 2.10 marks; then 1025 were sold for 1.80 marks per hundred; then 1000 at 1.50 marks; then 2000 at 1.20 marks; and finally, 12,500 at 60 pfennige (15 cents) per hundred.

These numbers . . . show that it was necessary to lower the price of oysters very soon after the arrival of a large importation into Hamburg harbour, if they were to be disposed of in an eatable condition, and not entirely lost, because there were no adequate means of transporting them into the interior. Such a fall in price guarded the oyster-beds from too destructive fishing. Soon, by means of steamers and railroads, oysters fresh from the beds could be spread far and wide into the country; then oyster-eaters began to increase in number; and so, despite the rapid advance in price, the demand for oysters increased from year to year. . . . A cask of Schleswig-Holstein oysters (700 to 800) was sold, in 1875-'76, to oyster-dealers, for 105 marks (about \$26.25). Fifteen years previous the price was only a third of that sum.

CHAPTER XXVIII.

OYSTER CULTURE IN ITALY.

XXXI.—A REPORT ON OYSTER-CULTURE IN THE MEDITERRANEAN, 1878. (*a.*)

BY G. BOUCHON-BRANDELY, SECRETARY TO THE COLLEGE OF
FRANCE.

OYSTER-CULTURE—OYSTERS AT THE GULF OF GENOA—LABOURS OF
M. COSTE—DESTRUCTION OF OYSTERS IN LAKE FUSARO—
MESSRS. GASQUET'S OYSTER ESTABLISHMENT—OYSTER PARCS
AT GIENS, BELON, AND AGAY—ANALYSIS OF SEA WATER BY
M. SCHUTZENBERGER—M. VIAND'S EXPERIMENTS—FLOURISHING
CONDITION OF OYSTER-CULTURE IN THE MEDITERRANEAN—
CAUSES OF DECADENCE, ETC.—ANALYSIS OF SEA WATER BY
SCHWEITZER AND USIGLIO.

It is to Italy we are indebted for the idea of establishing
in France that branch of industry, so flourishing at the
present time, known as oyster-culture. The Romans were

(*a*) Rapport au Ministre de l'Instruction publique sur la Pisciculture en France et L'Ostréiculture dans la Méditerranée, par M. Bouchon-Brandely, Secrétaire du Collège de France. Paris: A. Wittersheim et Ce., Quai Voltaire, 31, 1878 (Extrait du Journal Officiel des 16, 17 et 18 Mai 1878.) small 8vo. pamphlet, p. 103. Only that portion of the report devoted to oyster-culture in the Mediterranean (pp. 45—103) is reproduced here.

the first to engage in the cultivation of the oyster, and their methods, inherited by the Italians, have come down to us without any modification. The method of cultivating this mollusc at Tarente to-day is the same as that practised in the time of Sergius Orata. In 1853 M. Coste visited Fusaro, and from that remarkable journey of scientific exploration, it is said, he brought back the elements of the new industry to which science has assigned general rules that have since been improved upon by practice. But if, prior to that time, an exceptionally fine flavour was given to the precious bivalve at Marennes, Courseuilles, and Cancale, by a special treatment, we were still ignorant of the processes of taking the spawn and of supplementing the loss occasioned by the continued impoverishment of the beds on our coast, the sources of production which had formerly been erroneously supposed to be inexhaustible.

Oyster-culture, properly so called, is carried on in Italy in only one locality, Tarente. The celebrated Lake Fusaro, to which I will devote a few words hereafter, has become sterile and has been abandoned. The oysters consumed in Italy, beyond those received from Tarente, come from the gulfs of Genoa and Naples, from the coasts of the Adriatic, and from the ponds of Corsica.

The Gulf of Genoa produces small and delicate oysters, which are held in high repute. At Naples, near the rocks of Castel, and in other deeper parts of the gulf, oysters similar to those of Genoa, are still found, which are designated, scientifically, under the name *Ostrea plicatula*. At neither Genoa or Naples are the banks sufficiently well stocked to permit the use of the drag, with profit, in gathering oysters. The fishermen take them by hand, sometimes at a considerable depth. The products of this fishery are entirely consumed in the vicinity. Rome,

Florence, and the large towns of the peninsula receive a part of their supplies from Brindisi and Venice, at which places some natural beds exist. The oysters from these beds belong to the common Mediterranean species (*Ostrea edulis*).

LAKE FUSARO, NEAR NAPLES.

There is no necessity of our entering here into a retrospective examination of the industry of Lake Fusaro. M. Coste, in the learned report he has published concerning his mission to the shores of the Mediterranean, has performed this task better than I could do it. But I have thought it proper not to leave Naples without first endeavouring to ascertain the causes which have occasioned the sterility of this ancient lake and the loss of its secular industry. The principal cause, as well as the oldest and most incontestible one, which has at all times occasioned the greatest disasters, results from sulphurous emanations arising over certain portions of the bottom during the eruptions of Mount Vesuvius. At such times as these all of the inhabitants of the lake are imperiled, but shell-fish suffer most because of their inability to get out of harm's way. At various periods of eruption the oysters of Fusaro have been very nearly exterminated, but so great has been their fecundity that only a few years were required to enable the lake to recover its normal productiveness. In addition to this natural and inevitable cause, there are others of more recent origin and less extent, among which may be cited : (1) the accumulation of vegetable and animal refuse which has fouled the bottom ; (2) the too extensive cultivation of mussels ; (3) the excessive saltiness of the water ; and (4) the insufficient supply of fresh water. Finally, in 1856, the Neapolitan Government, with a view to rendering Lake Fusaro more healthy—as its marshy water propagated

the malady so common in certain parts of Italy, viz., malaria—caused a new canal to be dug at the extremity of the lake, in order to secure, to the greatest possible extent, the renewal of the water. It is claimed that this work hastened the decay of Lake Fusaro. The contact of this new current with the old resulted in the stirring up of the materials that had been accumulating in the lake for many years. Sands were brought down by the current, thus changing the nature of the bottom. The oyster-culturists, after vain endeavours to overcome this new misfortune, abandoned their concessions, and in the year 1869 the last oysters disappeared from Lake Fusaro.

TARENTE.

From the earliest times the maritime population of Tarente has busied itself in the cultivation of oysters and mussels. This industry is carried on in salt ponds which border the city on the west, and to which the name of “Little Sea” has been given. Being connected with a roadstead or open sea, by means of a narrow channel, sufficiently large, however, to insure the renewal of the water, the Little Sea (*piccolo mare*) presents the most favourable conditions for the production of shell-fish. The productiveness of this portion of the coasts of the Ionian sea is proverbial; fish and shell-fish of all kinds occur there in abundance, and in addition to the species which are also common to the Mediterranean and the Atlantic coasts of Europe, it likewise possesses certain other varieties peculiar to itself. The Little Sea, which is quite well sheltered from the sea winds by the eminence on which the city of Tarente stands, is also protected against the winds from the interior by the range of hills in the midst of which it lies. It measures twelve miles in circumference, and is six miles wide in its broadest part, that is, from the

gate of Naples to the convent of San Francisco (*Battentiere*). Its waters are pure; the bottom is composed of calcareous sands, and the shores at intervals are covered with seaweed, which the fishermen do not molest, and in which many different species of fish come to spawn and find shelter. The depth of the Little Sea is relatively great and its shores are narrow. In its deepest part it measures $17\frac{1}{2}$ to 18 meters (about 55 feet). At 2 or 3 meters from the shore ($6\frac{1}{2}$ to 10 feet) it is about 1 meter ($3\frac{1}{4}$ feet) deep, and thence it gradually deepens until at 200 meters (650 feet) from the shore it is about 6 meters ($19\frac{1}{2}$ feet) deep. Seven small streams whose sources are near at hand flow into the Little Sea, five into the upper part and two into the lower. The most important of these are the Galésio, the Oro, so called from the particles of gold brought down by it, the Battentiere, and the Adeja. The Little Sea receives, moreover, the waters of submarine springs, one of which, the Citrello, has been pointed out by geographers and is very well known; it rises nearly in the middle of the sea at a great depth, but with such force as to agitate the surface over a space more than 100 meters (325 feet) in diameter. The quantity of water supplied by this spring must be considerable, and it is even conjectured by some to be a veritable river which rises there. It is these bodies of fresh water that insure the prosperity of pisciculture; for during the months of July and August the heat is so great at Tarente and the evaporation so rapid in the Little Sea, that the water would soon become too salt for the oysters to live in it.

The temperature of the water in the Little Sea rises in summer to 27° and 28° C., and even higher at times; on the 15th of September, at 7 o'clock in the morning, my thermometer indicated 25° C. Its density varies greatly,

according as the examinations are made near to or at a distance from the places where the fresh water enters; three or four hundred meters (975 to 1,300 feet) below where the Citrello emerges I found the hydrometer indicated $2\frac{1}{4}^{\circ}$, while over the oyster and mussel parcs it marked from $2\frac{3}{4}^{\circ}$ to 3° ; in the roadstead, which likewise receives the fresh water of the Citro, and near which are situated the oyster beds that furnish the young oysters, I found an indication of 3° . It was not without astonishment that I became convinced that oysters could live and thrive in water as warm as that of the small sea of Tarente; for it had generally been admitted that their preservation was impossible in water exceeding 23° or 24° C.* In support of this assertion it was customary to refer to the oysters of Lake Fusaro, which died in large numbers whenever the temperature of the water reached such a height as this. But in reply it may be argued that the oysters of Lake Fusaro die rather in consequence of the action of volcanic emanations, or of sulphurous gases, which, under the influence of a high temperature, escape from the decaying animal and vegetable remains accumulated at the bottom of the lake. From this fact it is evident that the heat of the water on the French Mediterranean coast is not as insurmountable an obstacle to the establishment of oyster parcs as has been asserted.

The Little Sea of Tarente is leased by the city to a company that pays for it an annual rental of 38,000 francs (\$11,600). The oyster parcs are situated in the lower part, where the currents unite, always bringing with them fresh nourishment and an ever-changing supply of water. They are in number, twenty-one. Each oyster parc measures

* Professor Oronzio Gabrielle Costa, Del Fusaro.

from three to four hundred paces on each side. The parcs are farmed out by the company to the fishermen, who devote themselves to the culture of the molluscs, at the rate of one franc (20 cents) per seven palmes (about 6 feet). All concessions are marked off by strong posts driven into the bottom. In the spaces included within this first line of division there are other parallel lines of posts, arranged at intervals of fourteen palmes (about 12 feet). Of their uses we shall hear more further on.

The arrangement of oyster parcs is like that of the parcs for mussels, with this difference, that they do not generally extend quite so far into the sea. Beyond certain depths oyster culture presents great difficulties and entails great expense. These parcs are divided by stakes into equal squares of fourteen palmes (12 feet) on each side. They are entirely devoted to the raising of oysters. Breeding cannot succeed there on account of the large quantity of mud brought down by the current into the lower part of the Little Sea. Nevertheless, the adult oysters accomplish their generative functions there; but the young ones, on leaving the mother oyster, do not find collectors suitable to receive them and fall down upon the muddy bottom; the stakes of the parcs and the cords which they sustain are speedily covered with a thin layer of mud, which prevents the young oysters from adhering. Moreover, in the upper portion of the Little Sea isolated oysters, called "horse-feet," are sometimes found in the natural state, and these seem to leave traces of their spawning, doubtless on account of the purity of the water and the cleanliness of the bottom. But these molluscs are constantly displaced by the currents, and it would be quite hazardous to count upon a regular harvest of young ones. This kind of oyster, which is still found in very small numbers in the roadstead,

is highly esteemed by the Tarentians, who sell them for 15 to 50 centimes ($\frac{3}{4}$ to $2\frac{1}{2}$ cents) apiece. The beds near which the oyster culturists of Tarente have placed their collectors are situated in the large sea. It is not known whether these beds are of large extent or merely small aggregations; their exact limits as well as their actual situations are unknown. In the month of May the fishermen submerge fascines about two miles from the shore to serve as collectors. Stones attached to cords serve to keep them down at a suitable depth in the water, and they are found and recognized by means of pieces of floating cork. The fascines are examined fortnightly or monthly. Those which do not have a sufficient quantity of young oysters upon them are returned to the water after they have been cleaned of the mud that may have collected between the branches, and of all parasites which may have grown thereon, by leaving them exposed, for one or two days, to the heat of the sun. Those, on the contrary, on which the young oysters have attached themselves in large numbers, are immediately transferred to the parcs of the Little Sea.

The spawning season in the Gulf of Tarente is of exceptional length; it begins early in May and does not end until the close of September; and the yield, dependent upon the character of the year, may be abundant either at the beginning, at the middle, or at the end of this period; there is nothing fixed as regards this. Upon their arrival at the parc the fascines are suspended from cords stretched from one stake to another, and kept in the water at a depth of one, two, or three meters (3 to 10 feet). After having been there six months, the young oysters have already attained a length of two or three centimeters (about an inch). The time has now come to give them more space, and to place them under more immediate oversight; the

fascines are untied, the branches taken apart, and those bearing oysters are placed between perpendicular cords similar to those used for mussels. The young oysters which are detached during this operation are placed either in baskets, on screens, or in nets suspended from the horizontal ropes, but never on the bottom. This system of breeding avoids general mortality. At least every four months the cables and other apparatus carrying the young oysters are taken up and examined. Those oysters which have become large enough to sell are removed, and advantage is taken of this opportunity to give those which ought to remain some time longer in the parc the cleaning and care which they need. The growth of the oyster takes place rapidly and regularly; from two to two and a half years suffice for the young oysters to reach a diameter of from 7 to 8 centimeters (about 3 inches).

The oyster of Tarente is of good growth; its shell is usually rather thick, this being due to the great amount of calcareous matter contained in the sea-water. This peculiarity, however, in no way impairs the regularity of its form.

The number of oysters obtained each year from the parcs of Tarente is estimated at about 10,000,000. Before forwarding them they are exposed to the air for twenty-four hours, in order that they may be the more easily cleaned afterwards. The sale of oysters is absolutely free, whatever may be their size, or the season. But it is unnecessary to state that during the summer, the period of gestation, oysters are never sold. It is, moreover, to the advantage of the fishermen that their oysters should have attained a good size before being offered for sale.

The prosperity of the fishermen of Tarente is unfortunately disturbed from time to time. From a volcanic

excavation situated below the convent of St. Antoine, and which is obstructed during long periods of time, surges sometimes a boiling sulphurous spring, which flows down into the Little Sea. As soon as this phenomenon manifests itself, consternation spreads among this population of ten thousand fishermen, who live exclusively upon the products of the sea. The Little Sea then takes a reddish tint; the water of the springs, lighter than that of the sea, is rapidly transported by the currents. The fish are able to flee from this pest, but the oyster, the mussel, and shell-fish in general are quickly poisoned. When the water is in this state the fishermen call it "the sea of blood." This fortunately happens only at rare intervals; but, nevertheless, within the past twelve years it has taken place twice; formerly it had become almost a legend, for it had not occurred within the memory of man. (*b*)

TOULON.

The roadstead of Toulon presents, on first examination, most favourable natural conditions for the cultivation of

(*b*) The work lately undertaken in Norway by Lieutenant-General Wergeland, formerly Minister of War, enables us to further extend the comparative study of the methods of oyster-culture in the different seas.

There are remarkable differences between the processes in use in the Mediterranean and in the ocean, but these differences can only be the more sensibly realized if we go as far as the North Sea. Hitherto, Vivier-sur-Mer, in the Bay of Mont-Saint-Michel, seemed to be the most northern limit where oyster-culture assumed all its phases, for, if at certain more northern points on the Norman coasts, and at a few stations on the southern and eastern coasts of England, young oysters have been taken by the aid of scientific appliances, the means of preserving the spawn are still to be discovered, and these experiments have not been practically applied.

In connection with the above see the Chapter on "Oyster-Culture in Norway."

oysters, mussels, and edible shell-fish in general. All the edible species common to the Mediterranean occur there, and it produced, moreover, in the early part of the present century, very fine oysters. Gradually, however, the exhaustion of the natural beds there began to be felt, as was the case with most of the banks along our coasts, and the deposits which had been of considerable importance were speedily exhausted. The oysters now taken at Toulon are isolated ones found in the crevices of the rocks.

Did the ruin of these banks arise from excessive and unlimited fishing, or must we attribute it, as at Brest, to the successive transformations which the submarine soil must have undergone, in consequence of the great works performed in the bay, and the repeated dredgings which stirred up the sand and the mud, and covered up the solid objects to which the oysters might have attached themselves? All have, doubtless, contributed to this result; but it is certain that at the same time the oysters disappeared, several other edible shell-fish, the mussel, for instance, became rare, and certain migratory fish which usually visited the shores of Toulon, as well as some stationary species, deserted the coast. This state of affairs aroused the solicitude of the marine administration. The labors of M. Coste had just then been meeting with great favor in France. Numerous attempts to introduce into our waters the oyster-cultural methods, brought by that gentleman from Italy, were repeated at various points along our sea-coast. The task of renewing the oyster banks of the roadstead of Toulon, and making of oyster-cultural experiments there, was confided to M. Coste about the year 1859. He proceeded in the following manner: Spawning oysters, with which he hoped to accomplish the restocking, were brought from England and Arcachon, and planted, some at points that had been

previously explored, and found to be most favorable for the preservation and increase of the mollusk, especially near Seyne, the others in suspended baskets. Collectors, consisting of fascines or pieces of wood, were placed around the reproducing oysters. The oysters distributed in the improvised parks and those contained in the baskets acted differently; the latter spawned abundantly, and grew rapidly during the entire summer; the others spawned but little, or at least their spawn was without vitality; they thrived miserably during the season following their spawning, and finally perished. This was the fate of them all. This result, though not a negative one, having been deemed unsatisfactory, the experiments were, too hastily perhaps, abandoned.

In order that the fatal influences should not always exist as a check to oyster culture in the Mediterranean in the future, it is expedient to seek the causes that have led to them. In the first place, it must be remembered that M. Coste could not do everything. He had charge, simultaneously, of the attempts at oyster culture in the ocean and the restocking of our fresh-water streams; he was organizing a model fish-cultural establishment at Huningue, at the same time that he was pursuing in his laboratory at the College of France scientific researches, which he afterwards made known in his lectures; finally, he was engaged in the preparation of interesting reports. He was thus unable to observe with all the necessary assiduity the different phases of the experiment, to watch its progress, and to modify it in case of need. Notwithstanding the zeal and activity displayed by the persons to whom he had given his instructions, were they competent to fill the place of the master? Secondly, would it not have been preferable to choose as reproducers oysters from the Mediterranean,

instead of the English oyster, whose fine quality and powers of rapid growth and fattening were incontestable, or the "gravette" of Arcachon, with its fine shape and exquisite flavor? These oysters being accustomed to the waters of the ocean, which differ greatly both as regards saltness and temperature from those of the Mediterranean, it could not be expected that they would become acclimated without difficulty, and that the regularity with which reproduction took place in their native water would not be interrupted. The proof that these oysters were not suited to this place is the fact that no trace of them now remains there, while the indigenous kind, although few in numbers, it is true, has survived. It has been objected that the varieties may have become confounded in one type, or, that those planted at Toulon may have become transformed and have acquired the character of the native oysters.

The first objection is very easily refuted. It is probable that the foreign variety may have undergone some modification, but this could not have been great enough to have deceived the experienced eye of a naturalist.

From these facts it must not be inferred that the acclimation of foreign oysters is neither possible nor advantageous. There are precedents which demonstrate the contrary, and it will be sufficient to remind the reader that the American oyster (*Ostrea virginiana*) has prospered well in the basin of Arcachon; that the Portuguese oyster (*Ostrea angulata*) now reproduces naturally in the lower Gironde, just as it does at Arcachon, and that it does not suffer from its forced residence in the parks of Saint Vaast-la-Hougue, where the water is very considerably colder than it is at the mouth of the Tage, of which this oyster is a native. In the third place, some indispensable precautions

had been neglected. Thus, when the oysters were immersed, instead of being distributed and separated from one another, they were piled up in thick layers in the parks. It is known that the accumulation of too many individuals at one point is disastrous, unless the conditions for aerating the water are exceptionally favourable. The spawning oysters were also exposed to many other dangers. First, their habitation was soon invaded by mussels. This is by no means of rare occurrence ; it takes place whenever the oyster and mussel are brought too near together. In the next place, on account of the difficulty of keeping the place of experiment perfectly clean, owing to the absence of tides in the Mediterranean, the mud and sand, constantly kept in motion by the currents, accumulated by turns, and the reproducing oysters which suffered at the outset, as shown by the small development which they acquired in their parks, finally perished. It is the opinion that this experiment should not be considered as decisive of what can be done in oyster culture upon our southern shores. I think that if it were tried again with the more certain methods now employed the results would doubtless be encouraging. It is private enterprise, however, that should take the initiative, for to that in large part is due the great progress realized in the ocean, and the creation of oyster culture in France.

As I have before remarked, two varieties of oysters live naturally in the roadstead of Toulon (*c*). First, there is the *Ostrea plicatula*, which also occurs at Genoa, Naples, and on the coast of Africa ; and, second, the common

(*c*) It is pretty generally admitted that the oyster called the " Pied de Cheval " does not constitute a distinct species. It is supposed to be a common oyster that has grown old and large.

Mediterranean oyster found at Narbonne, Port-de-Bouc, Aigues-Mortes, in the enclosures of Leucate, as well as at Tarente, and in the Adriatic at Brindisi and Venice. The first is a small oyster, which lives isolated or in groups attached to the rocks. It never forms, however, what is known as an oyster-bed ; at least none are known on the coasts of France and Italy. The shell is small, rough, and irregular, seldom exceeding a large walnut in size. Its interior is pearly and of a slightly greenish tint, and the lower valve is very deep. This oyster is of an exceptionally fine flavour, which causes it to be much sought for. It is quite uncommon at Toulon. The second, if it were carefully parked and cared for, would not, as regards fineness and quality, be inferior to the best on our ocean coasts, and might compare favourably with the oysters of any region. The oysters of the pond of Leucate, the very rare ones taken at Narbonne and in the vicinity of the islands of Hyères, with those of the roadstead of Toulon, are the finest and best furnished by the Mediterranean. When properly cared for in a parc they attain a size of from 10 to 12 centimeters (4 to 4 $\frac{3}{4}$ inches). The shell becomes light, translucent, hard, and well enamelled on the inside ; it emits a sound like crystal upon being struck. The lines of growth are indicated on the exterior by slight and delicate tubular folds. The oyster is well shaped, without being too large or too fat, and its exquisite flavour has earned for it a great reputation among the people of the south, a reputation which would not be merely local if oyster culture was in favour in the Mediterranean. Finally, I will add that between the Quimper oyster, which is excellent and of high repute, and the oyster of Toulon or Leucate, there exists the greatest analogy.

PENINSULA OF GIENS.

ESTABLISHMENT OF MESSRS. GASQUET.

Messrs. Gasquet were the first to seriously attempt putting into execution the happy idea of cultivating other shell-fish than the oyster and mussel, and the experiments which they have been making, with the most painstaking and laudable efforts, since the beginning of the year 1877, on the north coast of the Peninsula of Giens, deserve to be made known. The oyster and the mussel are also among the molluscs raised at Giens. This marine establishment has been founded on the banks of a concession, measuring not less than 10 hectares (25 acres). The shores slope gently, and the sea-weed, with which they are almost everywhere covered, converts them, as it were, into marine meadows, similar to the "*crassats*" of Arcachon, which are known at Toulon by the name of "*mates*." The soil is formed of a mixture of clay, sand, and calcareous deposits. The proximity of aquatic plants for the raising of shell-fish and other fish offers undeniable advantages, particularly in the Mediterranean. In the ocean the breeding parcs are, at times, almost entirely uncovered, and the tide furnishes them with well aërated water. The tide also brings to the shell-fish confined there abundant and fresh food from all directions. The case is different in the Mediterranean. At less than 50 meters (160 feet) from the shore, except during storms, the bottom is never brought into contact with the outer air, and the animals which have not the power of locomotion are forced to feed on little else than what grows upon the bottom within a very restricted area. But in the present case aquatic plants tend to render less noticeable the effects resulting from the absence of tides. They always set free a small quantity of oxygen and pro-

duce multitudes of microscopic insects, which furnish food to other animals. These were not the only considerations which induced the Messrs. Gasquet to establish themselves on the Peninsula of Giens. The numerous kinds of shell-fish which took refuge in the gulf and the fine oysters occasionally found there were indications of the possibility of success.

In connection with the experiments of acclimation which the Messrs. Gasquet have made on the shell-fish brought from Cette, experiments which have given the most favourable results, I have thought it would be interesting to make known the chemical composition of the waters of the breeding-parcs. The following is an analysis made in the laboratory of M. Schutzenberg, a professor in the College of France :

Sodium and Potassium	..	..	..	..	11.02
Chlorine and bromine	..	..	..	..	21.61
Magnesia	..	..	..	..	3.03
Sulphuric acid	..	..	..	..	5.12
					<hr/> 40.78
Residuum for 1 liter (about 1 quart—61 cubic inches)					<hr/> 41.28

With some slight differences, the water at Cette resembles that at Giens. This fact must be borne in mind, for it shows that the acclimation of foreign species can only be obtained without difficulty, when the medium whence those species are taken closely resembles that in which they are to be placed. The water of the roadstead has a density of 3° by the hydrometer ; its temperature is very variable ; it attains, and even exceeds, 24° . This is not, however, an unfavourable condition. Under the action of the heat and the beneficial influence of the rain-water, the shell-fish rapidly develop.

M. Louis Figuier ("Ocean World," p.17.) informs us that—"The water of the Mediterranean contains more salts than that of the ocean.

The following are, according to M. Usiglio—who was one of a commission sent to examine the different kinds of salt water in the south of France—the component parts of 100 gallons of Mediterranean water.

	lbs.
Chloride of sodium	29·524
Chloride of potassium	0·405
Chloride of magnesium	3·219
Sulphate of magnesia	2·477
Chloride of calcium	6·080
Sulphate of lime	1·557
Carbonate of lime	0·114
Bromide of sodium	0·356
Protoxide of iron	0·003
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	43·735

The density of the water of the Mediterranean is, according to M. Usiglio, 1·025 when at the temperature of 70°.

The reason why the Mediterranean contains more salts than that of the ocean, is because the quantity of fresh water brought into it by rivers is less than that lost by evaporation. The Mediterranean must therefore grow saltier with time, unless its water is discharged into the ocean by a counter current, which would run under the current coming from the Atlantic by the Straits of Gibraltar."

A gallon of sea-water contains usually 2,500 grains of saline matter, of which 1,890 grains consist of common salt. ("Bloxam's Chemistry.")

Sea-water contains in solution the gaseous, mineral, vegetable, and animal substances present in the waters of the rivers which flow into the sea. These remain behind when the surface water of the sea is evaporated, as it is continuously, by the heat of the sun, hence perhaps one of the causes of the present highly saline condition of the sea. On the other hand, sea-plants and fishes are always abstracting solid matter from the sea, and adding to submarine deposits. Probably the sea gains access or has gained to soluble saline deposits such as those now occurring in the beds or mines of salt of our own country, and in the beds or mines containing many saline chemical substances now worked in Prussia. The suspended matters in the affluent rivers slowly settle in the sea, and, with the shells and skeletons of animals, &c., no doubt slowly raise its floor.

The dissolved solids in sea-water with their names and proportions are shown in the following Table. The different rates of evaporation from the surface of the sea in tropical as compared with polar regions, and in comparatively quiet as compared with boisterous seas, and the influence of dilution by the fresh water of contiguous rivers, causes some variation in the composition of the water of different seas and of different portions of the same sea. The saline taste of sea-water is due chiefly to the large proportion of common salt present, four and a half ounces per gallon, its bitterish character to the magnesium salts. Its greater buoyancy than fresh water is due to its greater density, one gallon weighing rather more than ten pounds and a quarter as against ten pounds in the case of pure water; in other words, in comparison with 1000 parts of pure water, the specific gravity is $1027\frac{1}{2}$.

COMPOSITION OF SEA-WATER.

(The figures show parts per thousand by weight. Multiplied by 72 they would show grains per gallon. Specific gravity 1027½.)

	British Channel.	Mediterranean.
	(Schweitzer.)	(Usiglio.)
Water.....	963·745	962·345
Chloride of sodium	28·059	29·424
Chloride of potassium	0·766	0·505
Chloride of magnesium.....	3·666	3·219
Bromide of magnesium.....	0·029	0·556
Sulphate of magnesium	2·296	2·477
Sulphate of calcium	1·406	1·357
Carbonate of calcium	0·033	0·114
Iodine	traces	
Ammonia	traces	
Oxide of iron		0·003
Total ..	1000·000	1000·000

Traces of silver, lead, copper, &c., have been detected in sea-water.

The industry of Messrs. Gasquet, consists in the breeding and rearing of the following species: the oyster, the common mussel and the red mussel, the “double *praire*” (*Venus verrucosa*), the “simple *praire*” (*Cardita sulcata*), the “*clovisse*” of Toulon (*Tapes decussata*), and the “*clovisse*” of Cette (*Tapes texturata*), the edible sea-urchin (*Toxopneustes lividus*), and the “*violet*” (*Ascidia Cynthia*).

As we see, the industry which the Messrs. Gasquet, are attempting to create has an economic bearing, for it supplies a demand. The parcs on the peninsula of Giens are all surrounded by stakes driven into the bottom, and to these hurdles are attached. This kind of enclosure serves the double purpose of presenting an obstacle to the waves, which beat on the coast, and of acting as a collector or place of refuge for the spat of the shell-fish. Within the parcs have been placed other collectors, consisting of stones

and tiles covered with a coating of hydraulic cement, which renders it possible, when the time has arrived, to remove the oysters from the place of attachment; this may be accomplished without the slightest difficulty.

The oysters which Messrs. Gasquet, have introduced into their concession came from Arcachon; the largest on their arrival, measured about 4 centimeters ($1\frac{1}{2}$ inches) in diameter; the others were still attached to the collectors. They were imported and parked in the spring of last year, and at once rapidly grew to be one centimeter in size. But since the manifestation of this first growth, until the month of September, at which time I visited the establishment at Giens, they had remained stationary, and moreover had given no signs of reproducing. There is nothing strange in this, for it must be considered that these oysters, which were still rather young for spawning, had, besides, undergone the fatigue of a long journey; the time they have taken to recover themselves coincides precisely with that of their growth and spawning. It is also necessary to add that a drier year than that of 1877 has been rarely seen. During more than four months the water of the roadstead of Giens, naturally salt, has not received the slightest addition of rain water. In spite of this fact very few oysters have perished. This is important and promises well for the future.

Messrs. Gasquet, like practical men, do not propose to limit their experiments to the oyster of Arcachon; this year they are going to obtain a supply of Portuguese oysters and of oysters native to the ponds of Corsica. They have taken advantage of the winter season to make important improvements in their parcs. Having learned of the excellent results obtained by distributing shells and sand over the bottom of the parcs, they have, like Messrs. Mauduit

and Solminihac, at Belon, carried calcareous sand mixed with clay to that part of their establishment where the young oysters are to be quartered. Boxes, such as are agreeable to the fry, ingeniously arranged, have been constructed to receive the young oysters and other valuable shell-fish, whose small size would expose them to the attacks of their enemies. If in the experiments made at Giens, nothing conclusive has been decided as regards the oyster, mussels have succeeded perfectly. They have grown very large during the past year, and have multiplied in a large proportion. Their spat was so abundant that it was found attached in quantity to a net several hundred meters (a meter is $3\frac{1}{4}$ feet) from the breeding beds. The hurdles surrounding the parc and the slates which served as collectors were also well covered with them.

Such is the result of the fortunate experiments made by Messrs. Gasquet, in their marine establishment at Giens. If, as it is to be hoped, shell-fish culture comes to take its place among the new industries, to them will be due the honour of having taken the initiative and of having marked out the path to be followed.

BERRE, CARONTE, THAU, LEUCATE, AND AGAY.

In view of the large extent, 20,000 hectares (50,000 acres) of water known as Lake Berre, it is astonishing that human industry has not yet taken possession of this little sea, which, in many respects, is to the Mediterranean what the basin of Arcachon is to the ocean. By its situation and close proximity to large centres, which would afford a market for its productions, and by the richness of its marine fauna, Lake Berre would seem destined to occupy an important place in fish culture.

Lake Berre presents the best conditions for the breeding of edible shell-fish and other fish. The *clovisse*, the *praire*, &c., live there naturally; mussels of an excellent quality, are sufficiently abundant to make it profitable for forty boats to spend a large part of their time in fishing for them. Nor is the oyster a total stranger to this locality, for some were formerly found there, and in the neighbourhood, near Port-de-Bouc, very fine ones still exist. The shores are formed of shell sand, very rich in lime, and in many places are covered with marine plants common to the most fertile oyster-cultural stations of the ocean, such as Marennes, Tremblade, the island of Oléron, &c. The lake receives several streams and rivers, and numerous pure and fresh springs are found on its banks. Its water, which is neither too salt nor too fresh, never attains an excessive temperature so as to endanger the life of the aquatic animals which industry might confide to it. Its density is very variable; in the month of October, 1877, towards the centre of the lake it ranged from $2^{\circ}.8$ to 3° , and on the banks it was about $2^{\circ}.5$ to $2^{\circ}.6$.

Lake Berre would not, however, in all its parts serve for the culture of shell-fish or for the establishment of fish-cultural reserves; in the first place those localities must be excepted which are too deep, or at too great a distance from the shore, and those in which such violent currents prevail as to render it impossible, as shown by experience, to maintain there pieces of apparatus, and, finally, the localities which are most exposed to the northwest winds. But there are to the west some sections of coast where violent winds and currents rarely prevail, and it is on one of these that the commissioner of maritime registry at Martigues has established a parc, by way of experiment, to attempt the acclimation, breeding, and raising of oysters.

The experiments are still in their infancy, but they promise a successful issue. The oysters that have been used were taken in the vicinity of Port-de-Bouc. They were first placed in baskets submerged at a suitable depth, quickly attained great vigour, and soon lost the salty and somewhat muddy taste which they had on leaving the sea; but still more important, not a single loss occurred. The experiment was made only with reference to the oyster, but an incident occurred which leaves no doubt as to the possibility of artificially cultivating the mussel in the lake of Berre. The baskets in which the oysters had been imprisoned, when placed in the water, at spawning time were covered in a few days with small mussels.

Let us seek to discover then (for it cannot require a great deal of time or money), the apparatus to be used in Lake Berre, in order to collect and preserve the spat of this mollusc: let the system of ropes which is used at Tarente and Fusaro with so much success again be tried, if, in this case, the crawls and the rafts do not succeed, and when the proper apparatus shall have been found there is a strong probability, not to say certainty (as is proved by what I have said above, especially if the rational rules which have been pointed out by science and practice be observed, and if suitable localities be chosen), that mussel culture will be established there, and attain all the prosperity which has been attained by the sister industry, oyster-culture, at Arcachon and in the sea of Morbihan.

Below Lake Berre is Lake Caronte, as rich in shell-fish and other fish as the first named, and finally Port-de-Bouc, where oyster-cultural experiments were made by M. Viand; but a dry summer coming, the oysters all perished. Since Caronte and Port-de-Bouc were placed in more perfect communication with Lake Berre, however, the fishermen

have remarked that certain kinds of edible shell-fish which had become very scarce have reappeared in large numbers.

Of the section reaching from the gulf of Fos to Lake Thau there is nothing to be said. In the latter, in 1865 and in 1866, M. Coste caused oysters to be placed at points chosen by himself. He wished to restore to these fine sheets of water the oysters which had disappeared from them, and to make Lake Thau an adjunct of the basin of Arcachon. M. Coste had analyzed the water and found its composition to be favourable. The first result did not deceive his expectation. The oysters soon attained a large size and acquired strength and flavour. They propagated perfectly, and the spat attached itself to the fagots arranged for that purpose and to a central rock, which became covered with them. I will remark in passing that the breeding of the *clovisse* has been very successful there. It is, therefore, an established fact that the oyster is capable of living and multiplying its kind in Lake Thau. How does it happen, then, that private industry has not been induced to come there also by the success of this first attempt, and that it should have forsaken a work so full of promise? It would, in the future, receive compensation for its labours there.

Among the other maritime stations where it would seem oyster culture might be profitably carried on, I will mention Lake Leucate, which has already been pointed out by Messrs. Coste and Gerbe as likely to become an oyster-cultural centre, and where, not long ago, there were well-stocked oyster-beds, producing splendid oysters of rare beauty and delicacy of flavour, the finest, perhaps, to be found in the Mediterranean.

The waters of this lake, a large portion of which is sheltered from the winds, is mixed to a suitable extent

with fresh water. The soil is rich in lime, and shell-fish of all kinds abound. But the level of Lake Leucate is not always constant; according as there is a drought or freshet its extent varies from six to eight thousand hectares (15,000 and 20,000 acres). It would, therefore, be necessary to take every precaution to prevent the inconveniences that would result to the oyster culturists from the changes in level.

Retracing my steps I will pass abruptly from the shore of Languedoc to that of the farther Provence. I will mention, as a reminder merely, the gulf of Saint-Tropez, where M. Coste made unsuccessful attempts, which may be tried again some day. Then I will stop at a little station which I particularly noticed in the course of my mission, and which seemed to me to unite all the natural conditions desirable for new and decisive experiments in oyster culture in the Mediterranean, namely, the bay of Agay. It is not surprising that it had escaped the attention of M. Coste in his explorations, for at that time it was far removed from all lines of communication, and frequented only by the fishermen of that section, or visited by barques in distress. Now it is on the line of the railway that connects Marseilles with Genoa. The water of the bay of Agay extends into a locality where it is protected from the north-west and north winds. As it communicates with the sea through a narrow entrance it is likewise protected on that side from the south winds, which are so terrible in autumn. A stream brings into it a tribute of fresh water, thus increasing the chances of success. An experiment made at a given point in the bay of Agay, with selected oysters, suited to the nature of the water, a parc well arranged, well kept, and well watched, an experienced man to follow up with attention and perseverance the

various phases of this experiment, would show definitely, I think, what might be obtained by oyster culture on our southern coasts. If the experiment was successful, as there is every reason to suppose it would be, it would form a starting point of information, calculated to establish oyster-cultural industry in the Mediterranean.

CONCLUSIONS.

Last year I stated with legitimate satisfaction that the industry of oyster culture in the ocean, although in its infancy, was in a flourishing condition, and secured the existence on our shores of a maritime population of 200,000 souls. What a different spectacle is presented between Port Vendres and Marseilles. At the former place it is the picture of a commercial life asserting itself—the dawn of prosperity. I have seen an entire fishing population engaged with indefatigable activity in all the labours demanded by the culture of the molluscs, certain of finding there the reward of their efforts. At the latter one sees barren lakes, a deserted beach, and an impoverished sea.

The causes of the decadence of our southern shores are extremely numerous and varied, and it is not for me to examine them all. The principal causes are doubtless geological ones. The alluvium transported by the rivers flowing into the Gulf of Lyons, the total volume of which exceeds 20,000,000 cubic meters (705,600,000 cubic feet) per annum, has caused a displacement of the shore line, the formation of lagoons, their progressive filling up, and their transformation into marshes which have become hotbeds of dangerous fevers. The fish, whose spawning grounds were constantly buried beneath the mud, sought a more stable shore, and man finally was obliged to flee from

its pestilential atmosphere. Now the general situation is daily improving. The direction and the place of deposit of the alluvium is known, the portions of the shore which must be abandoned to the geological phenomena have been circumscribed, and engineers are successfully resisting the filling up of the lagoons. Many marshes, moreover, have disappeared through the action of time, and man has dried several. The influence of the marshes has diminished in intensity since then; and the laws of hygiene, now better understood, renders it possible to combat more effectually the paludal poisoning. Thus the reclaimed lands are beginning to be peopled again, but the population is exclusively agricultural. It is useful, doubtless, to bring these shores, which have been reclaimed from the water, under cultivation, with a view to rendering them healthy, and rescuing them from sterility. But why not open a yet larger field to the activity of the people, who never fail to improve every new source of making a fortune, and give them these aquatic fields, which, like the land, can receive seed and yield a harvest? Does not the sea support multitudes of creatures which man may utilize as an important part of his food, provided he knows how to apply them to his use, not only by maintaining them under his hand, but, also, by encouraging their growth and multiplication according to well-known laws?

Reasons of the greatest importance, especially in view of their relation to the public maintenance, impose upon us daily more and more the necessity of placing under a regular system of cultivation the domain of the fluvial and maritime waters. As regards the rivers and streams, this necessity was long ago made known, and the art of cultivating fish is not unknown to us; whereas maritime fish culture, properly so called, has as yet received no attention.

I desire, therefore, to call public attention to the subject of restocking the lagoons by fish culture, as well as to the necessity of restocking our rivers.

Oyster-culture in the Mediterranean does not seem to me to promise so brilliant a future as on the Atlantic coast, although some stations seem to offer all the conditions recognized as indispensable to success.

The lagoons of Ferrare, Comacchio, and Venice may be compared to Leucate, Thau, and those of Aigues-Mortes. The inhabitants of the shore, however, have derived great benefit from these salt lakes, and in this no parallel can be drawn between the two. Whilst on the French side nothing but solitude and neglect* is seen, the Italians have not allowed to be lost the teachings in the art of cultivating the sea which were transmitted to them by the ancients. If, in the south, they practise oyster culture as in the last days of the Roman republic, along the Adriatic and in the Sardinias they have applied themselves to the breeding and preservation of sea fish.

At Comacchio fish culture has from time immemorial furnished material for a large export trade, and fisheries are numerous in all the lagoons of the coast.

This is the example to be followed—a profitable business, in which one can engage without doubt of success. The soil, the climate, the water being the same in the Gulf of Venice as in the Gulf of Lyons, the processes need not be sought for anew. The Italians succeeded with them :

* The average annual yield of the fisheries in Lake Thau amounts to 300,000 francs (60,000 dols). This is an indication of a certain activity. (Lenthéric, Villes mortes du Golfe de Lyon.)

why not apply them upon our Mediterranean shores? They might be speedily tested at little expense, and if found imperfect in any way they could be quickly improved, just as were the oyster-cultural processes brought from Fusaro by M. Coste.

Let it not be forgotten that the number of fish brought to our market is constantly diminishing. A part of the north of France is dependent upon foreign countries for its fishery supplies; in the south, fish of fine quality would be unknown if the coasts of Corsica and Sardinia, which are still prosperous, did not furnish their quota. The native fishery is insufficient to satisfy the demands of a market which increases day by day, in proportion as railroad communication becomes more extended. It can with great difficulty furnish Paris with little more than half the fish consumed there, and still fresh sea-fish are considered the favourite article of food; a gale of wind is sufficient to deprive Paris of its supply.* It is apprehended on all sides that the time will arrive when fish, other than preserved fish, will be a luxury which the rich alone can afford. This situation demands a prompt remedy. It has seemed to be my duty to point out where it might be found.

In an exceedingly kind letter I have just received from Prof. Arthur Issel, who is one, if not the greatest authority on ostra-culture in Italy, in which he tells me that since his last publication two new establishments have been founded in Italy for the rearing of oysters, one at Venice, under the supervision of Conte Alesandro Ninni, the other at La Spezzia, with which Prof. David Carazzi is occupied. In

* Maxime du Camp, *loc. cit.*

the latter establishment young oysters become attached to fascines in the middle and at the mouth of the Gulf of Spezzia, whence they are removed to the shallows according to the system adopted at Taranto ; that the adhesion of the young oysters to the fascines is difficult and incomplete, but the growth eventually is exceedingly rapid, reaching the dimensions of marketable oysters in one year ; the shell is thinner and more fragile than those at Taranto, and they generally have a rose tint on the interior of the shell.

CHAPTER XXIX.

OYSTER CULTURE IN SPAIN. (*a*)

The Spanish peninsula has 2920 kilomètres of coast, which, when considering the fisheries, can be divided into three districts marked by nature by means of slight variations. The first is comprised between the French frontier on the Bidasoa river and Mino limit of Portugal, forming a total length of 1567 kilomètres of coast. This is the part most productive in fisheries industry, and fishing is carried on by some steamers and chiefly by sailing vessels using nets, lines, and hooks.

The culture of oyster and other mollusca, as well as the protection and cultivation of lobsters, is carried on in that part of Spain. There are also many private establishments granted by Government to private individuals for the cultivation of mollusca, chiefly oysters; in consequence of this, and with the Government's prevision of preventing the depletion, we hope the ancient natural beds—formerly so rich and now nearly all exhausted by over-dredging—will again acquire their former wealth of mollusca.

(*a*) "The Fisheries of Spain," by Lieut.-Col. Francisco Garcia Sola. Papers of the Conferences, held in connection with the great International Fisheries Exhibition, 1883.

The Government is paying every attention to the matter, and is laying down, at the expense of the nation, a model parc of oyster culture in order to teach to those interested in the subject the most modern processes for the cultivation of oysters, and so replenish with the products the natural beds, now almost completely exhausted by, no doubt culpable abuses.

This district possesses the most favourable conditions that can be imagined for fisheries, because, owing to the unevenness of the bottom of the sea, with an exception of the estuaries, drag-nets cannot be used ; on account of the geographical position formed by a line from east to west, where the very many estuaries and small rivers deposit in great abundance food for fish, due to the fertile lands that they run through ; and so the inland estuaries favourable to the increase of the production of fish, there are many good elements given by nature to that privileged coast.

Some enterprising foreigners, encouraged by the abusive capture of oysters which is allowed to take place in Portugal, and by the high prices at which these molluscs are valued on account of their large size, easy production, and superior medicinal conditions attributed to them, intend to utilise the natural beds, and so drag them, heedless of all wasteful destruction ; but the Government has taken notice of it, and never will permit any establishments beyond those applied to the production of this favourite mollusc.

In his "Basis for Legislation on Fishery Questions," Lieut. Col. Sola, speaking of the depletion of oysters in Spain, says, when we speak of the depletion, or complete exhaustion of fisheries, it must be understood that these terms are not used in an absolute sense, but only so far as they affect the supply for the use of mankind, or in other

words, the output of the industry. The quantity of fish may be diminished in two ways, in the one case when the catch exceeds the reproduction, and in the other when the fish are frightened away from the haunts of the fishermen. I quite agree with the views so often expressed as to the difficulties which have hitherto stood in the way of a proper study of the life and habits of the inhabitants of the sea, which is the only thing that would conduce to an early solution of the problem ; but the experience gained from ascertained facts concerning fisheries, throws enough light to induce a conclusion, in any rational mind, in one or the other direction.

With regard to sedentary species, I do not think there is the least doubt that these *can* be exhausted by being overfished, or by improper methods of fishing, since it is clear that if a natural oyster-bed, for example, be dredged constantly and no time left for its reproduction, it will amount to the same thing as if one repeatedly dredged stones or other inert material—that is, the bottom would at last be perfectly clear of them.

Such an obvious argument as this needs no confirmation but if any such confirmation were needed, we might cite what has occurred on the north-west coasts of Spain, where until the beginning of the present century, so great was the quantity of oysters in the beds that they were sold at four cuartos, or a little more than one penny per hundred, while the present price averages 12 pesetas, or 9s. 7d., for the same quantity. Even if we take into account the small consumption at that time, owing to the defective means of communication, this circumstance is insufficient to explain the enormous difference just mentioned, which points clearly to the complete exhaustion of the beds.

CHAPTER XXX.

OYSTER CULTURE IN HOLLAND.

OYSTERS ONCE PLENTIFUL—OVERFISHING—ZEELAND—THE SCHELDE
—THE YERSEKE OYSTER-BEDS—THE DUTCH ZOOLOGICAL STATION
—LEASING OF PLOTS—IMPORTANT DISCOVERIES RELATIVE TO
SPAT—HOPEFUL EXPERIMENTS—ARTIFICIAL FECUNDATION.

AT the International Fisheries Exhibition Conference (London) on June 29th, 1883, Professor Hubrecht spoke as follows:

About six weeks ago I had the advantage of being present at a lecture “On Oysters and the Oyster Question,” which was given at the Royal Institution by one of your most eminent biologists, Professor Huxley.

It would be very presumptuous on my part to go over the same ground once more, after that very able discourse has come under the notice of you all, and I wish to limit myself to a few statements concerning the oyster fisheries and oyster-culture in the Netherlands.

Time was when oysters from natural oyster-beds were very plentiful with us. These beds were situated, partly in our Southern province of Zeeland, partly towards the North in the inland sea which we call the Zuyderzee, at the spots indicated on the map. The oysters were brought to market

in Amsterdam and were partly exported to Germany, at a price which bears no comparison at all with what is at present paid for them.

This having been the state of things a good many years ago, it is a pity that we have to recognize the fact of one of these natural beds being nearly destroyed. There is no serious doubt but this destruction has come about by over-fishing. The few oysters that are left are only worth the notice of the Nieuwe-Diep fishermen in the summer time when they are not employed in any other fisheries, and even out of their number only a few pay regular visits to those parts of the Zuyderzee where oysters may happen for the moment to be just a little more numerous than usual. There is no regular oyster trade in that part of the country.

The oyster trade with us is for the present concentrated in the province of Zeeland, where, as was noticed before, a second natural oyster-bed of some extent has existed. This bed was very fast on its way towards extermination, and would certainly have followed in the wake of the Zuyderzee beds, had not oyster "culture" at the right nick of time stepped in and replaced "oyster fishing." The already impoverished regions have since made rapid strides towards their maximum of productivity, and it is from them that the large numbers of so-called Dutch oysters or Dutch natives, which if I am not wrong are high up in the scale of merit according to the verdict of London palates, are derived.

It was in 1870 that this change of system was effected. Up to that year fishermen from the small village of Yerseke and from other hamlets round the so-called eastern arm of the river Schelde regularly fished and dredged on this bed in the five winter months (October—February). There was a close time for oyster fishing (during which period it was strictly prohibited) of no less than seven months, from

March 1 to October 1. Still it was generally accepted that notwithstanding these measures the bed gradually became impoverished.

About the same time that it was decided upon to no longer allow public fishing on these beds, but to give them into the hands of oyster-culturists, another important change has been effected in the geographical situation of the oyster-beds. A railway-dam had been constructed across the eastern arm of the Schelde where it was narrowest, and this practically changed the nature of its waters. It now became, as you will see from this map, a deep inland bay, instead of being one of the arms of the Schelde delta, through which part of the fresh water from this river could flow towards the German Ocean. This change has of course effected the salinity of the water, and it may be safely inferred that this has not remained without influence on the oyster-beds of the eastern Schelde and their productivity.

The first impulse towards prohibiting public fishing on the so-called Yerseke oyster-bed was given by private gentlemen, who in 1867 had visited the Arcachon oyster regions and who applied to government for aid towards an investigation of the condition of the Yerseke-bed. The result was that in 1870 and 1872 Government, or rather the Minister of the Finances under whose control are also the fishing waters of the country, withdrew the Yerseke oyster-bed from public fishery and leased it for purposes of oyster-culture to private individuals, after having divided it into plots varying in size from 12 to about 150 acres. The rent was to be paid yearly, and the time up to which it might be retained for the same rent was 15 years, facilities being offered to those who wished to give back their allotted plots before the expiration of the 15 years' term.

In 1885 the whole of the Yerseke oyster-bed, would come back to Government, and new agreements would then be decided upon. As this period is now rapidly approaching it was wisely decided upon by Government not to wait till 1885 before re-letting the bed, but to do so at least three years before the expiration of the present leases. So last year this new leasing took place, and the same 7720 acres which form together the Yerseke oyster-bed and which have been leased from 1870 to 1885 for a yearly rent of about £1720, will in 1885 bring into the Exchequer a yearly amount of £28,765. These figures speak for themselves, and go far towards demonstrating that oyster-culture in the regions we are speaking of is a success. The new lease runs for thirty years, with the right on the part of the lessees to give up their allotments every five years.

The extraordinary increase in value just alluded to of the different portions of the oyster-bed, has not similarly affected all portions of that area. I will give you figures to demonstrate this; but I must first call to your mind, that in the practice of oyster-culture, certain areas are principally devoted to "growing" the oysters, others to collecting the spat, and that the value of a certain area is principally determined by the intrinsic qualities which it is supposed to possess for the one or for the other of these operations. The collection of the spat essentially consists in the process of bringing out into the sea-water tiles, like these I have here on the table, covered by a layer of chalk, which is afterwards easily removed, together with the young oysters adhering to it.

These tiles are brought out in millions at the time when the oyster spat is expected to be most plentiful. If brought out too early, they get covered with a layer of earthy deposit, or lose the roughness of their surface, and the spat

will not then fix upon them ; if brought out too late the spat may have altogether disappeared for that season. It is thus a very important question when and where to deposit the collecting tiles. Up to the present, oyster-culturists have been guided mostly by empirical notions, tradition and experience having decided what portions of the sea bottom were most fertile for the collecting of the young. Theoretically this question is dependent on circumstances which are, indeed, complicated. It must first be asked, where are the oysters that furnish the spat ? secondly, how long does this spat swim about independently, before fixing itself ? thirdly, what is the influence of the currents in the vicinity of the mother oysters upon the distribution of the spat over a certain area ?

It has been the object of a series of investigations planned by the direction of the Dutch Zoological Station, of which I am a member, to try and get definite and reliable facts concerning these movements of the spat. I am sorry to say, that in this respect our results up to the present moment are rather scanty, although we are continuing our exertions. One fact is generally accepted, viz., that exceptionally good localities for spat collecting are those where there is a strong current of fresh sea-water at each tide in the immediate vicinity, and where, at the same time, this current is broken by headlands or other causes, so as to produce counter-currents of much reduced intensity. The spots where these counter-currents occur are very much valued, as are also those deeper pits here and there found in the sea-bottom, above which a sort of whirlpool is apt to occur. It would seem that in both these cases the spat is more easily deposited, is, so to say, precipitated, on the collecting-tiles or other substances (shells of dead molluscs, &c.) to which it can adhere. Localities answer-

ing to the above requirements are found on the spots I will indicate on the map.

In order now further to bring before your mind how the value of one locality above another for this and other purposes of oyster-culture, appears to be gradually established by experience, and is, indeed, recognized by those interested in this industry, I have promised to give you a few comparative numbers of the sums for which the same plots were leased in 1870, and will be so from 1885 forwards:—

Allotment No. 162, size 12 acres, was leased—

In 1870 for 1s. 8d. a year; will be in 1885 £202 a year.

No. 163	12 ac.	„	1s. 8d.	„	„	£227	„
„ 164	12 „	„	13s. 4d.	„	„	£252	„
„ 176	12 „	„	£22 10s. od.	„	„	£508	„
„ 220	120 „	„	£25 18s. od.	„	„	£33 15s.	„
„ 138	12 „	„	£18 10s. od.	„	„	£762 10s.	„

Others have gradually come down in the market, as for example—

No. 280	24 acres	brought in 1877, £45 16s.; in 1879, £1 10s.
„ 415	18 „	„ £2 1s.; in 1882, 10d.

The fluctuation is, as you see, indeed considerable, and only rivalled by that mysterious fluctuation of spat, which, in the breeding season, is carried to and fro at each turning tide, all through the basin of the eastern Schelde.

A question which we were also eager to answer in continuing our investigations at the Zoological Station, was this: From whence is the spat that occurs in such myriads on the Schelde essentially derived? The interest of this question was increased by the fact, that among the oysters which were dredged on the cultivated beds, the number of ripe specimens carrying eggs was very rare. This was partially explained by the fact, that the oysters are gener-

ally collected and sent into the market *before* the female generative products have attained their full maturity. However, this circumstance made it all the more wonderful that still the so-called *fall* of spat had, during the last ten years, been on the whole so considerable, the unproductive years being generally more the consequence of other circumstances than of the absence of young oyster larvæ at the right season.

It must, moreover, be specially mentioned, that after the Yerseke bed had been withdrawn from public fishing, no obligatory close time for oyster fishing was ever prescribed. The lessees could dredge for their oysters at whatever time of the year they liked. That they did not generally do so in summer was, in the first place, for fear of disturbing the growth, the delicate edges of the shell being at this period more particularly liable to break ; and secondly, because the oysters are found to be less palatable at this time of the year. I hardly presume that they were already convinced of the truth of Professor Huxley's view, which he repeated in his lecture above alluded to, and which I have no doubt is the right one, that a close time for fishing on oyster-beds may be very serviceable ; but that there is absolutely no reason to see why it should be more so *during* the spawning time than either *before* or *after*.

The great thing appears to be to leave a fair portion of the oysters on or around a natural bed, wholly undisturbed for a series of consecutive years. Now such an arrangement was never carried out *intentionally* on the Yerseke bed, every portion of it and of the whole eastern portion of the Oosterschelde having been leased for purposes of oyster-culture.

Continuing our investigations as to the source from whence the spat might be naturally derived, we were thus led to suppose that natural beds of a certain extent were present in the western portion further seaward. Dredgings were undertaken by means of a government steamer, but they gave a negative result, and this coincided with what had already been told us by fishermen, i.e., that no such natural beds existed.

One day, the idea occurred to us, that we were looking the wrong way, and that what we were searching for was much closer to us than we expected.

The fact is, and hitherto I have not yet mentioned it, that a regulation which has been rather strictly attended to, and which had originally been proposed by those government departments that are in charge of the maintenance of the dykes defending the country against invasions from the sea, runs thus: *it is not allowed to use dredging implements of any description for the capture of fish or molluscs within a line of 500 meters distance from the coast.* The reason of this prohibition was that the foot of the dykes running out into the sea is in several spots protected with specially constructed stone defences which might be seriously damaged by dredging, and might thus weaken the dykes, endanger the land behind them, and, at all events, necessitate expensive repairs. It was the more easy to enforce this regulation because dredging for oysters within this 500 meter area, wherever the stone-works had been constructed, was attended with great danger of losing the dredge, as it easily got entangled in one way or the other.

Now to this band of nearly a quarter of a mile in width, which surrounds the Schelde basin on all sides, our attention was more especially directed. A diver was sent down at numerous different points, to make the explorations

as thorough as possible. It was thus brought to light that really, wherever the stone works alluded to stood out on the sea bottom, which at those localities rapidly sloped down towards deeper water, there was a more or less numerous, at some spots even a very profuse crop of oysters of all ages, which, in consequence of the regulations above mentioned, had never been disturbed, and bore the evident traces of this. When at a few localities no oysters were found on the submarine stone-works, it was to be ascribed to these having been newly constructed or repaired, or to their having been covered over with sediment.

The results of these diving operations were mapped out, and are shown in the diagrams I have before me. The long band-like patches of oysters follow the stone-works, and both to seaward and towards the land, where a muddy bottom is prevalent in their immediate vicinity, no oysters occur.

The localities that have hitherto been thus investigated are shown in this map, and I may fairly infer that the continuation of our researches with the diving apparatus which are contemplated also in this summer, will enable us to trace the confines of this natural oyster-bed with precision.

It is hardly doubted by any of us, nor by the professional oyster-culturists themselves, who have a more direct interest in the productivity of the eastern Schelde, that here, indeed, we have before us the principal source from whence the spat is yearly, for the greater part, derived, and everybody appears to be anxious to maintain the present state of things, and to have the prohibitory clause against fishing within the 500 meter area most strictly observed.

The investigations concerning the oyster questions which were carried out by means of the transportable Zoological station, and which have just been alluded to, also extend in other directions. The anatomy of the oyster has been carefully inquired into by Dr. Hoek, and I have before me his elaborate treatise with numerous illustrations. The embryology of the oyster has been investigated by Dr. Horst, who is still continuing the researches, part of which are already published. The physical circumstances are similarly inquired into, and series of observations concerning temperature and salinity of the water are repeated three times a day at different points of the Schelde.

In the course of this summer our attention will be more especially directed to the process of fixation of the larvæ when, at the end of their free life, they settle down on some hard substance where to develop into a full-grown oyster. To get hold of the largest number of young oysters, fixed in this way to transportable apparatus, is a most important object to all oyster-culturists, and this problem is before them once every year at the breeding season. All the different forms and shapes of collecting apparatus, some of which are here on the table, and which you will find in great variety in the different departments of this Exhibition, tend to the same object. Still the process of being obliged to bring these out into the open sea, hoping that the invisible spat may fix down upon them in great quantities, may to a certain extent be compared to a man trying to catch birds by throwing his hat at a passing flock.

In order to bring this matter within the reach of man's voluntary interference, different attempts have been made to let the oyster give off its spat in an enclosed space, where it might be collected at leisure on the apparatus

which was deposited in the same enclosure. Such experiments have—in our country at least—always led to negative results. However, we are not certain that they were taken with the necessary precautions, the water being only very rarely and partially changed. The consequence of this must have been extensive mortality of the spat by the water becoming de-oxygenated, and loss of spat at those—whenever so few—occasions on which the water was partially renewed.

In our experiments we wish by all means to eliminate such sources of error. We have had the free disposition given to us, during the whole time of the experiment, of one of the largest oyster parcs. It is represented in this figure. At these points there are inlets for the sea-water that can be opened and shut, and the volume of water forming the oyster park is divided by smaller dykes and by wooden enclosures into several compartments.

One of these has been entirely separated from the rest, and is specially devoted to the purpose of our experiments. In this separated portion, here indicated by dark blue, and which has a superficial extent of about a quarter of an acre, about 10,000 mature oysters are about to be deposited, the floor of the compartment having been covered by apparatus for collecting the spat. As long as the breeding season has not yet so far advanced that the spat is set free, the water is changed with every tide. In the meantime we have here put up a steam engine, and by this we intend to bring about artificial oxygenating of the sea-water the moment the spat makes its appearance. We then shut all the exterior inlets of water once for all, and continue our experiments during the rest of the summer with the water at that moment contained in the park. In this way there is—1st, no possibility of the spat escaping.

2nd. No possibility of spat being introduced from outside, which would interfere with the reliability of eventual results.

To make a comparative experiment with different methods of aërating the sea-water, we have divided the space here indicated in two halves. In the anterior portion a revolving axis with blades attached to it causes a continual current, and at the same time introduces a certain amount of air. In the posterior portion compressed air is introduced into the water by a very large number of small orifices through which it is continually pumped, and from whence the air-bubbles must ascend towards the surface.

In this way we hope to provide our young oyster larvæ with a fair supply of oxygen, to the absence of which we ascribe the failure of previous experiments. Nobody can, of course, predict as to whether we shall be more successful, and whether in the breeding season we shall find the different sorts of collecting apparatus we are going to experiment with profusely covered with spat; but still it was our conviction that we ought to give the question a fair trial, the more so since the experiments of Bouchon-Brandely on the French coast have put it beyond doubt that with the Portuguese oyster (*Ostrea angulata*), artificial fecundation and collection of the spat in myriads is quite feasible. The market value of the Portuguese oyster is, however, very low; the oyster has quite a different shape from ours, and is generally considered of a very inferior flavour.

This example, though encouraging, does not, however, admit of the conclusion that we have equal chances of success with *Ostrea edulis*, our north-European oyster. Part of the development of the young of the latter species takes place within the shell; and as this is not the case with the

Portuguese oyster, artificial fecundation in the former species would be very hazardous.

For this reason the plan for the experiment has been traced in the way I have just explained.

I have dwelt at some length upon these experiments, because they will bring before your minds the phase at which the theoretical questions with which oyster culture has to deal have at present arrived.

As to its practical side, I am afraid time will not permit me to give you a fair description of the different implements and processes.

. . . . In terminating, I must not omit to mention that the favourable results of oyster culture in the Schelde have directed the attention of Government to the re-stocking and the methodic improvement of the Zuyderzee beds, on the same plan that has been followed since 1870 for the less over-fished Zeeland bed. As yet these measures are not far advanced, but it can hardly be doubted that in the course of a few years a new source of the prized delicacy we have been considering to-day will there be opened, the natural conditions having on the whole remained the same since the time these beds were so plentiful.

CHAPTER XXXI.

OYSTER CULTURE IN NORWAY.

CHEAP AND DEAR OYSTERS—OVER-FISHING AND CARELESSNESS—
WARM WATER BASINS DISCOVERED—EXPORT OF OYSTERS IN
1881—LIEUT.-GENERAL WERGELAND'S EXPERIMENTS.

M. FREDRIK M. WALLEM (Executive Commissioner for Norway to the International Fisheries Exhibition, London), speaking at the Conference on Thursday, July 5th, 1883, relative to Norwegian Oyster Culture, informed his audience that—"Twenty or twenty-five years ago we had plenty of oysters, everyone could get a bucket-full for sixpence. At present the price is two guineas for a barrel of oysters, and we have no oysters, or scarcely any. Our oyster banks have been ruined by over-fishing and carelessness, and give now altogether no more than three or four hundred pounds sterling a year to the fishermen. We have tried pretty hard to assist nature, but commenced too late, and have not succeeded. A couple of warm water basins, in which oysters may grow, almost like flowers in a hot-house, have been discovered on our coast; spat from these oyster hot-houses may be planted out on natural banks, and grow to marketable oysters, but we have not yet experience enough, and it seems to me that the French and English systems will not quite answer on our coast, without some important alterations."

The whole export of oysters in 1881 was 6800 kilogrammes (100 kilogs., = 1 ton), valued at 6800 kroner (18·2 k., = £1 sterling).

Considering the latitude of Norway, the intense cold which prevails there during a large part of the year—cold so intense that sometimes the spawning of the oyster on the natural banks is without results for several seasons ; and, moreover, considering the distance of Norway from those countries from whose experiences she might profit, and from which she might obtain information, it will be readily seen how numerous are the difficulties to be overcome in the establishment of oyster culture on the shores of Norway.

Lieutenant-General Wergeland (formerly minister of war) was not deterred by these obstacles. After carefully consulting works relating to oyster culture which had been published in foreign countries, and procuring exact data from M. Théodore Soelfeldt, who had come to Paris to study the French industry, he resolutely set to work in the month of April, 1877.

Various circumstances appeared to him encouraging ; first, the presence of the oyster in the North Sea ; second, the small amount of salt contained in the water of that sea ; third, the favourable influence of the Gulf-stream on the climate of these regions ; and finally, the ease with which shelter may be found in the numerous *fjords* which cut into the shores of the peninsula of Norway. A bay situated a few leagues from Christiania (towards the fifty-ninth degree of north latitude) was the spot chosen for the experiment. It was necessary to guard against the inconveniences resulting from the early setting in of winter, from the slight rise and fall of the tides, which at the syzygies rise but a foot or a foot and a half, and from the

violence of the storms, which sometimes displace a volume of water more than 7 feet in depth. On the arrival of winter in Norway, that is to say, toward the beginning of September, the young oysters are still too young to resist the shocks and sudden changes of temperature. It was, therefore, of the greatest importance that they should not come into contact with the outer air. These difficulties were surmounted in the following manner:—In the upper part of the establishment a supply reservoir, fed by a pump, worked by wind, was dug. Immediately beneath, within a house which protected it from the rigour of the cold, was placed a basin for holding the eggs, measuring 8 meters (26 feet) in length by 6 meters (19 feet) in width. A leaden conduit, furnished at its upper part with a grating fine enough to stop the passage of harmful fish, and in its lower part with faucets to regulate the supply of water at will, brought the two reservoirs into connection with one another. This tube took several windings, and passed through an inclosure filled with water, which could be heated when necessary, so as to maintain the water supplied to the hatching basin of a nearly uniform temperature. The level of the water in this latter basin was regulated by means of a tube, the opening of which was covered with a filter, to prevent the escape of the young oysters. In this basin 2200 female oysters were placed at the commencement of the season, and, although they had undergone the fatigue of a long journey, they emitted such a quantity of spawn that it was found upon the collectors by which they were surrounded.

The first experiment, as will be seen from the above, succeeded well, and the system invented by General Wergeland, for obtaining larval oysters in inclosed places, could be developed to any desired extent. The General intends

to try and obtain the spawn of free oysters, if the season be mild enough to permit, by surrounding with fascines a natural oyster bed that has been recently explored. He proposes subsequently to inclose the young oysters in floating preservative boxes, and to raise them on the spot.

The labours, works, and schemes which I have just explained, are due to the initiative taken by General Wergeland, whose laudable ambition it is to render to his country the same services which M. Coste has rendered to France. He is now engaged in restocking, by means of pisciculture, the large and beautiful lakes of Norway. If he succeeds, as there is every reason to believe he will, his country will be indebted to him for the introduction of a branch of industry for which there is a great future in store.

CHAPTER XXXII.

OYSTER CULTURE IN AMERICA.

INTRODUCTORY REMARKS—THE JOHNS HOPKINS UNIVERSITY—COMMISSIONERS' REPORT, ITS OUTLINE AND OBJECT—THE POSSIBILITIES OF THE MARYLAND OYSTER INDUSTRY—THE CAUSE OF THE EXHAUSTION OF THE BEDS—DESTRUCTION OF OYSTERS—PROTECTION OF YOUNG OYSTERS—THE RETURN OF SHELLS TO THE BEDS—EXPORTATION OF OYSTERS FOR PLANTING—PROHIBITION OF DREDGING—PROTECTION OF THE TONGING AND PLANTING INDUSTRIES—THE CLOSED SEASON—THE OYSTER FISHERIES OF TANGIER SOUND—STATE REVENUE FROM OYSTER FISHERY—OPEN AND CLOSED DISTRICTS—OYSTER PLANTING—OYSTER FARMING—PRIVATE CULTURE AND CULTURE BY THE STATE—THE OYSTER FISHERY OF CONNECTICUT—PUBLIC BEDS—PRIVATE BEDS—DEEP-WATER CULTIVATION—EXPENSE OF AN OYSTER FARM—OYSTER INDUSTRY OF NEW YORK—FORM OF APPLICATION FOR A GRANT—THE NORTH CAROLINA FISHERIES—SUMMARY OF WORK—INSTRUCTIONS—DELINEATION OF BEDS—TIDES—SPECIMENS—SUBSTRATUM OF BOTTOM—CURRENTS—NUMBER OF OYSTERS TO THE SQUARE YARD—JAMES' RIVER—THE FISHERY AND ITS EFFECTS—DENSITIES—DEPOSITS—EFFECT OF GALES AND ICE—CONCLUSIONS—SPECIFIC GRAVITIES—THE OYSTER INDUSTRY PRIOR TO 1887—OPERATION OF THE NEW LAW—METHOD OF LOCATING LOTS—OYSTER FISHERY ACT, 1887—FORM OF APPLICATION FOR PRIVATE OYSTER-GROUND—CONCLUSION.

“In North America the oysters are so fine and cheap that they are eaten daily by all classes. Hence they are now, and have been for a long time, a real means of sub-

sistence for the people. This enviable fact is no argument against the injuriousness of a continuous and severe fishing of the beds. . . . But as the number of consumers increases in America, the price will also surely advance, and then there will arise a desire to fish the banks more severely than hitherto, and if they do not accept in time the unfortunate experience of the oyster culturists of Europe, they will surely find their oyster beds impoverished for having defied the bioconotic laws.”—*Professor Möbius*.

In the compilation of this most important and interesting chapter, I am indebted, chiefly, to the scientifically-far-famed and highly valuable works of two American gentlemen, namely, Lieutenant Francis Winslow (*a*) and Dr. W. K. Brooks (*b*), each of whose courteous promptitude in answering my request for permission to quote from their “Reports” was only equalled by the generous consent which characterizes both their replies, and which I cannot praise too highly, the more especially so since they were strangers to me. I have, therefore, very great pleasure in publicly acknowledging and sincerely thanking these emi-

(*a*) “Report on the Sounds and Estuaries of North Carolina, with reference to Oyster Culture. By Francis Winslow, Lieutenant U.S. Navy, Assistant U.S. Coast and Geodetic Survey, Commanding Schooner Scoresby.”—Washington (Jan., 1889.)

“Methods and Results;” Report on the Oyster Beds of the James River, V.A., and of Tangier and Pocomoke Sounds, Maryland and Virginia. Appendix No. 11.—Report for 1881. (Washington, Government Printing Office, 1882).

(*b*) “The Development and Protection of the Oyster in Maryland.” By W. K. Brooks, Ph. D., Associate Professor of Morphology in the Johns Hopkins University. Being the Report written by him as Chairman of the Oyster Commission of the State of Maryland, and presented to the General Assembly, February, 1884. (Baltimore: Publication Agency of the Johns Hopkins University.)

nent scientists for their favour, not only in my own behalf and name, but also in that of my fellow-countrymen—at least that portion of them who take an interest in the subject of this work,—whom these extracts from books not generally accessible will, I feel assured, serve to interest, to instruct, and in the near future, perhaps, inspire to imitate the Americans in one of the grandest lessons in Governmental utility, duty, and wisdom, that the civilized world is witnessing at the present time.

Let the carping critic snarl his journalistic dissent, and growl at this “gushing eulogy of spread-eagleism, and march of Yankee progress in commercial prosperity;” neither he nor such as he, nor any right-minded Englishman, can deny the fact that in their seven-league-strides’-march of progress, the people on the other side of the Atlantic have, in many things, left the mother country far behind, and particularly so in oyster culture.

That the English people have failed to participate to any creditable degree in an industry so important, have even failed to appreciate its importance, should be a humiliating reflection to the Government, and is the more remarkable, and the more bitterly to be regretted, when we remember the national trait of conquering perseverance inherent in the British character.

But if

“— coming events cast their shadows before,”

then, I am pleased to say that there are not wanting signs that the public’s harmful indifference, and the Government’s lamentable neglect, are—if slowly, most surely—being succeeded by more promising phases of most necessary reform; so that the signs of the times are pregnant with healthy hope that oyster culture, in as fortunate an aspect of successful result on dutiful venture as wealth and

common sense, energy and perseverance, can make it assume, will, in the near future, form an essential part of England's commercial progress and prosperity.

In the volumes alluded to there is so much valuable information, written in so pleasing a style that I am almost at a loss to know where to begin or where to end,—where to abridge or where to quote in full. And, even with that problem solved, I regret to say that, in the extraction of what is really only a mere fragmentary portion of the scientific works in question, want of space has forced me to condense even that, but always with care that the reader should experience no difficulty in following the authors in their narrative.

Narratives of methods and results relative to oyster culture, so replete with all that bears the stamp of self-evidence, upon its appeal to the reader's comprehension of the subject—with all that can and does fulfil the English ostraculturist's most ardent desire in experimental result and financial success—with all that matter-of-fact-eloquence that should thrill and rouse our merchants from their sluggish apathy, and make them clamour for the adoption of the American methods, or at least a trial thereof, in most, if not in all of their developments, by those who choose to follow their teaching—yes, so replete with these and many more happy outcomes of a wise administration, that I respectfully venture to commend this chapter to the consideration of our worthy Legislators, convinced that, should they ever condescend to act upon the American method of oyster culture, they would merit the right of being considered benefactors of the British public.

It is not in a spirit of harsh criticism, but in the hope that our people may be awakened to their own interest, that I am about to point out the distressing difference

between the lethargic conduct—the want of mercantile self-respect involved in the views of our people and their legislators, and the extraordinary energy of the Americans.

We live in a highly civilized age, and if we fail to grasp its spirit we shall go to the wall before the oyster cultivators of America or France, or even Holland, just as surely as we are only awakening from the lethargy of our neglected opportunities to cope with, if not to rival, other nations, whose native wisdom and patient labour, rewarded by success, ought to raise the blush of shame upon the face of every Englishman.

It is true we cannot recall the past, nor can we resist the progress of events, but we can control it if we will be wise in time. Wise in time—what time? A year?—five years, or a decade—which? *Now is the Hour!* Granted, “It is never too late to mend;” but we have had many of those “now’s” and “hours” in time gone by, far more emphatically warning in their significance than italics can make them on paper, and they are daily repeating themselves—have we heeded, or do we heed them?

We have had, and we have still amongst us, able men of science—gentlemen who were and are qualified by an extensive experience with our fisheries—who have published pamphlets and volumes, and have proved in their Lectures, that while the reason for the non-success of our ostracultural attempts is perfectly clear and simple, the greatest ignorance upon this point exists in the minds of the people.

It is not essential that a patient should know the nature and cause of his disease, but this knowledge is of the greatest importance to his physician, and it is of equal

importance that our Oyster Legislators should clearly understand the true reason for their non-successful administration.

I state, then,—speaking chiefly of England and Wales (*c*)—that in spite of the flourishing condition of the Whitstable (*d*) Company, and the second and third-rate Thames and Medway, Colchester, Rochester, Faversham, and Ipswich Companies, our Oyster Cultivation is in danger of extinction, not so much on account of over-fishing, nor on account of the demand having outgrown the supply, but

BECAUSE OUR OYSTER LEGISLATION NEEDS REFORM.

This is the only possible remedy, which, once obtained, retained, and sustained, on the basis of the French or American present legislation—there will be no more ostracultural sorrow; no more vanishing of hard-earned cash into the at-all-times rather risky and too rapidly sinking fund of an English oyster-bed; there will be heard no more tales of bankruptcy and ruin; and such an occurrence (elsewhere stated) as that the expenditure of five hundred pounds should produce no more than a single oyster, would, instead of being a nationally disgraceful fact, be classed as a fabulous report of financial failure—a Münchausen fiasco—not possible of actuality, unheard of and unknown save in the fear-inspiring horrors of a drunken dredger's delirium.

I am using no figurative language in saying that I have felt deeply hurt at the callous indifference of tone in which I have heard read, or giggled over in quotation, the above sad item from (what, perhaps, I may be allowed to term)

(*c*) The fisheries of the two other countries being under the jurisdiction respectively of the Scotch Fishery Board and of the Inspectors of Irish Fisheries.

(*d*) The *one* bright pearl of England's Oyster Fisheries!

the "Curiosities of Oyster Culture," by some persons with whom I have come in contact, and have been saddened at the thought of what the foreigner must think of our faulty legislation, which involves the quite possible repetition of such an occurrence, the Quixotic squandering of our wealth, our stubborn foolhardiness in the persistence of erratic conduct, or our proverbial long-suffering and patience under social shortcomings or ministerial maladministrations.

In nothing that I can at this moment think of is the harmful folly of this more stinging apparent than in our system of oyster culture. It is true that the daily papers, from time to time, have published letters appealing for the utilization of our foreshores, or suggesting relative remedies all true enough in their way; but, unfortunately, they have been based upon such narrow experience that they are of little or no value as contributions to a broad, comprehensive view of the problem.

Some of these correspondents throw the blame of our failures upon over-dredging, or upon the spat having failed to find a suitable foothold; others upon climatic influence, or unpropitious physical conditions; others again, upon placing oysters intended for fattening on breeding grounds, and *vice versa*; while the few who have pointed out the true fault and remedy have done so with a very milk-and-watery admonition, lest a severer censure should be interpreted as being superfluously radical.

And so, it being unfashionable to blame our Legislators for their very wise ostracultural rules and regulations, all agree in throwing the blame on someone else, and all believe that some form of the business in which they are not interested is responsible for the present state of things, and should be altered or prohibited.

Having no convenient scape-goat on which to vent their spleen, the oyster question remains *in statu quo*, and the only wonder is that these would-be-reformers do not imitate the pious oystermen of Wellfleet, on Cape Cod, who, after they had exterminated their oysters by over-fishing, laid their loss upon Providence, which had, they said, punished them for their sins by inflicting a fatal disease upon the innocent oysters.

The contrast between the views upon the oyster question which are dawning upon the British public, and those which come from a broad-minded consideration of the question in all its relations, cannot be better illustrated than by the examples of France (already given), and that conveyed in the following extracts selected from Dr. Brooks' Report, in the numerical order of its chapters, as consecutively as is possible with, and necessary in, the limited space at my command. And, finally, as "The Maryland Report" is now very rare, and has been withdrawn from sale, I will begin by giving the reader a view of its object, in the following address :—

To the Trustees of the Johns Hopkins University.

In accordance with your request, a small edition has been printed, for the use of the University, of a Report of the Oyster Commission of the State of Maryland, which has just been presented to the Legislature of this State. Its author is one of our own staff, Professor W. K. Brooks, Ph. D., who has devoted the greater part of his time during the last eighteen months to the study of the problem of perpetuating the oyster beds of the Chesapeake. The fact that he was made a member of the Oyster Commission, by appointment of the Governor of the State, should not conceal the part which this University has taken in the prose-

cution of the enquiry. Dr. Brooks, for the last six years, has been the Director of the Chesapeake Zoological Laboratory, an organization maintained at the expense of the Johns Hopkins University, for the study of the manifold forms of living creatures which are found upon our sea-board. As long ago as 1878 he perceived the importance of the oyster, in its economical and in its scientific aspects, and began a series of prolonged, delicate, and original investigations, respecting the mode by which the young are propagated, and the conditions of their early life. The discoveries which he made were published in 1879, and have been fundamental to further practical attempts, on the part of Dr. Brooks and others, especially Lieut. Francis Winslow, U.S.N., Mons. Bouchon-Brandely, of Paris, and Mr. J. A. Ryder, of the United States Fish Commission, to secure the successful artificial propagation of the oyster in large numbers. They have also led to a study of the conditions which destroy the life of young oysters, and of the legislation which is requisite for modifying these conditions.

The report which follows discusses all these points. Its preparation devolved upon Dr. Brooks, as chairman of the Commission. I am confident that in all that he has done or said he has been governed by one consideration alone,—a desire to ascertain the exact facts, and to state them in such a way that others may understand them, and thus be enabled to protect and develop one of the most important industries of Maryland.

He desires to have it known that the Report is in great part a gift by the University to the people of the State, since it would have been impossible for him to have prepared it if the Trustees of the University had not allowed

him to devote a year to the work, while they continued to pay him the salary of his professorship.

D. C. GILMAN,

President of the Johns Hopkins University.

Baltimore, February 22, 1884.

*To the Honourable the General Assembly of the State of
Maryland.*

The Oyster Commissioners appointed by his Excellency the Governor of Maryland, under the Joint Resolution of the General Assembly of Maryland, assented to at the session of 1882, beg leave to respectfully submit the following report :—

The magnitude and complexity of the subject, and the diversity of the interests which are involved, has rendered the length of this report an unavoidable necessity, and we shall therefore present, first, a summary or abstract of the results of our examination of the question, and we shall then give our results and opinions in full. We have therefore divided the report into four parts : first, an outline or abstract of the whole ; second, a statement of the facts which we have been able to obtain ; and third, the recommendation of the measures of protection which we regard as necessary ; and fourth, a minority report by Wm. Henry Legg, stating his objection to some points of the report.

Respectfully submitted,

W. K. BROOKS, JAMES T. WADDELL, WM. HENRY LEGG,
Commissioners.

OUTLINE OF OUR REPORT.

As soon as possible after your Commissioners received notice of their appointment, they held a meeting for organization, and decided that their first duty

is to obtain accurate information as to the true condition of the oyster beds of the State by actual personal examination.

We have accordingly visited fifty-nine of our more important oyster beds, and have made three hundred and twenty-six examinations, and have accurately measured and counted all the oysters upon one hundred and twenty thousand nine hundred and fifty-eight square yards of oyster bottom, We are therefore in a position to state the present value of our oyster beds with very great accuracy; but the attempt to decide whether this value is diminishing, and if so, how rapidly, is attended with great difficulties, as there is no accurate official record of the condition of the beds in the past. The statements of interested fishermen, with limited local experience and with no written records, are clearly of little value in themselves, and in the absence of official records, we have been compelled to adopt an indirect method of comparison.

. . . . The results of our examination . . . show an average of one oyster to each four and a quarter square yards, or more exactly, two hundred and thirty-five thousandths of an oyster to each square yard. Our examination therefore shows that within the last three years our beds have lost more than 39 per cent. of their value.

. . . . (And this) fully justifies the worst forebodings, (and shows) that the oyster property of the State is in imminent danger of complete destruction. Having reached this conclusion, the next step was to discover the cause of the injury (and that arrived at by various methods was found to be), that the depletion of our beds is not strictly due to any particular method of gathering oysters, nor to the destruction of the young, nor to the working of the beds at wrong seasons, but to the great demand which

comes from improved means of transportation, and from the growth in our State of a great commercial industry, which has an unlimited and constantly increasing capacity for utilizing oysters.

No means of protection can have any permanent value unless they are based upon the fact that the present demand taxes the beds far beyond their natural productive power.

Of the ten and one-half million bushels of oysters which were gathered in our waters in 1880, only 875,000 bushels were used as food by the people of the counties, and 1,018,000 by the people of Baltimore and other cities of the State; while 8,675,000 bushels, or more than four-fifths of the whole, were consumed outside the State.

Those who hold that the people of our tide-water counties have a natural right to this supply of food may truthfully assert that, if the sale of four-fifths of our oysters to people outside the State were prevented, there would be an abundant supply for our own people; but all civilized communities have recognized the advantage of selling their productions in the best markets, and it is hardly necessary to point out the fact that it is not a few capitalists, but the thousands of oyster fishermen, who would suffer most by the destruction of the commercial business in oysters. The great mass of the oyster dredgers and tongmen are supported, not by the local demand, but by the wholesale dealers, and the destruction of the wholesale oyster business would deprive these people of the \$2,000,000 of earnings which are annually paid them by the dealers, and would deprive fully 50,000 persons of their means of support.

. . . Laws to regulate the length of the season, or the size of marketable oysters, or to compel culling on the beds, or to restrict the area open to dredgers, or to divide

the beds into open and closed districts, may all result in temporary improvement, and in the body of this report we have discussed various measures of this sort, and have recommended many changes in the existing laws, We have given careful attention to the possibility of artificially increasing the supply (of oysters). . . . The greater part of this report is made up of information upon this subject from various sources, and we believe that careful examination of it will convince all of the truth of the conclusion which we ourselves have reached—that the oyster bottoms of our State are of greater value than the dry land, and that they will some day support a great and prosperous population.

Their value in the past has been inconsiderable as compared with their possible value in the future, for while the oyster fishermen have never earned much more than two million dollars a year, it is no exaggeration to state that our grounds are capable of yielding hundreds of millions of dollars annually.

. . . . In another part of our report we have shown that, if all the grounds suitable for planting in our waters could be made as profitable per acre as the oyster grounds of the State of Rhode Island now are, they would return annually to their cultivators the sum of six hundred million dollars, and our beds are in reality far more valuable than those of Rhode Island, as our waters are free from the destructive enemies which there often destroy a large bed in a few days, and our milder climate protects our oysters from destruction by ice and frost.

. . . . Oyster farming (which is the rearing of oysters from the egg, and therefore true farming), the most important source of the oyster supply, is practically unknown in Maryland.

. . . The industry is profitable almost beyond conception, and we are told on official authority that a crop of oysters valued at eight million dollars was raised in this way upon a French farm of 492 acres ; while upon another French farm of 500 acres 16,000,000 oysters were taken in six tides, although there were no oysters to be found there when the farm was established, five years before.

Ingersoll, in his "Report on the Oyster Industry of the United States," says that twenty bushels of shells, laid down anywhere in Barnegat bay, New Jersey, will produce one hundred bushels of oysters, and a Connecticut writer gives the following account of the result of three years of oyster-farming under wise laws, in that State :—

"Fifty thousand acres of entirely barren ground, covered thirty, forty, and fifty feet deep by the waters of Long Island Sound, have been made into productive oyster beds, and have multiplied by a hundred-fold the production of native oysters. Ten years ago tens of thousands of bushels of oysters were imported from New York, New Jersey, and Rhode Island, and now hundreds of thousands of bushels are yearly exported to these States and to Massachusetts. Millions of dollars are now invested in the industry, thousands of men and women are employed, millions of bushels are in growing crops, and hundreds of thousands of dollars yearly come into the States as proceeds of exported oysters. The oyster authorities have paid more than fifty thousand dollars in the towns and to the State for grounds to cultivate, and pay a yearly tax to a large amount."

According to Ingersoll, 515,000 bushels of seed oysters were in 1879 taken from the Chesapeake bay, to be planted in Connecticut, and three years of wise management have produced such a change that one firm shipped to San Francisco, in the spring of 1883, 15,000,000 young oysters,

which had been reared on the Connecticut oyster farms, and were used for planting on the Pacific coast. This State is now able to sell seed oysters to the planters of adjacent States, besides sending an immense supply to Europe.

. . . . There is no measure of public policy in our State which is of greater importance to our people as a whole, or which is capable of contributing more directly to our growth and prosperity than this matter of oyster farming.

The only obstacle in the way of the development of such an industry among us is the existence of the sentiment that, since the oyster grounds belong to the whole people, they are not a proper field for private labour and industry. Sea fishes have always been regarded as common property, because it is not within the power of individuals to improve them, or increase their numbers or value ; but this is not true of oysters. An oyster is as subject to improvement by cultivation as a potato, and the cultivation of oysters is, therefore, a perfectly proper and legitimate employment for labour and capital, and the common right to the beds must in time give way to private enterprise, just as surely as the common right to the natural products of the soil has given way before the progress of civilization.

Such a change as this cannot be brought about rapidly without causing great hardship, and it is therefore best that it should come slowly ; but the common right of all our people to the use of the oyster beds is a very different thing from the right of a portion of our people to exterminate the beds ; and since it is plain that the interest of the whole people demands an immediate change in our oyster policy, your Commissioners believe that steps should now

be taken to render possible the growth of our oyster farming industry in the future.

The resolution under which we were appointed says that we are to lay before the General Assembly such information as will enable it to devise laws for the immediate protection of the oysters. We have therefore brought together, in the body of our report, from all the sources within our reach, all the information which we have been able to obtain, and your Excellency will there find a brief sketch of the oyster industry and oyster laws of Europe, of Canada, and of the Atlantic States of our own country.

Our report also contains many suggestions which we have omitted from our bill, as they refer to points upon which immediate legislation does not seem imperatively necessary.

THE POSSIBILITIES OF THE MARYLAND OYSTER INDUSTRY.

No one who is familiar with the history of the oyster beds of other parts of the world can be surprised at the deterioration of our own beds.

. . . . The immense area covered by our own beds has enabled them to withstand the attacks of the oystermen for a much longer time (than those of England, France, Germany, Canada, &c.); but all who are familiar with the subject have long been aware that our present system can have only one result—extermination.

. . . . It is a shame that the gifts so lavishly bestowed by nature upon Maryland and Virginia should receive so little practical appreciation.

There has been no lack of warning, nor can our people plead ignorance of the true remedy. In (a) paper (referred to) one of your Commissioners discussed at considerable

length, and warmly recommended, a plan which was employed two years after by the people of Connecticut on a very extensive scale, and with such good effect, that the oyster grounds of that State have been raised in three years from a position of insignificance to the front rank.

If the importance of shelling our oyster bottoms with dead and clean oyster shells had been recognized at the time when we recommended this practice, and if the laws which are needed for its encouragement had then been enacted, our oyster supply would now be in no danger of exhaustion.

The recommendation met with no attention, as it was looked upon as the *unpractical* view of a student; but our people may perhaps be able to learn from the *practical* example of Connecticut what they would not learn on the authority of a scientific paper. . . . If our population were increased fifty fold, the oysters needed for home consumption would even then be only a small part of the supply which our waters can be made to furnish; and everyone who is interested in Maryland, all business men who will be benefited by an increase in wealth and population, all farmers who pay taxes to the State, and all persons who own property here, should awaken to the fact that our greatest source of wealth is almost absolutely undeveloped.

The wealth which is within the reach of our people and their descendants, from the oyster grounds of the State, is great almost beyond expression, and it is not too much to affirm that the money value of the grounds under the water is equal to that of the dry land.

. . . . Our present oyster policy has had a thorough trial, extending over a long term of years, and

we may therefore ask now, with perfect propriety, what it has accomplished.

. . . . It has paid a profit of less than 100 per cent. annually upon the capital invested in the business, while money thus invested in other States has paid an annual interest of more than 200 per cent.

It has given employment to about fifty thousand of our people for part of the year, while our grounds should give profitable employment to five hundred thousand people for the whole year.

It has done nothing to encourage migration into our State, although our natural advantages, if they could be utilized, would draw to us a very desirable class of emigrants.

. . . . Our six hundred thousand acres of oyster ground has paid to the State treasury about fifty thousand dollars a year, and it has paid about ten thousand dollars a year to the school fund; while the Governor of Rhode Island reports that his State will this year receive a revenue of over eleven thousand dollars from eleven hundred acres of oyster ground, none of which is so valuable as that of our State. On the same basis our revenue should be more than six million dollars a year.

. . . . The statement that the public treasury of Maryland receives over fifty thousand dollars a year from the oyster grounds seems, at first, to imply that the oyster industry contributes to the general expenses of our government, but more careful examination shows that this is not the case. The revenue is not only very much less than it should be, but the cost of collecting it is in excess of the receipts. In proof of this we refer to the following table of receipts and expenses from this source, between 1878 and 1883.

It will be seen from this table that, while the receipts for the past five years have been the very considerable sum of \$210,332.24, the expenses have been \$217,753.07, or \$7,420.83 more than the revenue.

. . . . "The Middle States have some \$4,871,000 of capital embarked in the fisheries, employ over 19,000 persons, and return a gross income of nearly \$9,000,000.

"The Southern Atlantic States have invested over \$8,000,000 of capital, employ 57,000 persons, and collect a gross income of \$9,562,000.

"It will be noticed that while the Southern fisheries have nearly twice the capital invested, and employ three times as many persons as the Middle States, yet the income returned is only one-eighteenth more than that of their Northern competitors.

"The gross income of the oyster fishery in the Middle States is 204 per cent. of the invested capital, while in the Southern States it is only 94 per cent.

"To sum up this distressing exhibit, statistics show that one oyster from the Middle States is worth four from the South; that to get these four oysters, or one for that matter, the Southern fishery uses from two to three times as many men as their neighbours and rivals; and that notwithstanding the immense yield of the Southern fishery, it pays not half so much in gross income as that of the Middle States, and that out of this must come the wages of double the number of employees."

THE CAUSE OF THE EXHAUSTION OF THE BEDS.

. . . . We state then, in capital letters, that our beds are in danger,

BECAUSE THE DEMAND HAS OUTGROWN THE SUPPLY.

There are only two possible remedies. Either we must diminish the demand by killing the packing industry which has created it, or we must increase by artificial means the natural supply of oysters.

. . . . The tongmen know that most of the oysters have been taken away by the dredgers, and they

therefore advocate the prohibition or restriction of dredging. Ignorant of the fact that in localities where no dredging has been allowed the natural beds have been exhausted by tongmen, just as soon as a demand for the oysters sprung up, they believe that the prohibition of dredging is all that is needed to restore the beds. The dredgers, on the other hand, attribute the injury to the law which allows the tongmen to take oysters for private use in the summer, forgetting that the beds of Connecticut are rapidly increasing in value under a law which allows not only tonging, but dredging as well, all through the year. The small dredgers and scrapers hold that the larger vessels are destroying the oysters by the use of heavy dredges, although the Connecticut farmers find it to their interest to use on their own private beds far heavier dredges, which they drag over the beds by steam.

Many of the oyster packers, who carry on their business only in the winter, believe that all the damage is due to the oystermen who fish in March, April, and May; and men who have money invested in the oyster business in Maryland believe that the exportation of oysters in the shell, and especially oysters for planting in Northern waters, is the cause of the mischief.

. . . . We can hardly be surprised that our people should exhibit total ignorance of the true cause of the destruction, when we recollect that there is not a single word in any of the laws of Maryland which indicates that our legislators are aware that the supply of oysters can be artificially increased, or that there is need for any such increase.

. . . . Lieut. Francis Winslow . . . recently published the following expression of an opinion, which is

identical with the one we have given above—that the demand has outgrown the supply.

He says: “No mere restriction of the fishing can possibly accomplish the desired end. It may prevent the extinction of the beds as they are now, though that is doubtful. It certainly will not relieve in the least the present condition of the market. What should be done is to adopt a policy similar in essential features to that of Connecticut. The fishery of that State is one of the few instances of recuperation on record. I know of many destroyed oyster fisheries, and I know of a few that have been rebuilt, and I find one cause common to all failures, and as common to all successes. In the first instance, the fishery has been common property, its preservation everybody’s business—that is, nobody’s—and consequently it has not been preserved. In the second instance, the fishery has been conducted and owned by persons singly and together, as private property; it has been this, that, or the other man’s business, to see to its preservation; that is, its preservation has been everybody’s business instead of nobody’s, and consequently it has been preserved.”

The emergency can be met by legislation to prohibit dredging and wholesale fishing, and to drive the oyster business out of our State, but we can hardly conceive a greater misfortune to our people than this would be. Still, if this were the only way to preserve our oysters, we should be the first to recommend it, and thus preserve for the people of our tide-water counties the supply of cheap food, which nature has placed within their reach; but, fortunately, this is not the only remedy, and it is quite possible to increase our annual supply of oysters many hundredfold.

The ignorance of our people regarding the means which must be employed for this purpose, and their prejudices upon the subject, are so great that this cannot be done immediately, and it is therefore necessary for us to do all that can be done to preserve our present resources, and to keep our beds from complete destruction, until our natural supply can be supplemented by artificial methods.

ON THE WANTON OR UNNECESSARY DESTRUCTION OF
OYSTERS, AND ON THE PROTECTION OF YOUNG
OYSTERS AND THE RESTORATION OF OYSTER SHELLS
TO OUR WATERS.

One explanation which has been urged to account for the destruction of our oyster beds is the wanton or unnecessary destruction of young oysters. Upon the piles of shells which are thrown out from the packing houses great numbers of young shells can often be found. They are, of course, dead, and as they are too small to be of any use, their destruction is a clear loss to our people. It is impossible to prevent this from happening occasionally, as in many cases the little oysters are so small, and so firmly fastened to the old one, that they cannot be removed without destroying them; and even if the oystermen could be compelled to throw back into the beds any large oyster which has small ones fastened to it, there is reason to doubt whether this would be advantageous, for one full-grown oyster, like a bird in the hand, is more valuable than two small ones, which may or may not grow up to maturity. We believe, however, that in cases where great numbers of young are fastened to the large ones, the use or destruction of them at the packing house should be discouraged. This difficulty will disappear with the growth of the planting industry, for small oysters will then be

valuable as seed, and they will pass into the hands of the planters instead of going to the packing houses. The true remedy, therefore, is the encouragement of planting, and if our people would develop this business immediately, all need for special legislation would disappear.

. . . . The destruction of young oysters at the packing houses is trifling, however, compared with that which results from violations of the culling laws. When a dredge is brought up from an oyster bed it usually contains a few marketable oysters and great quantities of empty shells, which are often covered with young oysters. The law requires that these shall be thrown back upon the beds where they are taken, under a penalty of three years' imprisonment, or three hundred dollars fine, or the forfeiture of the boat used ; but the enactment of this law has failed to remedy the evil.

It is, and always must be, difficult to enforce a culling law ; and as the captain of a dredging boat wishes to improve his time on the beds to the best advantage, and to make the most of the pleasant weather while it lasts, it is of course to his interest to fill his boat as quickly as possible, and all hands are therefore so fully employed in catching oysters that there is no time to cull them.

Even when a captain is disposed to cull on the beds he may be compelled, by stormy weather, to run for harbour, and will then employ his crew in culling the oysters while lying in harbour. The shells are then dumped overboard in heaps around the anchorage, and even if the bottom should by chance be favourable for the growth of the oysters, they are smothered and killed under the heaps of shells.

The only way in which this can be prevented is by making it to the interest of the fishermen to save rather

than to destroy the small oysters, and this can be done by the encouragement of planting.

. . . . The aim of the culling law is twofold : first, to preserve the young oysters ; and secondly, to compel the return of the dead shells to the beds, that they may serve for the attachment of spat. The value of these shells for this purpose is not very great, as they are usually decayed and slimy, and covered with sponge ; but it is undoubtedly true that they are sufficiently valuable to justify the culling law. The dry, clean shells, which accumulate at the packing houses during the winter, are far more valuable ; and if these could be returned to the beds in the summer, a great increase in fertility would certainly follow.

. . . . The improvidence of the people of the United States in dealing with their oysters, so long as they were abundant, has been almost beyond belief.

. . . . Mr. Earle, of the U. S. Fish Commission, states that no longer ago than 1879 the oystermen of Pamlico Sound, in summer, when the weather became too warm for them to safely carry their oysters to market, were in the habit of catching "coon oysters," and carrying boat-loads of them up the rivers to the farmers, who purchased them for from 3 to 5 cents a bushel, and used them for manure.

In Maryland we have no general law forbidding these practices, although there are several local laws, such as the law of 1868, imposing a fine of \$500 upon any one who takes oysters in Worcester county for the purpose of converting them into lime, and the law which imposes a fine of \$10 upon any one who catches oysters for manure in Somerset county, or any person in said county who purchases oysters for manuring land, from any person who

shall have caught them in the waters of said county. The wording of the law seems to have been designed to permit the residents of this county to purchase, outside the county, oysters to be used for manure, and therefore suggests that a State law may be necessary.

We therefore recommend that a law may be passed prohibiting, under a penalty of three years' imprisonment, for each offence, the taking, or sale, or use of oysters as manure, or to be burned in lime-kilns, or to be used in the manufacture of iron.

THE RETURN OF SHELLS TO THE BEDS.

As it has taken our people nearly two hundred years to discover that we cannot afford to destroy oysters in this way, we can hardly expect them to perceive that clean, empty shells are also so valuable that their use for lime, &c., should be prohibited.

One of your Commissioners called attention to the very great value of oyster shells in 1879, . . . and showed that a great increase of fertility would follow the return of the shells to the waters of our bay.

The history of the Connecticut oyster fisheries for the last three years shows that, if this advice had been followed, our beds would not now be exhausted; and we therefore quote the passage from page 29 of the "Report of the Commissioners of Fisheries of Maryland for 1880," in which this advice was given, together with the reasons for it:—

"As the young oysters swim to and fro in the water, they are carried to great distances by the tides and currents, and reach all parts of the region of water in which the parent bed is situated. In a favourable year a floating plank or bush, or piece of driftwood, will be found to

become covered with small oysters which have fastened to it, although it may not be within miles of any natural oyster bank. The fact that the young may be collected in this way, in any part of the Chesapeake bay, shows that the young oysters must settle down upon the bottom in nearly all parts of the bay, and we should expect the adults to have an equally general distribution.

“This is far from the case, and nothing would be farther from the truth than the idea that the bottom of the waters of the oyster region is uniformly covered with oysters, and that it is only necessary to throw a dredge overboard, and drag it along the bottom for a short distance, in order to bring it up full. Nothing could be a greater mistake, for both in this country and in Europe the oysters are restricted to particular spots, “beds” or “banks,” which are as well defined, and almost as sharply limited, as the tracts of woodland in a farming country. These beds are so well marked that they can be laid down on a chart or staked out with buoys, and even in the best oyster regions they occupy such an inconsiderable part of the bottom that any one ignorant of their position would have very little chance of finding oysters by promiscuous dredging. Although the young are distributed every year, by tides and currents, to all parts of the bottom, the dredge very seldom brings up even a single oyster outside the limits of the beds.

“The restrictions of the oysters to certain points does not appear to depend upon the supply of food, nor upon the character of the water, but almost entirely upon the nature of the bottom. The full-grown oyster is able to live and flourish in soft mud, as long as it is not buried too deeply for the open end of the shell to reach above the mud, and draw a constant supply of water and food into the gills.

. . . . "The living and dead shells of the adult oysters furnish the best surface for the attachment of the young, and for this reason the points where oyster beds are already established are those where the young have the most favourable surroundings and the best show for life, and the beds thus tend to remain permanent and of substantially the same size and shape.

. . . . "It is well known that shell-fish of all kinds thrive best where the supply of lime is greatest.

. . . . "The dead oyster shell is soon corroded, and in a few years entirely dissolved by the sea water ; and I think this fact is another reason why the young oysters thrive best on a natural bed.

"How far the supply of oysters is limited by the supply of lime it is impossible to say ; but when we recollect how important it is that the young oysters should soon find solid bodies to fasten themselves to, and that they should protect themselves by strong shells of their own as quickly as possible, it will be seen that the danger of exterminating a valuable bed by over-dredging would be much less if the empty shells were replaced upon the beds."

. . . . If . . . a law were passed forbidding the dumping of shells anywhere except upon designated areas, where they would be useful, we believe that our public beds could be reshelled without expense to the State ; and as it is perfectly proper that the packers, who, by the demand which they have created for oysters to supply people outside our State, have caused the need for legislation, should bear the expense of replenishing the public beds, we recommend that a law be passed to forbid the use of oyster shells in lime-kilns, or in the manufacture of iron, or for road making, or wharf building, and that a law be passed requiring the commander of each police boat

to designate spots in his district where shells may be deposited upon the bottom, and that a law be passed directing that no shells shall be deposited in our waters from vessels at anchor, or from vessels which are not under weigh, or at any spot except those designated for the purpose by the officers of the oyster police.

EXPORTATION OF OYSTERS FOR PLANTING.

One of the causes to which the destruction of our oyster beds is often attributed is the exportation of small oysters into other States. We have tried to gather information as to the extent to which this is practised, but it is difficult to obtain exact statistics. . . . Within the last three years the growth of the oyster farming industry in Connecticut has caused a very great reduction in the demand for Southern oysters, as the farms of this State are now able to supply the local planters, as well as those of Rhode Island and Massachusetts. The Connecticut farms have this year furnished "seed" oysters for exportation to Europe and the Pacific Coast, and quantities have been sold in New York also. It is not probable that the total exportation of oysters for planting from the various waters of Maryland will this year exceed a million bushels, and the demand from New York and Rhode Island will probably continue to diminish from year to year, as the supply from the Connecticut farms increases; but even a million bushels is a tenth of our total crop, and there can be no doubt that the demand which has overtaxed our beds, and led to their destruction, has been materially increased by the exportation of oysters for planting, and the question whether this practice should not be discouraged is therefore a proper one for discussion.

At present the chief demand for seed oysters comes from Delaware, and I accordingly quote in full Ingersoll's

statement of the magnitude of the supply used by the planters of this State :—

“ PLANTING SOUTHERN OYSTERS IN DELAWARE BAY.

There remains now to be considered the great business of transplanting and maturing Southern oysters in the waters off this shore. Though this stock is chiefly owned in Philadelphia and operated by Pennsylvania, yet its consideration belongs properly here, since the beds are wholly in Delaware's waters.

“ The statistics I give in respect to this were furnished me chiefly by Mr. J. C. Cleaver, collector of the Chesapeake and Delaware Canal Company at Chesapeake City, Maryland, and refer to the last half of 1879 and the first month of 1880, completing an ‘ oyster season.’

“ All the Southern oysters which are brought to Delaware bay or to Philadelphia, both for planting and for immediate consumption, come through this canal, which leads from the Chesapeake. There may possibly be half a dozen outside trips made (all from Chincoteague island) in the course of the year, but this is a small exception.”

“ The vessels as a rule engaged in this traffic are ‘ wood-droggers,’ schooners of light draught, and able to carry from 500 to 1500 bushels. During the planting season they will average about 1300 bushels per load, but when running direct to market, in winter, carry only 900 bushels, the difference arising largely from an absence of any deck-load in the latter case. The number of schooners thus used varies from year to year; but the number of trips during the season reported upon by Mr. Cleaver was 868. At \$100 a trip, charter-pay, these schooners earned that year, therefore, \$86,800. Sometimes an even \$100 is given to make the trip, and sometimes a rate of about \$10 a day

is paid, but it amounts substantially to the same thing. In addition, the charterer pays the canal expenses, consisting of entrance toll, towage, and dues of 85 cents a ton on cargo, amounting in all to about \$50. The canal thus receives an annual revenue from this source of about \$4340."

"The schooners range in value from \$1000 to \$6000. The owners pay the captain of such a schooner, who must know all the little creeks and oyster-buying nooks along the whole Chesapeake coast, and be a capable man at a bargain for his employers, about \$50 a month. The men in the crews get \$25. The provisions supplied by the owners are said to be abundant and of good quality.

"Among this fleet are about 25 'role captains,' who own their vessels entirely, hire their own crew, get cargoes from the South with their own money, and plant on beds claimed and prepared by themselves. Attending to their plantations personally, they bring their cargoes to the market in the fall, in their own schooners or sloops, and leave them to be sold there on commission. They are thus both planters and carriers.

"During the fall and winter months most, if not all, of the vessels go directly to the Philadelphia market, and their cargoes enter into the immediate consumption of the city. Sales are made from the hull of the schooner, without unloading into a warehouse. The number of trips made for this direct market consumption makes only about one-fourth of the total recorded as passing through the canal. Three-fourths of the oysters brought out of the Chesapeake are intended to be planted, and find their destination in the beds along the western shore of the bay.

. . . . "When a load of oysters for planting arrives from the South, the owner of the cargo sends on board the

vessel all the men he has, and the schooner then sails back and forth around and over the designated ground. The effort in loading is to have as much as possible of the cargo on deck. It is an easy matter then, as the vessel proceeds, to shovel overboard; and as she is constantly changing her position, and the men shovel uninterruptedly until the whole load is overboard, the oysters are pretty evenly distributed. An ordinary crew of five will thus unload 400 bushels in an hour, for five or six hours in succession. Adding this expense to his first cost and charges, a planter who puts down large quantities expects the costs of his various lots of oysters, big and little together, will average about 25 cents a bushel."

. . . . In discussing this subject, we must bear in mind the fact that northern fishermen or boats are not allowed to catch oysters in our waters, and that the industry contributes to our State Treasury, and gives employment to our people, for all the oysters which are exported for planting must be purchased from our licensed fishermen.

. . . . So far as the exported oysters are mature and marketable for food, it is obviously to our interest to encourage the business, which is perfectly legitimate. The only ground upon which the practice can be objected to is that it leads to the sale by our people of oysters which would be much more valuable to them if they could be kept in our own waters until they reached maturity.

. . . The development of the Maryland planting industry is . . . the true remedy for the evil. But as this cannot be effected immediately, and as our beds are not now in a condition to furnish seed for other States, . . . we recommend that for two years our beds shall be closed on April 1st.

A DISCUSSION OF THE PROPOSITION TO PROHIBIT DREDGING, AND AN EXAMINATION OF THE BEST METHOD OF PROTECTING AND REGULATING THE TONGING AND PLANTING INDUSTRIES.

The favourite remedy for the difficulty, at least among those fishermen who are not dredgers, is the prohibition of dredging. Everyone knows that our beds are deteriorating because they are excessively fished, and everyone knows, too, that most of this fishing has been done by dredgers. It is therefore natural to conclude that since the dredgers have done the damage, the prohibition of dredging will cure the mischief, but this is by no means true. The great demand for oysters, which has come from the growth of the packing industry, has been supplied by dredgers, because the dredge is more effective and economical than the oyster tongs; but if dredges had not been invented, the demand would still have been supplied by the much more expensive and laborious method of tonging, and the prohibition of dredging now would simply cause an increase in the number of tongmen. The beds in deep water would escape, but they would then be, like many of the deep water beds of Virginia, of no use to anyone except pirates, and all the beds which could be reached by tongs would be as badly off as ever.

In order to show that this is the case, and that where no dredges are used the excessive working of the beds with tongs soon causes their destruction, we will here note some cases where beds have been exterminated with tongs alone.

. . . . In the early days of the colony of Rhode Island, oysters were found there in great abundance. No dredging has been allowed in this State for more than one hundred years, or since October, 1766, at which date the

taking of oysters by drags, or otherwise than by tongs, was forbidden under a penalty of ten pounds for each offence, but the Rhode Island beds are now almost completely exhausted. They yield no marketable oysters, and the only place where seed oysters for planting can be procured, in any considerable quantity, is a space of about five miles above the Seekonk River, and the preservation of this bed is due to the fact that the oysters are bright green and are not marketable. Rhode Island has a great and profitable planting industry, but the seed oysters which are used for planting are purchased outside the State. As no dredging has been permitted upon these beds for so long a time, the dearth of oysters in waters where they formerly abounded is certainly due to persistent raking and tonging.

. . . . Ingersoll gives the following instructive account of the extermination, within the last few years, of another valuable and prolific bed upon the New Brunswick coast, by rakes and tongs alone :—

In 1876, a fisherman says that in two weeks over 4000 barrels of oysters were taken away from the beds at Betlammin, in New Brunswick, by ships and schooners which brought their cargoes from the small raking boats upon the beds. At this time the oysters were distributed everywhere over the harbour so thickly that every square foot seemed to be occupied, and the beds swarmed with small boats, each operated by two men. Four years later, in 1880, the oysters were almost exterminated.

Old men still remember when rich beds were to be found in Hillsborough bay, in New Brunswick. The oysters were so abundant that they seemed inexhaustible, and a tonging boat could take eight bushels an hour. They have been almost entirely destroyed by tongs alone, and they now yield only a few bushels a year.

. . . . The early settlers of New England continually refer to the abundance of oysters, at points where not a single oyster can now be found. In 1634 William Wood, in a work on New England, speaks of a great oyster bank in the Charles river, near Boston, and another in the Mystic river, each of such size as to obstruct navigation. The oysters were the long, slender "coon" oysters, which are still to be found in our own waters on undisturbed natural beds. Of their size and form he says:—"They be great ones, in form of a shoe-horne; some be a foot long. These breed on certain banks that are bare every spring tide. This fish, without shell, is so big that it must admit of a division before you can well get it into your mouth." The oyster beds in these two rivers are spoken of by many of the early writers, but they are now gone so completely that there is not even a tradition to mark the place where, in 1634, according to Wood, "the oyster banks do barre out the bigger ships."

In 1637, Thomas Morton, writing of the Plymouth Colony, says:—"There are great stores of oysters in the entrances of all rivers; they are not round as those of England, but excellent, fat, and all good. I have seen an oyster bank a mile in length."

. . . . In all of these cases the exhaustion of the beds has been brought about almost or entirely without the use of dredges, although in a few cases dredges may have been used to a slight extent.

Enough instances have been given to show that the prohibition of dredging will not save any bed which can be reached with tongs, and as the dredge is a much more scientific, effective, and economical apparatus than the rude tongs which it has superseded, there does not seem to be any reason why its use should be prohibited.

. . . . In one way the use of dredges is a positive advantage to the beds. . . . The dead shells which are found on an unworked bed are usually so covered with sponge, slime, and other substances, that they furnish no clean surface for the attachment of spat ; and as dredging tends to turn up clean shells, to break up and scatter the clusters, and to tear away the sponges and other foreign bodies, it is a positive benefit to the beds. . . . the teeth of the dredge take hold of the rank growth of the oyster beds, and, by being dragged through them, loosen them and give them room to grow and mature properly ; moreover, beds are continually increased in size, for when the vessel runs off the rock with the chain-bags filled with oysters, the oysters are dragged off on ground where no oysters existed, and thus the beds are extended ; and when the vessel is wearing or tacking to get back on the oyster beds, the catch just taken up is being culled off, the cullings thrown overboard (to) form new cultch for drifting spat to adhere to.

. . . . Many persons who do not advocate the total prohibition of dredging, believe that the size of the dredging boats, and the size and weight of the dredges, should be restricted by law. They give two reasons why the size of the boat should be restricted, urging that the large boats are able to work upon the beds when the police boats cannot venture out, and that their size permits them to use very large dredges, and thus catch great quantities of oysters.

The police boats are unfit for service in rough weather, but that does not seem to be a sufficient reason for rendering the dredging boats unseaworthy also, but rather for constructing better police boats.

It is asserted that the use of large dredges causes much evil, as they ruin the beds by crushing or smothering, or burying in the mud, more oysters than they capture ; but the private farmers of Connecticut find it to their advantage to use much heavier dredges, and their farms improve under this treatment, although very heavy dredges are hauled by steam over the beds, even in the spawning season.

After carefully considering the subject, your Commissioners . . . recommend that dredging be prohibited upon the public beds in the Potomac River and in Pocomoke Sound ; but this recommendation is made as a political necessity, as the State of Maryland has no power to prevent illegal dredging in these waters, while she has the power to prohibit all dredging. We do not believe that this measure is desirable in itself, but it is the only measure which it is in our power to adopt.

If the prosperity of the natural beds were the only thing to be considered, we should, for the reasons which we have just given, favour the opening of all our oyster area to the dredgers ; but the welfare of the beds is not the only thing. The rights of the tongmen and those of the planters also demand consideration. At present it is well known that there is inadequate protection for our planted oysters, and that the law which prohibits dredging in most of our rivers and inlets is of no effect. Almost every day the newspapers contain accounts of the piratical incursions of the dredgers upon these reserved grounds, and the evil increases from year to year as the large beds in the deep waters become depleted. The chief duty of the nine sail-boats of the State fishery force, as at present constituted, is to guard the tonging and planting grounds from the depredations of dredgers, and the lack of efficient protec-

tion is usually attributed to their neglect of their duty; but the well known fact that Virginia, which maintains no oyster police, suffers very much more than Maryland, shows that our navy does afford some protection, and no one who is familiar with the subject can wonder that the service is not more efficiently done.

. . . . The complexity and indefiniteness of the boundary line is in itself a strong temptation to the dredgers to trespass beyond it; and while the organization of the oyster navy is a pressing necessity, the establishment of a well-defined boundary is a matter of even greater importance. We have shown again and again in this report that private cultivation of oysters is the true solution of most of our difficulties; but no one cares to engage extensively in the planting of oysters which may at any time be stolen by dredgers, and no great growth of the planting industry can be hoped for until the boundary of the bottoms reserved for tonging and planting, and closed to the dredgers, is simplified.

. . . . We also recommend certain changes in the law relating to tongmen. At present the tonging license only permits the taking of oysters within the county where the license is granted; but as the public oyster beds are the property of the whole State, and not of any particular county, we recommend that such a change be made that any holder of a tonging licence may take oysters in any waters which are open to the public. As the State bears the expenses of protecting the rights of the tongmen, we recommend that all money received for tonging licenses shall be paid into the State Treasury, to the credit of the oyster fund.

ON THE CLOSED SEASON.

Among the favourite remedies for the destruction of the oyster beds, the shortening of the season is a favourite measure, and it has many advocates. This remedy seems, at first sight, to be an effective one, but a little thought shows that it is, in reality, of no very great value.

So long as our present oyster policy is maintained, it will be necessary to have a closed season, to facilitate the enforcement of other legal measures; but as it is clear to everyone that a good number of fishermen, working upon a bed for a short season, will do just as much damage as a lesser number working for a longer time, we cannot hope that laws to shorten the season will, in themselves, effect any great improvement in the condition of the beds.

. . . . In Massachusetts any resident may take oysters for family use, between September 1st and June 1st, but no one can take them without a permit between June 1st and September 1st, although the local authorities have the power to grant permits to fish for oysters at any time.

Some of the public beds of Rhode Island are open to residents between September 15th and May 15th, while others are open *only between* April 1st and June 15th, but no one can take more than twenty bushels in one day.

Connecticut has no closed season, and her public as well as private beds are fished at all times. The beds in the river Thames, however, are closed by a local law between March 1st and September 1st.

New York has local laws for the closure of the beds of certain regions at specified times, and some of the towns have town laws to the same effect; thus the beds of Great South Bay are closed by a State law from March 1st to September 1st, and those in Harlem River from June 1st

to August 30th, while the town of Brookham has a town law closing the beds, which furnish the well-known "Blue Point" oysters, from June 15th to October 1st.

In certain counties of New Jersey, the closed season is from May 1st to September 1st; in others from July 1st to September 1st; and in still others from May 1st to October 1st.

The public beds of Delaware are closed from April 30th to September 1st.

In Virginia the closed season is from May 1st to September 1st, but any resident may catch two bushels a day for family use, and any owner of planted oysters may catch them at any time, and in any quantity, for family use.

. . . . In Maryland no dredging is allowed between April 1st and October 15th, and no oysters in the shell can be carried outside the State between April 1st and September 1st.

. . . . It will be seen by examination that almost the only thing which these laws have in common is the prohibition of oyster fishing in the summer months, and to this there are exceptions, as some of the Rhode Island beds are open only in the summer, while those of Connecticut are open at all times. This provision, which is borrowed from the laws for the protection of game, is based upon the fact that this time is the spawning season. Game birds soon desert a region where they are disturbed in the breeding season, and as they lay few eggs and care for their helpless young, the destruction of an old bird at this time may result in the death of the whole brood. The provision of the game law, which forbids the capture of game during the breeding season, is therefore a wise one; but oysters are very different from game birds. They discharge vast numbers of eggs into the water, but they take no care

of their young ; and while it is true that the removal of too many mature oysters from a bed destroys its productiveness, the time when they are removed is a matter of no consequence, and over-fishing in December is in this respect as bad as over-fishing in May.

One of your Commissioners has made a study of the spawning time of our oysters, and has carried his observations over several years. He has found spawning oysters in our waters in every month in the year except December, January, and February, and he has had no opportunity to visit the beds during these three months.

By far the greater number of these oysters, however, are found to spawn between May 20th and July 1st, and although the temperature of our spring months causes considerable variation, this period may properly be called the spawning season.

At any time before May 20th the disturbance of the beds can do little harm, and the experience of the Connecticut oyster farmers shows that the thorough raking of the beds, just before the spawning season, is a positive benefit. The young oysters cannot attach themselves to dirty and slimy shells, and if all the sponges, hydroids, and seaweeds could be dragged from our beds in April and May, and if the old decayed and slimy shells could be ploughed under, and covered with the cleaner shells from below the surface, by dredging just before the spawning season, the fertility of the beds would be greatly increased, and there is, therefore, nothing in the nature of the oyster to demand the closure of the beds in April and May.

. . . . We show elsewhere that the States where the oyster industry is most prosperous have found it necessary, and to their advantage, to use the natural beds chiefly as a supply of seed for planting, and we believe that when-

ever the people of our State are prepared to use our great natural advantages for oyster culture, it will be wise to throw open the natural beds in the summer time ; but at present such a measure would simply result in the depletion of the beds, without any compensating advantage.

Soon after the young oysters are born they fasten themselves to stones, gravel, empty shells, living oysters, and other clean, hard substances. They are at first so small that they are in no danger of injury by dredgers, and there is, therefore, no reason why the taking of marketable oysters should not be continued all summer, if the large oysters could be taken away without the young ones ; but these are at first so small that they are invisible, and for several months they are too small to be removed from the shells or larger oysters. As it is very difficult to enforce the culling laws, the opening of the public beds immediately after the spawning season would cause millions of the small oysters to be carried away on the shells ; and even if the culling laws could be enforced, many of the small oysters would be carried away on the large ones. This would do no harm, and it would, in fact, be a great advantage, if the small oysters were used as seed for planting ; but at present most of them are destroyed.

. . . . In another part of our report we recommend that each public bed be examined annually, in order to determine how many oysters it can yield without injury. This examination should be made in August or September, in order to learn how many young oysters have settled upon the bed, and as the analysis and publication of the results of this examination would require at least two months, the opening of the public beds should be postponed as long as possible.

. . . . We therefore recommend that, for the next two years, the taking of oysters from the public beds be prohibited from April 1st to October 15th, and that all laws or parts of laws inconsistent with this recommendation be repealed.

ON THE OYSTER FISHERIES OF TANGIER SOUND.

Your Commissioners believe, as the result of their personal examination of the State Fishery Force, that one of the most serious hindrances to the thorough enforcement of our laws is the existence of local laws, giving to certain counties the right to permit dredging without a license from the State.

The history of this subject is as follows :—In 1874 a law was passed . . . which . . . gives to the clerks of the Circuit Court of Dorchester and Talbot counties the right to issue to any resident of these counties a license to use any boat of not more than ten tons capacity, for dredging in certain specified waters of the Choptank River, upon the payment of two dollars per ton annually.

. . . . (This law seems) to be worded with sufficient care, and the practice of apportioning our oyster lands out among the counties would be a good one, if the counties could be relied upon to preserve the beds from destruction, and to enforce the laws. It is plain, however, that the people of the State at large should not be taxed to support a navy, for the protection of property of which certain counties have the exclusive use, and which pays no revenue to the State Treasury. Your Commissioners also submit that they find, by personal examination, that the local laws are not enforced.

In November, 1882, we visited the waters of Dorchester and Somerset Counties, on Tangier Sound, and

found upon the beds hundreds of vessels of more than ten tons capacity, engaged in dredging for oysters without displaying a State license number, as required by law. . . . Out of more than one hundred . . . we failed to find . . . a single one which was licensed, as required by the local law.

. . . We were informed by George T. Roe, magistrate of Deal's Island, Somerset County, that he himself issued 250 local dredging licenses in 1881, and that this year, 1882, he knew personally of only two dredgers in his district who had conformed to the law and taken out licenses.

. . . In our examination of the oyster beds we accidentally discovered a practice, which is so dangerous that it should be prohibited by law. A dredger, who was arrested by Captain Mitchell at our request, said that he had not yet received his license, but that he had paid his license money to the commander of the fishing sloop of his district, although he had no receipt to show. We afterwards found the commander of this sloop, and when brought aboard the steamer and questioned, he admitted that he did sometimes receive the money for licenses in this way, but that he took out the licenses as soon afterwards as possible, and retained them in his possession until he had an opportunity to deliver them. He also said that, in such cases, he did not usually give a receipt, as the dredgers were acquainted with him, and wanted none.

We . . . respectfully submit . . . that a law be passed to declare that no vessel shall be used to take oysters in this State, unless it shall have on board, at the time it is thus used, the license required by law, and that the penalty for the violation of this law shall be the same as the penalty for dredging without a license ; and we also

recommend that any fishery officer who shall receive a license fee from an oyster fisherman without at the same time delivering to him his license, shall forfeit his bond to the State, and shall be removed from his position, and shall not again be employed upon the fishery force.

ON THE STATE REVENUE FROM THE OYSTER INDUSTRY.

As long as our present policy of raising revenue by licenses is adhered to, we cannot expect any very great increase, and the depletion of the beds must, in any case, affect the income of the State.

. . . certain changes should be made in our present policy.

As there are six or seven hundred dredging vessels, all of them very much alike in appearance, the only way for the officers to determine whether dredging boats have complied with the license law is to observe whether they display license numbers, and it is assumed that any boat which is numbered is also properly licensed.

As a duplicate number can be made by anyone with a paint brush and a little black paint, there must be a strong temptation to evade the law by counterfeiting the numbers, or by using old ones, after the license has expired.

We therefore recommend that each officer of the fishery force be required to keep a daily record of the numbers of all dredging boats in his district, and of the beds upon which they are working, and to transmit a copy of this record, once a week, to the Oyster Commissioners, who shall be required to enter, in a book kept for that purpose, after the number of each dredging boat, the place where it has been seen on each day. Whenever this record shall show that the same number has been seen in one day at two distant points, the commander of the fishery

force shall issue an order to all officers to overhaul all vessels which exhibit this number, and to examine their license.

ON THE ADVISABILITY OF DIVIDING OUR OYSTER AREA INTO OPEN AND CLOSED DISTRICTS.

We have shown, in a preceding section, that we cannot hope for any marked improvement in the condition of our oyster beds through the enforcement of laws closing them for certain months in the year.

. . . . the effect of a closed season is simply to gather the oystermen upon the beds in greater numbers than ever, at the end of the season. If our waters, or any part of them, should be closed to the public for a term of years, the oysters would increase and multiply, and finally restock the beds. It is difficult to state exactly how long a time would be required, as this depends upon the condition of the beds. When there are plenty of mature oysters to supply the spat, and plenty of clean shells for the young to fasten upon, a few years will suffice to restore the bed ; but after an oyster bed is thoroughly exhausted, there is no reason why another natural bed should ever grow up in the same spot rather than anywhere else, and in any case the closure of certain districts cannot increase the supply beyond its natural limits.

. . . . Even if the waters are loaded with spat from adjacent beds, there is no reason why the young should gain a foothold on the site of the exterminated bed. Between the natural beds there are areas where the bottom is perfectly adapted for oysters, except that there is nothing for the spat to fasten to, and an exterminated natural bed is in the same condition. The regrowth of such a bed is, therefore, exactly like the original formation of a natural

bed, and it must be a very slow process indeed ; how slow, it is very difficult to say, as we have very little information which will help us to decide, although we have facts to show that a century may not be long enough.

. . . . The adoption by the State of a plan to close certain districts long enough for the beds to recover would, undoubtedly, delay the work of extermination, but it would also cause an immediate decrease in the supply.

. . . . We believe that the districting plan is neither a real remedy nor the best method for arresting the destruction. It is the best which can be put into force without delay, but while recommending it, we feel that it is our duty to call attention to the fact that there is a still better method, although it is one which would require considerable time, and the expenditure of large sums of money.

Under natural conditions each bed is able to yield a certain number of oysters each year, and whenever this number is exceeded the bed suffers, and if the practice is continued it must be destroyed. It makes no difference whether the oysters are taken in one month or in twelve, or in one year or in five. The ultimate effect upon the bed is the same in all cases.

In the absence of measures for artificially increasing the productiveness of the oyster grounds, or even when such measures are employed, the only way to effectually protect a bed is to examine it each year, and to learn how many oysters it can furnish without injury, and to take such steps as may be necessary for preventing each bed from being drawn upon in excess of its capacity.

When the natural beds are small and few in number, it is easy to do this, and the plan has been employed in some parts of our own country, and also in many parts of

Europe, where a few guard boats are enough to protect the beds, and to learn how many oysters are taken from each one.

. . . . If all our oyster area were divided up into private holdings, the whole could be watched, and its condition and capacity much more carefully and exactly ascertained, than can ever be the case under State management, and an enlightened system of private cultivation would be the most sure safeguard against the exhaustion of the beds.

. . . . As it is impossible to state, at present, how long it will take for any particular bed to become restored, we recommend that certain areas be closed for an indefinite time, and that no one be allowed to take oysters within these areas until examination shows that they are sufficiently restored. . . . if the whole of the closed area were in one place, the residents of the lands bordering upon it would be unfairly treated, as they would be compelled to go to a great distance for their oysters.

We therefore recommend that our waters be divided into two areas: "A Shore Oyster Fishery," . . . and a "Deep Water Oyster Fishery," . . . that no dredging be permitted within the "Shore Oyster Fishery," but that this be reserved for tongmen and planters exclusively, although we recommend that a licensed tongman be also allowed to take oysters on any grounds where dredging is permitted. We also recommend that one-third of the total area of the "Deep Water Oyster Fishery" be absolutely closed to the public for an unspecified time, and that this closed third be divided into five narrow belts across the bay, separated from each other by wider belts, where dredging shall be permitted as at present.

OYSTER PLANTING.

Oyster planting is the placing of small or "seed" oysters upon bottoms which are favourable to their growth. . . . Planting also adds very greatly to the value of oysters, as they grow more rapidly and are of better quality when thus scattered than they are upon the natural beds, and Ingersoll quotes the statement . . . that thirteen dollars worth of small "seed" oysters yielded, after they had been planted for two years, oysters which were sold for \$114, besides about thirty bushels which were used as food by the planter's family. Oyster planting can be carried on only on private grounds, and it cannot flourish in a community which does not respect the right of the private owner to the oysters which he has planted.

. . . . The industry does not require a large capital, and it can be carried on with profit on a very small scale, although the oysters need constant and intelligent attention. In all places where it has been employed it has added greatly to the prosperity of the communities which have engaged in it, and has greatly increased the population of the shores along which it has been encouraged and protected.

. . . . The history of the oyster industry of Rhode Island furnishes an interesting illustration of the value of an intelligent system of planting. All bottoms between high-water mark and the ship channel are public property, to be controlled and administered by the State in such a way as to secure the greatest good to the greatest number of its citizens. . . . The revenue of the State has been greatly increased, and it is stated that the rentals of the beds will in time pay all the expenses of the State government. . . . In 1865 oysters sold for \$1.75 per solid gallon; in 1878 the price was \$1.15 to \$1.10, and

in 1879 it had fallen to 90 or 95 cents. In 1865 the product of the State was 71,894 bushels, while in 1879 it was 660,500 bushels.

The area which was used for planting in 1879 was only 962 acres, yet this area paid \$6,582.90 into the State Treasury; it employed a capital of over \$1,000,000; it paid \$125,000 in wages to the people of the State; it furnished the market with 660,500 bushels of oysters, with \$680,500 to the producers, and it gave support to 2400 persons.

OYSTER FARMING IN AMERICA.

The American system of oyster farming, which presents some features of resemblance to the French system, and also many differences, has grown up as the result of private enterprise, without any help or any direct encouragement from government.

The French people are generally held to be the originators of modern oyster farming, but as an American I take pleasure in pointing out that our own industry, which is now so extensively developed in Connecticut, has not been borrowed from France, but has grown up independently.

Several years before Coste and De Bon commenced their experiments, the oystermen of East River, having observed that young oysters fastened in great numbers upon shells, which were placed upon the beds at the spawning season, started the practice of shelling the beds, in order to increase the supply; and in 1855, or three years before Coste represented to the French Emperor the importance of similar experiments, the State of New York enacted a law to secure to private farmers the fruits of their labour, and a number of persons engaged in the new industry on an extensive scale.

. . . . In portions of Long Island Sound, especially off New Haven, it has been needful to make a crust or artificial surface upon the mud, before laying down the shells. This is done with sand.

. . . . I (Ingersoll) quote from the "Report of the Shell-Fish Commissioners" of Connecticut, for 1882, the following account of the method of cultivating a private farm in that State. I also quote from their report for 1883 the following statement of the present condition of the industry:—

"The deep-water cultivators proceed in three different ways to make beds. (1.) The bottom being properly cleared off, the seed oysters, mixed with the gravel, jingles, and other shells, just as they are gathered from the natural beds, are distributed thereon more or less uniformly, and there left to grow. (2.) Or the bottom is spread over with clean oyster shells just before the spawning season begins, and brood oysters, twenty-five bushels to the acre, are distributed over the bed. (3.) Or, if the bed is in the neighbourhood of natural beds, the shelled bed is left without further preparation to catch the spawn as it is drifted above it. Sometimes the shells fail to 'catch a set,' and this makes it necessary to rake over the shells the following year, or to cover them over with more fresh shells for the next spawning. There is always an abundance of spawn in the waters of the Sound, and when a set (*e*) is secured an enormous crop is the result. On a private deep-water bed, during the past summer, the dredge was drawn at random in the presence of the Commissioners, and from an ordinary-size shovelfull there were counted 206 young oysters, in excellent condition, of the average

(*e*) '*Set*' (in the vernacular of the shore) means the attachment of the floating spawn.

size of a quarter of a dollar. As many as a hundred young oysters have been counted growing on a medium-sized oyster shell.

“The beds are carefully tended, and no pains are spared to kill all the enemies of the oysters found among them. By continual vigilance, the private beds are kept comparatively free from them. The larger proprietors of deep-water beds use steamers for this work, as also in doing their work of planting, raking over and dredging, and they use larger dredges than the sail vessels can, as they are also worked by steam, at a great saving of labour and expense. When the oysters have grown on these beds to a merchantable size, they are sometimes sold directly from the beds, but more frequently they are transplanted into brackish or fresh waters, where they are permitted to remain for a short period, to freshen and fatten for market.

“The foregoing table affords the ground for the assumption that by the time of the opening of spring work, in 1883, 45,000 acres of ground will have been deeded to applicants by the Commissioners. These, with the 45,000 acres deeded by the towns prior to May, 1881, will show an aggregate of 90,000 acres held by cultivators under State jurisdiction. Of this vast area a large portion has been cleared up and shelled. One firm laid down 250,000 bushels of shells. Several large growers have laid down as many as 200,000 bushels each. A still larger number have scattered a hundred thousand, fifty thousand, and twenty thousand each. There are about 30 steamers engaged in the business, besides a very large number of sailing vessels.

. . . . It does not admit of a doubt that the business of oyster growing, as carried on in the waters of the Sound, is exceedingly profitable.”

PRIVATE CULTURE AND CULTURE BY THE STATE.

Oyster cultivation may be carried on by the State, or by private citizens, and as both of these plans have been tried, we may learn from the history of the industry in other places which of these plans is most likely to be successful.

. . . . Nothing, which can be safely intrusted to private enterprise, should be undertaken by the State, and the history of the oyster fishing of Connecticut and Rhode Island, as well as that of France, shows that oyster culture can safely be intrusted to the private interest of the oyster farmers.

. . . . (But as) our own people have, at present, little practical experience in the methods of oyster farming, and are not yet prepared to engage extensively in the business, we . . . believe that it will be wise for the State to set aside a tract of oyster bottom as a State oyster farm, and to replenish and restock it, in order to exhibit to our people the value of oyster farming, and to give them an opportunity to witness the methods of working and the practical results ; and also in order to obtain a more exact and definite estimation of the value of our oyster bottoms per acre. The establishment of such an oyster-farm will require a large investment of capital for a year or two, but a system of thorough cultivation for a term of five or six years could be made to return this investment, besides yielding a great quantity of oysters for the use of the public.

. . . . As soon as the State farm is fully stocked with marketable oysters, which would probably be in about three seasons, it should be thrown open to the public, but a record should be kept of all the oysters removed from it,

and it should of course be made to pay back into the State Treasury the money expended in cultivating it. The best method of doing this is to collect a tax (say five cents a bushel) upon all oysters taken from it, and the method of collecting this tax should be determined by law before the farm is opened to the public.

The revenue from this source would show whether it is expedient for the State to continue the business on a larger scale ; but your Commissioners believe that the true policy is for the State to do only enough in this direction to instruct our people in the methods to be employed, and that the whole matter should then be left to private enterprise.

The history of French oyster culture is of very great interest in this connection. Nearly twenty-five years ago the French government undertook the cultivation of oysters, in order to restock the exhausted beds. The government farms were at first very successful, and they not only proved that oyster farming is very profitable, but they also served as a school for the instruction of the public in the methods of oyster culture. This example was followed by private cultivators, and the private industry upon the French coast is now in a very prosperous condition ; but a government report (*Oyster Culture in Morbihan*) upon the subject, in 1875, contains the statement that " the worst merchant in France is the State."

This report shows so clearly the great superiority in every respect of private enterprise over government management, that we beg leave to call attention to the following extract :—

" Coste did not doubt the result ; failure seemed to him almost impossible ; he foresaw the complete transformation of the sea coast, and exclaimed, in his letter of March

20, 1861, to the Emperor: 'I thank your Majesty for having placed me in the front ranks of the greatest enterprise of the age, in connection with animate nature.' Attempts were multiplied, but progress and success seemed more and more retarded and lessened in the course of time. The bay of Saint-Brieuc was swept by a tempest. At Arcachon discouragement seized upon those who, in the beginning, were most enthusiastic, for little or no spawn was collected. Coste heard the name of charlatan sounded in his ears; his work was ridiculed even by those whom, in the expectation of success, he had loaded with favours, and our modern Athenians were lavish in criticisms, in which neither sarcasm nor bitterness were spared. Enfeebled by his labours and deprived of sight, Coste struggled on. He hoped against all hope, and maintained that the application of his principles would even change the social conditions of the sea-coast communities. His views were met only by incredulity. He died at his post, despondent, greatly discouraged, and to the last hour misunderstood by that multitude who treat with contempt all great ideas which do not meet with immediate success. While others were occupied in criticising, a few men laboured faithfully, and in a few years, between 1868 and 1875, the production and cultivation of oysters made remarkable progress on the shores of Morbihan."

"Principal cause of the failure of Coste.—It is evident to all that, in spite of the scientific knowledge, the zeal and the labours of Coste, his attempts, so far as regards commercial results, were radically fruitless. Nevertheless, he had at his disposition apparatus, boats, auxiliaries as intelligent as devoted, and also, to a certain extent, the resources of the public treasury. Still the reason is very simple. That impersonal being, called the State, is incapable of

creating any industry. It sufficed to relinquish oyster culture to the culturists, who, although intelligent and well informed, are, in the majority of cases, neither savants nor academicians, to insure success, where only failure had been predicted."

"This is because the State lacks that powerful lever called individual interest. An occupation is not possible unless an assured profit may be realized from it. The merchant alone can be certain of this, from a study of the markets and the demands of the consumers. The poorest merchant in France is the State. The State has quite another part to play. Charged with the protection of all, it cannot descend from this elevated sphere of general usefulness into the arena where opposing interests are contending—an arena which it always leaves defeated and often injured. To abandon its reserve, and endeavour by taxation to create a national industry, is an act of socialism, generous, perhaps, but from which others will derive the benefits."

"Napoleon III., in his youth, had a passion for studying these questions, and sometimes lent an attentive ear to these grand socialistic theories: this was why Coste obtained so much support from the Emperor. Led away by his own ardour, he did not notice that he was gliding down a fatal slope, and that he would fall at last, in spite of all his efforts. If, instead of going to the Tuileries, he had addressed himself to an association of capitalists, or to the trade, who could have participated in his confidences, then oyster culture, disengaged from the shackles of the State, would, from the beginning, have taken a higher stand and progressed with surer steps."

"We do not wish to underrate the importance of the part played by the State, for we are going to appeal to its

aid in another matter ; but we think it should be well understood that the two domains of industry and of government are totally distinct. By confounding them, powerlessness replaces fertile effort, and the most important work is crowned only with failure."

"We do not wish in any way to diminish the gratitude due to those, whether functionaries of State or others, who have laboured for the creation and development of this industry ; but we feel the necessity of proclaiming, in a certain measure, the omnipotence and vigilance of individual interest. We believe that, imbued with this thought, the public administration would desire, even more in the future than in the past, to free from fetters and obstacles the pathways along which this industry must move, in order to attain a high degree of prosperity."

It must be plain to everyone that our hope for an abundant supply of oysters in the future must rest upon the growth of a private farming industry, rather than upon State aid ; and we come now to the question, what shall be done to encourage private oyster culture ?

. . . . The question of immediate revenue to the State is a very secondary consideration. The chief danger which is to be avoided is the monopoly by a few persons of the oyster area, and this danger can be avoided by granting to any resident of Maryland who wishes to use it, a small farm for oyster culture. The law known as the "five acre law" gives to any resident the right to appropriate five acres of ground, where there are no oysters, for oyster planting. The holder pays nothing for the right ; he receives no title from the State, and he pays no taxes.

We recommend that the State give to each holder of land under this law a lease or title, like a title to real

estate, making it his for ever, so that he can dispose of it, or mortgage it, to obtain the necessary capital for cultivating it, and that the nominal fee of one dollar per acre be charged for the lease. We believe that it would be wise to grant this privilege to all persons, residents or non-residents ; but we leave this subject for future consideration, as well as the question whether it is wise to permit one person to hold more than five acres, by purchase from other holders. The title should be made as absolute and unqualified as a title to real estate, but we have not made it so in the bill which accompanies this report, since many points can be discussed and settled at some future time. We believe and recommend, however, that the law should be amended in such a way as to permit any resident of the State to appropriate his five acres, whether it contains natural oysters or not.

THE OYSTER FISHERY OF CONNECTICUT.

The methods employed in this State are of the greatest interest, for Connecticut has been able, by the adoption of a wise plan, to build up a great oyster industry in a very short time, and to place the business upon a sound and substantial foundation. The natural resources of this State are as nothing compared with the resources of our own waters, for, upon the most liberal estimate, her natural beds do not exceed 5000 acres, all told, . . . (which) furnish few marketable oysters, and are chiefly valuable as a supply of seed oysters for planting ; . . . Three years of efficient protection, under wise oyster laws, have produced such a change that the State, which was so recently compelled to purchase oysters for planting, has, as we are informed by good authority, this year furnished seed in considerable amounts to New York, Rhode Island, and New Jersey, besides sending an immense supply to

European planters. One firm shipped, in the spring of 1883, sixty car-loads of seed-oysters to San Francisco, from the beds of Connecticut. The sixty car-loads, or more than 15,000,000 young oysters, had been engaged by persons employed in planting on the Pacific coast.

A method which is capable of producing such a result as this, in three years' time, is worth most careful examination. . . . The waters of the State are divided into two districts, a shore district, . . . and a deep-water area In each area there are natural beds which are open to the public, and private grounds which are appropriated to individuals or companies by law, for the cultivation of oysters.

THE PUBLIC BEDS OF CONNECTICUT.

The natural beds are open to all residents of the State, at all times except at night ; but no one is allowed to use a steam boat upon them, or to use a dredge which weighs more than thirty pounds.

The use of steam vessels, for dredging upon the public beds, has only recently been prohibited. Steam vessels are used upon the private oyster beds, and the proposition to close the public beds to them was warmly attacked, but was finally adopted, and made a law by the Legislature, in 1881.

“ In gathering seed near shore, and somewhat otherwise, tongs and occasionally rakes (those with long curved teeth) are used ; but the marketable oysters are nearly all brought from the bottom by dredges of various weights, and slight differences in pattern. In the case of all the smaller sail-boats, the dredges having been thrown overboard and filled, are hauled up by hand—a back-breaking operation. The oysters themselves are very heavy, and frequently half the amount caught is composed of shells, dead oysters,

winkles, and other trash, which must be culled out, thus compelling the oyster-men to do twice or thrice the work which they would be put to if there were nothing but oysters on the ground. The work of catching the oysters by any of these methods is, therefore, very tiresome and heavy, and various improvements have been made, from time to time, in the way of labour-saving, from a simple crank and windlass to patented complicated power-windlasses, similar to those used in the Chesapeake boats. When a proper breeze is blowing, dredging can be accomplished from a sail-boat, with one of these windlasses, with much quickness and ease. In a calm, or in a gale, however, the work must cease, as a rule."

"Under these circumstances, and as the business increased, it is not surprising that the aid of steam should have been enlisted; nor perhaps is the controversy which has ensued to be wondered at, since the introduction of novel or superior power into some well-travelled walk of industry has ever met with indignant opposition."

"The first utilization of steam in this business, so far as I can learn, was by Capt. Peter Decker and Brother, of South Norwalk, about 1870."

"After the Messrs. Decker's experiment, Mr. W. H. Lockwood, of Norwalk, not an oyster-man, but an enthusiastic believer in steam-dredging, built the steamer *Enterprise* expressly for the business. Her length is 47 feet; beam, 14 feet; she draws 4 feet of water. She handles two dredges; has a daily capacity of 150 or 200 bushels."

"These were followed by several other steamers. . . . there are now in all seven in Long Island Sound, but it is generally acknowledged that the most thoroughly equipped boat for this purpose of the fleet is owned by H. C. Rowe & Co., of Fair Haven, Connecticut. It is

named the 'William H. Lockwood,' and is comparatively new, and cost between six and seven thousand dollars. The dimensions of this boat are : length, 63 feet ; beam, 16 feet ; draught, $5\frac{1}{2}$ feet. Her boiler is larger and her engine more powerful than usual, in a boat of her size, and she can therefore be used for towing, and can force her way through heavy ice in the winter ; so that her owner is sure of a supply of oysters for his customers when other dealers may be unable, with sailing vessels, to get them. Besides her regular propeller, she has a double engine for hauling dredges, which hauls all four dredges full of oysters at once, and lands them on deck, two on each side, at the rate of 800 bushels a day, if needed. This employs a crew of ten men, who are protected from the weather by a housing which covers in the whole deck."

THE PRIVATE OYSTER GROUNDS OF THE STATE OF
CONNECTICUT, WITHIN THE AREA WHICH IS UNDER
LOCAL MANAGEMENT.

. . . . No person can appropriate more than two acres. The lands which are thus appropriated are taxed like real estate. And they may be attached or executed upon like real estate. The oyster committee of each town has power to decide upon the sum which is to be paid for the grounds, and the term of years for which they are to be leased. No person can gather any oysters upon private grounds unless they are properly staked or buoyed out, and marked at each corner with the owner's name.

The removal of oysters from private grounds, without authority from the owner, is punished by a fine of from \$300 to \$500, or by imprisonment for one year ; and the injury or destruction of the stakes or buoys, or the grounds, or the oysters upon them, is punished by a fine of from

\$50 to \$700, or by imprisonment from one month to six months ; and any boats which are used in violation of these laws are sold at auction, the captor receiving one-half the proceeds, and the town the other half.

Certain towns, however, have a somewhat different law ; thus the town of Guilford has, by special act of legislature, the right to lease its grounds for ten years, to the highest bidder at public auction, but it cannot lease more than five acres to one person.

The grounds which are thus appropriated to private parties by the towns are not used for farming or propagating oysters, except in a few cases, but simply for planting, and the seed is either taken from the public beds, or is purchased from the holders of private grounds in the area under the jurisdiction of the State, or from persons outside the State.

The system does not therefore materially increase the number of oysters, but it does greatly increase their value ; and it is therefore a great source of wealth to the people of the State, and nearly all lands adapted for the purpose are now appropriated.

OYSTER CULTIVATION IN THE DEEP WATERS OF CONNECTICUT, ON GROUNDS OVER WHICH THE STATE HAS EXCLUSIVE JURISDICTION.

The business of planting oysters in Connecticut, under the provisions which have just been explained, grew so rapidly that all the available inshore bottom near New Haven was soon occupied, and these waters looked like a submerged forest, so thickly were they planted with boundary stakes ; and at last Mr. H. C. Rowe ventured out into the deeper water of Long Island Sound, and inaugurated a new era in American oyster culture by the establishment of an oyster farm in water forty feet deep.

This new departure has led to the development of a new form of oyster culture, which is not planting, but farming in its true sense, since the "seed" oysters are seeds in reality, bringing forth after their kind a thousand fold, and thus building up, on private grounds, what can be most briefly described as artificial *natural* beds of oysters. The movement which has led to this result is the most important step which has ever been taken in America towards an enlightened method of managing the oyster industry. It has been met at each stage by the most violent opposition, and its history should be of the very greatest interest to all States which control waters in which oysters flourish. Mr. Rowe soon had many imitators, and as oyster culture in deep water cannot be managed on a small scale, the tracts which were appropriated were necessarily outside the limit of two acres, which was all that was allowed by a strict interpretation of the law.

The rapid development of the industry was watched with angry excitement, and as it was seen that the existing statutes had never contemplated anything of this sort, alterations and amendments rapidly followed one another, now in the interest of the deep-water cultivators, and now in the interest of the owners of the small planting tracts nearer the shore.

The fishermen along shore indignantly opposed the capitalists, and on the ground that everything under the water is common property, openly removed the oysters from private grounds. As there was no survey or exact delineation of the "natural beds," unlimited stealing from private grounds was perpetrated, and looked upon with general favour by the great majority of the fishermen, on the plea the grounds in question were "natural beds."

The deep-water cultivators, increasing in numbers and in influence, were able, in 1875, to secure the passage of a law declaring that in a considerable area of the State there are no legally "natural beds," and the possibility of successfully propagating oysters in great numbers, in deep water, was soon proven, and the business continued to grow and to increase in importance, in spite of opposition; but so much discontent existed that the following resolution was passed by the Legislature of 1879. (Want of space has compelled me to omit this resolution.)

. . . . The following account of the method of laying out and stocking a deep-water oyster farm in Connecticut, and the statement of the attendant expenses, is copied from Ingersoll's "Report on the Oyster Industry of the United States."

"The process by which a man secures a large quantity of land outside has been described. It is thought hardly worth trying unless at least 50 acres are obtained, and many of the oyster farmers have more than 100 acres. These large tracts, however, are not always in one piece, though the effort is to get as much together as possible. He obtains the position of the ground, as near as he can, by ranges on the neighbouring shores, as described in his leases, and places buoys to mark his boundaries. Then he places other buoys within, so as to divide his property up into squares, an acre or so in size. In this way he knows where he is as he proceeds in his labours. Having done this, he is ready to begin his active preparations to found an oyster colony."

. . . . *Preparation of a Deep-water Oyster Farm.*

"When a cultivator begins the preparation of a deep-water farm, his first act is to scatter over it, in the spring (about May), a quantity of full-sized, healthy native oysters, which

he calls 'spawners.' The amount of these that he scatters depends on his circumstances; from 30 to 50 bushels to the acre is considered a fair allowance here, I believe. The rule is, one bushel of spawners to ten bushels of cultch. He now waits until early in July (from the 5th to the 15th is considered the most favourable time), when he thinks his spawners must be ready to emit their spat. He then employs all his sloops, and hires extra vessels and men, to take down to the harbour the tons of shells he has been saving up all winter, and distribute them broadcast over the whole tract of land he proposes to improve that year. These shells are clean, and fall right alongside of the mother-oysters previously deposited. The chances are fair for catching of spawn. Sometimes the same plan is pursued with seed that has grown sparingly upon a piece of ground; or young oysters are scattered as spawners, and the owner waits until the next season before he shells the tract. Sometimes there must be a preparation of the ground, before any preparation can be begun upon it, by elaborate dredging or otherwise. Within the harbour, for instance, considerable muddy bottom has been utilized by first paving it with coarse beach-sand. No spot where there is not a swift current is considered worth this trouble. The proper amount is 200 tons of sand to the acre, which can be spread at the rate of five-sharpie-loads a day, at no great expense. The sand forms a crust upon the mud firm enough to keep the oyster from sinking, and it need not be renewed more than once in five years."

Expense of an Oyster Farm.—In either case, therefore, the planter's expense has not been enormous. I present herewith two statements of the outlay under the operations outlined above, which are as follows:—

No. 1.—Fifty Acres.

2000 bushels spawners, at 30 cents	\$600 00=£125 0 0
15,000 bushels shells, at 3 cents ..	450 00= 93 15 0
Planting 15,000 bushels shells, at 4	
cents.....	600 00= 125 0 0
	<hr/>
	\$1650 00=£343 15 0

No. 2.—Sixty Acres.

2000 bushels spawners, at 56½ cents	\$1130 00=£235 8 4
17,000 bushels shells, at 4 cents ..	680 00= 141 13 4
4453 bushels Bridgeport seed, at 10	
cents.....	445 30= 92 15 5
	<hr/>
	\$2255 30=£469 17 1

In a third case, Capt. George H. Townsend gave me a statement of the expenses of starting a farm of 25 acres, off the mouth of East Haven River. This was a more elaborate arrangement, but on the other hand was accomplished, through a variety of favourable conditions, cheaper than would have been possible with ground otherwise situated.

2000 bushels small river oysters,	
at 25 cents	\$500 00=£104 3 4
Spreading same and staking, at 5	
cents	100 00= 20 16 8
600 bushels dredged seed, at 40 cents	240 00= 50 0 0
10,000 bushels of shells, put down	
at 4 cents	400 00= 83 6 8
	<hr/>
	\$1240 00=£258 6 8

“I think it would not be unfair to average the cost of securing, surveying, and preparing the deep-water beds at

about \$40 an acre, or about \$4000 for 100 acres. To this must be added about \$2 an acre for ground surveys, buoys, anchors, &c. But now that he has got his set everywhere upon this 50 acres of shells, the planter's anxieties have just begun.

“ The cultivator finds his work as risky as mining. ‘You can’t see into the water,’ he says; and the miner quotes back his proverb, ‘You can’t see into the ground.’ A sufficient cause may usually be assigned for the death of large districts of infant oysters, which appeared to get a good start. Starvation is probably the true explanation. Some evil current bore away from them the necessary food. In other cases specific causes, the most potent of which are storms, can be pointed out.

“ *Vicissitudes and Losses of Oyster Planting.*—In the fall, just when the young oyster-beds are in their most delicate condition, occur the most destructive gales that afflict the Connecticut coast. They blow from the south-west, and if, as occasionally happens, they follow a stiff south-easter, they produce a cross-sea of the worst character. The water is thrown into a turmoil to a depth, in some cases, of four or five fathoms, and everywhere between that and the beach the oyster-beds are torn to pieces, all boundaries are dissolved, and windrows of oysters, containing thousands of bushels, are cast up along the whole extent of the beach. Although so great a disaster as this is rare, it does occasionally happen, and hardly a winter passes without more or less shifting of beds, or other damage by tempest. The burying of beds under drifted sand is more uncommon off New Haven than easterly; but in the harbour, where the bottom is soft, mud is often carried upon the beds to such an extent as to smother, if not wholly to hide, the oyster. All that part of the harbour near the mouth of

West River is so liable to this accident that oyster-men have abandoned that district altogether. It is believed by many that the beds in the Sound, in water more than twenty-five feet deep, are safe from disturbance from gales ; but others decline to put their faith in any depth thus far planted. Frequently oysters cast up by storms, if attended to immediately, can be saved and replanted with profit."

"Management of the Oyster Farm.—Having secured a colony of young oysters, upon the stools which have been laid down for them, they are left alone until they attain the age of three, four, or five years, according to their thrift and the trade for which they are designated, by the end of which time they have reached a large size and degree of fatness, if the season has been favourable. If, as is largely done by those planters who live at Oyster Point, the oysters are to be sold as seed to Providence River or other planters, they are taken up when only one or two years old. Not a great quantity of this seed was so disposed of last year—not over 20,000 bushels, I should say. It is not considered, as a rule, so profitable as to wait for the maturity of the stock."

THE OYSTER INDUSTRY OF NEW YORK.

In early days, the waters of the vicinity of the city of New York abounded in oysters, and most of the early writers speak of their fine flavour, and great size and abundance. As early as 1715 the colonists began to be alarmed by the diminution of the supply, and it was found necessary to pass the following law :—

"From and after the publication of this act, it shall not be lawful for any person or persons whatever, native free Indians only excepted, from and after the first day of May until the first day of September, annually, to gather, rake,

take up or bring to the market any oysters whatever, under the penalty of twenty shillings for every offence, to be recovered before any of His Majesty's Justices of the Peace, who are hereby authorized and required to hear, and finally determine the same, one-half thereof to turn to him or them that shall bring the same to effect, and the other half to the poor of the place where the offence shall have been committed. And it shall not be lawful for any negro, Indian, or mulatto slave, to sell any oysters in the city of New York, at any time whatsoever, under the penalty of twenty shillings for every offence, to be paid by the master or mistress of such slave or slaves, to be recovered and applied as aforesaid."

Ingersoll says this is the first oyster law which was passed in this country.

Many of the natural beds in these waters have been entirely exterminated, but notwithstanding the great drain upon them which has followed the growth of the city of New York, many of the beds in East River, and upon the south shore of Coney Island, are still in a prosperous condition, and continue to yield fine oysters for food, as well as a valuable supply of seed oysters for planting. The preservation of these beds is no doubt due in part to the prohibition of dredging, but chiefly to the fact that for the last fifty years their fertility has been increased by the practice of shelling them just before the spawning season, and thus securing the attachment and growth of a great number of young which would be lost without this artificial aid.

The methods of oyster farming which are employed by the cultivators of New York are fully described in our chapter on oyster farming, and it is only necessary to say here that these efforts have resulted in the preservation of

beds which, owing to their proximity to the great centre of commerce and population, have been very heavily taxed by the demands which have been made upon them.

LAWS OF NEW YORK.

No person who has not been a resident of the State for six months can take oysters within the State, unless such non-resident is employed by a resident.

No dredge operated by steam, or weighing more than thirty pounds, can be used.

No natural bed can be used for planting, or can be staked off for private use.

No non-resident can plant oysters in the waters surrounding Staten Island, without the consent of the owner, and no non-resident can take oysters from the natural beds in the same waters.

No person is allowed to dredge on the natural beds in the vicinity of Staten Island.

Any owner of land adjoining Harlem River may plant oysters in front of his property, where the ground is not occupied, and no person can take oysters from such ground without his permission, under a penalty of \$50.

The penalty for catching or dredging oysters on private grounds in East River is a fine of not more than \$250, or imprisonment for six months, or both.

In Queen's county, any resident may plant oysters in any public waters where there are no natural beds, but no person can hold more than three acres, nor can he hold it unless he uses it for planting.

No person is allowed to take oysters in Great South Bay, Long Island, with a dredge, or in the night, or between June 15 and September 15, under a penalty of a fine of \$250, imprisonment for six months, and an additional fine

of \$600 for each offence; half the penalty goes to the informer.

In Suffolk county any five or more persons who hold oyster lots may form a company or corporation, for the promotion of oyster culture in these lots.

The towns of Babylon and Islip, in Suffolk county, have a special law, which is substantially as follows:—

“Any person who is of age, and who has been an inhabitant of the county for a year, may appropriate four acres, ‘where the taking of clams cannot be profitably followed as a business,’ and upon the payment of \$1 per acre annual rent and the costs of surveying, he has the exclusive use of the land for the cultivation of oysters, so long as he keeps it marked out and remains an inhabitant of the county; but he is required to pay his annual rent on or before the first day of April, and to plant at least 100 bushels of oysters and shells on the ground, within one year of the date of his certificate, and in case of failure, the Oyster Commissioners have the power to terminate the lease.”

“Any person may sell and assign his interest in private oyster ground to any inhabitant of the county for one year, but no person can at one time hold more than four acres.”

There are three commissioners appointed by the town auditors, with power to determine what grounds shall be appropriated, to make surveys and maps, to settle disputes regarding boundaries, and to receive money.

The unlawful taking or disturbance of oysters on private grounds is punished by a fine of not less than \$100, or by imprisonment for not more than sixty days, or both.

There is no oyster police, but the planters have formed a protective association, and employ private watchmen.

Any inhabitant of the towns of Hempstead and Jamaica, in Queen's county, may appropriate three acres of any lands which are not already appropriated for the cultivation of oysters; and upon the payment of an annual rent of \$3 per acre, he has the right to use the land for this purpose so long as he remains an inhabitant of the towns. No dredging is allowed in these waters, under a penalty of \$100 fine, or sixty days' imprisonment, or both, and the taking or disturbance of oysters in private beds is punished by \$100 fine, to be recovered by the owner.

APPLICATION FOR A GRANT TO THE OYSTER COMMISSIONERS OF THE STATE OF MARYLAND.

The application of ———, a resident of the town (or county) of ———, in the State of Maryland, respectfully shows: that he has resided in said State more than one year next preceding the date of this application; that the grounds, hereinafter described, are undesignated grounds; that he wishes and intends to use said grounds for cultivating oysters. He therefore respectfully requests that the said Commissioners, pursuant to ———, will grant to him, in the name and behalf of the State of Maryland, a perpetual franchise for cultivating oysters in ——— acres of grounds, located under the waters of Maryland, within the limits of District No. 6, which grounds are more particularly bounded and described as follows, to wit:——

Dated at ———, Maryland, this ——— day of ———, A.D. 188—.

———, applicant.

(Thus far I have drawn solely from Dr. Brooks' Report; the remaining portion of this chapter is taken from Lieut. Winslow's Report, which begins as follows):—

In March, 1886, in consideration of the hydrographic data to be incidentally added to the archives of the United States Coast and Geodetic Survey Office, the schooner "Scoresby," with a hydrographic party, was placed under the command of Lieut. Francis Winslow, U.S.N., and Assistant U.S. Coast and Geodetic Survey, to aid in the development and definition of areas adapted to the cultivation of shell-fish in the sounds and estuaries of North Carolina.

Although the investigated areas lie within the boundaries, and are subject to the jurisdiction of a single State, the cheapening of a universally-esteemed and valuable food product by the extension of the cultivable area adapted to its growth renders their development a matter not of local but of general interest. The extent to which that interest is affected is implied in the fact . . . that within the brief period of less than three years since the commencement of his operations, they have resulted in the development of nearly 600,000 acres of such cultivable area, capable of producing annually perhaps twice or thrice the product of the Maryland oyster-beds in 1880; in the discouragement of excessive fishing, and consequent destruction of the shell-fisheries; in the diffusion of information and increase of public interest in the subject, with the resultant organization of a State shell-fish commission, and enactment of effective legislation for the protection and encouragement of the shell-fishing industry, including the opening for entry and record, by citizens of any State, of cultivable and easily described areas or tracts for oyster-beds; under which law fully 50,000 acres of such areas have already been taken up by both residents and non-residents of the State.

. . . . At an early stage in the investigation, it was discovered that the means at the disposal of the State were entirely inadequate to the accomplishment of the desired ends. But a small sum of money was available ; the State possessed neither vessels, boats, instruments, nor observers skilled in the methods of hydrographic surveying. The instruction of assistants would require considerable time ; the improvisation of material, a large amount of money. Neither could be done in time to afford any information for the use of the Legislature, the principal object of the investigation. A superficial examination of the waters of the State had indicated that not only were considerable areas already occupied by oysters, but that in all probability an enormous additional area was suitable for the cultivation of the most valuable of American sea-products.

The continued increase in the demand for oysters all over the country ; the continued diminution in the supply from the oyster-growing localities, together with the rapid rise in prices during the past ten years, showed that an increase of the productive area was not only desirable, but would prove a great benefit to the people of the country at large. The foregoing facts were presented to the Superintendent of the Coast and Geodetic Survey, and a request was made for assistance in prosecuting the work.

The request was granted, and the schooner *Scoresby* and an ordinary hydrographic party detailed to work in co-operation with the authorities of the State.

. . . . To accomplish the results (of the instructions and investigation) with the least expenditure of time, labour, and money, required constant care and forethought. Work would be suspended in the sheltered localities, whenever a chance offered to proceed with the investigation of

the exposed deep-water areas ; and frequently a favouring gale would cause cessation of all operations, that a hasty run to port for necessary stores might be made. It was necessary to go from fifty to one hundred miles for drinking-water, coal, provisions, and medical attendance, and the delay consequent upon this necessity was most seriously felt throughout the prosecution of the work. Operations carried on under such conditions necessarily became disjunctive and unfinished : but time only was necessary for their entire correlation and completion.

The inclement weather peculiar to Pamplico Sound, and the neighbourhood of Cape Hatteras, caused a great deal of vexatious delay ; on an average fully one-third of the working days have been lost from this cause. Coupled with the bad weather, especially during the spring and autumn (otherwise the best months), has been the bad health of both officers and men. Out of the small complement allowed, the loss of even one man is seriously felt ; yet it has been a frequent occurrence to have one-third or one-half the working force incapacitated.

. . . . Notwithstanding the many difficulties with which the party has had to contend, it is believed that no other in the field has accomplished a larger amount of work in the same space of time, or at so small an expense, as is shown by the following summary of observations and results :—

Summary of Work.

Area of beds located, acres	8,327.90
Area of public grounds located	20,553.11
No. miles soundings and dredging lines	1,712
No. soundings recorded	150,660
No. angles taken, afloat	15,902

No. angles taken, ashore	2,334
No. stations occupied in boats	5,629
No. determinations specific gravity	2,500
Total area examined, acres.....	1,325,419

These results have been obtained with a total expenditure, to January 1st, 1889, for "party expenses," of \$1,227.88, and of \$558.49 for "repairs." probably nowhere in the world, unless it was in France after Coste's investigations and experiments, has an examination and survey been followed so immediately by such valuable results as has been the case in North Carolina.

Prior to the investigation there existed a few natural oyster-beds, and an inefficient and precarious system of cultivating a few hundred acres of bottom, under a law which offered no inducement to enterprise nor encouragement to exertion, and which afforded no protection to either public or private property. As a direct result of the efforts of the authorities of the State, and of the Coast and Geodetic Survey, the area of the public property has been extended over fifty per cent.; the reputation of the stock has sensibly increased; the Legislature has adopted a law which has been generally characterised as the wisest in existence, and in the short space of a year lands to the extent of over 50,000 acres have been entered for the purpose of cultivating oysters. The ultimate result cannot be foreseen. But it is not unreasonable to predict that the few hundreds of dollars expended on the investigation of Pamlico Sound and its tributaries will be the means, in the not distant future, of establishing an industry worth hundreds of thousands of dollars, employing many thousand people, and supporting many thousand more; returning a considerable income to the State, and largely increasing the present supply of marketable oysters.

Before commencing the extracts, which, extending over a wide field of ostreocultural knowledge, must necessarily be brief and fragmentary, it were as well, perhaps, that I preface them with the "Instructions" acted upon, and the "Methods of conducting the Investigation," pursued by Lieut. Winslow in its object, so that the reader may the more readily grasp their instructive purpose, and comprehend more fully their practical outcome.

Instructions.

"The instructions of the Superintendent, dated August 2, 1878, directed that the investigation of the oyster beds should include the following:—

1. The determination of the positions and areas of the oyster beds of the Chesapeake and the adjacent waters, and the depth of water over them at high and low water.

2. The determination of the character of the beds; whether natural or artificial; whether the oysters were spread all over a given area, or grew in clusters of large or small size, or were scattered singly or in small groups.

3. The determination of the temperatures of the surface and bottom water at each locality, and the velocities of the currents.

4. The preservation of specimens of oysters of different ages, from each locality, and specimens of the bottom and bottom water.

5. The determination of the existence of any deposit of mud or other earthy or vegetable material, and the determination of the character of the bottom beneath the oyster beds.

6. The determination of the source of the sediment, if any was deposited, and the means of directing it, if injurious, away from the beds. Also to determine whether ice ever rested on the beds, and so destroyed them.

7. The determination of the density of the water, with special reference to the question of displacement of the salt water by the fresh water from adjacent streams and rivers."

The Superintendent also desired that the examination should at first be confined to a limited area, and made exhaustive. Subsequently the investigation was to be extended, as far as the means at the disposal of the Survey would permit.

The instructions were received on the 3rd August, 1878. On the 7th of that month the vessel sailed from Baltimore, Md., to execute them, and the party remained actively in the field until the 15th October, when the season closed. As the investigation was novel in design and execution, and as the difficulties encountered by the party were mainly due to the absence of all experience and previous exertions in the same field, I have thought it best to preface the account of the results of our labours by a short description of the methods employed in making the several determinations required by my instructions.

METHOD OF CONDUCTING THE INVESTIGATION.

The examination of the beds was carried on in the following manner :—

DELINEATION OF THE BEDS.

The services of an oysterman of experience, and who was well acquainted with the localities of the different beds, was first obtained ; the vessel was then anchored in such a position as to enable her use as one of the points for angling upon, and her position carefully fixed by sextant angles, upon all points recognizable upon the chart. At the same time angles were taken upon any object that might be useful subsequently in fixing positions, either of

the boats or schooner. By carrying forward our own points in that manner it was possible to dispense with signals, the erection of which would have occasioned much delay, and the sacrifice of time and labour, to procure an unnecessary degree of accuracy. The boats then ran transverse lines, more or less open, over the adjacent beds, the size of the anterior angle and the length of the line depending upon the supposed size and character of the bed; our general method was to work with the tide, and endeavour to cross the lines as we returned over the ground.

The "oyster pilot" was sent in one boat, and one of the ship's company, who was an old oysterman, was sent in the other. They were provided with poles, which were marked to feet, and continually probed and examined the bottom as the boat passed over the line. The depth of water and character of the bottom were recorded as in ordinary hydrographic surveys. The position of the boat was frequently ascertained by sextant angles, but as the "points" were not always well defined, two angles were not considered sufficient, and angles on all prominent objects were taken. Occasionally, when in proximity to the schooner, mast-head angles and bearings were used for ascertaining the position of the boat, and in a few cases the bearing and distance of some well defined point of land was estimated.

At intervals the boat was anchored, her position fixed, and specimens of oysters, bottom, and water obtained, and the temperature of the air, and surface and bottom water, observed; the character of the substratum of the bottom was also noted, and the set and velocity of the current recorded.

The observations for ascertaining the character of the bottom beneath the surface, and those for temperature,

were more frequently made than the others, and the current was measured only at such points as would give a fair idea of the general set of the flood and ebb tides; but whenever an oyster specimen was taken, all the observations, with the exception of those for strength and direction of current, were made.

Only general instructions could be given as to the points on the beds where it was desirable to obtain specimens of any kind, of observations for temperature or character of bottom, and much was necessarily left to the discretion of the officer of the boat, not only with regard to those points, but also as to the general delineation of the beds.

So far as it went the work was satisfactory, but there were three great drawbacks to the use of the boats, viz.: The time and labour necessary to effect anything with them, the inability to use the pole with any accuracy in depths over three fathoms, and the failure of the pole to discover anything but the solid beds. We attempted to use with the boats a small and light dredge made especially for us, but found it impracticable, the largest boat, when under oars, fully manned, or when under sail in a stiff breeze, being unable to tow the dredge or even to move it; consequently the boats were useless for collecting any information, except over solid beds in less than three fathoms of water.

To define the limits of those beds lying in deeper water and of those not entirely solid, or where the oysters were scattered either in groups or singly, recourse was had to dredging with the schooner, using an ordinary oyster dredge of thirty-six inches width and with twelve teeth. This method was found to be so much more satisfactory in all respects, that all the boat work, whenever it was

possible, was supplemented by dredging lines run by the schooner. Traverses were made as with the boats, and observations for ascertaining the character of the bottom, both of the surface and substrata, observations of temperature, and the selection of the various specimens, were carried on.

The position of the vessel, however, was more frequently ascertained than had been customary in the boat work. The lowest possible rate of speed was maintained that was consistent with safe and ready manœuvring (a matter of some difficulty), and the dredge put over at intervals varying from two to ten minutes, and depending upon the character and extent of the bed, depth of water, and ability of the crew to get the dredge in, it being at times necessary to heave the vessel to in order to recover it.

The dredge was put over from the weather side, and, after having dragged a sufficient distance to insure its bringing up a specimen, should there be any oysters, was hauled in by hand. The presence of oysters on the bottom was readily detected by placing the hand on the dredging rope, the uneven, jumping motion of the dredge as it gathered the oysters and shells being distinctly perceptible.

The dredge was usually on the bottom from thirty to forty-five seconds, which length of time was sufficient for our purpose and sometimes enough to fill the dredge, a catastrophe which was not desirable. Soundings were taken along the lines, and, with the character of the bottom, recorded.

The following form for keeping the record was used and found to be of great value.

RECORD.

(Date, Sept. 5th, 1878. Day-mark, S. Recorder, S. E. Stevens).

Time.	Depth.	Station.	Bottom.	Dredge.	Amount in Dredge.	Ground Log.	Right object.	Left object.
<i>h. m. sec.</i>								
7 10 20	15 feet	3	Hard.	Over	1-3rd full	34 fathoms.	Clay Island Light House	Red Trees
30	..	..	..	Taking	168	..	Red Trees	Tall Trees
11 00	..	..	..	Off bot.	Oysters	..	Tall Trees	Solomon's Lump Light House
Angles.	Specimens.			Tide.	Temperatures.		Remarks on Oysters.	General Remarks.
	Oysters.	Bottom.	Water.		Air.	Surface.		
0 /					°	°		
52 08	3	1	1	$\frac{1}{2}$ -flood.	59	68	Large, single, young growth and clusters, many young and drills; no sponge.	Probed: 2 ft. oysters, then hard. 100 sail dredging to south- ward. Wind, S.W. —3.
68 23	..	..	..	..	..	..		
28 00	..	..	..	..	..	..		

. . . . At intervals during the day the number of dredging vessels in sight was recorded for reference, and subsequently an attempt was made to collect data for the estimation of the number of oysters taken in a day by each sail. At each anchorage the current was measured.

From the results given by using the pole in the boats and the dredge in the schooner, the outlines of the beds (were) traced on a chart.

. . . . The limit of scattered oysters can only be considered as approximate, as the lines (on the chart) were drawn from information received from local oystermen, and from such observations as we were enabled to make ourselves. . . . the boats (being) unable to ascertain the positions of any but the solid beds or large clusters, and the schooner not being able to work in less than eight feet of water, our ability to determine the area covered by the scattered oysters was necessarily limited. As that area, and indeed that of the solid beds also, is variable, changing from year to year, the line inclosing the scattered oysters may be considered as accurate as it is necessary to have it.

TIDES.

Considering the great depth of water over the majority of the beds, it was concluded that the slight variation in those depths, caused by the tides, could have but little influence on the oysters,

SPECIMENS.

. . . . One specimen of an adult oyster of two years' growth or more, one of from one to two years' growth, and one less than a year old, were usually selected from each locality. . . . In their selection we attempted to reserve such as would indicate the effect of natural conditions. At the close of the day's work the oyster specimens were washed in salt water, opened care-

fully with a sharp-pointed, thin-bladed knife, and the upper valve detached from the muscle, and then replaced. A small wooden peg was then placed between the bills of the shell, the valves tied tightly together with twine, and the oyster wrapped in cotton cloth of a very open texture. The whole was placed in alcohol. The wooden peg kept the shell open sufficiently to allow the alcohol access to the body of the animal, and the cloth wrapper prevented the destruction or loss of anything of interest which might be attached to the shell. Six parts of alcohol to four of water were used, and to each specimen was attached a wooden label, showing from whence the oyster came.

BOTTOM AND WATER SPECIMENS.

The specimens of bottom were obtained from large amounts of sand, mud, and gravel, brought up by the dredge or tongs. When the bottom was hard, an ordinary bottom specimen cup screwed into a 25-pound lead was used, but over the solid beds, or where the bottom was of hard sand, it was very difficult to obtain anything, either with dredge, tongs, or lead.

The specimens of bottom were secured by using drop-water cylinders.

. . . . All the specimens were tested with a hydrometer, and the readings reduced to those at the standard temperature of 60° F.

SUBSTRATUM OF BOTTOM.

The character of the bottom beneath the surface was roughly ascertained by means of an iron probe, 5 feet in length, attached to a long wooden staff. The probe was thrust as far as possible into the bottom, and the composition and character of the substratum estimated, the different constituents, whether sand, shell, mud, clay, or gravel, being easily recognized. Owing to the velocity of

the currents, the speed of the vessel, and the difficulty of handling a long staff, but few determinations of the character of the substratum were made when the depth of water was greater than three fathoms.

CURRENTS.

The currents were measured by a current meter, or by an ordinary chip log, though the latter was not used frequently.

NUMBER OF OYSTERS TO THE SQUARE YARD.

The number of oysters to the square yard was found by using a ground log in connection with the dredge. From the information derived from experienced oystermen, and from our own examination of those beds that had been dredged, I was of the opinion that a dredge, when of considerable size, and dragged slowly, usually collected everything met by it in its course. Considering that, at the suggestion of Mr. Rice, I used a small ground log to measure the distance travelled by the dredge. As that instrument was exactly one yard in width, it was concluded that it swept approximately clean one square yard for every linear yard it passed over. The ground log consisted of a small lead, a few ounces in weight, attached to a light line 1000 feet long; between the lead and line was a length of copper wire of 20 feet; the line was marked every five fathoms, and kept in a tub or on a reel ready for use; the lead was conical in shape, to prevent its catching on shell clusters. When the dredge was thrown over, the lead was dropped to the bottom and allowed to remain there, the line running out freely until the dredge was lifted off the bottom, when the line was stopped and the number of fathoms run off with the number of oysters in the dredge recorded. The dredge was not allowed to remain on the

bottom long enough to be filled, consequently none of the oysters were lost from its inability to receive them.

Though the foregoing method was imperfect, it was the best that could be devised under the circumstances, and a similar method was used by Möebius in ascertaining the number of oysters on the Schleswig-Holstein bed. From the very small number of oysters to the square yard, as shown by the method ; from the small number of oysters it assigns to the beds ; and from comparison of the latter number with the number known to have been taken off the beds during our stay in the sounds, it is evident that the "number to the square yard," given in the records of the work, are useful for comparison only ; for in almost all cases the number of oysters given to the square yard must be considered as far below the real number. For instance, the number of oysters on the beds in Tangier Sound, south of Jane's Island Light-house, was estimated from the data of the record given by the dredge and log to be 7,994,692, while from other observations I am positive that at least 2,000,000 were taken from those beds in six days, at the commencement of the oyster season.

Such could hardly have been the case had there been but 8,000,000 oysters on the beds, and consequently, we must regard the "number of oysters to the square yard," as shown by the methods used, only valuable as establishing an initial number and standard by which the increase or decrease of oysters on the beds may be ascertained, and by which one bed or locality can be compared with another. Alone, the results of the dredge and log are valueless.

TEMPERATURE OF THE WATER.

It was originally intended that the temperature of the bottom water should be obtained by means of thermo-

meters attached to "drop cylinders," used for obtaining the specimens of water from the bottom, and six of those cylinders were fitted at the office with mercurial thermometers, inclosed within the spindle upon which the cylinder moves, the bulb of the thermometer being a little above the centre of the cylinder when closed on the lower disk, and the graduated stem being exposed above the top, thus allowing the temperature to be read within any limits that would probably occur.

. . . . The cylinder is closed upon the lower metal disk by means of a spiral brass spring, which also holds the cylinder down firmly, thus preventing the escape of the specimen. The spring acts with considerable force, and we found that invariably the shock of the closure of the cup was sufficient to break the mercurial column, and prevent any reading of the thermometer. Attempts were made on board the vessel to remedy the evil by diminishing the strength of the spring, and by placing a rubber buffer on the lower disk; but we were unable to prevent leakage, and subsequently the same difficulty was experienced at the office.

Owing to the failure of the thermometers in the water cylinders, and the inability to obtain any apparatus, at so short a notice, in time to be available for the season's work, we were forced to use ordinary unprotected thermometers, furnished by the Coast Survey Office, with corrections established by experiments made previously and subsequently to the work of the party. The thermometers were fastened to a lead, lowered to the bottom, and kept there a sufficient time to acquire the temperature of the surrounding water. They were then hauled up as rapidly as possible and the temperature read; at the same time the temperature of the air and water surface was noted.

Owing to the rapid change of reading when the thermometers were moved through strata of different temperature, the observations are only reliable when the temperatures of the air, surface and bottom water were identical.

NAMES AND AREAS.

In naming and describing the beds I have used the local names given them by the oystermen. The term "rock" is with them synonymous with "bed," as they regard only the solid portions of the area covered by the oysters. In the following pages the term "rock" indicates the solid, or approximately solid, portions of the bed. Areas are given in feet and miles. When the latter unit is used it is the nautical mile of 6080 feet, and not the statute mile.

OYSTER BEDS OF THE JAMES RIVER, VIRGINIA.

The examination of these beds was a very hurried one, and the delineation must be regarded as merely approximate, being the result of a hasty reconnaissance.

. . . . Below Deep Water Light the beds of any consequence are twelve in number, and of a total area (approximate) of 10.4 square miles. Taking them in order from Deep Water Light to Hampton Roads, they are the Mulberry Point Bed, Point of Shoals Bed, Jail Island Bed, Blunt Point Bed, White Shoal Bed, Thomas's Point Bed, Kettle Hole Bed, Brown Shoal Bed, Bally Smash Bed, Naseway Shoal Bed, Cruiser's Bed, and the Nasemond Ridge Bed.

. . . . In order to determine whether the salt water over the beds in the river, and especially over the Mulberry Point, Point of Shoals, and Jail Island Beds, was displaced by the fresh water of the spring ebbs, specimens of water were obtained at every two fathoms of depth, on

a section across the river just above Deep Water Light, at low water, spring tide. . . . Comparing the specific gravity of the water obtained in the sections with that of two stations below Deep Water Light, which was obtained nearly at high water, the difference of density was so slight that it can hardly have any material effect upon the oysters, and, except during long continued freshets, which occur sometimes during the spring, the animals in all probability do not suffer therefrom.

According to the oystermen, during the winter ice frequently grounds on the shoal spots on the beds, but never remains there long, unless the weather is of unusual severity, the strength of the current and the variability of the climate being sufficient to remove the ice in a short space of time. As to the amount of damage done to the oysters by ice, opinions varied a good deal; the general impression was that, though the oysters were poorer in quality and flavour, the ice did not remain long enough to kill many of them. Only a few persons could be interrogated, and they were not very intelligent, but, in the absence of any opportunity to investigate the matter ourselves, their opinion is given.

All the beds in the James River are subject to the deposit of mud and vegetable matter brought down by the freshets that occur in the spring. . . . The spring freshets always cover the Mulberry Point, Point of Shoals, and Jail Island Beds, but not always for a sufficient time to very seriously damage the oysters, the current managing to sweep off the deposit in time to expose the cultch to the spat. Occasionally the damage is great; for instance, we were informed that during 1871 and 1872 there were a succession of heavy freshets, which destroyed the fishing for several years. In 1876, the mud having been washed

away and the cultch exposed, a growth of young oysters was noticed in all the beds about and above Jail Island. In 1877 the oysters about Deep Water Light were good, and probably during the coming seasons (1878-'79) the catch on all the beds will be large, as at the time of our observations the oysters were numerous, with the young growth predominating. Apparently, then, it requires from three to five years for the beds to recover from the effects of heavy freshets, and as the oyster becomes marketable in about two years, from five to seven years must elapse from the date of the freshet before the beds can be profitably worked.

. . . . In addition to the deposit by the James River, the Nasemond Ridge and beds off Pig Point receive a portion of the sediment brought down by the Nasemond River; but other causes not operating, that deposit would not be sufficient to seriously injure the beds. Below Jail Island, on the northern side of the river, the beds are not so much affected by the deposit, and the oysters found on them are of a better quality than those on the opposite side of the channel.

Without incurring an expense not justified by the end sought, there is no practicable means of protecting the beds from this evil. Natural efforts appear to have sufficiently protected them in the past, and if they are guarded in other respects, the loss on account of the deposit of matter brought down by the current, which is but occasional, will not interfere to any great extent with the industry.

Mulberry Point Beds.—These beds comprise an area (approximate) of 3,656,000 square yards.

Point of Shoals Bed.—Comprise an area of 14,941,000 square yards, approximately; and the Jail Island Bed has

an area, approximately, of 5,730,000 square yards. . . . On the shoalest parts of the beds the bottom was found to be a stratum of shells, with a light covering of mud and a substratum of hard sand. On these shoal places the oysters and shells were most abundant. The oysters were not evenly distributed over the entire bed, but grew in detached patches and ridges on and in the vicinity of the shoals, with numerous narrow mud sloughs intersect in and separating them. The deep water was found over these sloughs, and, generally speaking, the shallower the water the larger the number of oysters and the thicker and more solid the bed, this being especially true about the boundaries, where the beds rise abruptly from the main channel, and where great difficulty was found in attempting to penetrate them with the probe; while in the interior portions and in deeper water the surface stratum was of shells and mud, with six feet or more of soft mud underneath.

. . . . The oysters on the three beds are of the class known among the dealers as "snaps." They are small and poor, single or in small clusters of two or three, and when not transplanted are used for canning. There was no sponge or grass attached to the shells, and but very few of the usual inhabitants of a bed other than the oysters appeared to be present. Young oysters, of about one year's growth and under, predominated, and the proportion of young to mature oysters was greater on the shoal spots and ridges at the edge of the bed than elsewhere, owing, probably, to the fact that such portions of the bed being shoalest, hardest, and cleanest, they offered superior points for the attachment of the drifting spat.

The oysters from the Jail Island Bed were considered superior to any in the river for planting purposes, though

no reason was assigned for the preference. The oysters from all these beds are generally transplanted before being sent to market. No oysters were found in the main channel, and in the swash channel only a few, and those widely separated.

. . . . *Blue Point Bed*.—The area of this bed is about 1,125,000 square yards.

Thomas Point, Kettle Hole, and White Shoal Beds.—The areas (approximate) are, respectively, 949,000 square yards; 1,792,000 square yards; and 1,300,000 square yards. On the Kettle Hole and Thomas Point Beds no oysters were found on the shoals when the falling tide exposed them, but great quantities of broken shells were mixed with the sand; on all contiguous parts the oysters were very thick.

. . . . The covering of mud over the animals was quite light. . . . The oysters were single and in small clusters, and whilst those from the Thomas Point Bed were small and of an inferior quality, those from Kettle Hole were larger, of good quality, and with a moderate amount of white and gray sponge clinging to them, and on both beds the proportion of young oysters of less than a year's growth to those mature was very large.

THE FISHERY AND ITS EFFECTS.

The oysters are removed from the beds in the James River with the tongs alone, no dredging being permitted, and this may account to some extent for the beds being made up of patches and ridges of oysters. This formation is only advantageous in so much as it assists the rapidity of the current, and in all other respects it is an evil. Beds such as Cruiser's Rock, Nasmond Ridge, and Point of Shoals, where the oysters in places are too thick, would be much improved by using a light scrape or dredge, instead

of the tongs, in the fishery. If used with moderation, the surface of the bed would be cleaned, its area extended, the animals would be more evenly distributed and allowed more room for development, and the spat, having a larger and cleaner amount of "cultch" exposed, would probably attach in greater numbers.

As, however, without stringent laws, rigidly executed, it would be impossible to keep the dredging within proper limits, and as there is but little prospect of such a thing occurring, it is perhaps better, on the whole, that dredging is prohibited. The mud surrounding the beds is of too soft a character to permit any great extension of the present area, and thus one of the principal advantages of using the dredge would be lost, while all its evils would be retained. Even as it is the fishery is carried to excess, and all the beds, especially those in the neighbourhood of Hampton Roads, are deteriorating.

THE MUSCLE HOLE BED.

This bed lies on the western side of the channel, south of the Mud Rock. It extends north and south about three miles, is from one half to one quarter of a mile wide, and comprises an area of 3,060,000 square yards. . . . The depth of water is from 12 to 34 feet, and the bottom very irregular, The mature oysters were large and single, and of good quality. A very large proportion of young growth was noticed, at least one-half the oysters being of that description. A large number of young, but few drills (*astyrus*), were found on the hard bottoms of the central part of the northern portion. On the central and southern portions of the bed the number both of young and drills decreased, while they increased greatly on the western portion. A large amount of red sponge was found, and in greater quantities about the edges of the bed, especi-

ally the western, than elsewhere, but its presence appeared to have no effect upon the young or drills. East of the bed the oysters were of the same general character as those on it; the same proportion of young growth was also noticed; but there was almost an entire absence of young and drills. To the westward, as a rule, the oysters were somewhat larger than those on the bed, but as many young growth were present as elsewhere. The number of young and drills was, however, much diminished, as was also the amount of red sponge. The number of oysters to the square yard, the mean of thirty-six observations, was 0.70. The number to the square yard, on the area occupied by scattered oysters, the mean of seventeen observations, was 0.07.

DENSITIES.

Specimens of the bottom water taken on each bed, at all stages of the tide, have been tested with the hydrometer, and its readings reduced to a standard temperature of 60° Fahr. These results show a maximum density of the waters of Tangier Sound of 1.0164, which was found in the lower part, about the California Rock, at half flood-tide. The minimum density of 1.0111 was found in the upper part of Fishing Bay, with the tide three-quarters ebb. From the comparison of densities tabulated, it appears that the state of the tide has but little influence upon the density, though the depth of the water has, and the prevalence of strong winds may increase or diminish it.

. . . . There were no heavy rains during my stay in the Sounds, and the densities given (in the table) therefore show only the condition of the water in that respect during dry weather. I was informed that there was a noticeable change in its character about the mouths of the

tributaries of the Sounds, after a heavy rain-fall, and the effect upon the oysters was also perceivable.

The difference between the maximum and minimum density of the Sound amounts to 0.0053 ; but the difference between the maximum and minimum density on each bed will give a more correct idea of the changes to which the oysters are exposed. The greatest difference is 0.0025, which occurs on the Shark's Fin and Fishing Bay Beds, and the least difference on any of the main beds is 0.0009 on the Little Thoroughfare.

. . . . If the change of density over these beds (as shown by these tables) represents with approximate accuracy the change of salinity of the water, the fluctuation is too slight to seriously affect the beds or oysters ; but if the slighness of the change is due to organic matter held in solution by the waters of the ebb tide, which would replace the salt of the flood, there may be a much greater difference in the salinity of the flood and ebb than has been indicated by the hydrometer.

CURRENTS.

In reviewing the statements regarding the currents, Lieutenant Winslow says " that the strongest on both tides were those over Terrapin Sands during the spring tides, their velocity being about one mile per hour." As the observations over the Sound were made during various states of the weather and of tide, the highest velocity obtained is probably as great as ever sets over any of the beds.

The velocity, except within wide limits, however, is not so important to the oysters as the direction of the current.

DEPOSITS.

. . . . Those beds lying in the deep water are particularly free from an undue proportion of mud on the bottom, the shoalest beds having the thickest mud covering.

If there was a constant and increasing deposit upon the beds they would long ago have disappeared, or at least have become of much smaller area; but the reverse is the case, the beds increasing in area constantly.

They are, however, exposed to one species of deposit which is very injurious. Heavy gales occurring in winter and summer, frequently tear up the large quantities of grass, sea-weed, and sponge on the sand shoals about the Sound, and deposit upon the beds. If this occurs in summer, when there are a small number of dredgers at work, the effect is very injurious, the "cultch" being covered, and the young, if spawned, smothered by the grass, weeds, sand, and mud which it collects.

. . . . The gales also have the effect of covering the scattered oysters on the leeward sands, which process is called "sanding," and, from what I could learn, appears to be a very injurious one. The oysters are buried, and the bottom becomes smooth and hard. Where at least thirty bushels could be taken previous to a gale, not one oyster could be found subsequent to it. The winter gales have the greatest effect, owing probably to their greater severity and direction, which is from the northward and westward.

. . . . The "sand" oysters are said not to recover from the "sanding" for several months, and upon their reappearance are noticeable on account of the whiteness of their shells. Though there were several very heavy blows while we were in the Sound, they were not of sufficient severity to produce the effect spoken of, and if they had

been I should not have been able to detect it, on account of the shallowness of the water in which the scattered oysters lie, which prevented the schooner's dredging for them.

EFFECT OF GALES AND ICE.

As there was no opportunity for me to investigate this question in person, the examination of the beds having been accomplished during the summer and autumn months, the following information is derived from the queries put to the oystermen and persons inhabiting the shores of the Sound.

. . . . The gales from the eastward, southward and eastward, and southward, cause an increase of depth over all the beds, amounting sometimes to two feet, and the northerly and westerly gales a contrary effect, but not sufficient to leave any of the natural beds uncovered. . . .

. . . Gales from any direction cut away considerably the leeward shores and points, especially when they are of a sandy nature.

. . . . Though it is said the amount washed away from these points is considerable, no additional deposit was ever noticed on the beds, nor did the gales appear to affect them in any way other than has already been described, except in conjunction with the ice in the winter.

Ice never rests upon the main beds except in a few isolated cases, where there happens to be a very shoal spot on the bed ; . . . The injury done to the oysters by the grounding depends upon the length of time the oysters are in contact with the ice. If it only touches in a few places, not much harm is done ; indeed, it is supposed to protect the majority on the bed by covering them ; but where there is a contact all over the "rock," the oysters are killed in a short space of time. The number of points

in the Sound where it is possible for the ice to rest is considerable, and not many of the animals are destroyed by the grounding of the ice, though they are affected seriously by its long continued presence.

The winter gales break up the ice fields, and pile them up in immense masses on the leeward shores and over the adjacent beds. . . . A good deal of damage is done to the shores by the ice, and the oysters feel the effect, showing it by becoming what is called "winter killed," or poor and weak, having a slimy, sickly appearance, when opened. Many die on the beds from this cause, and after the disappearance of the ice, ten days or two weeks must elapse before they are fit for marketable purposes. Ordinary cold weather and a moderate amount of ice is said to improve the fishing, the oysters appearing to be drawn more to the surface of the beds, and the shells to sink more toward the bottom. My informant said this effect was quite noticeable.

No one that I was able to interrogate had ever seen an oyster frozen *in the water*, and the impression was that so long as the oysters were covered they would recover from any ill effects of ice or ordinary cold weather.

. . . . The heavy gales that occur in winter and summer, though principally during the former season, increase or diminish the depth of water on the beds sometimes as much as three feet. Strong northerly and north-westerly gales have the effect of diminishing the depth of water, piling up any floating ice upon the leeward shores, and cutting away parts of those shores. Heavy south-easterly and southerly gales will increase the depth of water on the beds, stir up the soft muddy bottoms of the channels and beds

Generally speaking, the beds in this (Pockomoke), as in Tangier Sound, are in too much water to permit their being uncovered by even the heaviest gale, or to allow the ice to ground upon them at any time; but those beds in shoal water (of about one fathom), and the planted beds, which are generally in less, are subjected to both evils. The effect of gales and ice in Pockomoke Sound seems to be less than that in Tangier Sound, in consequence of its less extent and smaller area.

GENERAL INFORMATION GIVEN BY OYSTERMEN.

The following information is that derived from the answers to the questions propounded to the fishermen and others.

All the oystermen and dealers that were encountered during the season, so far as was possible, were interrogated. That which was not pertinent to the subject, or evidently influenced by self interest or other considerations, has been excluded.

There has been no material change of the channel within the memory of the oldest fishermen, nor have they ever found oysters in the deep water of the main channel of either Sound. With regard to the improvement or deterioration of the beds, it was the general opinion that the beds had been much extended in size, that the quality of the oysters had improved, both as to size and flavour, but that the number on the beds had been very materially diminished, so much so that it was hardly profitable to work on the same beds.

. . . . In Fishing Bay, . . . though the beds as a whole had deteriorated, during the last four years there had been some improvement on account of a more rigid observance of "close time."

The cause assigned for the deterioration, and even the admittance of the fact, depended very much upon the occupation of the informant. The tongers, or those who pursued the fishery with tongs alone, were unanimous in laying the deterioration to excessive dredging, while the dredgers, or those owning pungies or other vessels employed exclusively with the dredge, while they admitted the decrease in the number of oysters, laid such decrease to the action of natural and unexplained causes, arguing that the evident extension of the beds and improvement of the oysters, due to dredging, was sufficient to prove its good rather than its ill effects.

With regard to the effect of ice in cold weather, everyone coincided in the opinion that the oysters in deep water were most affected, and those in shoal or brackish water were least so. In the same depths and character of water, those oysters about the edges of "muddy rocks," and close to muddy channels or sloughs, were most affected by the cold or a severe freeze. After the latter event the packers distinguish the deep water oyster by its dark, slimy appearance, and decline it, though at the same time shoal-water oysters are in good order, and are accepted.

. . . . Regarding flavour, those from the salt water were the best, and generally the salter the water the better the flavour.

With regard to an increased freshness of water, due to freshets and heavy rains, it was the general opinion that during the winter season it was not of much consequence, but that in spring or summer heavy rains or freshets were very beneficial, especially in the spawning season, hastening its advent and shortening its duration. An increased freshness of water always fattened the oysters. Oysters in salt water were always poor, and oysters were generally poorer

after a dry season. Planted oysters above Pig Point and the Old Rocks, in Pockomoke Sound, have been known to die from absorbing too much fresh water, and those on the Old Rocks have sometimes suffered from the same cause ; but this only occurs during heavy freshets.

With regard to the depth of water and character of bottom, shallow water was preferred, and sticky mud or mud and sand, about six inches in thickness over a hard substratum, was considered the best, though a larger amount of mud did not matter, provided it was not so soft as to allow the oysters to sink in it, and had a strong current over it.

The oysters were said to feed on the flood tide, having their bills open then and at no other time. No one had noticed any enemies or animals that preyed upon the oysters, and all seemed ignorant of the drills and their destructive effects.

The oysters are "culled," that is, they are separated from the old shells and other *débris*, while the boat or vessel is on or near the bed. Everything except the oyster is thrown back, sometimes striking the bed and as often the mud. The young oysters under a year and a half in growth, and less than two inches long, are also thrown back.

All persons interrogated were of the opinion that at least 75 per cent. of the oysters on a bed are taken off each year, and that no more than 50 per cent. should be removed. Off the beds near Haine's Point at least 100,000 bushels, or about 20,000,000 oysters, were taken in the season of 1878. Off the Great Rock about 100,000 bushels were taken by one hundred boats, in October and November of 1877. The oysters on the Rock at the end of November were so scarce that but a very small number of boats could

find profitable work on the bed. In the spring, about 75,000 bushels more were taken up and sent north, and as the oysters were small, they amounted to probably 15,000,000 at least. Exclusive, then, of the fishing done during the winter months, in one season it is estimated that 30,000,000 of oysters were removed from one bed alone.

Nearly all the oystermen advocate a "close time," either from April 1 or May 1 to October 1; many considered a prolongation until November 1, and an entire rest every other year, would be beneficial.

With regard to transplanting the oyster and its transportation, all experienced persons were of the opinion that delicacy of handling, and freedom from jars, concussions, and shocks of any kind, were desirable. Oysters when under hatches have very frequently been killed by heavy thunderstorms and firing of guns. Any concussion or sudden shock will prove destructive, if the animals are in a confined space. Oysters taken up during the summer are much more susceptible to injury from this cause than those obtained during the winter.

Oysters are transplanted at any and all seasons, but generally in the spring and autumn. Oysters obtained by the use of the "tongs" are preferred to those dredged, and generally those taken either before or after the spawning season are most desirable. The dredged oysters are apt to be broken about the bills, and will die on the planting grounds sooner and in larger numbers than the "tonged" ones. Those oysters planted about the Sounds are generally obtained from "tongers," but those sent to the north, being in such large numbers, are usually dredged. The size and age of the oysters to be transplanted depend on whether they are for early consumption or not. If the

former, the larger and older the better ; but in the latter case young oysters, from one to two years old, are preferred.

Generally, any and all oysters are taken without regard to age or size. The oysters for the northern planting grounds are usually taken up as soon as ice clears away, and are used during the spring. Those transplanted in the Sound are taken up later in the spring, or during the early summer or autumn months, and used during the following winter. Blunt-nosed oysters, with thick shells, do not thrive on the planting grounds. A change of bottom in transplanting oysters is not considered of so much importance as a change of water. The planted beds should be laid at the mouths of creeks and rivers having a rapid current. The bottom best for natural beds was considered best for planted ones.

The spawning season was said to be from May until August, inclusive, though most of the spawning was done in June and July. All opinions coincided that the oyster in shoal water spawned first, but differed as to whether, the depth being the same, all oysters on the same bed spawned at or about the same time, as many being for as against the theory. Currents were said to have no effect upon the spawning. Oysters of one year's growth, three-fourths of an inch long, have been seen with the spawn in them, and oysters on natural beds were thought by the majority to spawn sooner than the planted ones, though there was not much difference. Oysters transplanted with the spawn in them, however, will cease spawning. A wet or warm spring would hasten the time of spawning, but would not shorten its duration.

. . . . The young were supposed to "strike" every three years, though there was but little regularity about it, a bed sometimes running for ten years with a

young growth on it every year, and then failing to produce anything for two or three years. Sometimes one part of the bed will be covered by young, and another totally barren.

. . . . Ten bushels of oysters were considered a profitable day's work for a tonger. For a dredger the number of bushels varied on account of their different sizes. About 60 bushels were considered a profitable day's work for the larger vessels, and from 20 to 30 for smaller craft. The dredging vessels employ from four to nine men, and the "tonging" canoes one man and a boy. Tonging could not be carried on profitably in depths greater than four fathoms in the Sound, and dredging in not more than six. The dredges vary in size from two to four feet across the mouth, with from eight to sixteen teeth. Generally they are made about three feet wide, with twelve or fourteen teeth, but vary a good deal in weight. My informant found that, generally speaking, it was more profitable to fish with the tongs exclusively, for the large oysters used for barrelling by the dealers, and to dredge for packing and canning establishments. The tongs are worked at small expense, and the "barrel" oysters bring a much larger price, though they are necessarily selected oysters and more difficult to obtain.

The prices paid during the season of 1877-78 were about \$1 per barrel for "barrel" oysters, and from 5 to 40 cents for the ordinary oysters from the beds; the "snaps," or most inferior quality, bringing the lowest price, and 40 cents being paid only for "extra culled" oysters. About 20 cents per bushel would allow a small profit. The flavour is not generally taken into account, and the degree of fatness and the size settle the price. Salt-water oysters

sometimes command better prices when intended for a special market, or to supply some unusual demand.

CONCLUSIONS.

The following remarks are simply the conclusions drawn from certain peculiar features and facts established by the investigation and testimony, and an attempt to account for them.

. . . . There are, then, two similar facts noticed in both Sounds with regard to the presence and absence of the young and "young growth;" the former have been found in deep water and on hard bottoms, the latter in shoal water, on or near soft bottoms. The character of the bottom can hardly be of much importance in this case, and the only probable cause known to us is the difference of depth of water.

. . . . The class termed "young growth" by us were from three-fourths of an inch to one-and-a-half inches long.

. . . . The difference in time of spawning, in shoal and deep water, is probably due to difference in temperature, the deeper water naturally being of the lowest. The establishment or the refutation of this supposition, as also that of the difference of the times of spawning (*f*) is very necessary, especially of the latter, as it would afford a sure basis for such legislation for the protection of the beds as will soon be necessary.

(*f*) In searching for spawn in the oysters during the latter part of August and first part of September, Mr. Rice was unable to discover any except in those from deep water, and that fact, together with the inference drawn from the preceding paragraphs, leads me to believe the oystermen correct in stating that there is a difference in the time of spawning of the shoal and deep water oysters.

Aside from the general absence or presence of young on particular beds, it was noticed that a much smaller number were found on or adjacent to the muddy bottoms, or on the sands where there was much grass or sponge. . . . The absence of the young may be very readily accounted for, if the sponge had formed previous to the "spatting," as it would prevent the exposure of the "cultch." The sponge is of very rapid growth, and I was informed that on an unworked bed it had been known to become three or four feet thick in a few months. If, then, it had formed and commenced growing after the "spatting" season, the young would not be as much disturbed by it as they would if the growth had been previous to their advent. This is another reason in favour of the theory that the depth of the water influences the time of spawning, as the effect of the sponge on the numbers of young was greater in deep than in shallow water.

The number of drills (*astyrus*) was, generally speaking, in direct proportion to the number of young, and the Pockomoke Beds, especially the Bird and Hern Island Beds, appeared to have suffered most from their ravages. . . . Very few star-fish and whelks, and no other enemies were discovered in the Sounds, and the drills are probably the only ones that do any considerable damage.

With regard to the beneficial effect, or the reverse, of fresh water, there can be no doubt that the oysters at least appear fatter and are superior after absorbing it, though they become poorer in flavour. In order to test the effect of fresh water upon them, and to determine if the low spring tides had any share in causing the decrease in the numbers on the beds, a dozen oysters were selected from the same bed and haul of the dredge. Six of them were opened immediately, and inspected and found to be rather

poor, of small size and dark colour, but of the ordinary flavour. The remaining six oysters were placed in perfectly fresh water for twenty-four hours, the water being changed several times during that interval. They were then opened and inspected. They were alive and in good order, very fat, or apparently so, and of a creamy white colour and much swollen, but of very insipid taste. As the oysters were alive at the end of a day's immersion in fresh water, they cannot well be destroyed by the brackish water of low spring ebbs, to which they would not be exposed for more than six hours, though a continuance of heavy freshets might very seriously affect them.

The evil effects of sudden jars and concussions are probably due to the breakage of the delicate pedal muscle, which after the spawning season, in common with all other parts of the animal, is in a more or less weakened condition.

In explaining the fact that the oysters in deep water are more affected by cold water and ice than those on the shoals, it is necessary to remember that the lower the temperature of sea water the greater its density, and thus, as the surface water becomes cooler, it would sink. The freezing point of salt water is below that of fresh. Therefore the oysters in the deep water, or, generally speaking, those remote from the mouths of the streams, may have surrounding them water of a slightly lower temperature, depending upon the amount of salinity, than those oysters near the creeks and rivers that are surrounded by ice. Again, the deep water would be much slower to lose or acquire heat than that on the surface or in less depths, which would necessarily be affected quickly by all changes of weather.

The statement that the oysters recover and reappear after the "sanding" process must be received with great caution, opposed as it is to most experience. That some

few may survive is possibly the case, but that the majority recover, after being covered with sand for any length of time, is very doubtful.

The testimony of all persons in the neighbourhood of the Sounds was to the effect that the beds were deteriorating. . . . Accepting, then, the statement, it is necessary to account for the deterioration if possible.

. . . . Briefly, the change in the beds has been a material expansion of their limits, and a material diminution of the number of oysters upon them, and therefore the causes for such changes must be sought among such as it is known would produce like effects.

Disregarding for the present the agency of man in the matter, the question is, what natural cause or causes would both expand the beds and diminish the number of oysters? A bed is extended naturally by the drifting spat or "young brood" attaching themselves to any clean, hard, and moderately rough substance contiguous to the bed. The locomotive powers of the "spat" exist for but a short time, and, except when assisted by the current, they can only move a short distance, and unless some suitable object presents itself for their attachment, they will sink into the soft bottoms and die.

The principal expansion of the beds, so far as could be effected by nature, must, however, have been accomplished long ago, the beds being surrounded originally, and indeed at present, by soft bottoms of a character which would be most destructive to the "brood," unless some substance was interposed between it and them for their reception. Natural expansion can only be achieved to any extent in the manner described, and though probably there is and has been a slow extension of the beds due to natural,

unassisted causes, their great increase in area during the last thirty years must be assigned to other agents.

The diminution of the number of oysters may be effected by several causes. An increased deposit of earthy or vegetable matter upon the beds would, if in sufficient quantities to bury the oyster, effect the destruction of both old and young ; but no such deposit has been noticed, nor could it well occur without showing its presence in other ways, principally by changing the channels and causing shoals, and no such changes have occurred. . . . A change in the character of the water and bottom, which would probably follow a change of channel, and might occur without such change, might, by depriving the animals of their proper food, cause their deterioration and destruction ; but such a change, though it would certainly diminish the number on the beds, would do so suddenly, and the evil effects would be noticed in the oysters remaining, their quality and flavour, indeed their vitality, being very much impaired. No such impairment has been observed, however, the oysters being larger and finer than when the beds were first discovered. That fact alone will eliminate many quantities from the equation, for any natural cause injurious to all the oysters on the beds would be evident at once by an examination of those found at present. If, however, the destruction or non-production of the necessary number of young is accomplished by means that are not harmful to the mature oyster, a cause is discovered for the diminution of all, in harmony with the existing facts. . . . The destruction of the young . . . by the falling of the "spat" on unfavourable grounds, the prevalence of heavy freshets, . . . the ravages of various enemies . . . all these causes have been in operation continually since the first formation of the beds, and the animals have sur-

vived and increased while contending with them. Therefore, an increase of power for injury must be assigned to one or all of these, to account for the diminished number of oysters. Probably the "spat" falls on more favourable ground since the beds were discovered than was formerly the case, owing to the increased amount of "cultch" due to the fishing of the beds, and aside from that, the conditions surrounding and operating upon the beds are so similar to those in the past that the loss of the young could not be much greater from the want of attachment.

Discarding the theories of "the freshets and other natural causes, the ravages of enemies, including *astyrus* (and especially the latter as the *principal* causes), for the deterioration of the beds," Lieutenant Winslow proceeds: But as there is also a marked deterioration upon those beds upon which no drills were found, still another cause must be at work, and must be sought in the non-production of the young.

This is caused by the failure of the "brood" oysters, they having removed or become extinct, thus causing a failure of impregnation. If the theory is correct that there is a mutual fecundation, partaken of by all oysters on the beds, the spermatozoa being formed and milted somewhat prior to the formation of ova, then it can easily be understood that if the oysters are so much separated that even the tides and currents cannot bring the spermatozoa within reach of the adjacent animals, there could be no production of young.

Taking for instance the most exaggerated case in both Sounds, that of the Muddy Marsh Bed, it will be seen that the set of the current over it not generally from any adjacent bed, the nearest one being Parker's Rock, which is over three miles distant; the oysters on the Muddy

Marsh Bed were very few, and the mass of shells immense, (*g*) affording ample surface for the attachment of the drifting "spat," should there be any.

But supposing the oysters on the beds to have been so much diminished that they were not sufficient for mutual fecundation, the distance and situation of other beds is such as to prevent the current from bringing the products of generation voided on them to the Muddy Marsh Rocks, and there would be, as was noticed, an almost entire failure of young. In the same manner, though in less degree, would the other beds suffer, the amount of spawn voided depending not only upon the number of mature "brood" oysters, but upon their distance from each other, and the spaces separating the beds. This theory is supported by the investigations that have been made in England, France, and Prussia, and almost all opinions coincide that the number of young in any spatting season is dependent upon the number of "brood" oysters upon the beds. Indeed, it seems so self-evident a proposition that it is hardly worth while to experimentally establish it.

(*g*) To give some idea of this, I quote Lieutenant Winslow's statement (or rather the concluding part of it) relating to the dredging of the bed in question:—"The oysters on the bed and from its vicinity were of medium size and fair quality, single, and very scarce. Very few young, no young growth nor drills, and no sponge, grass, or parasitic attachments of any kind were found, but an immense amount of broken shell and other *débris* was brought up by each haul of the dredge. On one occasion the dredge filled in three minutes; shells and one oyster resulted. A similar haul produced a dredge full of shells and five oysters. As the dredge held about two bushels, the percentage of *débris* is thus shown to be enormous. The hauls were made on the shoal, solid portion of the bed, where, according to most experience, the oysters should have been most numerous."—Report for 1881, p. 35.

It is necessary, then, having accepted the theory, to determine what proportion of the oysters should be taken off the beds, and what proportion is actually removed. As there is no data to my knowledge, derived from observations made in this country, to determine the first of these two desired points, it is necessary to turn to the experience of foreign oyster fisheries for guidance; and though the animals and the conditions under which they live are not entirely similar, yet some information may be obtained and a line of investigation marked out for the future.

The following is a synopsis of the deductions of (the late) Professor Karl Möbius, professor of zoology in the University of Kiel, whose work, in manuscript, on the oyster was kindly lent me by Professor Baird. The observations were made over the Schleswig-Holstein oyster-beds by government officials, from 1730 to 1852, and were carried on in, practically, the following manner:—Each bed was dredged over in three or six places, according to its size, and the oysters taken were divided into three classes, and carefully counted.

The classes were denominated “marketable,” “medium,” and “young growth.” The “marketable” oysters were full grown and mature, from 7 to 9 centimeters in length and breadth, and 18 millimeters thick. The “medium” were half-grown oysters, from 16 to 18 millimeters thick and of less than 9 centimeters in breadth. The “young growth” were those one or two years old. From these observations Professor Möbius discovers that there was an average of 421 medium oysters to 1000 full grown ones. The average of all the observations differs very little from the number given by each, and consequently shows that there was but slight fluctuation in the proportion in one hundred and twenty-two years. The medium oysters are considered by

Professor Möbius to be those descendants of the marketable ones that have survived their most precarious years of existence, and escaped their principal enemies, and are consequently likely to reach their full growth. They thus represent the total number of embryos spawned which have survived in the struggle for existence.

From his (Möbius') experiments he decides that an oyster spawns about 1,000,000 embryos in a season, and that 44 per cent. of the mature oysters give forth "spat." [Other authorities are of the opinion that only about 10 per cent. spawn; Professor Möbius' data appear hardly sufficient to justify his conclusion.]

From the above it is evident that in an assemblage of a thousand oysters, 440,000,000 embryos will be voided every season, and of them 421 would survive, or 1,045,000 embryos would be destroyed where one was preserved. But the medium-sized oysters also spawn, though they send forth a much smaller number of embryos. Möbius estimates that the 421 in the community would produce about 60,000,000 of "spat." It would therefore require about 500,000,000 embryos to produce 421 medium oysters, or 1,185,000 to produce one. Regarding these results, Professor Möbius is of the opinion that no more than 40 per cent. should be removed each year; but, in my opinion, in order to maintain the oysters at a constant number in the above case, no more than 25 per cent. should be taken, as the one oyster in four would be replaced each year. No comparison between the Schleswig-Holstein beds and those on our coast can well be instituted, but as the beds in Tangier and Pockomoke Sounds are of greater extent, and as the more extensive the bed the greater the breeding power, I should consider that, until the annual number of mature oysters produced is known, it would be

safe to take about 50 per cent. from the beds, supposing them to be in good condition.

This is but an estimate, and may be an erroneous one, but certainly it is not too small. It now remains to be seen what number of oysters are actually removed from the beds. I regret that statistics of the oyster trade in the Sounds are not at hand for reference, and also that the pressure of other work while I was in that locality prevented me from obtaining them. Such observations as we were able to make, however, will furnish a basis for a somewhat rude estimate of the number of oysters and young taken off the beds during the season.

While in Crisfield Harbour, about the 11th October, we counted fifty-seven sail oyster dredgers. The number of bushels carried by them was estimated . . . and the result for one day was found to be 2408 bushels.

“The day had been a bad one for dredging, and but a small number of dredgers had been at work, and they had come into port much earlier than usual; consequently, the average and total number of oysters are below the usual figures. . . . Estimating the number of oysters to be between 150 or 200 (to a bushel) we have for the result of one day's fishing from 361,200 to 481,600 oysters and about 486,000 young.

. . . . The vessels were of different sizes and from different localities, and were classified as sloops, schooners, and buckeyes. In order to ascertain the number of bushels to each vessel, the total number of bushels brought in (2408) was divided by the number of sails (57), which would give 42 bushels as the average to a sail. A closer estimate is obtained from Table II., where the number of bushels assigned to each craft is that given by their master. The

total number of bushels (551), divided by the number of sail (12), gives 45 and a fraction as the number of bushels to each sail.

. . . . The total number of bushels taken from the beds in both Sounds (Tangier and Pockomoke), in thirteen days, was 47,842, and allowing from 150 to 200 oysters to a bushel (though the number is probably larger), there would be removed from the Sounds in the very first of the season from 7,176,300 to 9,568,400 oysters. This, however, is far below the real number, as the entire area and number of sail were not visible at the same time.

. . . . Though there were dredgers in large numbers at work early in September, and also many during the entire summer, yet in order that any error may be under, rather than over estimation, I will consider the working season to be from the 1st of October to the 1st of May, and allow three days in each week for bad weather, which would prevent dredging. That allowance will leave 120 working days, and in that time (by the preceding table) over 184,600,000 oysters would be removed from the beds in the Sounds, supposing them to supply the same number during the entire season.

. . . . The average number of young to a bushel was 202. That number represents the number of young oysters attached to the shells of the full-grown ones that were removed from the beds. . . . 20 and 30 young were frequently found on one shell, and in one case 54 were counted. In estimating the total number removed from the beds in one day, only those vessels dredging on such beds as were known to have a large proportion of young upon them have been considered, and even then the estimate reaches the astonishing figure of 1,238,790. These oysters are those of from two to five months'

growth, . . . many of them would doubtless perish (even) if undisturbed, for though all oysters on the beds, mature or others, would suffer if exposed to unfavourable conditions, yet many of those conditions would affect the young and young growth to a greater degree than the mature and more hardy oysters.

I will therefore suppose that 50 per cent. of the young taken up would never have reached maturity, and will also make another and very liberal supposition, that by the 1st of April the young would have reached such a size as would make it profitable to open them. That would make the working season, so far as the young were concerned, 104 days, and the number of young removed would amount in that time to 128,834,000, of which about 64,417,000 would probably have attained their full growth. These young are a total sacrifice, never seeing the water again after their removal, and generally perishing on distant or adjacent shell heaps.

Many more are probably destroyed by carelessness in disposing of the old shells brought up by the dredge. The dredging is usually across the bed, and the shoal hard ridges noticed along the edges of the beds on the western side of Tangier Sound, and on all edges adjacent to muddy bottoms, are no doubt caused by the dredgers, who, as they approach the edge of the bed, having dragged across it, haul in their dredges just before getting over the muddy bottoms. They then stand on, tack or "wear," and as soon as on the bed drop the dredges again. In the meantime the crews have been busily "culling" the oysters, and, as likely as not, have thrown over on the soft mud a far larger number of young attached to the shells than they have taken off on the oysters.

No account has been taken of the number of mature or young oysters removed by the tongers, and the estimates are based upon observations made at the commencement of the fishing season, when, the prices being low, a smaller number of dredgers would be at work ; therefore, there is every reason to believe that the estimate of both classes of oysters is under rather than above the real number removed. We have then, aside from the ravages of the drills, a yearly destruction of over 64,000,000 young, and the removal of 184,000,000 mature oysters, to account for the deterioration of the beds.

SPECIFIC GRAVITIES.

Before I begin this part of Lieutenant Winslow's valuable work, I must, in behalf of my non-scientific patrons, respectfully solicit the scientific reader's indulgence for presuming to give a definition of the above title.

According to the Dictionary, specific gravity means—"the weight of a body compared with another of equal bulk, taken as a standard," but the definition that will suit my purpose better, and, at the same time, instruct the reader in a more desirable and comprehensive manner, is that given by Captain Maury in his very valuable work on the Sea (*h*), wherein he shows that the general circulation of the sea is dependent upon its specific gravity, and the constant and successful efforts of that element to preserve an uniform condition, and he illustrates the idea in the following ingenious manner:—

"Let us suppose a globe of the earth's size, and with a solid nucleus, to be covered all over with water two hun-

(*h*) The Physical Geography and Meteorology of the Sea. By Captain Maury, LL.D., Superintendent of the National Observatory, Washington. Sampson Low, Son, & Co., London, 1861. Ninth edition.

dred fathoms deep, and that every source of heat and of radiation be removed, so that its fluid temperature becomes constant and uniform throughout. On such a globe, the equilibrium remaining undisturbed, there would be neither wind nor current. Let us now suppose that all the waters within the tropics to the depth of one hundred fathoms suddenly becomes oil. The aqueous equilibrium of the planet would thereby be disturbed, and a general system of currents and counter-currents would immediately commence—the oil, in an unbroken sheet on the surface, running towards the poles, and the water, in an under-current, towards the equator. The oil is supposed, as it reaches the polar basin, to be converted into water, and the water to become oil as it crosses the tropic, rising to the surface in the hot region, and returning as before. Thus, *without wind*, we should have a perpetual and uniform system of tropical and polar currents, though *without wind* Sir John Herschell maintains we should have no ‘considerable currents whatever in the sea.’”

Captain Maury then proceeds to show how, by the rotatory movement of our planet, these currents, instead of flowing due north and south, are thrown to the right; and that, if, in addition to this cause for deflection, you introduce a series of obstacles in the shape of continents, islands, and shallows, you would easily create those cross-currents, those variations in volume and velocity, which are met with in the circulation of the ocean of our planet; and he concludes by asking whether the cold waters of our northern regions, and the warm waters of the Gulf of Mexico, made specifically lighter by tropical heat, do not, in their present system of currents, represent in a great degree the relation of the imaginary oil and water.

Gladly would I avail myself of the opportunity of quoting further from this interesting and highly instructive book, but that the tempting pursuit were of too digressive a nature for the subject in view. But those who read his work cannot do otherwise than follow the writer into all the ingenious proofs adduced in support of his views, and agree with him that the grand currents of the ocean are occasioned by the endless variations in temperature, specific gravity, and saltness of its waters, as well as a multitude of other agencies which extend from the poles to the equator; and that, of those causes, the winds represent merely a unit, and act solely on the surface of the sea, or to the extent of a few fathoms below it. The rain and the snow which fall upon its surface serve equally to disturb the equilibrium, as well as evaporation in one quarter, congelation in another; and although the sea has its deserts as well as the land, yet its waters are far more densely filled with animal and vegetable life than either the air or *terra firma*; and every creature, every coral, every phosphorescent molecule and weed, is ever abstracting or adding to the component parts of the waters in which they exist; their action is as ceaseless as the variations of heat and cold which cause our atmosphere to be ever in motion, thus calling for perpetual oceanic currents to undo their perpetual work.

To give the reader an idea how very particularly and how thoroughly the coast survey was accomplished by Lieut. Winslow, I will give an example of one particular part of his work which may serve as a guide as to what can and perhaps ought to be done elsewhere.

It is but fair to him to add that I have very much condensed his Report, which, being rather copious, might not, upon that account, serve to interest readers on this

side of the Atlantic ; but in this condensation thereof there will be found as much as is perhaps necessary for all practical purposes.

“ The general examination of the waters of the State, with reference to their possibilities for oyster culture, was the most difficult and delicate part of the work. It required a scrutiny of the water and bottom ; measurement of the currents ; determination of the specific gravities at various states of the tides and seasons of the year ; microscopic examinations of water, bottom, and oysters ; a study of all the various surveys that have been made from time to time, and a more or less particular examination of the fauna of each locality. . . . In order to carry out the spirit as well as the letter of the resolution, and make the examination of as early practical benefit as possible, included in the general scheme was a project for diffusing knowledge as to the possibilities of the industry in this State, and the best manner of utilizing them. So many of those most directly interested in the extension of the industry were of the poorer classes, without educational advantages, that publications alone would either fail of attention or fail to reach them at all. Consequently, it was deemed best to put such advice and information as could be given in the shape of familiar and informal lectures, directed especially to those who were to be most benefited by the knowledge of the experiences of other oyster-growing localities. A number of such lectures have been given with most gratifying success, both as to the interest of the audience and as to the effect in a practical way ; quite a number of additional oyster-gardens having been taken up in the several counties since the middle of November, 1885, and a very large area during the past year (1888).

. . . . The character of the water has an important, if not the most important, influence upon the life of the oyster. Chemical analyses are desirable, and in some cases necessary, but, generally speaking, the determination of the specific gravity of the water provides a sufficiently accurate standard for forming either comparisons or opinion.

The investigations of the Coast Survey in Tangier and Pockomoke Sounds, tributaries of Chesapeake Bay, and probably the largest oyster grounds in the world, have indicated 1.0140 as the standard specific gravity, 1.0000 indicating the density of distilled water at 60 degrees F. The investigation also showed that the specific gravity of those waters could fall considerably below the standard without serious effect, and Count Pourtalès, who investigated the subject many years ago, came to the conclusion that oysters would live in water of as low specific gravity as 1.0010, which is .013 below the standard here accepted. Indeed, within reasonable limits, it is not so much the absolute specific gravity as it is the rate and range of the fluctuations which must be considered, for oysters can be accustomed to water of very great or little density; but water that changes rapidly from a high to a low specific gravity, or the reverse, will soon destroy the animals.

In determining the specific gravity of the water, the delicate hydrometers, devised for this purpose by Professor Hilgard, late Superintendent of the U.S. Coast and Geodetic Survey, have been used. Three are necessary to cover the ordinary variation between sea and fresh water. They are described in the Report of the Coast Survey for 1874, Appendix 16.

. . . . All readings of the hydrometer have been reduced to the standard temperature of 60 degrees F."

Lieutenant Winslow speaks at great length on the specific gravity of Pamlico Sound, situate on the coast of Carolina, south of Chesapeake Bay, in North America. He describes it as an enormous sheet of land-locked water, comprising with its tributaries an area of 1,149,400 acres. The general depth of the water is from fifteen to twenty feet. In the deep water the bottom is soft, but in the neighbourhood of the shoals and shores it becomes harder, consisting of sticky mud or sand. There are no rocks other than "oyster rocks," in this or any of the other Sounds. There are two small openings into it from the sea, giving just sufficient amount of sea-water to temper the extreme freshness that would otherwise prevent the growth of shell-fish.

It occasionally happens that in the extreme north part of the Sound, after heavy freshets, the water will become too fresh, and oysters will either perish or become greatly impaired in quality; the average density of the water is 1.0115, which, however, varies greatly with the locality, weather, and season of the year. The usual practice was to obtain and test a specimen of water every two and four hours when under way, and every four hours when at anchor. The current was measured whenever an anchorage specimen was taken. There were 2500 specimens of water tested in this locality.

Considerable variations were found in density in every locality, and in many the range was abnormally large. These variations did not appear to be altogether influenced by the wind prevailing at the time, and both high and low specific gravities were found in the same locality, with the wind in nearly the same direction and of nearly the same force. Neither did the current appear to have the influ-

ence to be expected. With an approximately similar current the specific gravity at a point will vary considerably.

The condition of the water was found not to be dependent upon the wind prevailing at any particular time, but upon the wind that had prevailed ; while, except in the neighbourhood of the inlets, the exact opposite was (and is) the case with the currents.

From a careful inspection of the determinations of specific gravity and observations of winds and currents, the following are deduced :—

Easterly winds will cause high water and high densities.

Westerly winds will cause low water and low densities.

Southerly winds will cause low water and low densities in the southern part of Pamlico Sound, and high densities in the northern part.

Northerly winds will have an exactly opposite effect in each locality.

The greatest density and the highest water will be found, after continued easterly weather—

In the northern part of the Sound, immediately before the shift of the wind to N.W.

In the southern part of the Sound, immediately before the shift of the wind to the S.W.

The strongest currents will be found immediately after a shift of wind.

The weakest currents will be found immediately before a shift of wind.

This portion of the coast is in close proximity to the general track of cyclones, and an advancing circular storm is always felt beforehand, through the influence of the cyclonic wave, in increasing the height of the tides or general level of the water. Hence an increase of density

and high water will indicate the approach of easterly weather.

. . . . The average of the density determinations taken at twenty-three different points west, but within five miles of the Bluff Shoal, gives 1.0106 as the specific gravity of the water of the area.

The average of the determinations taken at twenty-two different points east, and within five miles of the Shoal, gives 1.0125 as the specific gravity of that area.

In other words, east of the shoal the specific gravity is 0.0019 higher than west of the shoal. . . . The difference in the character of the water is apparently due to the difference in origin of the water on the east and west sides of the shoal—that on the east coming from Albemarle, and being influenced by the tidal currents of the inlets, while that on the west is from the Pamlico and Neuse Rivers, and is not subjected to any oceanic influence.

. . . . The study of the specific gravities of water offers an interesting field for investigation at all times, but in the figures given below the object is the determination of the average specific gravity of the areas, and the amount of variation in “a general summary of the results of all observations, arranged by 27 sections and by counties,” of which the following are the totals:—

SUMMARY BY SECTIONS.—Area in acres, 1,325,419. Area upon which oysters can be grown, 756,520. Average specific gravity, varying from 1.0040 to 1.0230, averaging about 1.0112. Extreme depths of water, 1 to 28 feet, averaging about 12 feet. General character of bottom: 7 being spoken of as sand, 14 sand and mud, and 6 mud.

SUMMARY BY COUNTIES.—Area in acres: public grounds, 20,553.11; natural beds, 8,327.90; suitable ground (approx.), 583,330; available for entry (approx.), 502,000.

GENERAL CONDITION OF THE OYSTER INDUSTRY PRIOR TO 1887.

The condition of oyster industry of North Carolina, at the time the present investigation (1886) was begun was insignificant.

The natural beds of the State comprise some 8000 acres. These beds produced in 1880, according to the U.S. census, 170,000 bushels of oysters, valued at \$60,000, and afforded employment for 1020 persons and \$68,500 of capital. The yield of the beds was therefore about 20 bushels per acre, and the value of the ground in gross income \$7.00 per acre. As a considerable portion of the area of the oyster-beds is non-productive at present, either on account of the inferiority of the oysters or want of a market for the particular grade of stock they supply, those grounds that are worked must be yielding somewhat more than 20 bushels per acre; but allowing a margin of 50 per cent. for non-productive areas, 40 bushels per acre are secured.

According to the report of the Maryland Oyster Commission, the beds of that State comprise an area of 123,520 acres, and the census gives their product as 10,600,000 bushels, or an average of 87 bushels per acre. In 1880 the Maryland oyster-beds were already in a much impaired condition, and consequently they produced much less than a natural bed in a normal condition; but comparing the average yield of the Maryland beds with that of the North Carolina areas, a difference of 47 bushels per acre is shown in favour of Maryland. Either one of two conclusions can be drawn from this comparison: the fishing in Maryland was more systematic and thorough, or the beds of North Carolina yielded much less for the same exertion. Natur-

ally they were more productive, as they were in shoaler water and the oysters were more easily obtained ; therefore, if other indications point in the same direction, the evidence as to the proportionally small product must be accepted as additional proof that the beds have deteriorated.

Such additional proof was not wanted. All oystermen encountered expressed the opinion that the beds were by no means in as good condition as in the past, and invariably the cause was stated to be over-fishery. In addition, nearly all the beds examined showed an undue proportion of empty and broken shells, and a corresponding poverty of oysters. This was certainly not due to the ravages of enemies, as none of any consequence were found. In the upper part of Pamlico Sound many areas have suffered, either from a deposit of sediment or from the action of fresh water, and in a few other localities beds in shoal water have been damaged by ice ; but with these exceptions there was no evidence of any deleterious natural influence having been at work. Remaining, then, was the influence of the fishery, and the testimony of the fishermen as well as of the beds was conclusive to the effect that in many localities the fishery was excessive.

The experience of other localities has been, without exception, that excessive fishery leads to extinction, and there was no doubt that the beds of North Carolina, if they continued to be exposed to an unrestricted fishery, and obtained no measure of relief, would share the universal fate and be destroyed.

The beds being in not only an impaired condition, but threatened with complete destruction, some remedy was necessary that would counteract the destructive influence. This could be accomplished by restricting the

fishery, or by endeavouring to increase the number of oysters on the beds. To restrict the fishery would, in effect, deprive many of the poorer class of people of a portion of their substance and means of livelihood; nor was it necessary, except in extreme cases, to do so. The root of the evil was that the demand had outgrown the supply, and so long as that continued, restrictive measures would not only be very difficult to enforce (as the periodic oyster war in the Chesapeake bore witness), but would cause an increase in the price of a desirable and nutritious article of food.

Restriction, except in special cases, was, then, not a practicable or desirable remedy. The other alternative was to strike at the root, and endeavour to increase the supply; and this could be done only by the cultivation of additional areas which were unproductive. A feeble effort had been made in this direction, under the authority of those sections of the Code which permitted individuals to cultivate tracts of bottom; of those sections the following is a brief synopsis:—

Section 3390 provides that any inhabitant of the State may have not more than 10 acres of bottom, provided he first obtains a license from the Clerk of the Superior Court, stakes out the ground with substantial stakes, and has not more than one such bed in a county; and provided, also, that the riparian rights of owners of adjacent lands shall not be affected, nor any natural clam or oyster-bed be inclosed nor navigation obstructed.

Section 3391 authorizes the Clerk of the Superior Court, in his discretion, to grant licenses.

Section 3392 authorizes the County Commissioners, in their discretion, to make surveys of the private beds or gardens, and declares any owner who is found to have

more than 10 acres, or any natural bed inclosed, to have forfeited all rights in the premises, and the same penalty is provided should the owner fail for two years to use his bed or garden or keep up his stakes.

Section 3393 provides for the punishment of depredators upon the private beds or gardens. These provisions were defective and inadequate in the following particulars:—

1. The grants were confined to inhabitants of the State, the impression being that the area of suitable and desirable ground was limited, while, on the contrary, it is practically unlimited, our investigation having shown some 600,000 acres as available.

2. The tracts which could be taken up were confined to 10 acres. This was due to the same impression as to the limited area of suitable ground. It was unwise, as success in raising and cultivating oysters is as dependent upon the fundamental laws of political economy as any other business, and no business has been known to succeed when there was no hope of expansion, stimulus to exertion, or gratification to ambition. Neither has any enterprise a chance of success, or of becoming of great importance, when it neither claims nor receives the unremitting and undivided attention of those engaged in it. Exclusive attention cannot be given to so small an area as 10 acres. The results would not justify it. In fact, if the owner relied upon such a lot alone for his livelihood, he would probably starve; and, indeed, no one did do so; the business (if it can be called one) of raising oysters being merely adjunctory to other pursuits, and men keeping oyster "gardens" as they did kitchen gardens, and oysters as they did a few pigs, almost entirely to supply their own tables. Evidently the oyster interest had no more to

hope from such a state of things than agriculture had from the kitchen garden.

3. The provision allowing each person but one bed was unjust. Circumstances or location enabled one man to take his full 10 acres in a lot, and another but 2 acres; but the law allowed but one lot, which should not exceed 10 acres, and thus some men obtained more than others.

4. The provision protecting the natural beds was right and proper, but worked disadvantageously on account of the use of a general instead of a specific description of the areas it was desired to protect. As explained in the first pages of this report, there is a great difference of opinion as to what constitutes a natural oyster-bed, and so long as no legal and exact definition existed to govern those desirous of establishing artificial beds, more or less insecurity was felt.

5. The provision, granting to the Clerk of the Superior Court discretionary power to issue licenses, had no foundation in justice. It opened the door to favouritism and partiality, and it is particularly to the credit of the clerks of the courts of the several seaboard counties that they did not take advantage of the provision to forward ends other than those of a public nature.

6. The provision giving the County Commissioners discretionary power to make surveys was also a disadvantage. Unless the Commissioners chose to act, there was no means of determining whether the law had been complied with or not.

7. The absence of a requirement that lots should be surveyed and located with reference to some well-defined and permanent landmark before the issuance of the license, was apt to cause confusion of titles and needless litigation. Many clerks required surveys to accompany the application

for license, but those surveys were rude in the extreme, and it was the exception and not the rule when they would plot. In many cases the description of the lot was radically in error—in one case the metes and bounds given being practically one straight line, and this lot was supposed to contain 10 acres. In numbers of instances no description at all was given beyond the statement that the lot lay in such and such a creek or bay, and contained 10 acres. How the area of the lot was determined is impossible to conceive. Many lots were said to begin at a "point," or opposite a "house" or "wharf," but the general description was that the lot "begins at a stake." A stake is a perishable object, and frequently disappears. In such cases the owner sets up another, sometimes in the same place and sometimes not; but there was nothing to prevent his taking up an entirely new area, or infringing upon other lots, and nothing to protect him from similar infringement upon his own.

Two examples of characteristic surveys are quoted:—"Begins at a stake, running N. 66° W., 30 poles; thence S. 66° E. to the shore; thence with the various courses to the beginning, containing 10 acres.

The two courses given here are one and the same, and the description is utter nonsense.

"This is a plan of an oyster-bed layed off for ——, in —— Creek, in said county, on Hunting Quarters, containing 10 acres on the east side of said creek, adjoining the lands of said ——."

A rough sketch without courses or distances accompanies this description, and naturally no plot can be made nor its area determined.

In addition, the law required good and substantial stakes to be maintained, and also that free navigation

should not be interfered with. But stakes of the description required did interfere, to some extent, with navigation by small boats, and their maintenance was in some localities a source of complaint.

Reviewing the several provisions of the statutes, it will be seen that the clerk of the court might or might not grant a license at his discretion ; that he who obtained the license for 10 acres might take more than that amount, and that there was no method of detecting his appropriation of extra ground, unless the County Commissioners should choose to exercise their powers and cause a survey to be made ; that those who had honestly taken up nothing more than the law allowed were constantly in danger of losing the fruits of their labour through inaccurate surveys, or through the presence in the area of something or some spot which some person might choose to consider a natural bed, and which, for all the owner knew, might be one within the meaning of the law.

Supposing that the cultivator observed the law and managed to preserve his property, he was confronted on his death-bed with more or less inability to dispose of the ground. The license was good in him and his assigns, but if his children were already in possession of lots they could not maintain their title to any additional areas they might inherit ; nor could neighbours or others purchase if they happened to have attempted oyster cultivation, and as already explained, the lots were too small to induce cultivation by any but those living conveniently near them. Thus, through the provisions of an act intended to foster the growth of shell-fish, and at the same time prevent a monopoly of the ground, the growth of the industry was checked, its profits rendered hazardous, and a most rigid monopoly vested in a few people living near the water fronts.

Naturally conditions such as these awakened discontent, not only among those who worked on the natural beds, but among that better and more influential class who had made some effort to improve such ground as they could legally hold. Labouring under insecurity of title, open to depredation under the guise of law, and confined to areas so small as to hardly pay the attention given them, it was surprising that even two hundred and fifty persons should have had the courage to enter the business. And, in fact, the only cases where a real success was achieved was where at least three or four lots, containing ostensibly 10 acres each, were held in the same family, and the property secured by a gun.

In the appendix of the preliminary report, made to the Governor in January, 1887, is given a list of the owners of oyster-gardens, and the area, so far as it could be determined, of each lot. To cure the foregoing defects, and remove the obstacles which lay in the road to the establishment of the industry upon a firm and just foundation, I suggested that the following recommendations be incorporated in a new enactment by the Legislature :—

1. That the control of the shell-fish interests of the State be committed to some body, which should be large enough to enable it to exercise the semi-judicial functions which its duties would entail, and yet sufficiently small to secure executive qualifications and full responsibility.

2. That, as the entire area of the waters of the State had not yet been surveyed or examined, and as the areas and positions of all the various natural oyster-beds had not yet been determined, the several sections defined in the first part of this report should be accepted and made legal divisions of the area. The sections had been laid off with a view to their possible utilization in this way. They

began and ended at points established with all the accuracy of the most accurate surveyors of the world—the officers of the U.S. Coast Survey—and their limits were therefore clearly and sharply defined. In many the surveys had been completed, and by adopting those or similar divisions portions of the area could be opened to entry from time to time as the natural beds were located, and thus an immediate revenue secured and a portion, if not all, the expenses attending the installation of the work be defrayed. The action would be similar to laying off a town in blocks, and permitting building in each as fast as the grades were established and public ways defined.

3. That the body controlling the shell-fisheries, after suitable surveys had been made, and the positions of the natural beds defined and laid down on proper maps, should determine upon the areas and positions of the Public Grounds of the State in each section.

4. That the Public Grounds should include all natural beds, and such adjacent areas as might be necessary to provide for such natural expansion as would occur within a reasonable time, and that a definition should be given to the term “natural bed.”

5. That the body controlling the fishery should have full power and jurisdiction over the Public Grounds, and should prescribe such rules and regulations for the government of the same as might be necessary.

6. That upon the determination of the location and area of the Public Grounds in any section, the same should be published for the information of those whom it might concern, and that opportunity to be heard should be given any person who was dissatisfied with the decision as announced; and that all objections and protests should

receive consideration, and be substantiated or refuted, if necessary, by additional surveys and examinations.

7. That the body controlling the fishery, after being fully satisfied as to all the facts in the case, should come to a final decision, which should be binding upon all persons until reversed by due process before the courts, to which appeals should lie.

8. The body controlling the fishery, after having determined the positions and areas of the public grounds, should have power to grant perpetual franchises, for the fishery and cultivation of shell-fish on any area not within the boundaries of the Public Grounds.

9. That the Legislature should determine upon a certain fixed price per acre to be paid, and on its payment the applicant for ground should be entitled to his franchise.

10. That the body controlling the shell-fishery should furnish each owner of ground with a survey, plot, and description of his lot, for the actual cost of making the same, and should prescribe the place, character, and number of stakes, buoys, or monuments for ranges which the owner should maintain, so that there should be no interference with navigation or the fishery of migratory fishes.

11. That all holders of licenses under the old statute, who had complied with the law, should obtain from the body controlling the fishery franchises for their grounds, and that the surveys and locations of the same should be verified before issuing such franchises.

12. That a regular tax should be levied and collected on all private grounds, in the same manner as upon other property.

13. That any private ground which was not improved within five years should revert to the State.

14. That forms for all applications, grants, assignments, and protests, should be determined upon by some competent authority, and be adopted for use.

15. That regular books of record and plots of the grounds should be kept by the body controlling the fisheries, and that all grants, transfers, and assignments should therein be recorded.

These suggestions were general, and of course admitted of elaboration as might be deemed best.

They provided for intelligent supervision of the whole industry, for the opening of the undeveloped area, for the maintenance of the rights of individuals and of the public, and insured even justice to all. They contained the essential features of the Connecticut law, which had passed beyond the domain of experiment, and their adoption by the State would, I believed, bring about great benefits, and would not, I knew, result to the detriment of anyone.

The foregoing recommendations met with the approval of his Excellency the Governor, and their general and important features were incorporated in his message to the General Assembly. After a most elaborate discussion in committee, a bill was reported which passed both houses, and became a law on the 28th of February, 1887. It was entitled "An Act to promote the cultivation of shell-fish in the State," and a copy will be found a few pages further on.

OPERATION OF THE NEW LAW.

The Board of Commissioners of Shell-Fisheries having completed their labours, and the areas in the several counties, not included within the limits of the Public Grounds, having been declared from time to time open for entry, under the provisions of the new oyster law, an immediate movement towards securing tracts began. The new departure of North Carolina had been largely advertised through

the press, and much interest was excited among oyster growers and others who appreciated the importance of the opportunity offered. Not only were the inhabitants of the tide-water counties and of the State seeking locations, but numerous inquiries were received from citizens of other States.

As will be seen from its perusal, the Act is a very liberal one, and practically invites non-residents of the State to enter into the cultivation of oysters, the only discrimination against them being in the prohibition of entry of ground less than two statute miles from the shore.

The effect of this liberal policy was immediately felt, and ground has been entered very generally by both non-residents and others, fully 50,000 acres having been taken up. . . .

The method to be adopted to obtain a grant is as follows: The forms for applications, grants, warrants, and assignments which have been approved by the Attorney-General, being on file in the offices of the Secretary of State, and Registers of Deeds of the Counties of Dare, Hyde, Pamlico, and Cartaret—

(1.) The person desiring a tract of bottom makes an application in writing, stating as nearly as may be the location and area of the desired tract to the Entry Taker of the county in which the ground lies. The fee is 40 cents per entry.

(2.) The Entry Taker issues a warrant to the Engineer of the Board of Commissioners of Shell-Fisheries, to survey and locate the ground.

(3.) The Engineer surveys the ground, and lays it down on the general map. His fees are as follows:—

For each or fraction of a day employed, \$2.

For each acre contained in the lot, 5 cents.

For each corner located, 25 cents.

Mileage at the rate of 5 cents per mile.

(4.) The Engineer transmits to the applicant a certificate of survey, together with a plot of the ground. A copy of the form of certificate adopted will be found at the end of this chapter.

(5.) The applicant transmits to the Secretary of State the certificate and plot, together with the following sums of money :—

For fees for application of the great seal, postage, &c., \$2.05.

For purchase money for ground, 25 cents per acre.

(6.) The Secretary of State issues a grant conveying a perpetual franchise to the fishery of shell-fish on the ground, and records the same in his office, and notifies the Engineer of the issuance of the grant.

(7.) The owner of the ground records the grant in the office of the Register of Deeds of the county in which the ground lies, and establishes his marks defining his boundaries. The grant must be recorded within three months of its issuance.

The ground must be improved within five years.

METHOD OF LOCATING LOTS.

The corners of the lot are established by taking the horizontal angles between three established objects, or, in other words, the location is effected by the method generally in use in hydrographic surveying, and ordinarily known as the "three point problem." The corners can be established on the map, the angles subtended at each corner by objects on shore, measured by the protractor, and then by their use stakes or buoys placed in the proper

position on the ground, by finding the point where the angles measured between the objects agree with those already determined upon the map. Or this process may be reversed: the lot can be staked off, the angles measured at each corner, and then subsequently laid down by the protractor on the map, and the boundaries of the lot determined. The method is not only simply and accurate, but is the only one practicable at small expense. Its advantages are:—

1. Any lot entered and located on the water can be laid down in its exact relative position on the map, and, *vice versa*, any lot located on the map can be laid down in its exact relative position on the water.

2. There is absolutely no method of making a fraudulent survey, as any fraud on the part of the Engineer could be instantly detected by any examiner, and any misappropriation of area by the owner, by moving stakes or buoys, could be immediately ascertained by re-measurement of the angles subtended at the suspected mark.

3. After the angles are once ascertained, the stake or buoy can be re-established, if lost, without difficulty.

4. But three instruments are needed at the most, viz.: Two sextants and one three-armed protractor. After the lot is laid down on the maps the area is found either graphically or by calculation, and the description, giving metes and bounds and the angles subtended at each corner, is drawn up. The whole, together with a plot, is recorded in the record-books of the Engineer. A scale of $\frac{1}{1000}$ (equal to about 27.8 yards to an inch) has been adopted for lots of 10 acres and under, and a scale of $\frac{1}{20000}$ (equal to about 556 yards to an inch) for lots of 100 acres and upwards. Intermediate scales will be used as necessary.

AN ACT TO PROMOTE THE CULTIVATION OF SHELL-FISH
IN THE STATE.

The General Assembly of North Carolina do enact :

Section 1. That the State shall exercise exclusive jurisdiction and control over all shell-fisheries which are or may be located in the boundaries of the State south of Roanoke and Croatan Sounds, and north of Core Sound.

Section 2. In order to carry out the purposes of this Act, the southern boundary line of Hyde County shall extend from the middle of Oracoke Inlet to the Royal Shoal Light-house, thence across Pamlico Sound, and with the middle line of the Pamlico and Pungo Rivers, to the dividing line between the counties of Hyde and Beaufort, and the northern boundary line of Cartaret County shall extend from the middle of Oracoke Inlet to the Royal Shoal Light-house, thence to the Brant Island Shoal Light-house, thence across Pamlico Sound to a point midway between Maw Point and Point of Marsh, and thence with the middle line of the Neuse River to the dividing line between the counties of Cartaret, Craven, or Pamlico ; and that portion of Pamlico Sound and the Neuse and Pamlico Rivers not within the boundaries of Dare, Hyde, or Cartaret counties, and not a part of any other county, shall be in the county of Pamlico ; and for the purposes of this Act and in the execution of the requirements thereof, the shore line as now defined by the U.S. Coast and Geodetic Survey shall be accepted as correct.

Section 3. The State Board of Agriculture shall, at the next regular meeting following the passage of this Act, elect three commissioners of shell-fisheries, whose term of office shall be one year, and the said Board of Commissioners of Shell-Fisheries shall be maintained so long as

may be necessary to carry out the special duties confided to them by the provisions of this Act, and no longer, and they shall employ such engineers and clerks as may be necessary for the execution of the said duties, and fix their compensation.

Section 4. The Board of Shell-Fish Commissioners shall make or cause to be made a survey and map of the area hereinbefore described, whereon shall be shown the location and area of all the natural beds, and of all the grounds which may have been occupied under authority of previous Acts for the growing, planting, or cultivation of shell-fish, and, upon the completion of the said surveys in, and maps of, each or any county, the Board of, Commissioners of Shell-Fisheries shall determine the location, area, limits, and designation of each and every public ground in the county, and such public grounds are to include the natural beds, together with such additional areas adjacent thereto as may be deemed by the Board of Commissioners of Shell-Fisheries as necessary to provide for the natural expansion of the said natural beds ; and having decided upon the location, area, limits, and designation of the said Public Grounds, the Board of Commissioners of Shell-Fisheries shall publish the same for the period of thirty days, at the court-house door, and in four other public places in the county wherein the said Public Grounds are located ; and any person or persons objecting to the decision of the Board of Commissioners of Shell-Fisheries, as published, may file a written protest, stating the ground for his or their objection, within the said thirty days, with the Clerk of the Superior Court of the county wherein the said publication is made, upon payment to the said clerk of the sum of 25 cents, and at the expiration of the said thirty days the said Clerk of the Superior Court

shall forward all such written protests to the Board of Shell-Fish Commissioners ; and in case such protests are so filed and forwarded, the said Commissioners, or a majority of them, shall, upon fifteen days' notice in writing, mail or personally deliver to all parties in interest, hear and pass upon such protests or objections, in the county in which the said public grounds are located ; and the said Board of Commissioners of Shell-Fisheries, having fully informed themselves of the facts in the case, shall make, within twenty days of the hearing, a decision which shall be final, and shall be so considered until reversed on appeal to the Superior Court. And at all hearings authorized by this Act the said Commissioners may, by themselves or their clerk, subpoena witnesses and administer oaths as in courts of law.

Section 5. The Board of Commissioners of Shell-Fisheries shall, upon making the said final decision as to the location, limits, area, and designation of the several Public Grounds in the county, publish the same in the county in which the said Public Grounds are located, and in two newspapers having a general circulation in the State, and shall announce in the said publication that at the expiration of twenty days from the first day of publication the territory within the said county, and embraced within the provisions of this Act, will be open for entry in manner and form as hereinafter provided ; and any person or persons desiring to raise, plant, or cultivate shell-fish upon any ground in the county which has not been designated as Public Ground by the Board of Shell-Fish Commissioners, may, at the expiration of the said period of twenty days, make an application in writing, in which shall be stated, as nearly as may be, the area, limits, and location of the ground desired to the entry-taker of the county

in which the said area for which application is made is situated, for a franchise for the purpose of raising or cultivating shell-fish in said grounds, and the said entry-taker, having received said application, shall proceed, as with all other entries, as provided in Section 2765 of the Code as amended, except that the warrant to survey and locate the ground or grounds shall be delivered to the Engineer appointed by the Board of Commissioners of Shell-Fisheries, and not to the County Surveyor, and the said Engineer shall make such surveys in accordance with the provisions of Section 2769 of the Code, except that it shall not be necessary to employ chain-bearers, nor to administer oaths to assistants, nor to make surveys according to the priority of the application or warrant.

Section 6. The Secretary of State, on receipt of the Auditor's Certificate, as provided in section 2778 of the Code, shall grant to the applicant a written instrument conveying a perpetual franchise for the purpose of raising and cultivating shell fish, in and to the grounds for which application is made; and the said written instrument of conveyance shall be authenticated by the Governor, countersigned by the Secretary and recorded in his office.

The date of the application for the franchise and a description of the ground for which such franchise was granted shall be inserted in each instrument, and no grant shall issue except in accordance with Certificate from the Engineer of the Commissioners of Shell Fisheries, as to the area, limits and locations of the grounds in which the said franchise is to be granted; and every person obtaining such grant or franchise within three months from the receipt of the same, shall record the said written instrument in the Office of the Register of Deeds for the county wherein the said grounds may lie, and shall define the boundaries

of the said grounds by suitable stakes, buoys, ranges, or monuments; but no franchise shall be given in or to any of the Public Grounds, as determined by the Commissioners of Shell-Fisheries, and all franchises granted under this or previous Acts shall be and remain in the grantee, his heirs, and legal representatives: *provided that* the holder or holders shall make—in good faith, within five years from the day of obtaining such franchise—an actual effort to raise and cultivate shell fish on the said grounds; *and, provided further*, that the area hereinbefore described, lying between two statute miles of the main land or any island, shall be entered or held only by residents of the State of North Carolina; and no grant shall be made to any one person of more than ten acres of the said territory, and no person shall hold more than ten acres in any creek unless the same shall be acquired by devise, inheritance, or marriage.

And all that territory within the provisions of this Act, and lying more than two miles from the mainland or any island, shall be subject to entry by any person; but no person shall be permitted to enter in any one period of five years more than 640 acres.

Section 7. Twenty-five cents. per acre shall be paid to the State Treasurer for all franchises granted, and all monies received for the granting of franchises or for taxes laid on the said grounds or on property thereon shall be set apart and kept separate for the purpose of defraying the expenses entailed by the provisions of this Act, and any monies remaining after the payment of said expenses shall be paid into and credited to the School Fund.

Section 8. The Secretary of State is hereby empowered to hire and take upon leases, not exceeding a term of ten years, in the name and behalf of the State, any such

plot or plots of ground within the State as may be deemed necessary for the constructing, erecting, setting, maintaining, and protecting of signals, beacons, bound stones, posts, or buoys, to be used in designating, locating, surveying, or mapping any shell-fish grounds ; and any persons who shall wilfully injure or remove any such beacon, bound stone, post, or buoy, or any part, appurtenance, or inclosure thereof, or any buoy, stake, mark, or range of any private or public shell-fish ground, shall be guilty of a misdemeanour.

Section 9. All grounds taken up or held under this or previous Acts shall be subject to taxation as real estate, and shall be so considered in the settlement of the estates of deceased or insolvent persons.

Section 10. The Board of County Commissioners shall have entire control and jurisdiction over all Public Grounds lying within the boundaries of the counties ; shall place and maintain such marks, and shall prescribe and publish at the court-house door, and at four other public places in the county, such rules and regulations as may be necessary for the governance and control of the fisheries on such Public Grounds.

Section 11. Any person who shall wilfully commit any trespass or injury with any instrument or implement, upon any ground designated under this Act, upon which shell-fish are being raised or cultivated, or shall remove, destroy, or deface any mark or monument set up by the Board of County Commissioners, by virtue of Section 10 of this Act, or who shall violate the rules and regulations prescribed by the said Board for the governance and control of the fishery on the Public Grounds, or who shall work on any oyster-ground at night, shall be guilty of a misdemeanour. But nothing in the provisions of this or

any Act shall be construed as authorizing interference with the capture of migratory fishes, or free navigation, or the right to use on any private ground any method or implement for the taking, growing, or cultivation of shell-fish.

Section 12. Entry-takers shall make returns to the Secretary of State of all franchises granted under this Act, in the same manner as provided in Section 2775 of the Code, and the provisions of Sections 2777 and 2778 of the Code are hereby extended, so as to cover the grants or franchises in ground for raising or cultivating shell-fish as authorized by this Act, and all applications, grants, warrants, and assignments of franchises in or near oyster-grounds, shall be in manner and form as approved by the Attorney-General of the State.

Section 13. All grants of grounds under previous Acts, for the purpose of cultivating shell-fish in the territory within the provisions of this, are hereby confirmed and made good in the grantees, their heirs and assigns, provided the holders of said ground shall within one year file with the Secretary of State certified copies of their license and surveys, and that the said surveys be found correct by the Engineer of the Commissioners of Shell-Fisheries; and in case such surveys are found to be incorrect, the ground shall be re-surveyed by said Engineer as soon as practicable; and in designating lots, any person who has made in good faith an actual effort to raise or cultivate shell-fish on the area for which application is made, shall have the prior right to a grant or franchise in said grounds, but nothing contained in this Act shall be construed to validate any entry heretofore made of a natural bed.

Section 14. The Commissioners of Shell-Fisheries shall keep books of record, in which shall be recorded a full description of all grounds granted under the provisions of this Act, and shall keep a map or maps upon which shall be shown the positions and limits of all public and private grounds.

Section 15. Any persons who shall steal or feloniously take, catch, or capture, or carry away any shell-fish from the bed or ground of another, shall be guilty of larceny, and punished accordingly.

Section 16. All Acts or parts of Acts in conflict with the preceding sections are hereby repealed.

Section 17. This Act shall take effect on and after the day of its ratification.

Ratified February the 28th, 1887.

STATE OF NORTH CAROLINA.

FORM OF APPLICATION FOR PRIVATE OYSTER GROUND.
WARRANT..... COUNTY..... ENTRY No.....

Application of.....of the County of
.....State of.....

DESCRIPTION BY SURVEY.

(Courses, true ; distances, statute.)

Begins at a point situated.....yards from.....
at which point the following angles are subtended.

.....
Thence yards to a point where the
following angles are subtended.....

.....
Thence yards to a point where the
following angles are subtended.....
.....

Thence
yards to the beginning, containing.....acres.

I CERTIFY that the foregoing is a correct description of area, limits, and location of the ground for which application was made under the above entry, and the same liesthan two statute miles from the land, and does not include any of the Public Grounds as determined by the Board of Shell-Fisheries
.....

Witness my hand this ...day of....18....

.....

.....

Plotted on sheet No.....by

Plat by

Description by Book p....

CONCLUSION.

Before the inception of the examination of the oyster area of the State, the industry was not only insignificant, but had every prospect of remaining so. The examination and survey have directly or indirectly entirely changed this condition of affairs. Where widespread ignorance as to the real condition of matters existed in the past, intelligent comprehension of all phases of the question is found in the present. In place of ignorance of the positions and areas of the natural beds and possibilities of oyster culture, is a general diffusion of knowledge on both subjects. Instead of continual strife among those who worked the common and those who worked the private property, there is practically general harmony. Where, under cover of law, robbery of the common property was carried on by one class and depredations on private property by the other, now exists a complete restriction of both. The rights of the public and of the individual are equally protected.

In place of what was virtually discouragement of enterprise in this field, is now liberal encouragement to all who will venture labour or capital in the development of the area. Instead of an insignificant business, yielding little to the individual and nothing to the State, a new industry, promising wealth and prosperity to the individual and increased income and importance to the State, has begun its existence ; and, finally, confidence in the future may be substituted for the fear of disaster to the greatest of American fisheries.

The Chesapeake beds may and probably will be destroyed through the excessive and illegal fishery they undergo ; the oyster-farms on Long Island Sound may continue their struggle with star-fish and inclement weather—with the ravages of man and nature ; but so long as North Carolina holds open her hundreds of thousands of acres of territory to the cultivator, the oyster industry of the country, employing its thousands of people and its millions of capital, cannot perish.

CHAPTER XXXIII.

THE OYSTER INDUSTRY IN NEW SOUTH WALES.

PROFESSOR RAMSAY, speaking at one of the Conferences (held in connection with the great International Fisheries Exhibition of 1883) on the Fisheries of New South Wales, (a) said, with respect to the oyster production of that country, that most of the beds are natural beds, and that very few of them are formed by artificial layings, while all are under lease, and more or less under cultivation.

He classified the native edible mollusca under *Ostrea glomerata*, Gould, *O. virescens*, *O. subtrigonia*, Sow., *O. mordax*, Gld., *O. edulis*, var. *purpurea*, Hanley.

The Rock-Oysters (he observed) although usually known under several different names, are now by most conchologists admitted to be only localised varieties of one and the same species, *Ostrea glomerata*. If we accept this view, then we have only two species which are used as articles of food—*O. glomerata*, in its many varieties, and *O. edulis*, L., *O. purpurea* being only a variety of the latter, which is identical with the small form known as the “Native,” in the London markets.

(a) “The Fisheries of New South Wales,” by Edward P. Ramsay, Commissioner of the New South Wales Fisheries. (Conference Papers, &c. William Clowes & Sons, London.)

The *Ostrea glomerata* assumes numerous forms in various places (which fact was convincingly illustrated by the exhibition of a collection from 70 different beds and localities), giving undeniable proof of the wealth which may be developed by proper legislation, administration, and cultivation of the oyster-beds in N.S. Wales.

A variety of the same species from Coffin's Bay, in South Australia, is found in the Adelaide market, frequently producing irregularly formed pearls of large size but of no commercial value.

Recent experiments tend to prove that the Rock-Oyster of the N.S. Wales shores, which is left dry by every tide, is only a variety of the Drift-Oyster ; and spat taken from the rocks at low tides, when laid in beds always covered by the sea, are said to thrive well ; and although oysters may thrive on natural beds of *mud and sand*, whenever these beds are over-dredged the animals become diseased by the infiltration of mud into the shells. Steamer traffic over the shallow water-beds of the Hunter River, formerly so prolific, has in many cases either deteriorated, or completely destroyed them. These oysters only live a few days after being taken from the water, and even when freshly-opened the animal is of a dirty-white colour, and quite unfit for food. The black mud stirred up by steamer traffic, and brought down by the tides or "freshes" in the river, infiltrated into the shell ; the animal, unable to get rid of it, deposits a layer of nacre over it time after time, until the shell becomes formed of thin layers of mud and nacre, and the animal becomes exhausted, diseased, and dies.

That natural oyster-beds can be, and are, in fact, being destroyed daily by over-dredging, and by traffic when situated in shallow waters, in other countries as well as in

Australia, must be patent to anyone who has taken the trouble personally to examine into the subject. It is also clear, from the numerous specimens exhibited from the Australian waters, that the depth up to 10 or 15 feet is not material, although the best oysters are obtained from the shallowest beds, and are grown on a rough, shelly, gravelly, or stony bottom. The most highly prized in New South Wales are those from the rocks or beds where the fresh and salt water mingles at certain seasons of the year; for instance, at the estuaries of the river and vicinity of fresh water creeks.

Ostrea virescens is a rare species, only occasionally found at very low tides on some of the numerous islands in Port Jackson. Other species (*O. crista-galli* and *O. imbricata*) are obtained from Queensland; and the "Hammer-head Oyster" (*Malleus albus*, Lam.), &c., are found on the Australian coasts, but do not find their way into the market as articles of food.

The value of oysters in Sydney is from 4/- to 10/- per bushel, and are retailed at 6d. to 1/- per dozen.

Those who are desirous of obtaining further information on this subject will do well to consult the Reports of the Royal Commission on the (Oyster) Fisheries of N.S. Wales, 1877, 1880, &c., and the "Proceedings of the Linnean Society of New South Wales" for 1881-83, where several interesting Papers will be found on the subject by Dr. J. C. Cox, F.L.S., the Rev. J. E. Tenison-Woods, F.L.S., and Mr. John Brazier, C.M.Z.S.

CHAPTER XXXIV.

THE OYSTER INDUSTRY IN WEST AFRICA.

EDIBLE oysters are found in beds, on the rocks running out into the sea, which are uncovered at low tide, and on trees (mangrove). The trade in oysters is large, but chiefly, in fact altogether, confined to the coast, as their delicate nature, even when cured as the natives affect, does not admit of long keep.

The trees on which oysters are usually to be found in the tropics are of the mangrove family, the nature of which, with their aerial roots, admits of their growth in the flow of the oyster spat, which is thus at times in part intercepted, adheres, and develops into what is commonly spoken of as the tree-oyster. Mangrove oysters are not as much sought after as bed or rock-oysters, although they are collected for the sake of their shells, for the purpose of conversion into lime.

Bed-oysters are more extensively sought after. A solitary canoe at anchor over oyster-beds may be seen at times with no occupant. He has dived with his basket, and grabs in the mud (so long as his breath will allow him to remain under) for his prey, until by such repeated efforts he succeeds in filling his canoe. Women are usually the buyers and subsequent retailers of such commodity.

Rarely, except for European tastes, oysters are sold open, but in bulk with shell on. Such as are not disposed of fresh are cured similarly as are shrimps and fish.

The oyster season, although the mollusc may be taken at any time, may be viewed to extend, as far as the Gold Coast colony goes, over six months or so of each year, during the rainy season. Oyster collectors make yearly presents to the fetish priests, to invoke and propitiate the god of fish.

There is a certain danger associated with this industry, for it has been known that persons concerned in the same have fallen victims to sharks and crocodiles. The collection of the raw material can be followed out by any man or woman. Odd to say, among the Yorubas, he who follows the oyster industry is considered as of the lowest grade of society. In the past such a man would be denied marriage in a family of position above his social estimate. Women go in for the collection of mangrove-oysters.—*Papers of the Conferences held in connection with the great International Fisheries Exhibition, 1883. "West African Fisheries," by Captain C. A. Moloney, C.M.G.*

CHAPTER XXXV.

OYSTER CULTURE IN CHINA. (a)

IMMUTABLE, immemorial China, on the far western coast of the Pacific, with its highly developed industries and long descended customs, the land from which many a product, both of nature and of art, has found its way to western countries, forms an appropriate connection between ancient and modern times. Amongst other occupations, fishing received its full measure of attention, and the various forms under which it is practised are far too numerous to be here described, though a few of the principal must be noticed. Rather more than a century and a half ago, the encyclopædia, Koo Kin Too Shoo Tseih Ch'ing, in one thousand volumes, was drawn up by Imperial authority, and two articles on fishing are contained in it, under the section Shuh Teen. A few plates are to be found in connection with the article; but most students will probably prefer to consult the French work of M. Dabry de Thiersant, whose abundant illustrations are only equalled in interest by the excellence of the invaluable information conveyed in his text. The cultivation of oysters is on a very large scale, and dates from a remote age.

(a) See relative information, pp. 275-77.

Notwithstanding the enormous consumption of oysters from time immemorial in China, there appears to be no diminution of the supply. In the north, on the shores of the Shantung promontory, at the mouths of the Yangtsze and Ningpo rivers, all along the coasts of the Fohkien and Kwantung provinces, and on the seaboard of Formosa, the cultivation of oysters is carried on with much skill and success. Considering their dearness and scarcity in Europe, a thoroughly scientific inquiry as to the methods pursued by the Chinese would undoubtedly yield important results. (*b*)

(*b*) "The Fisheries of China," by J. Duncan Campbell, Commissioner for China. (Papers of the Conferences, &c., International Fisheries Exhibition.)

CHAPTER XXXVI.

STATISTICAL AND OTHER INFORMATION.

EUROPEAN STATISTICS—DIFFERENCE BETWEEN THE OYSTER INDUSTRY OF EUROPE AND AMERICA—STATISTICS OF THE UNITED KINGDOM AND CANADA—FRENCH AND GERMAN STATISTICS—AMERICAN STATISTICS—ICE USED IN THE COOLING OF OYSTERS—CANNED OYSTERS—ICE USED IN THE PRESERVATION OF FISH—THE LONDON FISH SUPPLY—PINNOTERES—AMERICAN RESTAURANTS—ENORMOUS SUPPLIES—FUTURE PROSPECTS.

THERE is nothing living which is more widespread than the oyster; it is to be found in every part almost of the habitable globe. Every sea—except the Baltic—contains some sort, and everywhere almost they are used as an article of food. The immense consumption of these molluscs, principally in Europe, may give some idea of their astounding fertility, since their abundance appears scarcely to diminish, despite the considerable quantities which are taken from the bottom of the sea.

The figures showing one year of the European supply are not without interest, especially as they point at the same time to the locality and extent of the various fisheries :

Great Britain	1,600,000,000
France	680,400,000

Holland	21,800,000
Italy	20,000,000
Germany	4,000,000
Belgium	2,500,000
Spain	1,000,000
Portugal	800,000
Norway	250,000
Russia	250,000
Denmark	200,000

Giving a total supply for the whole continent of 2,331,200,000 annually.

Most of these countries consume their own products, but at least one-half of the Dutch oysters come to England, while America exports millions of oysters yearly to our shores.

The main difference between the oyster industry of America and that of Europe lies in the fact that in Europe the natives have long since been practically destroyed, perhaps not more than 6 or 7 per cent. of the oysters of Europe passing from the native beds directly into the hands of the consumer.

It is believed that 60 to 70 per cent. are reared from the spat in artificial parcs, the remainder having been laid down for a time, to increase in size and flavour, in shoal water along the coast.

In the United States, on the other hand, from 30 to 40 per cent. are carried from the native beds directly to market.

As the Oyster Statistics of America will occupy a large portion of this chapter, I deem it best not to interlard statistical fragments concerning her with those of Europe (unless where strictly necessary), but to confine myself first to European countries, beginning with those of our own,

with which object in view I herewith present the reader with a most reliable and exhaustive tabular statement relative to our Oyster Fishery, which cannot fail in instruction and interest.

RETURNS OF STATISTICAL TABLES AND MEMORANDA.

(Published by order of the House of Commons.)

From these I quote the Quantities and Values of Oysters for the years 1886 to 1889 inclusive. This is the fourth year during which the statistics have been collected for the whole twelve months ; the collection itself having been commenced in the spring of 1885. To the tables for England and Wales are also added tables, for the last three years, relating to the fisheries in Scotland, and, for the last two years, to those of Ireland, where the collection of such statistics was commenced during the year 1887, but was not made for a complete year until 1888. The method of collection was generally obtained through the Coast-Guard Officers, and supplied to the Board of Trade once a month.

The statistics, it should be remarked, are those of oysters first landed on the coasts—that is of oysters landed direct from the fishing grounds,—excluding all imported from foreign countries, as well as all oysters that had been previously landed elsewhere in the United Kingdom.

It will be seen by the following tables that there is a great diminution both in quantity and value since 1887. Unfortunately, it is impossible to say how far this is a real falling-off, owing to the positive refusal of different Companies to make returns ; but it is probable that this refusal accounts for a very large part of the apparent decline. Not having any means of compulsion, the Board of Trade can only note the fact of refusal to make returns.

Detailed Statement of the total Quantity and Value of Oysters returned as landed on the English and Welsh Coasts, from the fishing grounds during the years 1888 and 1889, for each individual month with totals of all the coasts on which landed.

QUANTITY.

1888.	JAN.	FEB.	MARCH.	APRIL.	MAY.	JUNE.	JULY.	AUGUST.	SEPT.	OCT.	NOV.	DEC.	TOTAL.
EAST COAST ..	3,504,000	2,785,000	1,857,000	1,823,000	1,564,000	1,358,000	1,050,000	1,776,000	2,857,000	2,744,000	2,220,000	2,715,000	26,253,000
SOUTH COAST	171,000	268,000	126,000	273,000	124,000	158,000	44,000	181,000	255,000	352,000	276,000	171,000	2,399,000
WEST COAST..	62,000	33,000	66,000	71,000	23,000	.....	16,000	15,000	64,000	111,000	35,000	82,000	578,000
TOTALS....	3,737,000	3,086,000	2,049,000	2,167,000	1,711,000	1,516,000	1,110,000	1,972,000	3,176,000	3,207,000	2,531,000	2,968,000	29,230,000
1889.													
EAST COAST ..	2,557,000	2,121,000	2,273,000	1,801,000	1,142,000	919,000	1,259,000	1,473,000	3,878,000	4,266,000	4,182,000	4,430,000	39,301,000
SOUTH COAST	238,000	332,000	140,000	114,000	268,000	170,000	226,000	222,000	277,000	484,000	311,000	185,000	2,967,000
WEST COAST..	81,000	73,000	72,000	93,000	186,000	818,000	995,000	927,000	58,000	74,000	95,000	83,000	3,459,000
TOTALS....	2,876,000	2,526,000	2,485,000	2,008,000	1,590,000	1,907,000	2,390,000	2,622,000	4,213,000	4,824,000	4,588,000	4,698,000	36,727,000

AMOUNT.

1888.	JAN.	FEB.	MARCH.	APRIL.	MAY.	JUNE.	JULY.	AUGUST.	SEPT.	OCT.	NOV.	DEC.	TOTALS.
EAST COAST ..	£14,678	£10,469	£8019	£6306	£3443	£2202	£2010	£4275	£10,116	£9329	£7719	£12,337	£90,993
SOUTH COAST	387	591	294	589	269	332	88	362	510	744	639	367	5172
WEST COAST..	174	101	190	200	68	.....	20	20	167	262	97	240	1539
TOTALS....	£15,239	£11,161	£8503	£7095	£3780	£2624	£2118	£4657	£10,793	£10,335	£8455	£12,944	£97,704
1889.													
EAST COAST ..	£8163	£6038	£6259	£5325	£2302	£1925	£2678	£4080	£13,632	£12,601	£13,457	£14,173	£90,624
SOUTH COAST	572	702	321	248	527	351	452	444	562	979	747	443	6348
WEST COAST..	243	219	216	264	368	1443	1583	1623	169	210	280	247	6865
TOTALS....	£8978	£6959	£6787	£5837	£3197	£3719	£4713	£6147	£14,363	£13,790	£14,484	£14,863	£103,837

It must be understood that the figures are of landing value only.

The coasts of England and Wales have been made into three divisions, namely, the east, south, and west. The east coast representing that part from Berwick to Margate inclusive; the south coast from Broadstairs to Mousehole inclusive; and the west coast from Sennen Cove to the Scottish Border in Cumberland; the latter including the Welsh coast and also the Isle of Man.

SUMMARY STATEMENT

Of the Total Quantity and Value of Oysters returned as landed on the English and Welsh coasts, from the fishing grounds, during the years 1886 to 1889 inclusive, together with the average prices of the same.

There were landed in the year—

1886.—45,554,000 oysters, valued at £135,056.

Valued at £2 19s. 2d. per thousand.

„ 0 5s. 11d. per hundred.

„ 0 os. 8½d. per dozen.

1887.—53,577,000 oysters, valued at £163,255.

Valued at £3 1s. 0½d. per thousand.

„ 0 6s. 1¼d. per hundred.

„ 0 os. 8¾d. per dozen.

1888.—29,230,000 oysters, valued at £97,704.

Valued at £3 6s. 10½d. per thousand.

„ 0 6s. 8¼d. per hundred.

„ 0 os. 9½d. per dozen.

1889.—36,727,000 oysters, valued at £103,837.

Valued at £2 16s. 5½d. per thousand.

„ 0 5s. 7¾d. per hundred.

„ 0 os. 8¼d. per dozen.

SUMMARY STATEMENT

Of the Total Quantity and Value of Oysters returned and landed on the Scotch coasts during the years 1887, 1888, and 1889, together with the average prices of the same.

There were landed in the year—

1887.—213,200 oysters, valued at £970 os. od.

Valued at £4 10s. 10d. per thousand.

„ 0 9s. 1d. per hundred.

„ 0 1s. 1d. per dozen.

1888.—153,400 oysters, valued at £744 os. od.

Valued at £4 17s. 1d. per thousand.

„ 0 9s. 8½d. per hundred.

„ 0 1s. 2d. per dozen.

1889.—316,800 oysters, valued at £1,470.

Valued at £4 12s. 8½d. per thousand.

„ 0 9s. 3¼d. per hundred.

„ 0 1s. 1¼d. per dozen.

SUMMARY STATEMENT

Of the Total Quantity and Value of Oysters landed on the Irish coasts, during the years 1888 and 1889, together with the average price of the same.

There were landed in the year—

1888.—359,190 oysters, valued at £662.

Valued at £1 16s. 10d. per thousand.

„ 0 3s. 8¼d. per hundred.

„ 0 os. 5¼d. per dozen.

1889.—972,970 oysters, valued at £1,549.

Valued at £1 11s. 10½d. per thousand.

„ 0 3s. 2¼d. per hundred.

„ 0 os. 4½d. per dozen.

SUMMARY STATEMENT,

Showing the Total Quantity and Value of Oysters landed on the coasts of the United Kingdom, during the years 1888 and 1889, together with the average price of the same.

There were landed in the year—

1888, in England and Wales, 29,230,000 oysters, valued at £97,704.

Valued at £3 6s. 10½d. per thousand.

„ 0 6s. 8¼d. per hundred.

„ 0 os. 9½d. per dozen.

1888, in Scotland, 153,400 oysters, valued at £744.

Valued at £4 17s. 1d. per thousand.

„ 0 9s. 8½d. per hundred.

„ 0 1s. 2d. per dozen.

1888, in Ireland, 359,190 oysters, valued at £662.

Valued at £1 16s. 10½d. per thousand.

„ 0 3s. 8¼d. per hundred.

„ 0 os. 5¼d. per dozen.

1889, in England and Wales, 36,727,000 oysters, valued at £103,837.

Valued at £2 16s. 5½d. per thousand.

„ 0 5s. 7¾d. per hundred.

„ 0 os. 8¼d. per dozen.

1889, in Scotland, 316,800 oysters, valued at £1,470.

Valued at £4 12s. 8½d. per thousand.

„ 0 9s. 3¼d. per hundred.

„ 0 1s. 1¼d. per dozen.

1889, in Ireland, 972,970 oysters, valued at £1549.

Valued at £1 11s. 10½d. per thousand.

„ 0 3s. 2¼d. per hundred.

„ 0 os. 4½d. per dozen.

Total quantities and values :—

1888.—29,742,590 oysters, valued at £99,110.

1889.—38,016,770 „ „ £106,856.

STATEMENT,

Showing the yield and value of the Oyster Fisheries in the Dominion of Canada, for the years 1886, 1887, and 1888.

1886.—62,905 barrels, valued at \$189,915=£37,983

1887.—61,360 „ „ \$187,580=£37,516

1888.—56,234 „ „ \$163,902= £3,278 8s. od.

FRENCH STATISTICS.

The oyster industry of France employed in 1881 29,000 men, women, and children, in the parcs, beds, and preserves. The number of such establishments on the Royal domain was 32,364, with an area of 19,891 acres, and 970 establishments upon private property, with an area of 926 acres. From them 734,985,770 oysters were dredged during the season of 1880-81, from September 1 to June 15, worth 7,061,753 francs; while the total number of oysters disposed of during this period amounted to 680,372,750, worth about seventeen millions of francs. The total includes the oysters dredged in the sea, as well as those gathered from artificial breeding grounds or parcs.

In 1867, the consumption of oysters in Paris was 26,750,775, of which the greater portion came from Corseulles-sur-Mer, and from St. Vaast-de-la-Hougue. (a) In the “*Revue des Deux Mondes*,” Janvier 1er, 1884, it is stated that the consumption of oysters in Paris alone was 2,000,000.

(a) “*Revue des Deux Mondes*,” “*L’Alimentation de Paris*,” tome 75, 15 Juin, 1868.

Oysters are imported into Marennes, for fattening and rearing, from all parts of France, and the number in 1880-81, including Portuguese oysters, amounted to 130,000,000. In 1882, Marennes sent out 151,000,000 oysters, representing a value of 5,900,000 francs.

From the *Pall Mall Gazette* (August, 1889) I cull the following statistics relative to Arcachon, 34 miles from Bordeaux :—

“The annual exportation of oysters from Arcachon is now greater than that from any other place in France. Last year over 203 millions were exported, of a total value of £178,887. The oyster beds, as mostly established at Arcachon, are enclosures shut in by low boards erected on the seaweed-covered sandbanks of the bay ; they are about two to three acres in extent, and in them are placed a certain number of tiles (often as many as 10,000), previously dipped in a solution of lime. The infant oysters collect upon and grow up on these tiles, the number on one tile being on an average 250, but sometimes reaching 1000. Only about 30 per cent. of the annual number of oysters cultivated are, as a rule, brought to market for exportation, for nearly 70 per cent. perish from manifold causes, viz., frost and other sudden changes of temperature, bad weather, destruction by predatory fish, as well as from diseases of infancy. Of the oysters exported from Arcachon last year, about 80,000,000 were exported to the United Kingdom, 100,000,000 to various parts of France, and about 23,000,000 for breeding purposes to the oyster farms of Marennes, Tremblade, and Sables d'Olonne. Arcachon oysters comprise many different kinds of French oysters, in addition to Portuguese. The latter are considered the commonest, coarsest kind, while those of ‘Marennes’ are the best. None of the oysters cultivated

at Arcachon are, however, at all equal in flavour to English or Scotch 'natives,' or to the oysters of Ostend and Holstein."

And, as a supplementary item, with respect to Poole, the following from the *Poole Herald* (July 25, 1889):—

"OYSTER CULTURE.—Readers will remember that a few months ago the Fowley Oyster Fishery Company imported from the South of France a cargo of about a million and a quarter of young oysters, which were laid down in the Company's beds in Poole Harbour to fatten. We are glad to learn that the experiment has been remarkably successful, that the young oysters have thriven well, and are many of them already in condition fit for the market."

. . . . In the year 1874-'75 (says Möbius) there were produced in this bay (Arcachon) 112,000,000 artificially-grown oysters, and in 1875-'76 about 196,000,000. This important yield of the last year, as compared with the poor returns of former years, may be accounted for principally through two causes:—

First. The natural oyster-beds in the Bay of Arcachon had had complete rest for the entire two years immediately preceding these rich harvests. During the years 1870-'71 they had produced only 4,897,000 oysters; but after this period of rest, in November, 1874, 8500 persons assembled, and in the space of three hours, during which time the gathering was in progress, 40,360,000 oysters were taken from the sea. A great number of these were transplanted, as breeding oysters, to the prepared beds, which covered altogether an actual area of sea-bottom of 2669 hectares (about 5338 acres).

Second. The former imperfect method of caring for the oysters had been improved to the extent that the young

oysters were protected from their enemies, and care was exercised that during hot and cold weather they should always be kept under water.

With the earlier methods very many of the young oysters were destroyed by their enemies, and often, during a few unfavourable summer or winter days, when a low tide left the beds dry, all the young oysters died. The extraordinary yield of oysters in the Bay of Arcachon, and at other points along the coast of Brittany, as a result of the improved method of artificial oyster-breeding, has very materially lessened the price of oysters in France, despite the greater consumption occasioned by this abundance. In 1873 oysters sold for 43 francs per thousand, while in 1876 the price was 25 francs per thousand. On this account only those oyster-breeders who attend personally to the work, and are assisted in it by their families, make anything over and above all expenses. Those who undertake the breeding of oysters, relying upon outside help to do the great amount of work necessary, can gain returns scarcely worthy of the name; at least this is the case in the Bay of Arcachon, as I know from trustworthy sources.

The cost of transforming a hectare of sea-bottom along this coast into an oyster-bed, together with the necessary apparatus for oyster-culture, and a guard-vessel as required by the government, is not less than seven to eight thousand francs. (*b*)

The very celebrated rich oyster-beds of the Bay of Cancale, on the coast of Normandy, have produced, according to official reports, the following number of oysters :

(*b*) "The Oyster and Oyster Culture."—Möbius, pp. 18-19.

Year.	No. of oysters.
1800	1,200,000
1801	1,500,000
1802	1,300,000
1803	900,000
1804	1,400,000
1805	800,000
1806	500,000
1807	1,090,000
1808	1,800,000
1809	1,200,000
1810	700,000
1811	1,130,000
1812	1,100,000
1813	600,000
1814	400,000
1815	800,000
1816	2,400,000
1817	5,600,000
1818	5,300,000
1819	6,800,000
1820	6,700,000
1821	6,000,000
1822	11,800,000
1823	18,000,000
1824	20,000,000
1825	20,000,000
1826	25,000,000
1827	28,000,000
1828	33,000,000
1829	31,000,000
1830	36,000,000
1831	42,000,000
1832	38,000,000
1833	41,000,000
1834	46,000,000

Year.	No. of oysters.
1835	43,000,000
1836	40,000,000
1837	36,000,000
1838	44,000,000
1839	42,000,000
1840	52,000,000
1841	56,000,000
1842	63,000,000
1843	70,000,000
1844	68,000,000
1845	67,000,000
1846	65,000,000
1847	71,000,000
1848	60,000,000
1849	52,000,000
1850	50,000,000
1851	47,000,000
1852	20,000,000
1853	49,000,000
1854	20,000,000
1855	20,000,000
1856	18,000,000
1857	19,000,000
1858	24,000,000
1859	16,000,000
1860	8,000,000
1861	9,000,000
1862	3,000,000
1863	2,090,000
1864	2,200,000
1865	1,100,000
1866	1,960,000
1867	2,000,000
1868	1,079,000

The records of inspections of the Schleswig-Holstein oyster-beds have furnished the means by which such an impoverishment of these rich beds can be explained. From 1800 to 1815 there were taken yearly from the beds of Cancale less than two million oysters. The oysters, both marketable and spawning, had thus an opportunity to accumulate in greater quantity, to form the increased production which occurred in 1822. If the French oysters live as long as those of the Schleswig-Holstein beds, some of this stock, which had accumulated during the period of

comparative rest at the time of the Napoleonic wars, would have been lying upon the banks as late as about 1830. From this time on, for nearly a score of years, it is probable that the ever-increasing yield was the produce of only those oysters existing upon the beds from 1820 to 1830. From 1840 to 1847 the number of oysters taken was extraordinarily great—evidently too great for the productiveness of the beds, since from this time they produced fewer oysters each year.

The total number of oysters taken between the years 1840 and 1847 was about 512,000,000, being on an average about 64,000,000 per year. If this average represents the natural stock of marketable, full-grown oysters upon the beds of Cancale, then the number taken yearly should not have been over twenty-six to twenty-seven millions, if it was desired that this degree of productiveness should be maintained. This I assert upon the supposition that the productiveness of the oysters in the Bay of Cancale is no greater than upon the Schleswig-Holstein banks. If this productiveness was higher than upon our sea-flats, then we ought to have at Cancale, not 421 half-grown oysters for every 1000 full-grown ones, but, for example, 500. Under these circumstances, the presence of 64,000,000 matured oysters would permit the fishing of 32,000,000 yearly, but no more if the fruitfulness of the beds would be kept at that number, since such a stock would be absolutely necessary, in order that a sufficient number of young should be produced to secure the maturing of 32,000,000 yearly.

After the impoverishment of the beds of Cancale, the inspection officers enforced once more the laws protecting the oyster, since they did not believe that all the mature breeding oysters had been taken off the beds. Upon some

of these beds there has already been a very significant increase of oysters through this action; for in 1872-'73 7,300,000 oysters were taken, in 1873-'74 9,056,000, and in 1874-'75 9,342,000. To preserve oyster-beds, a stock of full-grown oysters, for the purposes of propagation, must be left lying upon the banks. The number thus left must depend upon the fruitfulness of the oysters of each section, or, still better, of each single bed. (*c*)

GERMAN STATISTICS.

. . . . The number of descendants from any one oyster which . . . arrive at maturity is so small even upon the best beds, where for more than a hundred years the finest and most productive Holstein oysters have been caught, that I am persuaded no one would give credit to my words if I was not able to substantiate them by means of figures.

In 1587, Frederick II., King of Denmark and Duke Holstein-Gottorp, appropriated the oyster-beds of Schleswig-Holstein as royal prerogatives. (*d*) They were then

(*c*) "The Oyster and Oyster Culture," pp. 19, 37, and 38.

(*d*) The public order by which the Ducal-King, Frederick II., took possession of the oyster-beds of the sea-flats along the coast of Schleswig-Holstein and Jutland, is printed by H. Krøyer, in his work, "De danske Ostesbanker," Kjöbenhavn, 1837, page 110. Translated into English, through the German, it reads as follows:—"We, Frederick, &c., make known to all by these presents, that since it has been brought to our knowledge that in the waters of the West Sea, in the fief of Ribe, a kind of fish called an oyster can be found and caught, therefore we have commanded our liege Albert Früs, superintendent and guardian at our castle at Ribe, that he permit this kind of fish to be caught in our name and sent to us; and in order that a future lack of them may not occur, we forbid one and all, whoever he may be, from taking oysters, or allowing them to be taken in that place. We

leased, generally, for a long term of years. From time to time the government caused the banks to be officially examined, in order to find out their condition and prevent their depletion by over-fishing. The examination was conducted by commissioners appointed by the government, and the dredging carried on in their presence was performed by fishermen specially sworn for the purpose. The smaller beds were dredged in three, the larger in six different places, and all the oysters taken were divided, according to size and age, into three classes, known as—

1. Zahlbar Gut, or marketable.
2. Junggut, or medium (half-grown).
3. Junger Anwachs, or young growth.

The *marketable* oysters are those which are large and full grown. Their shell is at least 7 to 9 centimeters in length and breadth, and when closed the greatest thickness must be more than 18 millimeters. The left valve, or the one which is most curved, is from 6 to 9 millimeters thick at the point of attachment of the shell-muscle, and also under the ligament.

The greater number of full-grown oysters are from seven to ten years of age, yet many older ones are found, which can be distinguished from the younger ones by the greater thickness of their shell. Oysters more than twenty years old are seldom seen. The oldest which I have personally examined I estimated to be from twenty-five to

except, however, those who take them in our name by the authority of our liege at Ribe. Whoever shall dare to act contrary to this command, and he can be justly convicted of so doing, shall be punished according to his deserts. Each one is then to govern himself accordingly, and guard against transgressing.—Given at Skanderborg, the 4th day of February, 1587.”

thirty years old. The left valve, at the muscular impression and below the ligament, was 20. to 25 millimeters in thickness.

. . . . During the period from 1730 to 1852, ten records were made of all the oyster-beds of the Schleswig-Holstein sea-flats. If from these records the numbers of all the marketable and all the medium-sized oysters are taken and added together, we will have a series of very different totals, showing no particular general law. But if for each of these reports the proportion of marketable to medium oysters is taken, then we will arrive at the surprising result that this proportion fluctuates but very slightly during all the records.

The following table gives a summary of the marketable and medium oysters recorded as caught during each of the ten investigations. From these numbers I have reckoned for each record the proportion of medium oysters to every thousand of those which were full grown.

YEAR OF RECORD.	NUMBER OF MARKETABLE OYSTERS.	NUMBER OF MEDIUM OYSTERS.	PROPORTION OF MARKETABLE TO MEDIUM.	
1730.....	5394	2692	1000	486
1734.....	16,770	5205	1000	310
1740.....	7185	3007	1000	418
1756.....	6793	3333	1000	490
1795.....	2078	1006	1000	484
1799.....	2705	831	1000	307
1819.....	2828	1087	1000	388
1830.....	1956	797	1000	417
1839.....	3272	1552	1000	440
1852.....	3534	1673	1000	473
Total..	.....	.....	10,000	4213
Mean proportion	.....	.....	1000	421'3

The following table gives the quantities of oysters which were taken during these investigations from two of the largest and most productive beds of the Schleswig-Holstein coast, the Huntje and the Steenack banks.

YEAR OF RECORD.	HUNTJE.		STEENACK.	
	MARKETABLE	MEDIUM.	MARKETABLE	MEDIUM.
1730.....	355	164	158	69
1734.....	1353	874	465	90
1740.....	323	158	26	110
1756.....	736	99	149	35
1771.....	931	66	607	197
1795.....	87	461	261	106
1799.....	183	119	236	56
1819.....	363	173	53	79
1830.....	40	3	11	4
1852.....	128	64	116	58
Total..	4499	2181	2082	804
Proportion..	1000	484	1000	385

The proportion of marketable to medium-sized oysters is thus seen to be almost the same upon single beds as in a mean of all the beds taken together.

In this similarity of proportions between the marketable and medium oysters, in different years and upon different beds, a natural law is very strikingly manifested. The medium-sized oysters of any bed consist of the descendants of the marketable ones. They are those members of the young broods which have escaped the numerous enemies living upon and around the beds, and which, despite the numerous attacks made upon their lives, have grown into very respectable-sized animals.

The medium oysters thus represent the total number of embryos from the bed which, in the struggle for existence,

have continued to exist. A thousand mature oysters will produce during a breeding period, . . . at least 440,000,000 of young; but upon the beds alongside of these 1000 mature oysters are to be found, on an average, not more than 421 half-grown ones; so that, as a rule, for every Holstein oyster which is placed upon the table, more than 1,045,000 young are destroyed or die; and indeed even more than this, for not only do those oysters which are over six years of age produce eggs, but those which are two and three years old also reproduce their kind to a certain extent. The younger oysters, however, produce much less spawn than those which are mature, so I estimate that those half-grown oysters lying beside the mature ones, on the same banks, and which are their offspring, will produce 60,000,000 young oysters.

We thus have, upon a surface of oyster-bed occupied by 1000 full-grown and 421 half-grown oysters, at least 500,000,000 of young produced during the course of the summer, and of this immense number only 421 arrive at maturity. The immolation of a vast number of young germs is the means by which nature secures to a few germs the certainty of arriving at maturity. In order to render the ideas of germ-fecundity and productiveness more easily understood, I will make a comparison between the oyster and man.

According to Wappäus, (*e*) for every 1000 men there are 34·7 births. According to Böckh, (*f*) out of every 1000 men born 554 arrive at maturity, that is, live to be twenty years or more of age; thus, on an average, 34·7

(*e*) Wappäus, Handbuch der Geographie und Statistik. Band I, 1855, Abth. I, p. 197.

(*f*) Böckh, Sterblichkeitstafel für den Preussischen Staat im Umfange von 1865. Jena, 1875.

children are produced from 554 mature men, or 62·6 children from 1000 mature men. Since 1000 full-grown oysters produce 440,000,000 of germs, then the germ-fecundity of the oyster is to the germ-fecundity of man as 440,000,000 to 62·6, or as 7,028,754 to 1. On the other hand, the number which arrive at maturity is 579,002 times as great with mankind as with the oyster; for of 1000 human embryos brought into the world, 554 arrive at maturity, or of 440,000,000 newly born, 243,760,000 would live to grow up; while of 440,000,000 young oysters, only 421 ever become capable of propagating their species. The proportion is then 421 to 243,760,000, or as 1 to 579,002. I am fully persuaded that these figures represent the number of oysters which arrive at maturity more favourably than is really the case, since from every thousand of full-grown oysters it is certain that, on an average, more than 440,000,000 young are produced. The correctness of my argument that the number of oysters which arrive at maturity is very small indeed, as compared with the exceedingly large number of germs produced, is corroborated by the experience of those who have engaged in oyster-culture in France and England. (*g*)

AMERICAN STATISTICS.

The North American oyster . . . is longer from the hinge-ligament to the shell-muscle than is the European oyster, . . . and the left valve is generally more curved than with our oyster. . . . During late years the North American beds have furnished an annual

(*g*) See, I. Report on the Oyster and Mussel Fisheries of France, made to the Board of Trade by Cholmondeley Pennel, Inspector of Oyster-Fisheries. London, 1868. II. Report from the Select Commission on Oyster-Fisheries, 1876, and Chapters 17-22 (England), 23-26 (France), and elsewhere herein.

average of about thirty million bushels of oysters for market ; this is about nine to twelve billions of oysters, since there are from three to four thousand oysters in a bushel. In 1859 the number of oysters sold amounted to from six to eight billions. In 1867 there were over 10,000 men employed in the oyster trade in Baltimore. The yearly capital employed in this business in New York was, about 1870, over \$8,000,000. (*h*)

In America the oyster is an institution of great importance. On the sea-board of that vast continent they are found in natural beds of wonderful extent, and are distributed by means of railways and steamboats throughout the cities and villages of even the far inland districts. Numerous as are the shell-fish shops of London, they are but as one in ten when compared with the oyster-houses of New York, in which city oyster-eating appears to be almost the sole business of life, so many people are to be found indulging in that pleasure. The custom in America is to have the oysters cooked, and this culinary process is accomplished in a variety of ways ; the mollusc being stewed, fried, or roasted, according to taste. They may be had cooked in about twenty different ways, in any of the well-known oyster taverns of New York, at a few minutes' notice. The great market for oysters in America is the city of Baltimore, in Maryland, where it is not uncommon for one or two firms each to "can" a million bushels in one year ! Immense numbers of these "canned" oysters are dispatched all over the States, to the prairies of the far west, to the cities of New Mexico, to the military forts of the great American desert, to the restaurants of Honolulu, and to the miners searching for gold on the

Rocky Mountains ; whilst fresh oysters packed in ice have been sent to great distances. (*i*)

I am reminded here of a very noteworthy fact, warningly dwelt upon by Möbius (p. 55), relative to the use of ice for oysters :—" If ice is used to keep oysters fresh, care must be exercised that the water from the melting ice does not come in contact with the molluscs, or their flavour will be injured. Care should also be taken, especially with shelled oysters, that the ice used to cool them off does not entirely cover them. (*j*) Preserved oysters, packed in tin cans, are brought into the markets from North America. In these the natural flavour, for which the oyster is so highly prized, is as much destroyed as is that of the tropical fruits which come to us cooked in sugar. If they were not preserved oysters they would hardly find purchasers. They serve merely as suggestions of fresh oysters."

· Tempted by the truth and wisdom of Möbius's assertion, I was about to give the following information in a footnote, but partly on account of its length and partly that of its instructive interest, I deem it of sufficient importance for insertion in the text, believing that its analogical pertinence to the subject will amply atone for the brief digression.

Mr. J. K. Kilbourn, speaking on " Preservation by Conditions of Temperature," (*k*) says : It is well known

(*i*) " The Harvest of the Sea," p. 263.

(*j*) The Romans were in the habit of cooling their oysters with ice from the mountains : " Addiditque luxuria frigus (ostreis) obrutis nive, summa montium et maris ima miscens." C. Plinii Sec., *Naturalis Historia*, lib. xxxii., 6, 21.

(*k*) " Fish Preservation and Refrigeration," by Mr. J. K. Kilbourn. Papers of the Conferences held in connection with the great International Fisheries Exhibition. (William Clowes & Sons, London, 1883.)

that freezing completely checks all putrefactive action, and when in this frozen condition meat or fish can be kept for an indefinite length of time. A noticeable instance of this was seen in the salmon brought from Labrador, in the ss. *Diana*, in 1881. A part of this cargo was taken from London to Australia, and after this long voyage across the tropics, and 200 days out of water, these salmon were found to be in good condition.

. . . . The advantages to be derived from this method of preservation (freezing) have not been, nor are they now, fully appreciated ; public opinion seems to have settled quietly into the belief of the oft-repeated statement that it “destroys the flavour of fish to freeze them,” and that “they go bad so quick after they are restored to normal temperature.” Neither of these statements is well founded, although they may be in accord with the observations of those who make them.

The flavour of a fish and its keeping quality after thawing, depend more upon its *condition* when frozen than upon the deleterious action of the low temperature in which it has been kept. It should be constantly borne in mind that there is *no* restorative power in any system of preservation.

. . . . Inasmuch as a temperature above freezing does not completely check, but only retards, bacterial development, (1) it follows that the preserving effect can only be for a limited period. The duration of this period,

(1) Schwann, of Berlin, was the first to prove that living germs are the cause of putrefaction, and in 1837 he made the important announcement that when a decoction of meat is effectually screened from ordinary air, and supplied solely with calcined air, putrefaction never sets in. Putrefaction, therefore, he affirmed to be caused not by the air, but by something in the air which could be destroyed by a sufficiently high temperature.

under the most favourable conditions, is none too long, but it is in a measure dependent upon controllable causes, and these are worthy of careful consideration.

To extend this period to the utmost limit, it is of the very greatest importance that the preserving influence begins as soon as the fish are out of the water, and before deterioration sets in; in other words, the animal or natural heat should be withdrawn, and the fish cooled from surface to centre as quickly as possible. This speedy cooling necessitates not only a low temperature, but room for spreading the fish, or appliances for separating them into layers, so as to allow free circulation of the cooled air. Absolute cleanliness in every department is of vital importance. You may as well lodge a perfectly healthy person in the bed of a small-pox patient, as to pack freshly-caught fish in boxes or compartments contaminated with the filth and slime of previous putrefaction. If any fisherman entertains a doubt upon this point, let him place a row of fish side by side, backs upwards, upon a filthy board in the bottom of his boat, and he will find that the bellies of these fish are completely rotten when the sides and back are apparently sound.

. . . . Packing fish in ice may be fairly considered as a choice of evils. Some fish, salmon for instance,

These results by Schwann were confirmed by the experiments of Helmholtz in 1843, by Schröder and Von Dusch in 1854, by Schröder alone again in 1857, by Pasteur in 1862, and by Tyndall in 1868-9.

In 1872 Cohn of Breslau announced that "putrefaction begins as soon as Bacteria, even in the smallest numbers, are introduced. It progresses in direct proportion to the multiplication of Bacteria. It is retarded when the Bacteria (for example by a low temperature) develop a small amount of vitality, and is brought to an end by all influences which either stop the development of Bacteria or kill them."—"Fish Preservation and Refrigeration," pp. 1-3.

appears to bear it better than others, but in no instance does it improve the quality or flavour.

. . . . Fish, when in a perfectly sound condition, placed in a temperature ranging between 32° and 35° , will remain sound for a long time ; but the range between 35° and 40° may perhaps be considered as debateable ground. The highest degree of temperature, compatible with safety, once determined, a constant temperature below this point will be found to be an essential requisite. . . . Piling fish one upon another tends to shorten the period of preservation, and frequent handling impairs the quality. . .

Writing on the same subject in the "Lancet" (January, 1890), Mr. J. H. Hamilton (after arriving at similar conclusions with Mr. Kilbourn) points out that in the United Kingdom fish is seldom caught on Saturday afternoons, and the nets also remain idle all Sunday, so that Friday's fish does not reach the Metropolis until Monday morning. He says that much of the best prime trawl-caught fish sold at Billingsgate is from three to ten days old. Everyone knows that London fish is very different from fish freshly caught, and, that what Mr. Hamilton (comments the "Lancet") has stated may enable us to understand the cause. Unfortunately it is difficult to suggest an efficient remedy. (*m*)

(*m*) In corroboration of the "Lancet's" lament I quote the following from the "Morning Post," of no later date than October 22nd, 1890. "London Fish Supply.—At a meeting of the Commissioners of Sewers yesterday, it was reported that during the four weeks ending September 27th there were 10,757 tons of fish delivered at Billingsgate Fish Market, of which 5285 tons were sent by sea and 5472 tons by land. During the same period there were 103 tons 4 cwt. delivered at the London Central Fish Market. Of the total quantity delivered 150 tons 10 cwt. 3 qrs., or about $2\frac{3}{4}$ per cent. of the total quantity, were seized by the officers of the Fishmongers' Company."

In the Oyster Fisheries of Maryland as many as 600 vessels of about 23 tons each are engaged, in addition to 2000 small boats or canoes. These employ about 7000 men, and if we add those engaged in the carrying trade, it would give the number of persons employed in the oyster trade of the State of Maryland as at least 10,000, all obtaining remunerative employment. (*n*)

According to the Statistical Summary by Professor G. B. Goode, (*o*) the Oyster Fisheries of the United States employs 52,805 persons, and yielded in 1880 22,195,370 bushels, worth to the producer \$9,034,861. There is to be considered an enhancement on 13,047,922 bushels in passing from producers to market. This enhancement, which amounts to \$4,368,991, results either from replanting or from packing in tin cans, and increases the value of the products to \$13,438,852. This fishery employs 4155 vessels valued at \$3,528,700, and 11,930 boats valued at \$708,330. The value of gear and outfit amounts to \$712,515. The value of shore property amounts to \$5,633,750. The total capital invested in Oyster Industry is \$10,583,295. The actual fishermen number 38,249, the shoresmen 14,556. About 80 per cent. of the total yield is obtained from the waters of Chesapeake Bay.

For every man engaged in the fisheries there is at least one other man who is dependent to a considerable extent upon his labours for support. To the class of "shoresmen" belong (*1*) the capitalists, who furnish

(*n*) "The Harvest of the Sea," p. 263.

(*o*) "The Fishery Industries of the United States," by G. Brown Goode, M.A., Assistant Director of the U.S. National Museum, and Commissioner to the International Fisheries Exhibition of 1883. (Papers of the Conferences held in connection with the Great International Fisheries Exhibition. William Clowes & Sons, London.)

supplies and apparatus for the use of the active fishermen ; (2) the shopkeepers from whom they purchase provisions and clothing ; and (3) the skilled labourers who manufacture for them articles of apparel, shelter, and the apparatus of the trade. In addition to the professional fishermen, there is a large class of men who have been called "semi-professional" fishermen—men who derive from the fisheries less than half of their entire income.

Taking into account all those persons who are directly employed in the fisheries for a larger or smaller portion of the year, those who are dependent upon fishermen in a commercial way for support, and the members of their families who are actually dependent upon their labours, it cannot be far out of the way to estimate the total number of persons dependent on the fisheries at from 800,000 to 1,000,000. Of the twenty-nine States and territories whose citizens are engaged in the fishery industry, sixteen have more than a 1000 professional fishermen. The most important of these States is, of course, Massachusetts, with 17,000 men.

At present the oyster is one of the cheapest articles of diet in the United States, and though it can hardly be expected that the price of American oysters will always remain so low, still, taking into consideration the great wealth of the natural beds along the entire Atlantic coast, it seems certain that a moderate amount of protection would keep the oyster seed far below European rates, and that the immense stretches of submerged land especially suited for oyster planting may be utilised and made to produce an abundant harvest at much less cost than that which accompanies the complicated system of culture in vogue in France and Holland.

Experiments have been tried, both on the French and English coasts, to acclimatize the large American oyster, *Ostrea Virginica*, or *Ostrea Virginiana*, (*p*) but they did not succeed, and although when the weather was warm they seemed to fatten and grow, they still would not spawn or spat. Large quantities of American oysters are sent over to Liverpool and other parts of England, and are sold at a moderate price—from 1/- to 1/6 was the cost of them in 1876. In 1879, 90,663 barrels of oysters were shipped to England from New York and its neighbourhood, at a total value of £90,661.

Mr. Nichols, in his "Forty Years in America," tells us that oysters are never out of season in New York. They are brought from the shores of Virginia and planted to grow and fatten; so that every quality and flavour can be produced by the varying situations of the banks, and the time of planting and the depth of water regulates the season of the oyster and keeps the market in constant supply.

There is a celebrated restaurant for oysters in New York, No. 783, Sixth Avenue, and the late proprietor, Mr. Robert Burns, informed Mr. Marshall, in November, 1879, that he had then in stock about 50,000, and in holiday time he kept from four to five thousand oysters. The shells of one of the large Cow Bay oysters measured $10\frac{1}{2}$ inches in length and averaged $4\frac{1}{2}$ inches in width, and the fish inside averaged 6 inches by 4 inches. Mr. Marshall was shown

(*p*) Mr. Say (*q*) says, that a small crab (a species of *Pinnoteres*), which lives in the shell of the common American oyster, is much valued by oyster eaters in the United States, and that in opening a large quantity of oysters these little crabs are collected apart and serve to gratify the palate of gourmands. They are only seven-twentieths of an inch long by two-fifths wide. (*r*)

(*q*) "Journ. Acad. Sc. Phil.," 1, 68.

(*r*) "Popular Hist. Brit. Crustacea."

15,000 of these monsters stored away in bins in a cellar under the house. Sometimes even larger specimens are to be met with. Cow Bay is an inlet of Long Island Sound, about fifty miles above New York. (*s*) From information received in 1883 (says M. S. Lovell), kindly given by the manager of the restaurant, which is now carried on by a son of Mr. R. Burns, it appears that since 1879 the business has been doubled and double the amount of oysters consumed.

It is not only in seaport towns in America that oysters are eaten in enormous quantities, but towns a 1000 miles inland are well supplied, and oyster suppers are as common in Cincinnati or St. Louis as in New York or Baltimore. It was stated by Mr. Consul Rainall, in 1869, that eight millions of bushels of oysters are annually landed at Baltimore for home consumption and packing, and as many more to other places. Baltimore is the largest oyster market in the world. The average consumption for seven months in the year is 35,000 bushels per day. One firm alone from October 1st till June 1st averages 4000 bushels a day, packing from 16,000 to 25,000 cans daily, hermetically sealed, containing 1 lb. and 2 lbs. of oysters.

Wading through such an array of facts and figures (as represented in the tables of Professor Goode, and of which those quoted herein under his name are only the totals) I am almost tempted to believe with him, that "A speedy extermination of this most valuable mollusc will doubtless result, unless some effective means of protection and artificial culture are soon employed.

"The preservation of the oyster-beds," he continues, "is a matter of vital importance to the United States, for oyster-fishing, unsupported by oyster-culture, will, within a

(*s*) "Through America," by W. G. Marshall, M.A.

short period, destroy the employment of tens of thousands, and the cheap and favourite food of tens of millions of our people."

Something may be effected by laws which allow each bed to rest for a period of years after each season of fishing upon it. It is the general belief, however, that shell-fish-beds must be cultivated as carefully as garden-beds, and that this can only be done by leasing them to individuals. This is already the practice in the Northern States, where oysters are planted in new localities; there is difficulty, however, in carrying out this policy in the case of natural beds, to which the fishermen have had continued access for centuries. It is probable that the present unregulated methods will prevail until the dredging of the natural beds come to be remunerative, and that the oyster industry will then be transferred from the improvident fishermen to the care-taking oyster-culturists, with a corresponding increase in price and decrease in consumption. (*t*)

Yes! as I have said, wading through Professor Goode's columns of statistics relative to the United States Fisheries, and the oyster fisheries in particular, I *am* almost tempted to agree with him in his somewhat pessimistic inferences, but, upon more mature consideration—taking it for granted that "the conclusions gained by Professor Baird tally exactly with those of Professor Huxley, that the number of any one kind of oceanic fish killed by man is perfectly insignificant when compared with the destruction effected by their natural enemies;" (*u*) and that *such* has been the course of nature for unknown ages—I am the more steadfastly inclined to believe in the ostracultural infallibility of

(*t*) "The Fishery Industries of the United States," pp. 22-23.

(*u*) *Ibid.*, p. 65.

America (so long as her Fishery Legislation is efficiently regulated), and take my creed from Lieutenant Winslow's bold and patriotic prophecy, which the reader will find at the end of the chapter on the "Oyster Culture in America."

CHAPTER XXXVII.

CURIOSITIES OF OYSTERS.

STRANGE CIRCUMSTANCES IN THE EARLY HISTORY OF OYSTERS—
GROWTH ON BOTTLES—OYSTER GROWING IN A TEAPOT—A
STRANGE AGGLUTINATION—OYSTERS AND MICE—THE FOX AND
THE MUSSEL—THE “WHISTLING” OYSTER—SIR RICHARD
STEELE’S STORY OF THE OYSTERS.

THE sober oyster is about the last creature one would suspect of forming undesirable connections, or contracting bad habits. Like Diogenes in his tub, he keeps secure in his shells, and his very appearance is suggestive of anything but the idea of “fast” living. But attachments early formed are with difficulty broken, and, alas! for the deceptiveness of appearances, the oyster often takes in early youth to the “bottle” and the “pipe,” and sticks to them through life. Many and curious indeed are the objects to which these creatures have been known to adhere. As the dredge of the oyster-fisher is dragged over the submarine colony, it sweeps up many queer articles besides oysters: clay pipes, bottles, old boots, horns and bones of animals are among the miscellaneous catches, and on these a cluster of oysters are often found to have taken up their abode. Sometimes, instead of a quiet, stay-at-home life, an oyster is compelled to become a traveller *malgré lui*; if he

chances to have settled on the back of a lobster or a crab, he is obliged to join in the excursions of his unwitting entertainer, whether he likes it or not. Fortunately for both parties, these crustacea cast their shells periodically, or the oyster would become a confirmed rover, and when he grew to any size his presence would most probably become very unpleasant to the unlucky crab, who would be unable to levy any tolls for his locomotive accommodation.

In Frank Buckland's "Log-book of a Fisherman and Zoologist," a picture is given of a terrapin that unconsciously carried an oyster on the lower part of his back, close to the tail, till it had attained a very large size.

From the above it will readily be surmised by the reader that the future circumstances of a single brood of the oyster are marked by a great and often strange diversity. Mr. Busk mentions (*a*) the valve of an oyster-shell which resembles a combination between an oyster and a pholas, one of the rock-boring molluscs. He thought that the oyster had encased the pholas, or, at least, that the pholas is enveloped in its valve. Professor Henslow, however, has come to a different conclusion :—

"I suspect," he says, "that such is not the case, and that Mr. Busk has the genuine shell (one valve) of an oyster only. A specimen of a fossil oyster which I prepared for the Ipswich Museum, a few weeks ago, seems to explain Mr. Busk's puzzle. This shell (probably a detrital relic from the Suffolk drift) had attached itself by the lower convex valve to an ammonite, and as it grew, had taken in a very complete manner the impression of its whorls. But the curious result has been that the upper valve, which

(*a*) "Annals and Magazine of Natural History," March, 1855.

was not in contact with the ammonite, has become partially modelled to represent it. Thus the two valves together have the double impression of the ammonite, in intaglio below, and in cameo above. I suspect from this that Mr. Busk's oyster had grown with the lower valve (which he does not possess) attached to the outer convex surface of a pholas, and that the upper valve (the one in question) has, in consequence, been partially modelled after it. We must suppose, in these cases, that the mollusc accommodates itself to whatever curvature is impressed on the lower valve, and then the materials secreted for the upper valve will necessarily follow the contour thus given to the animal."

In the *Illustrated London News*, August 11, 1855, there is an engraving of an old-fashioned champagne bottle, taken from the wreck of the Royal George, having on it four oyster-shells or lower valves, all of which are modified in form by the figure of the bottle. The two more immediately in front, instead of being concave internally, are convex, moulded, in fact, by the globose body to which they adhere, so that the oyster, instead of sinking into a bed, must have been elevated or perched up, and consequently covered by an arched or vaulted valve instead of a flat valve, the order of things being reversed. The two other shells show rather how, by the disposition of layer after layer, the oyster makes the best of an unfortunate attachment, than display any decided alteration of the normal character of form. That lying on the base of the neck of the bottle, though somewhat irregular, is fairly concave, and is raised up by numerous rough external layers, acting as a sort of buttress. These shells bear marks of great age, the oysters having lived and died in their present condition. Other shells, of different ages,

some small, some mere *spat*, are attached to the bottom and opposite side of the bottle.

Another engraving, in the same paper, represents an ancient Chinese teapot without a spout, but perforated at the spot from which it once projected by three small orifices, like those of a crow-quill, which, being at some time at the bottom of the sea, became the abode of an oyster, either washed into it in the state of *spat*, or at some subsequent stage of its progress. In this strange abode the oyster lived and grew, deriving its subsistence from the water that flowed in through the orifices.

Its dwelling too became a prison, for the mouth of the teapot was tightly and closely plugged up by the lower valve of the shell. This part rose abruptly from a lower flat margin, extending disc-like or ring-like within the vessel, to its swollen circumference, or nearly so ; hence the escape of the oyster was impossible, as this substance fitted the mouth of the teapot like a bung. Its surface is transversely marked with lines, the result of growth, and with longitudinal ridges and furrows. It consists of many layers of lime, placed one upon another, to the thickness of half an inch ; the whole appearing as if the oyster, clothed in a shell of thick putty or liquid plaster of Paris, had tried to break through its prison-house by pressing upwards, and had thereby converted its shell into a plug, so as to block itself in, the putty or plaster becoming hardened. Such is, at least, the appearance, though not the fact, for the growth and adaptation of form kept pace with each other. This singular dwelling was dredged up in Falmouth River, and is (or was) in the possession of Mr. Payne, of Blackheath.

The naturalist by whom this specimen was described mentions an instance in which three oysters, at an early

stage of their existence, became agglutinated together by the union of their convex valves. Thus they grew, accommodating themselves to each other, with a certain degree of distortion, which, with the ruggedness of the surface of each, and with a crop of acorn-shells affixed thereon, produced a singular and not unpicturesque effect. At the time when this specimen came into his hands the oysters were living, and the valves were opened by the knife for the ordinary purpose.

Carew (*b*) mentioned an oyster that closed its shell on three mice. Some years ago a dish of oysters was laid in a cellar of the New Inn, at Ashburton, when one of them, soon opening its shell, was instantly pounced on by three mice, only, however, to be as quickly crushed by the valves. The oyster, with the three mice dangling from its shell, was long exhibited there as a curiosity.

According to an old number of the *Inverness Courier*, a still stranger capture was made by a molluscos animal. At Ardinisgain, on Loch Carron, mussels of an immense size are found, some of them nearly as large as a man's shoe. One of these mussels being left exposed by the retiring tide, naturally enough opened its yawning mouth when the sunbeams fell upon it, and in this attitude it was approached by a prowling fox, whose hunger was sharper than his discretion. The temptation was too strong for Reynard to withstand; but no sooner had he thrust in his tongue between the accommodating shells than they closed upon it, and he was thus held fast till drowned by the returning tide.

I think I cannot do better than include in this chapter the story of the "whistling oyster." One day in the year

(*b*) History of Cornwall.

1840, the proprietor of the well-known oyster rooms in Vinegar Yard (which Charles Lamb never passed “without shaking forty years from his shoulders”), “heard a strange and unusual noise proceeding from one of the tubs, in which the shell-fish lay piled in layers one over the other, placidly fattening upon oatmeal, and awaiting the inevitable advent of the remorseless knife. The landlord listened, hardly at first believing his ears. There was, however, no doubt about the matter. One of the oysters was distinctly whistling, or, at any rate, producing a sort of ‘sifflement’ with its shell. It was not difficult to detect the phenomenal bivalve, and in a very few minutes he was triumphantly picked out from among his fellows, and put by himself in a spacious tub, with a plentiful supply of brine and meal. The news spread through the town, and for some days the house was besieged by curious crowds. That the oyster did whistle, or do something very much like whistling, is beyond all question. How he managed to do so is not upon record. Probably there existed in his shell a minute hole, such as those with which the stray oyster shells upon the beach are usually riddled, and the creature, breathing in its own way by the due inspiration and expiration of water, forced a small jet through the tiny orifice each time that he drew his breath, and so made the strange noise that first caught the ear of his lucky proprietor.”

The following, although, strictly speaking, it is somewhat out of place in this chapter, will bear repetition, because it “points a moral (and) adorns a tale” :—

“An intimate acquaintance of Sir Richard Steele dined with him one day, shortly after he had been married and set up a carriage. His lady, two or three times at dinner, asked him if he used the chariot that evening ; to which

he only answered, 'Oysters, my dear.' When the table-cloth was taken away she said, 'Well, my dear, I'll take the chariot!' To which he again replied, 'Oysters!' She dropped a curtsey, and confessed she was in error, and stood reproved. On retiring, Sir Richard's friend thus addressed him :—' Sir, absurd as your answer might seem to others, I know your manner so well that I am assured there is some moral instruction in your word *oysters* ; as it must be some gentle reproof—do me the favour to let me into the secret of it.' ' You know,' said Sir Richard, ' that we have just set up a chariot ; and being apprehensive that it might have such an effect on my wife's heart that she might inconsiderately talk of it too much, thereby betraying a weakness of mind I would gladly have prevented, I told her a story of a young fellow who had lately set up an equipage, and had always the vanity to be talking about it, which was as follows :—

" Ned Sparkins, on the death of his elder brother, left the attorney to whom he was clerk, set up an equipage, and commenced *petit maître*. He was fond of his chariot ; thus he was seldom out of it, or hardly a moment without making some mention of it. He was one day talking with some gentlemen in the Mall, when one of them asked him to be one of the party to dine at an eating-house near Charing Cross. ' With all my heart, my dear Sir,' says Ned. ' I'll step to my servant, and give him some orders about the chariot, and be with you again in a moment.'

" On this, one of the gentlemen said, ' How can you ask that puppy to be with us ? We shall hear of nothing but his chariot. I'll lay half a dozen of claret he talks of within ten minutes after the time he comes into the room.' ' As I think that impossible,' says another, ' It is a bet.'

“Ned by this time joined them again, and they proceeded to the house. They were scarcely in the room, when the gentleman who had laid the wager proposed having some oysters before dinner, as a whet ; but at the same time feared there were none fresh enough at that end of the town, and proposed to send down to Billingsgate for some. It was objected that it would take too much time, otherwise they approved the notion. ‘Nay,’ says Ned, ‘let that be no hindrance. My chariot is at the door, and I’ll despatch Tom away with it directly ; and he may be back in half-an-hour.’

“‘You see,’ continued Sir Richard, ‘the intent of this story, on how absurd a foundation soever it may be built. I told it my wife as a family piece of instruction, and you see that she has good sense enough, on the mention of ‘oysters,’ to see and confess her error.’”

CHAPTER XXXVIII.

THE PEARL OYSTER.

“ What hid'st thou in thy treasure-caves and cells,
Thou hollow-sounding and mysterious Main ?
Pale glistening *Pearls*, and rainbow-coloured shells,
Bright things that gleam unrecked of and in vain.”

Hemans.

DIMYARIA.

FAMILY MELEAGRINIDÆ (PEARL OYSTERS, &c.)

MELEAGRINA, LAMARCK—PINTADINES (MELEAGRINÆ)—AVICULA (LES ARONDES) CUVIER—THE BROAD-WINGED AVICULA (AVICULA MACROPTERA)—THE PEARL OYSTER (MELEAGRINA MARGARITIFERA)—MYTILUS MARGARITIFERUS, LINNÆUS—AVICULA MARGARITIFERA, SOWERBY—THE ETHERIA OF LAMARCK—THE CHAMIDÆ—THE ETHERIA SEMILUNATA—HOW PEARL IS FORMED: ITS CHEMICAL COMPOSITION, WHERE AND HOW OBTAINED AND PREPARED—HOW FORMED BY ARTIFICIAL PERFORATIONS—NOTED FISHERIES—FISHING SEASON—PRICE OF PEARLS—MOTHER OF PEARL—THE PEARL-BEARING MYA—HOW ARTIFICIAL PEARLS ARE MADE—“ BREEDING PEARLS ”—THE AMERICAN PEARL.

UNDER the comprehensive genus *Avicula*, Cuvier includes two sections: one, the Pearl-Oysters, *Meleagrina*, Lam.

(*Margarita*, Leach); and the restricted genus *Avicula*, Lam., of which the *Mytilus Hirundo* of Linnæus, a native of the Mediterranean, and the *Avicula macroptera*, are examples.

To the genus *Avicula* Sowerby also refers the genus *Meleagrina* of Lamarck; regarding the distinctions between them as of trivial importance. The shell in both is foliaceous externally, and internally of a brilliant pearly lustre. The left hand valve is contracted and notched posteriorly, and so is the right, very slightly. Through the sinus thus formed passes the byssus, by which the shells are moored to rocks and stones. The ligamental surface is marginal and broadest in the centre, and there is generally a small tooth in each valve near the umbo. Generally this tooth is most conspicuous in *Avicula*, but is not always found; whilst in *Meleagrina* it is, on the other hand, often apparent, though sometimes absent. The muscular impression is nearly central, somewhat circular and large.

As thus characterized, *Avicula* will comprise two sections, namely, one in which the species have the hinge-line considerable prolonged—*Avicula* of Lamarck; the other comprising such species as are without that prolongation—*Meleagrina* of Lamarck.

Cuvier thus defines *Avicula* (Les Arondes):—The shell has the valves equal, with a rectilinear hinge, and is often carried out into wings; the ligament is narrow and elongated; small dentilations often appear on the hinge, on its anterior part; and below the angle on the side near the mouth is the notch for the byssus. The anterior adductor muscle is still extremely minute.

(a) Those species are termed Pintadines (*Meleagrinae*) which have the auricles slightly salient. The term *Avicula*

(a) M. Deshayes states *Avicula* to be *Monomyarian*.

is reserved for those in which the auricles are more pointed and the shell is more oblique; they have on the hinge before the ligament the vestige of a tooth at least, of which scarcely any trace is perceptible on the Pintadines.

As the two so-called genera thus stand, it may be convenient to consider them separately, under a family title; for even if it be deemed unphilosophical to retain the two genera, still *Avicula* seems to be the type of a family form.

THE BROAD-WINGED AVICULA.

(*Avicula macroptera*). This shell, when the valves are represented open so as to display the hinge, will convey a better idea of the general characteristics of the genus than any verbal details. These shells, as those also of the genus *Meleagrina*, are natives of the warmer seas, where they moor themselves at various depths to the surface of rocks, old shells, and other submarine objects.

THE PEARL OYSTER.

(*Meleagrina Margaritifera*.) *Mytilus Margaritiferus*, Linnæus; *Avicula Margaritifera*, Sowerby.

The young of this interesting shell are marked with beautiful foliations, which disappear when the shell has attained to a large size.

The valves are semicircular, greenish externally, and lined internally with a layer of the most beautiful nacre.

The foot in this tribe is small, and produces a byssus, by which the animal attaches itself firmly to submarine objects. The mantle lobes are free, the shell usually oblique and somewhat triangular, with the valves unequal, and the hinge usually without teeth. The ears are comparatively small; that is, in comparison with others of the *Aviculaceæ*.

Nacre, or mother-of-pearl, is the inner part of the shell of the pearl-oyster or pearl-mussel. This is of a brilliant and beautifully white colour, and is usually separated from the external part by aqua-fortis, or the lapidary's mill.

Pearl-mussel shells are on this account an important article of traffic to China and many parts of India, as well as to the different countries of Europe. They are manufactured into beads, snuff-boxes, buttons, and spoons, counters for card-players, and innumerable other articles. The pearl-mussels are not considered good as food; though, after having been dried in the sun, they are sometimes eaten by the lower classes of people in the countries near which they are found.

The Oriental Pearl-Mussels (*Mytilus Margaritiferus*), to which we are indebted for nearly all the pearls of commerce, have their principal habitations off the coasts of Hindostan and Ceylon. The fishing usually commences about the month of March, and the process is almost the same as that of Pearl-Oyster fishing. When the mussels are taken out of the boats, they are placed in heaps on the shore, where they continue about ten days, till the animals become quite putrid. They are then opened and searched for pearls. One mussel sometimes contains many pearls, a hundred and upwards, large and small; and sometimes a hundred mussels have been opened without yielding a single pearl large enough to be of any value. The pearls are sorted according to their size, by being passed through large brass sieves, or through saucers with round holes in the bottom. After having been sorted, they are drilled; and then washed in salt water, to prevent any stains which might be left by the drilling. The arranging of them on strings is considered the most difficult task of a pearl

merchant, in consequence of the correctness of judgment which is requisite in classing them according to their value.

From the size of the ornaments made of this nacre, or mother-of-pearl, some idea of the magnitude attained by the shell (*b*) may be appreciated. Were it only for the production of this article, so much in request for all kinds of "bijouterie," this shell would form an important object of commerce; but yielding as it does its nacreous lining in such abundance and solidity, it affords also those more valued nacreous drops or nodules called pearls, estimated in the East, time immemorial, as "of great price"—the ornaments of Kings.

The article called mother-of-pearl is not a product of the pearl mussel, but the substance of the shell of another genus, found in warm seas, where the water is not very deep; it is obtained in the Indian Ocean; but more abundantly, and of the finest colours, in the Red Sea, the seas on the coasts of China, and the waters of the Eastern Isles. It is named *Nautilus Pompilius*, or great chambered sailor fish. The inner side is exquisitely polished by nature, of the whiteness and water of pearl itself; and the outside, after the external coating has been removed by aqua-fortis and the lapidary's wheel, has a similar lustre. It is cut into pieces with a saw, and made into many sorts of trinkets. It is also used with great advantage as *buhl*, in inlaying the nicer sorts of cabinet work.

(*b*) Commenting upon the Geology of Patagonia, Darwin says:—"The most common shell is a massive gigantic oyster, sometimes even a foot in diameter."—"Voyage of a Naturalist," p. 170. Whether these belonged to the Common or Pearl-Oysters is not stated; most probably both.

The word pearl, in the Latin and Greek languages, is expressed by *Margarita*, signifying *purity*.

“Of all beautiful things in the world, the pearl is the rarest and most beautiful. Nothing can exceed it, nothing can equal it, although they try very hard in ‘French’ and ‘Roman’ ways, in glassy globules which continually crack, or in round spots of wax, which, instead of adorning, adhere to the neck of beauty, and when old age comes upon it, turn yellow and wrinkled like the skin of a dowager. Nay, nothing can well imitate it, although art has gone somewhat near it. But to a knowing eye one might as well seek to imitate truth, or palm away upon the unwary a copy of true virgin innocence, as to imitate a pearl. We know all the answers that the dowagers can make; we know that the imitations are ‘so cheap,’ so pretty; we know that certain dowagers—witness Margaret, Duchess Dowager of Lancaster—sell their real pearls and wear cunning imitations; we know that they in vain try to persuade themselves that the false are as good as the true ones; but only look hard at the ornaments, and the Duchess is abashed. To test false pearls, one has only to put a true one by them, and the ‘difference,’ as advertisers say, ‘will be at once perceived.’”

Let us devote this portion of our book to the history of the pearl. Its very names are pretty. *Looloo*, *Mootoo*, *Mootie*, *Margaritæ*, *Perles*, *Perlii*, *Perlas*, *Pearls*, all sweet, pretty, mouth-rounding names, but worthy to be applied to the lustrous and beautiful spheres which we call pearls. *Principium culmenque omnium rerum pretii tenent*: “Of all things, pearls,” said Pliny, two thousand years ago, “kept the very top, highest, best, and first price.” What was true then is true now. There are few things so immortal as good taste. Let us pay something “on account” of

our debt to the oyster. Having regarded that placid creditor as an article of food, I now propose to treat him as an assistant to the toilet. And, looking at him in that point of view, here is not a bad instalment of the aforesaid debt, contributed by Barry Cornwall :—

“ Within the midnight of her hair,
 Half hidden in its deepest deeps,
 A single peerless, priceless pearl,
 (All filmy-eyed) for ever sleeps.
 Without the diamond’s sparkling eyes,
 The ruby’s blushes—there it lies,
 Modest as the tender dawn,
 When her purple veil’s withdrawn—
 The flower of gems, a lily cold and pale.
 Yet, what doth all avail ?—
 All its beauty, all its grace ?
 All the honours of its place ?
 He who plucked it from its bed,
 In the far blue Indian Ocean,
 Lieth, without life or motion,
 In his earthy dwelling—dead !
 All his children, one by one,
 When they look up to the sun,
 Curse the toil by which he drew
 The treasure from its bed of blue.”

Costly as pearls are, they are merely the calcareous production of molluscs. Diamonds have elsewhere been shown to be merely charcoal ; the pearl is little else but concentric layers of membrane and carbonate of lime. (*c*)

(*c*) The chemical composition of the Pearl is carbonate of lime, associated with a small proportion of organic matter : it is easily affected by acids and fœtid gases, and may be calcined on exposure to heat. It possesses a lustre peculiar to itself, which is known as the “orient.” Its specific gravity is 2·5 to 2·7, those found on the coast of South America, termed Panama Pearls, being somewhat denser than the Oriental Pearls.

All molluscs are instances of that beneficent law of nature, that the hard parts accommodate themselves to the soft. The common naked snail, the mussel, cockle, oyster, garden helix, strombus, and nautilus, elegant or rough, rare or common, each illustrate this grand law. The body of a soft consistence is enclosed in an elastic skin. From this skin calcareous matter is continually exuded. This protects the animal, and forms the shell. Where the waves are rough and rocks superabundant, then the shell is rough, hard, stony, fit to weather anything ; where only smooth water and halcyon days are to be looked for, Nature, which never works in vain, provides but paper sides and an egg-shell boat, such as the little nautilus navigates and tacks and steers in.

Besides forming the rough outside, the calcareous exuvium, the mucus of the oyster, and other molluscs, form that beautiful substance, so smooth and polished, and dyed with rainbow tints and a glorious opalescence, which, be it as common as luxury has made it, still charms the eye. This is the lining of the shell, the mother-of-pearl, nacre. "The inside of the shell," said old Dampier—that old sailor with a poet's mind—"is more glorious even than the pearl itself."

It is glorious ; it has the look of the morning, and the tint of the evening sky ; the colours of the prism chastened, softened, retained, and made perpetual in it : this is mother-o'-pearl.

To render its bed always soft and cosy, to lie warm, packed as one might be at Malvern in wet sheets, seems to be the oyster's pleasure. This singular exuvium, this mucus, not only creates pleasure, but alleviates pain. Some irritating substance, some internal worry and annoyance, it may be a dead embryo, or a grain of sand insinu-

ates itself, and, lo! the creature covers it with this substance to ease off its unkind tooth, and converts it into a pearl.

That is the way they are made, these wondrous gems! And very beautiful is the thought that the most highly prized of gems should be but the effect of a creature to ease off a sorrow. Everyone knows Shakespeare's wondrously fine reflection upon the uses of sorrow and adversity, which,

"Like the toad, ugly and venomous,
Bears yet a precious jewel in its head."

The precious jewel of the toad, which some critics and commentators have endeavoured to prove its glittering eye, has long been exploded. Our old alchemists believed in the toadstone: we do not. The fable remains in its pristine beauty; but here is one truth equally beautiful, that the adversity of the oyster turns to a jewel so costly and glorious, that monarchs reckon it amongst the records of their houses and conquered provinces. May we ever turn our sorrows and troubles to as good an account; may we ever continue to do so, for assuredly some men do. The best of men are those who are tried by affliction and trouble, or those who have some deep and secret care, which they hide in their hearts, and which makes them wiser and better. Shelley has a theory that poets are made somewhat after the fashion of pearls, or that, at any rate, their poetry is so produced. He sings—

"Most wretched men
Are cradled into poetry by wrong;
They learn in suffering what they teach in song."

We have very little doubt but that the true poetry, from which the world learns anything worth learning, is so produced. (d)

(d) "The Oyster," &c.

There have been other theories as to the production of the pearl, some holding that the interior formation which we state to be a grain of sand, is a dead ovum which the fish attempts to exude. This theory, too, has its supporters.

“If,” said Sir Everard Home, a distinguished surgeon in the early part of this century, who was led to study the structure of Pearls, “if I can prove that this, the richest jewel in a monarch’s crown, which cannot be imitated by any art of man” (he is rather wrong there: it can be imitated, and wonderfully imitated too), “either in beauty of form or brilliancy of lustre, is the abortive egg of an oyster enveloped in its own nacre, who will not be struck with wonder and astonishment?”

Wonder and astonishment are words which scarcely exist now. Science has shown so many wonders that we are hardly astonished at anything; but Sir Everard’s assertion admits of proof. A pearl cut in two exhibits the concentric layers like an onion, as may be seen through a strong lens; and in the centre is a round hole, very minute it may be, but wherein the ovum has been deposited. (*e*)

Year by year some thousands of Pearls are cut in half by working jewellers, and their universal experience is that a nucleus is always to be found.

On the other hand, the pearlers in the North-West of Australia state that most of the Pearls broken there have presented a small golden-coloured cavity, capable of holding a No. 8 shot. The experience of these pearlers on the general subject, however, is much inferior to that of the jeweller.

(*e*) “The Oyster,” &c.

The nucleus of the Pearl may be either a grain of sand, or the frustule of one of those minute siliceous vegetables known as *diatoms*, or a minute parasite, or even one of the ova of the Pearl oyster itself. Around this foreign body thin layers of nacre are deposited, one after another, like the successive skins of an onion, until the object is completely encysted. The Pearl is formed of concentric layers of carbonate of lime, of extreme tenuity, but of the same general character as those composing the shell.

For a long time it was currently believed that Pearls were found only in diseased shell-fish, and to this day, in some parts of Great Britain, when a Pearl is discovered in a mussel or oyster, the edible part is thrown away as unfit for use, while the Pearl, however valueless, is carefully preserved. Hence we often find, even at the present day, that Pearls are alluded to as “morbid secretions.” (*f*)

On this subject, Professor Coutance, of the Medical School of Brest, has some remarks which are at once sensible and amusing :—“From the physiological point of view, the oyster does nothing abnormal in producing the pearl, since the nacre of the shell is formed of the same substance. It does not draw from its inside any new material to make the pearl, it only employs for that purpose, perhaps to the detriment of its shell, a portion of the carbonated element which constitutes it, or even serves to repair it. The disease of the oyster is therefore only a hyper-secretion ; without doubt it is much, and we continue to lament it as we commiserate a man with a cold in the brain. Another observation to make is, that nothing is

(*f*) “Pearls and Pearling Life,” by Edwin W. Streeter, F.R.G.S. (London : G. Bell & Sons. 1886.)

changed in the animal who secretes or who has secreted the Pearl. Any modification in the confirmation, or in the histological nature of its tissues, does not indicate a malady, an organic trouble; the presence alone of the Pearl is the indication of something abnormal.

And after a few more pages in a similar strain, he proceeds to say of the Pearl-Oysters, in reference to their secretions:—"Instead of pitying them for it, we may felicitate them for it. And if we were at any cost to presume for the calcareous secretion, it would then be necessary to say, how very ill these oysters would have been if they had not had this malady! In thinking hereafter of the rich pendules, ornamented with pearls, in the fine and delicate ears of an aristocratic beauty, we will think no longer of an oyster sick, but of an oyster saved. *It is more lively.*" (g)

So many difficulties surround the study of the Formation of Pearls, that it is by no means surprising that a host of conjectures, often of a very fanciful and even wild character, have from time to time been promulgated with the view of explaining the origin of these enigmatical little bodies. Time was when the oyster was credited with breeding it by the simple process of yawning at springtide, and swallowing the "limpid, fertilising dewdrop." Pliny held this view, and described the "fruit of the oyster" as "pearls, better or worse, greater or smaller, according to the quantity and quality of the dew received by these shell-fish." The early Arabian bards, too, entertained no manner of doubt that pearls were drops of vernal rain, con-

(g) A Chapter, "La Perle," in "Diamants et Pierres Précieuses," by E. Jannettaz, E. Vanderheyem, E. Fontenay, and A. Coutance. Paris, 1881.

gealed in oyster-shells ; and Benjamin of Tudela authoritatively stated that “in the month of March the rain-water falling on the surface of the sea is swallowed by the mothers-of-pearl, and carried to the bottom of the sea ; these, being fished for and opened in September, are found to contain pearls.” Marbodus, a writer of the first century, set forth the same theory in his “*Lapidarium*,” as we gather from a graceful paraphrase of his crabbed verse : “At certain seasons do the oysters lie, With valves wide gaping toward the teeming sky, And seize the falling dews, and, pregnant, breed The shining globules of the ethereal seed.” For the darker shades of colour displayed by certain pearls he accounts as follows : “Brighter the offspring of the morning dew ; The evening yields a duskier birth to view.” The erudite author of “*Pearls and Pearling Life*” points out that poets have deemed the “chaste and charming gem” worthy of a more sacred paternity than that attributable to a commonplace rain-drop ; hence their assumption that pearls were formed “from tears wept by angels, or shed by mortals under circumstances of peculiar trial.” In Mani-Málá, “The Chain of Gems,” Rajah Sourindro Mohun Tagore, only nine years ago, recorded the “general belief”—prevalent, we presume, in his native country—that the pearl originates in clouds, elephants, boars, conch-shells, fish, serpents, oysters, and bamboos ; the cloud pearl being the rarest and most valuable of all these varieties, while that lurking in the serpent’s crest is “embosomed in a blue halo of surpassing glory, like the flash of a polished sword,” and may not even be looked at by “persons void of merit.”

The same learned Oriental magnate dilates eloquently upon the medicinal virtues of pearls, which, ground into powder, are still prescribed by native practitioners through-

out the East as a sovereign cure for heart-disease, ague, and indigestion. According to Rajah Sourindro, pearl-dust not only heals "the ills that flesh is heir to," but "ministers to a mind diseased." Outwardly applied, it extirpates leprosy and stops bleeding; taken inwardly, it is a "sure antidote to poison, drives away all imaginary fears, and removes all bodily pain." Used as snuff, it dissipates cataract, and imparts a brilliant lustre to the eyes.

But with the advance of science these crude fancies and curious fables have gradually passed away. So far as the lights of our present knowledge can guide us in solving these difficult problems of the origin and formation of Pearls, Mr. Streeter submits the following rational explanation :—

"The oyster lies at the bottom of the sea, at an angle more or less considerable, but is generally inclined to the sea bottom at about 20° to 25° . The shell is usually open about $1\frac{1}{2}$ inches, to admit the entrance of water, its owner's natural sustenance, and the mantle is spread out over the horny outside lips of the shell. Respiration is carried on by means of the gills, and any organic particles in the water which bathes these vascular organs are transferred to the mouth. Scientists have taught us that 'hæmoglobin,' or the colouring matter of the blood in the animal kingdom, is the agent, that owing to its great affinity for oxygen, extracts that supporter of life from the air inhaled. Of the agent that extracts the oxygen from water, either salt or fresh, we are, however, still untaught. The water is admitted between the 'mantle lobes' into the 'pallial chambers,' where it is oxygenated: the oyster evidently retains a considerable amount of gas within itself, many shells being discovered by the divers, simply by the

betraying bubbles of gas emitted by the oyster, in the act of closing its shell, The effete water is renewed by diffusion, as there is no regular pulsating movement to eject it.

In most fishes there is a special arrangement to guard against the admission of foreign substances to the respiratory organs, the branchial arches being developed into a kind of fringe. In the invertebrates, however, there is no special apparatus for that purpose, and when, after storms or other disturbing causes, the water becomes thickly charged with sand, mud, and other substances in suspension, it is evident that the water admitted within the pallial chamber of the oyster must be equally thick, and it can hardly be doubted but that some particles of this suspended matter are accidentally retained entangled in the tissues of the oyster, especially if the latter happen to be weakened by disease.

The healthier the appearance of the oyster, and the greater the amount of water emitted when opened by the knife, the less probability will there be of finding any Pearl. . . . It is within the mantle that many of the Pearls are found, and the inference is that the interior surfaces of this integument secrete the fine pearly layers around the nucleus of what is to become a Pearl ; whilst the layers of the shell are secreted mainly by the exterior surfaces of the mantle. With the first layer deposited around it, the intruder becomes a Pearl, and if this nucleus is of animal or vegetable matter, decomposition, or probably absorption, will in time leave an apparently empty space, the cavity being lined and discoloured by the residue, a hollow Pearl is thus formed. . . .

The oyster is not entirely dormant, and its movements, together with the varying position of the Pearl within its tissues, probably regulate the shape assumed by the con-

stantly accumulating layers; owing, however, to the inclined position of the oyster, the tendency of the Pearl is always to work downward through the tissues, towards the hinge of the shell. Small Pearls often work their way into the adductor muscle, and, owing to the fibres of this part being coarse and close, it is almost impossible for a large Pearl to penetrate them, but numbers of small ones are frequently found here, bound together like a cluster of grapes, showing that even within this muscle these Pearls receive further accretions. In course of time such Pearls as avoid passing into this muscle find their way downwards to the lowest part of the oyster, and, according to their position therein, may or may not find their way out of the tissues of the oyster into the shell.

Up to this time the Pearl has received regular layers all over its surface, but rings and other marks of lesser brightness frequently occur, the result probably of contact with the coarser tissues of the oyster. For a short time the Pearl is loose in the shell, and it falls into the same category as a stone, or any other intruder. It is encircled by the growing layer of shell, and proceeds on its downward course through the shell, like an ordinary "blister," (*h*) the upper portion receiving further layers, until it is hidden beneath the shell, which by degrees resumes its natural shape.

The shell is worn away from the outside at the same rate that it is renewed within, so that in time the Pearl, with its surrounding tomb, yields to the general dissolu-

(*h*) An unnatural excrescence on the surface, often found in the *Meleagrinæ*, and formed in the renovation of their shells by the habit of the animals burying such intruders as they cannot rid themselves of. Stones, mud, small shells, wood, and more especially layers of weed, are thus found embedded in shells.

tion, and the nucleus of the Pearl, if of organic matter, after having been the cause of infinite annoyance to its unfortunate captor, is returned to the place from whence it came.

It may be urged that the layers of shell enveloping the Pearl or blister are laid equally upon the top of it and at the sides, and that an unnatural excrescence would still remain on the inner surface of the shell, long after the original cause of it has passed away ; but this is not so. It must be remembered that the laws of development by which creatures are adapted to cope with the surrounding conditions and difficulties of their existence are as applicable to an oyster as to any other form of life, and the same power that taught the oyster to protect itself against the inveterate attacks of its enemy, the "borer," by increasing the thickness of its shell at the point of danger, might also teach it to rid itself of an uncomfortable tenant in its bed, by exactly the reverse process.

Pearls, when of extraordinary beauty, size, or brilliancy, will sell for sums which appear extravagant in proportion to what is given for ordinary specimens. The reason for this is obvious, for no sooner is one of surpassing beauty in the market than it is removed from the common category, and the price will depend more upon the fancy of the purchaser than any system of valuation.

The larger, the smoother, the rounder and brighter the Pearl, the more it is prized. The lustre of Pearl shells and Pearls is owing to their formation of regular, very thin laminæ, or layers of two very different substances ; one of these is lime, which is opaque, the other is animal matter, which is transparent. Thus, the real colour of the one being pure white, and the other devoid of colour, the light is divided into different tints at the surfaces of the plates

or layers, in the same way that the solar rays are distributed in divers colours in the rainbow, by the surface of drops of clear water.

The Chinese and other eastern nations, knowing the details of the Pearl-producing process, are in the habit of introducing small particles under the mantle of the molluscs, and of thus procuring in due time artificial Pearls. Small metallic figures or images may sometimes be seen, which have been coated with a pearly or nacreous deposit through their introduction within the shells of the Pearl Oyster and others. Pearls being a calculus, or morbid concretion, are also formed in consequence of some external injury which the shell receives, particularly from the operations of certain minute worms, which occasionally bore even quite through to the animal. The pearls are formed in the inside on these places. Hence it is easy to ascertain, by the inspection of the outside only, whether a shell is likely to contain Pearls. If it be quite smooth, without cavity, perforation, or callosity, it may with certainty be pronounced to contain none. If, on the contrary, the shell be pierced or indented by worms, there will always be found either Pearls or the embryos of Pearls. It is possible, by artificial perforations of the shells, to cause the formation of these substances. The process which has been chiefly recommended is to drill a small hole through the shell, and to fill this hole with a piece of brass wire, rivetting it on the outside like the head of a nail; and the part of the wire which pierces the interior shining coat of the shell will, it is said, become covered with a Pearl. In connection with the Pearl-bearing shells above mentioned, there is also the *Unios*, or fresh-water mussels of our own rivers, to which I will presently allude. As the reader has already been given to understand, in the

opening of this chapter, the *Meleagrina* is not, strictly and zoologically speaking, an oyster. The shell is rounded in form, and usually coloured greenish on the external surface. The animal moors itself by a beard or "byssus," like the common mussel. The chief fisheries are those of Ceylon, (*i*) which, together with the fisheries in the Persian Gulf, were known to the ancients. The chief seat of the Cingalese fishery exists in the Gulf of Menaar, a bay on the north-east aspect of Ceylon. It begins in February or March, and extends over a period of about a month. (*j*)

(*i*) Here the greatest of all pearl fisheries has been carried on for many centuries. They seem always to have been considered the property of the King or Kings of Ceylon; but, since the occupation of the island by the British, the privilege of fishing on them has been sold sometimes by auction, the sales being only made for one season.

According to the *Queen* newspaper for December 9th, 1889, "the last Pearl fishery season in Ceylon could not have been more successful than it was. The season only lasts 22 days, and during that period 11,000,000 were brought to the surface by 50 divers, who are paid by one-fourth of the number caught. This season the whole produce was sold at the rate of 24s per 1000 shells. The Government received £20,000 as their share, and the divers £6,400. The largest pearls are worth in Ceylon from £40 to £60, and in Europe they fetch three times the price, or more."

It is said that the number of Pearl Oysters collected last year (1889) at these fisheries merely covered the cost of bringing them from the sea bottom. One reason for the falling off in the returns was the outbreak of Cholera, which attacked the workers in the spring. Another is found in the circumstance that, later in the year, a shark carried off one of the divers; his fellow-workmen, fearing the same ghastly fate, refused to enter the water.

(*j*) Writers vary in their accounts: the author of "The Adventures of an Oyster" says:—The pearl fishery always begins in the month of April, because the sea has then a beautiful tranquillity, and it is generally continued to the middle or end of May."

It attracts to the coast not only a multitude of the Cingalese, but crowds of speculators from all parts of the vast Indian peninsula, whose variety of language, costume, and manners, is described as very striking and pleasing. On the eve of the fishery there is a curious and picturesque spectacle. A mass of huts, composed of a few poles stuck in the ground, interwoven with light bamboos, and covered with the leaves of the cocoa-nut tree, is at once seen to arise on the solitary sea-shore. Bazaars, too, appear in long rows, gaily decorated, and packed with all varieties of merchandise ; while there are booths for the sale of strong liquors, as well as of sweetmeats and native drinks.

Amidst the trading assemblage a temple, with its cloths, flags, and flowers, has been observed, attended by its priests, who are no less eagerly seeking for profit by selling charms to the divers, and which are deemed lucky for those who intend to make purchases.

They even put forth a claim to temple oysters, which is yielded to by the divers, most probably from the fear of refusal involving some malignant influence.

Conspicuous among the assembled crowd, when the fishing is about to commence, is the shark charmer, who is supposed to exert some magic power over the monsters of the deep, and without whose presence no diver will undertake his task.

He is usually a tall, dark, and long-haired man, bearing on his skin mysterious characters, and with his neck and arms adorned with strings of heavy beads.

He strongly resembles the "medicine man" of the American Indians, and the sorcerers of every age, who find a prey in the ignorant and superstitious. Striking as his appearance is to such persons, he does not rely upon it for

his influence, but often harangues them on the greatness of his power and on his marvellous exploits.

In addition to the variety of persons attracted, as has been seen, to the pearl fishery, there annually arrive troops of Indian artisans, who are very expert in piercing or drilling the pearls, and who practise their art on the spot at a very moderate charge. They sit in the open air before the tent of any person who employs them. Nothing can be more simple than the implements they use. These are merely a block of wood in the form of an inverted cone, which rests on three legs, and whose upper surface is pierced with circular holes of various diameter, fitted to receive the pearls according to their size, with a few drills. Their drill is merely a short, sharp needle, inserted in a stick, which is made circular at the top, and is set in motion by a bow, like those used by our watchmakers. Sitting on the ground cross-legged, they keep the block of wood between their knees, and apply the drill perpendicularly to the pearl, which they pierce with extraordinary rapidity and accuracy.

In stormy days the divers cannot proceed. The boats set off at the signal of a gun, about ten o'clock in the evening, when the land breeze is in their favour; they reach the banks about break of day, and about noon the sea breeze rises, with which they return to land. A fleet of about 250 boats are engaged in the fishery, each boat being manned by about twenty hands, half of whom are to row the boat and assist the divers, especially in coming up, when they are considerably exhausted. Of the other ten, who are divers, five go down at a time; one company resting while the other dives. The average depth at which the oysters are found varies from 60 to 70 feet, and to these depths accordingly the divers descend, being let down into

the sea-depths by a stout rope weighted by a heavy stone, weighing about 56 pounds, or more.

When about to descend, the diver seizes the rope between the toes of his right foot, for by custom he can use his toes as well as his fingers, and he holds a net-bag with his left foot. He grasps another rope with his right hand, and, holding his nostrils with his left, he (naked, save for a cloth around his loins) plunges into the sea, and having reached the bottom, the stone is pulled up.

Laid on his face, he quickly gathers the oysters, and places them within the net. At the end of thirty seconds he generally signals to be pulled up ; the longest period possible for the divers to remain under water being stated to be about eighty seconds. When in the boat again, the violence of the operation appears by his discharging water, and sometimes blood, from his mouth, ears, and nose. He then rests while the others descend.

Each man will thus go to the bottom from three or four to twenty, and even forty or fifty times a day, bringing up possibly a hundred shells each time. They are the poorest of the people who labour in this dangerous way, and live but a few years, being liable to the bursting of blood-vessels, drowning, being devoured by sharks, or dying of consumption. A knife is generally carried by way of protection against sharks, and the native priests on shore exact fees to keep up a beating of drums, and to say prayers for the assumed protection of the divers from their finny enemies.

Well has Mrs. Hemans said :—

“ Thou hast been where the rocks of coral grow,
Thou hast fought with the eddying waves ;—
Thy cheek is pale, and thy heart beats low,
Thou searcher of ocean’s caves !

Thou hast looked on the gleaming wealth of old,
And wrecks where the brave have striven :
The deep is a strong and fearful hold,
But thou its bar hast riven.

A wild and weary life is thine—
A wasting task and lone,
Though treasure-grots for thee may shine,
To all besides unknown !

A weary life ! but a swift decay
Soon, soon shall set thee free ;
Thou'rt passing fast from thy toils away,
Thou wrestler with the sea !

In thy dim eye, on thy hollow cheek,
Well are the death-signs read—
Go ! for the pearl in its cavern seek,
Ere hope and power be fled !

And bright in beauty's coronal
That glistening gem shall be ;
A star to all in the festive hall—
But who will think on *thee* ?

None !—as it gleams from the queen-like head,
Not one 'midst throngs will say,
'A life hath been, like a raindrop, shed
For that pale quivering ray !'

Woe for the wealth thus dearly bought !—
And are not those like thee,
Who win for earth the gems of thought ?
O wrestler with the sea !”

“ Mr. Marshall, for many years surgeon to the forces at Ceylon, states that he rarely knew the submersion of a diver last longer than fifty seconds.”

This is about the time that the men in the Bay of Naples, who dive for small molluscs, and the Greek islanders of the Archipelago, who dive for sponges, remain under water.

These are the most famous divers in Europe, and are likely, from their physical structure, sobriety of life, and constant practice, to carry their art as far as possible.

But a recent visitor says :—"There was a move on deck, the signal flag rose slowly upwards, the Union-Jack fluttered in the morning breeze, and just as it touched the masthead a thousand divers, with their stones and nets, plunged silently in the sea. I shall not easily forget the sensation I experienced when I saw the crowd of human beings sink, as by magic, in the depths below, leaving but a few bubbles to mark their downward path : I pulled out my watch, a minute elapsed, and not one of all the thousand appeared ; a minute and a quarter,—a minute and a half,—three-quarters,—two minutes,—still not a soul arose to the surface. I dreaded some fearful calamity. Two minutes and a quarter had flown ; the drops of perspiration gathered thickly on my forehead ; my hands trembled so that I could scarcely hold my watch. I turned to the Adapanaar—the head-man of the district, in his ten-oared cutter, in which I stood—in an agony of anxiety, but he was sitting calm and quiet as an oyster. How gladly my heart beat when I saw, first a dozen heads and shoulders, then fifty, then five hundred and more, ascend to the surface, bubbling and spluttering, as they well might, after such a submarine excursion.

"The old shark charmer had stationed himself from the commencement of the diving on the stern of his boat, which was in the centre of the fleet ; occasionally he muttered a charm, flourishing his long arms about in his accustomed manner ; but at intervals he descended to sip something from a cocoa-nut shell bottle. At one of these times loud cries arose of 'The shark ! the shark !' A poor diver, lacerated grievously by the monster, was dragged

into a boat, and fishing was stopped for that day. The inspector sent for the shark charmer, who stated with the greatest effrontery that there were some spirits adverse to the powers he possessed ; and that during the brief time of his taking a little refreshment one of them had broken his charm, and unclosed the jaws of the shark.”—(*Adventures of an Oyster.*)

The owners of the boats wait and superintend the landing of the precious cargoes, the oysters being carried to shore, and heaped in pits, which are lined with mats, to prevent them coming in contact with the earth itself, or else they are laid in piles on mats of esparto grass, or they are deposited in spaces of ground called coultôts, enclosed with poles and transverse pieces of bamboo, but open to the air.

In about ten days the oysters become thoroughly decomposed, the smell in the neighbourhood of the putrefying heaps being said to be almost unbearable by a stranger unaccustomed to the scene, yet the health of the precarious but crowded population gathered there is in noways affected.

“During two years that I did duty at the fishery,” says M. de Noé, “I never saw a soldier of my regiment sick ; Europeans and Sepoys all enjoyed good health ;” and it has been remarked, on other authority, that in this climate, where the effects of vegetable decomposition are so fatal and so rapid, those of animal decomposition are almost innocuous.

The object of thus allowing the molluscs to decompose is that of insuring their being easily opened and examined in the soft putrefying state, without fear of injuring the concretions they may contain ; for they could not be opened while alive without great force and more trouble :

but when they begin to putrefy they fly open, and, of course, the pearls are taken out without injury. They are then placed in troughs made of the trunks of trees, hollowed, and sea-water is thrown over them. The pearls are now readily shaken out and washed, by men who stand on one side of each of the troughs. The largest are carefully picked up, and washed repeatedly with clean water; the next in size and quality are merely taken from the trough, and spread out on white napkins to dry in the sun; and it is not till this is done that any attention is paid to the smallest pearls, which are generally left to the care of the women, who pick them up and dry them. The shells, after being cleaned, are split into layers for the sake of the nacre of which they are composed. This nacre is commercially known in three forms—the “silver-lipped” of India, China, and Peru; the “bastard-white,” and the “bastard-black” nacre.

The first mentioned is the most valuable; it is imported in cases weighing from 250lbs. to 280lbs. each.

The second kind of nacre is imported in casks of about 250lbs. weight; this latter variety is coloured yellowish or greenish, or may exhibit reddish or bluish tints. The nacles are used chiefly for the purpose of inlaying wood and marqueterie work. Pearls should be of a clear white, and highly glistening; this lustre is called their *water*. So we say in Europe; but in the East those tinged with a little yellow are preferred, especially as they are reported never to change their colour.

The Cingalese prefer those which are rose-coloured, and the Indians and some other orientals the yellow pearls. Besides pearls of these three colours, others are found of a delicate blue tint, while some have a golden and others a silvery hue.

The white are apt to degenerate to a very dingy yellow, after forty or fifty years' wearing. The Ceylonese paint them with powder of pearls, and (as already mentioned respecting the *mytilus margaritiferus*) drill them with great dexterity, so that they may be strung ready for use.

Pearls are valued according to the squares of their weights. If a pearl of one carat be worth 10/-, a pearl of six carats will be worth thirty-six times as much, or £18; for the square of 6, that is 6 multiplied by itself, is 36.

The uninitiated are often deceived by buying, as genuine productions of nature, articles which are mere fabrications, or *artificial pearls*. Some pretend to unite several small pearls into one large one, which is impossible. From the scales of some fish a silvery matter may be obtained: this is dropped into a hollow bead of very thin glass, and the appearance is so nearly that of the real pearl that none but a practised eye can distinguish the difference. Nay, a thin skin from the eye of the mackerel may be stamped into a half-globular shape, which, when set, may deceive the inattentive. The French are very dexterous imitators of pearls, and the pastes they make of a certain powder, united with isinglass, possess the weight, the lustre, and nearly all the properties of real pearls.

“The pearl-fisheries of Ceylon are under government control and inspection, the coast being officially inspected each season. The fishings may be let, or may be retained in the interests of the government of Ceylon. Of late years the Ceylon pearl-fisheries have been unproductive, chiefly, it must be presumed, from over-fishing and the want of definite knowledge respecting the habits of the oysters, with a view to their cultivation and due preservation. In 1797, the first year in which the government

obtained the control of the fisheries, the annual produce was £144,000, and in the following year, 1798, it rose to £194,000. But these favourable conditions after that period at once fell off, until the beginning of the present century, when the fishing prospects again improved, the ground being let to private speculators under certain wise restrictions as to the extent of ground to be fished. (*k*) During the ten years 1863-73, the pearl fisheries of Ceylon again greatly declined, but they revived in 1874, and a good return was again obtained from these fisheries in 1877. James Steuart, Esq., of Colpetty, in his Notes on Ceylon, gives much interesting information regarding the Ceylon pearl fisheries. This gentleman remarks that in 1851 it

(*k*) I regret that the able and well-informed writer of the above highly interesting contribution to Messrs. Blackie & Son's "Popular Encyclopædia,"—whose valuable aid I gratefully acknowledge,—did not chronicle the said restrictions, because I feel assured that they were not only "wise," but even as wisely applicable at home, at the present time, to the more prolific cultivation and produce of our *edible* oyster as they were then, in that far distant land, to the Pearl Oyster. At least, I judge so from the one I now quote from a very useful book of general information, and which, though probably one of the actual "wise restrictions" referred to, cannot be too emphatically impressed upon the minds of all our oyster-fishing cultivators as a WARNING—not to be slighted. Here it is: "The bank where the pearl fish abound lies about twenty miles out at sea, opposite the Bay of Condatchy. The government does not allow the whole bank to be fished in any one season, but it is divided into four portions, one of which suffices for a year; thus, as the fishers make progress through the whole, each portion has time to recover the devastations made upon it. The number of beds is about fourteen, of which the principal bed, or bank, is ten miles in length and two in breadth; and the best fishing is in six or eight fathoms of water. The produce is variable: in some years to the value of two hundred thousand pounds sterling, and in others less than £30,000."

was first determined by the late Dr. Kelaart that, although the pearl-oyster had no power of detaching its byssus from the rock, it yet could detach itself in turn from the byssus, and could move to another spot, there to form a new byssus. (*l*) This power of changing the position may therefore in some degree have affected the apparent scarcity of the oysters in certain parts of the fishing-grounds. (*m*)

(*l*) It may interest the reader, by the way, to learn that from the most remote periods of antiquity the byssus, by which the Great Pinna, or Sea Wing (*Pinna nobilis*), affixes its shell to rock or stone at the bottom of the sea, has been spun and woven into different articles of dress. For this purpose the shells are dragged up by a kind of iron rake, with many teeth, each about seven inches long and three inches asunder, and attached to a handle proportionate to the depth of water in which the shells are found. They are found in great abundance in the Mediterranean, and in the sea near some parts of the coast of America. When the byssus is separated, it is well washed, to cleanse it from impurities. It is then dried in the shade, and straightened with a large comb; the hard part from which it springs is cut off, and the remainder is properly carded. By these different processes it is said that a pound of byssus, as taken from the sea, is reduced to about three ounces. This substance, in its natural colour, which is a brilliant golden brown, is manufactured in Sicily and Calabria (with the aid of a little silk to strengthen it) into stockings, gloves, caps, waistcoats, and other articles of extremely fine texture. All these, however, are to be considered rather as curious than useful, and the manufacture of them is now almost a thing of the past.

(*m*) In interesting connection with this I quote an instance which, to the ignorant, would doubtless seem a corroboration of the above, and which idea the writer of the newspaper paragraph quoted below seems to have been impressed with. My information gives no date because the extract bore none, but from its tenour it was apparently recent, and (from the date of issue of my authority) would prove to be the early part of June, 1889. I give it verbatim:—

STRANGE IMPORTATION OF OYSTERS.—Some thousands of

The pearls appear to vary in colour and size, according to the nature of the ground on which the oysters rest, and in the kind of food supplied to them. The pearls are sometimes of so inferior a quality that the cost of fishing is hardly or not at all repaid.

When the pearls are found adhering to the valve or shell, they are carefully detached with pincers ; more commonly they are found imbedded amid the putrefying tissues of the oysters, the soft parts being carefully examined, boiled, and strained, so as to detect and secure the more minute pearls, which would otherwise be overlooked. The pearls found attached to the nacre of the shell are of inferior quality, and are disposed of by weight. The finest pearls are those found within the soft parts of the oysters. These latter are generally large, and occur singly. They are termed *virgin pearls*, or *paragons*, and are sold at so much per pearl. They are generally of spherical or pear shape, and are subjected to a preliminary process of being polished by being rubbed in a bag with powdered nacre. Thereafter the mass of virgin pearls is passed through a series of copper sieves, the meshes of which are of various

oysters have just been imported into Liverpool in a most unusual manner. It seems that the steamer *Dodo*, just arrived from the West Coast of Africa, was placed into the Queen's Graving Dock, and when the dock became dry it was found that the bottom of the ship was plated with thousands of oysters. Many of the bivalves were of large size and in capital condition. The circumstance was soon known, and in a short time crowds of people invaded the Graving Dock with buckets, baskets, and other receptacles, and quickly set to work stripping the steamer of her strange passengers. The oysters are said to have been of excellent quality. After all these oysters were, probably, nothing else but *Ostrea multistriata*, sometimes found on ships' bottoms from Africa.

sizes, with the view of separating the larger, and of thus fixing a standard of size and worth. There are generally twelve sieves, set one within the other, and each is pierced with a certain number of holes, varying from 20 to 1000. The pearls which do not pass through any sieve containing above eighty holes are of the larger size, and are named first-class, or *mill* pearls. Those which lie between the sieves containing from 100 to 800 holes, are known as *vivadæ* pearls, or those of the second class. Those which pass through the remaining sieves, and at length reach the 1000-holed sieve, are the *seed* or *dust pearls*, and are of comparatively small value, being sold by weight or measure, to be converted into powder. The larger pearls are threaded, and are exposed for sale in rows. The American pearl-oysters are opened by knives, and the pearls are sought for at once among the fresh tissues of the animal—a process which, though less certain of securing the concretions, is yet said to have the merit of obtaining them in a fresher state, and less liable to discolouration.

The Indian pearl-fisheries of the Bay of Bengal, those of Japan, of China, and of the Eastern Archipelago, are estimated to yield an annual produce of about £800,000. The fisheries of the Isle of Bahrein, on the coast of Arabia, in the Persian Gulf, produce about £240,000 annually; all the Arabian fisheries yielding an annual total of about £350,000. The South American pearl-fisheries of the Mexican coasts, and of the Islands of Panama, Margarita, &c., were formerly in high repute. In the time of Charles V. of Spain these fisheries sent pearls to that country of the value of £160,000. The present value of the South American fisheries is stated as averaging about £60,000 annually.

From the *Detroit Free Press* (Sept. 6th, 1890), I have culled a more detailed and reliable account, which I have much pleasure in quoting :—

“The Wisconsin pearl craze is not of recent date,” said Charles T. Cook, the head of the pearl department for Tiffany & Co. “For several years we have been receiving pearls found in the rivers and brooks of that state. The pearl fisheries in Wisconsin are very prolific just now, and a day seldom passes without our receiving specimens or being advised regarding them.

“The fact is, American pearls are not a new thing among jewellers. I have no doubt they were found in the days of Washington, and there are records of such discoveries sixty years ago. The first real excitement over American pearls occurred some thirty odd years ago, when a man found a magnificent one in Bound Brook, N. J. Mr. Tiffany obtained that pearl for \$1000 in gold and a watch and chain. The pearl was subsequently sent to Paris and sold to a jeweller, who in time disposed of it to the Empress Eugenie. This accidental discovery caused great excitement, and Bound Brook was despoiled of every full-grown fresh-water mussel during that year. A great many pearls were found, but none equalled the first except one that was not discovered until it had been boiled. In its cooked state it was not worth five cents, and experts greatly differed in their estimates regarding its probable value when raw. Judging from its size and formation, it would no doubt have brought nearly \$2000.

“American pearls have a wide range. They are found in the creeks of Connecticut, New Jersey, Massachusetts, Pennsylvania, New York, Vermont, Ohio, Tennessee, Wisconsin, Virginia, and in Canada. Other states contribute pearls, but not in such quantities as these I have named.

The Gulf of California contributes a black pearl, and fully nine-tenths of the black pearls bought and sold throughout the world come from that section. They are very handsome and valuable.

“The great objection to American fresh water pearls is their lack of uniformity in shape, size, or colour. The oriental pearls are pure white, and, in almost every instance, as perfectly round as nature can make them. The American gems are nearly all button-shaped. They are also varied in colour. The Wisconsin pearls vary from a light purple to a dark brown, though there are some of a delicate pink, which are extremely beautiful. Here are some Wisconsin specimens. That one has a metallic lustre, this is a pure purple, and here is another entirely brown. The lustre is not as bright as those from the Indian Ocean, salt water having, I suppose, something to do with it. These Wisconsin pearls are valued at from \$300 to \$500 each.

“Very few white pearls are found in America. Those we have come from the Big and Little Miami Rivers in Ohio. Here is one valued at \$900. These Miami pearls are also the most brilliant. Some very handsome pearls are found in Tennessee, and the rivers and creeks of that state are regularly fished every summer when the water is low. Whenever pearls are found they are purchased by the local storekeepers, who forward them to New York. In valuing a pearl, its size, brilliancy, colour, and weight are taken into consideration.

“The American pearl is well known in Europe, being chiefly valued for its oddity and prismatic colours. Nobody can give an estimate of the value of the yearly harvest, for though this house receives the larger part of the best specimens, there are thousands sold we never hear of.”

Pearls have formed valued articles of decoration and ornament from the very earliest times. Pliny tells us of the enormous extent in which they were used by the ladies of classic Rome. Seneca reproached a patrician for the extravagance of his spouse, by saying that the lady wore all the wealth of his house in her ears. Julius Cæsar presented Servilia, the mother of Marcus Brutus, with a pearl valued in modern computation at £48,000. Clodius, the son of the tragedian, was said to have swallowed one gem valued at £8000; whilst Cleopatra's similar escapade disposed of a pearl said to be worth £60,000 or £80,000 of our coin. This queen is also said to have possessed a second pearl of equal value. A Panama pearl, said to be of the size of a pigeon's egg, and presented in 1579 to Philip II. of Spain, was valued at £4000; a prince of Muscat possessing another so clear and transparent that, though only weighing 12 carats, it was estimated to be worth a similar amount. A Spanish lady of Madrid, in 1605, was the happy possessor of one gem valued at 31,000 ducats. Pope Leo X. obtained one in Venice worth £14,000; and from Venice a pearl was presented to Sultan Soliman the Great, the value of which was estimated at £16,000. A pearl purchased by the traveller Tavernier, at Califa, is alleged to have been sold by him to the Shah of Persia for £180,000. Philip the Second's celebrated pearl, which weighed 250 carats, and was valued at 150,000 dollars, came from St. Margarita. Yet the pearls of the West are not to be compared with those of the East in shape, beauty, colour, or texture.

I am not aware that any established fishery is now conducted at St. Margarita, or on the coast of Columbia, on an extensive scale, after the failure of the Columbia and Panama speculation in 1826. On the contrary, the

pearl fisheries of the Gulf of Persia, of Ceylon, and Coromandel, are still actively prosecuted during the appointed seasons.

Many other instances might be cited of large-sized jewels of this kind, the values of which were proportionally high. Pearls from the fisheries of Ceylon are considered more valuable in England than those from any other part of the world.

A handsome necklace of pearls, smaller than large peas, is worth from £170 to £300, whilst one of pearls not larger than peppercorns may not be worth more than £20.

The largest round pearl that has been known belonged to the Great Mogul, and was about two-thirds of an inch in diameter.

The following Table is taken from a work on "Diamonds and Precious Stones," by Mr. Harry Emanuel, and gives the estimates for 1865 :—

A round pearl of 3 grains each,				18/-	to	20/-
"	"	4	"	28/-	"	35/-
"	"	5	"	40/-	"	50/-
"	"	6	"	70/-	"	80/-
"	"	8	"	100/-	"	120/-
"	"	10	"	£10	"	£11
"	"	12	"	14	"	16
"	"	14	"	18	"	20
"	"	16	"	20	"	30
"	"	18	"	30	"	40
"	"	20	"	40	"	50
"	"	24	"	60	"	72
"	"	30	"	80	"	100

"At the present day (1886), says Mr. Streeter, black pearls, if of the finest quality, are more valuable than white."

When we consider the origin of pearls and their identity with nacre, it will not surprise us to learn that these valued ornaments are abundantly produced by many species.

One species indeed, abundant in our rivers (already alluded to), has been long celebrated for this production, and according to Pennant there were formerly regular pearl-fisheries established on many of our rivers.

As early indeed as the time of the invasion of our island by Julius Cæsar, British pearls were celebrated; and, according to Suetonius, one inducement at least to the descent of the great Roman and his legions, on our island, was the acquisition of these valuables—not that I credit such a story; statesmen and warriors are influenced by far different motives in their plans of usurpation and conquest. It would, however, appear that Cæsar dedicated a breast-plate adorned with British pearls to Venus, in her temple; but Pliny, who speaks of the pearls of our island, refers to those very specimens (which were small and ill-coloured) as a proof of their inferiority.

In far later days, however, several rivers were noted,—among these were the Esk and the Conway. In the days of Camden (who died in 1623), the latter river had not lost its reputation; and Sir Richard Wynn of Gwydir, chamberlain to Catherine, queen to Charles the Second, is said to have presented her Majesty with a Conway pearl, which, says Pennant, is to this day honoured with a place in the regal crown.

The river Irt, in Cumberland, was also famous for pearls, and the circumnavigator, Sir John Hawkins, had a patent for the pearl fishery of that river.

Nor is it to the rivers of England alone that pearl-bearing mussels are limited. Ireland is not without her

share, and some specimens of considerable size and value have been procured, especially in the rivers of Tyrone and Donegal; I have been informed of one which weighed thirty-six carats (a carat is nearly four grains), and was estimated at forty pounds; but was not of perfect shape and colour, otherwise it would have been more valuable. Other pearls have been sold from four to ten pounds, and one purchased at the latter sum was deemed so admirable that, as Pennant states, Lady Glenlealy refused eighty pounds for it from the Duchess of Ormonde.

Dr. John Gwyn Jeffreys, in the second volume of his scientifically-exhaustive "British Conchology" (page 111), treating upon the mussel in question, says:—

"Pearls too are produced by them in considerable quantities, although of an irregular shape and indifferent lustre. Formerly they were applied medicinally as an absorbent. Great numbers are still collected at the mouth of the river Conway, in North Wales, the fish being boiled and trodden out by the naked feet of women. What is done with these 'seed-pearls' is a mystery. I have been told that the Jews purchase them, for the Birmingham market; and a correspondent in *Loudon's Magazine of Natural History* for 1830 mentions a surmise that they are exported to India to be dissolved in the sherbet of the nabobs."

Pearls have also been obtained from the Unionidæ, or Fresh-water Mussels of Scotch rivers and streams. Some of these were exhibited in the Great Exhibition of 1851, which were obtained from the deepest parts of the river Strule, near Omagh. Similar pearls were also shown from the river Ythan, Aberdeenshire. It is probable that pearls from this source, collected by the ancient Britons, may have given rise to the statement by Tacitus, in his "Life of Agricola," of pearls "not very orient, but pale and

wan," being among the indigenous products of Great Britain.

In the river Tay some of these shells are found to contain good pearls; but fine ones are very scarce, and the greater part are of little value. They are of various shapes, round, oval, or elongated, cylindrical, hemispherical, and resembling buttons. Several of the oblong ones have a contraction towards the middle, which gives the appearance of two pearls joined together.

The Scotch pearls were famed even in the middle ages, and pearls to the value of £10,000, from the Tay and Isla, were sent to London between the years 1761-84. In 1864 the sum of £10,000 was said to represent the gains of the Scotch pearl-hunters for a single year. The rivers Don, Tay, Doon, Forth, Isla, and Spey, were among those most noted for their pearl-mussels; but the pursuit in the present day (1889) has dwindled away to very insignificant proportions, as compared with its extent some years since.

In 1864 Mr. Unger, of Edinburgh, to whose exertions as a dealer in gems the revival of the Scotch pearl-fishery was chiefly due, calculated that £10,000 represented that year's value of the fishings. Some Scotch pearls have brought as high prices as £60 each. About 1860 may be taken as the date of the revival of the Scotch pearl-fisheries, but, as I have said, at the present date, they have greatly declined, owing to the reckless way in which the rivers have been devastated.

Pearls are also found in the Elster, a river in the Voigtland, in the kingdom of Saxony, from its origin down to the small town of Elsterberg, as well as in rivulets which fall into the Elster. Since 1621 a pearl-fishery has been established there, of course for the benefit of the sovereign. Also in the river Watawa, in Bohemia, and in the Moldau

river, from Kruman to Frauenberg, pearls are found, sometimes of great beauty, and difficult to be distinguished from the oriental pearl. The latter fishery is the property of the owner of the land.

The most curious finding of pearls that I ever read of came under my notice in *Lloyd's Newspaper*, June 1, 1890, of which the following is a copy :—

“PEARLS IN A CRAB.—A few days since a strange discovery was made by Mr. C. T. Chivers, of 12, High-street, Poplar. While eating a crab, purchased at a local fishmonger's, he came across a hard substance, which, on examination, proved to be two pearls, of decent size, one round and the other oval-shaped.”

Amongst all the ideas which have been entertained, both in ancient and more modern times, with regard to pearls—grotesque and fanciful though many of them be—none appears more romantic than that of their reputed powers of re-production.

In 1878, the subject of “Breeding Pearls” occupied the attention of the Royal Asiatic Society at Singapore, and was introduced to their notice in a paper read by Dr. N. B. Dennys.

In the Malay Archipelago, and especially on the coast of Borneo, the natives allege that “Breeding Pearls” exist, that is to say, there are pearls which possess the power of reproduction, or rather *germination*. It is asserted that if a few of these pearls be placed in a small box, with some grains of rice and a little cotton wool, and then sealed up, on opening it a few months afterwards one or more additional pearls are found within, and the original ones none the worse ; but the grains of rice have their ends apparently nibbled off. Many native women claim to possess these pearls, and set great store by them, though they

never exceed the size of a pin's head, and are not worth, at most, more than sixpence each.

Credible European evidence was adduced; *pros* and *cons* were strenuously maintained in the discussion that followed the reading of Dr. Dennys' paper. But, as usual, neither side convinced the other, and spontaneous creation in the matter of pearls still owns its supporters. For our own part, we cannot conceive it possible that one pearl can be developed from another *de novo*, however much the "nibbled end" of the rice particle may give colour to the idea. Yet the author can testify that, after having kept some rice and some pearls together in a box for a long time, the grains of rice, though originally perfect, have suffered some change, whereby they present all the appearance of having been nibbled. While unable to explain this phenomenon, he does not for a moment believe—although the belief is entertained by many intelligent Europeans resident in the East—that it has any connexion with the reputed reproduction of the pearls; indeed, it need hardly be added that the pearls placed with the rice have not increased in number or in magnitude.—(Streeter, "Pearls and Pearling Life," &c., p. 68.)

There is a very curious passage in Philostratus (Life of Apollonius), in which Apollonius the philosopher relates that the inhabitants of the shores of the Red Sea, after having calmed the sea by means of oil, dived after the shell-fish, enticed them by means of some bait to open their shells, and having pricked the animals with a sharp-pointed instrument, received the liquor that flowed from them in small holes made in an iron vessel, in which it hardened into real pearls.

Pearls were formerly used in medicine, but their thera-

peutic effects are not different from those of any other calcareous earth.

The "seed-pearls" procured at Kurrachee, on the Bombay coast, are still used for such purpose by the Persians and some of the Hakeems of India.

The oysters producing the "seed-pearls in question are washed up by the surf-waves to high-water mark, and are left there as the tide falls. They are gathered by Coolies employed for the occasion, put into boats, and landed at Keamaree point. There the shells are broken and the pearls extracted, under the superintendence of the contractors, who pay the Julpore government forty thousand rupees per annum for the pearl contract. Even the gleaners who come after them pay for the right of sifting the broken shells in search of any pearls that may remain." (*n*)

In concluding this highly interesting subject of the pearl as a gem, combined with its value, I venture to quote a most pleasing incident which occurred about forty years since, in America :—

"A little orphan boy, about twelve years of age, while fishing on the banks of the Tennessee, in the United States, picked up a large pearl which he found lying among the shells. Returning home, he accidentally exhibited it while rummaging his pockets, filled with fish-lines, baits, corks, shells, and coppers, when a gentleman standing by, observing the costly treasure, asked him how much he should give him for it? The boy, unconscious of its value, asked in return only one or two small coins. 'No!' replied the gentleman, 'you must not sell it for a trifle: it is worth a large sum. I will send it to Nashville to be sold, and the proceeds of it shall be applied to your

(*n*) "Silver-shell; or, The Adventures of an Oyster."

education.' 'The pearl,' says Elihu Burritt, 'was sent to a lapidary, who estimated its value at five hundred dollars! Let it glitter in the diadem of a crowned head, and that boy's mind be enriched with jewels whose lustre shall outlive and outshine the light of diamonds, and he will have parted with it for a pearl of greater price.' "

The passion for pearls was at its height about the period when Roman freedom was extinguished, and in the imperial city pearls were valued as highly as precious stones. A pearl, celebrated in Pliny's time, was bought by Tavernier for £10,000. In Asia this taste was of more ancient date, nor has it ever declined.

A string of pearls of the largest size is an indispensable part of an Eastern monarch's decorations. It was thus that Tippoo was adorned when he fell before the gates of his capital; and the rulers of Persia have for ages been similarly decorated. Shakespeare gives us the following colloquy:—

Cleopatra.—How goes it with my brave Antony?

Alexas.—Last thing he did, dear queen,

He kiss'd—the last of many doubled kisses—

This orient pearl;—his speech sticks in my heart.

Cleopatra.—Mine ear must pluck it thence.

Alexas.—'Good friend,' quoth he,

Say, the Roman to great Egypt sends

This treasure of an oyster.' "

Again, the poet says:—

"Honesty dwells like a miser in a poor-house, as your pearl in your foul oyster."

Having so far exhausted the subject of the Pearl Oyster—I hope to the satisfaction of the reader,—I must now conclude this Chapter with a few remarks upon the said oyster's near relations.

Cuvier, in his "Régne Animal," places in close contact with *Avicula* and the pearl-oysters the genus *Etheria* of Lamarck, and which writers regard as belonging to the *Chamidæ*. Blainville, Deshayes, and Broderip, however, all agree that the *Etheriæ* ought to be separated from the *Chamidæ*; and Blainville considers them as coming within the pale of the *Margaritacea*, or family of pearl-oysters.

Lamarck regarded the *Etheriæ* as oceanic, and accounted for those shells having escaped the notice of zoologists on the presumption that they were attached to rocks at great depths. The first conchologist who ventured to doubt this, and to suspect them to be fluviatile, or at least the inhabitants of estuaries at the mouths of rivers, was Sowerby; his opinion was confirmed by Cailliaud, who was the first to make known the fact that the genus is an inhabitant of fresh waters. From Cailliaud's materials Férussac published a paper in the "Mémoires de la Société d'Histoire Naturelle," vol. 1, including a revision of the species.

Rang, during a voyage to Senegal, made some interesting observations on the *Etheriæ*, which live 200 leagues from the mouth of the river of Senegal, and, together with Cailliaud, who received the animal from the Nile, published a memoir ("Mémoires du Muséum d'Hist. Nat."), replete with information, in which the mollusc was for the first time described.

The rivers of Africa and Madagascar appear to have afforded all the specimens, still by no means common in cabinets, which have hitherto been collected. M. Férussac gives the following information from M. Cailliaud:—

"We meet with *Etheriæ*," says that zealous traveller, "after passing the first cataract, and they do not appear to exist below; they become very abundant in the province

of Rebata, and below the peninsula of Meroe. The inhabitants collect them on the banks of the river, to ornament their tombs with them, and they say that they come from the more elevated parts of the Nile, from Saïda, where they are eaten." M. Cailliaud found them as far as Fazogl, the most distant country into which he penetrated from the Blue River.

In Sennaar the inhabitants informed M. Cailliaud that during the summer season, when the river was low, they took them with the animal; but notwithstanding all his endeavours, M. Cailliaud could not obtain any living specimens, the river being then always too high. They are said to be common in the Jaboussi, a river which runs into the Blue River, and in all appearance the numerous confluent streams of this great arm of the Nile produce them also. The number found upon the tombs throughout Ethiopia is so great, that it is astonishing that Bruce and Burckhardt should not have mentioned them. (See "Zool. Journ.," vol. 1.)

M. Deshayes, in his treatise on the genus, in the "Encyclopédie Methodique," states that individuals of the same species adhere by the one or the other valve indifferently, which is not the case either in the oyster or the Chamæ. The Chamæ, however, as has been observed by Mr. Broderip, are found to be attached sometimes by the right and sometimes by the left valve.

The shell of *Etheria* is characterised as thick, nacreous, adherent, very irregular, unequivalve, and inequilateral. The umbones are short, thick, and indistinct; the hinge is toothless, irregular, undulated, and callous; the ligament is longitudinal, tortuous, external, and penetrates pointedly into the interior of the shell. The muscular

impressions are oval and irregular; pallial impression narrow and small.

The mollusc is described as closely resembling unio. The lobes of the mantle are disunited and without siphons. The mouth is rather large, with a pair of palps, as in unio; and what is singular in an animal which lives adherent to foreign substances, it is provided with a very large foot, which may be compared, in regard of its form and position, with that of unio. May not this large foot have reference to the acquisition of food?

THE SEMILUNATE ETHERIA.

(*Etheria semilunata*). The species of the genus are at present in some degree of uncertainty. Lamarck records four: these M. Férussac and M. Deshayes reduce to two; and M. Rang considers E. Tubifera of Sowerby and E. Cailliaudii of Férussac as identical; and E. Cortoni of Michelm to be the same with E. Peumbea of Férussac.

The variation in the form of the shell from age and other circumstances is so great, that were not this fact kept in view, each individual might be regarded as a distinct species. Even in the same species there are individuals armed with spines and others devoid of those appendages.

CHAPTER XXXIX.

OYSTER FISHERY LEGISLATION.

PRINCIPLES OF STATE RELATION TO FISHERIES—IMPORTANCE OF FISHERY STATISTICS—EXTENT AND VALUE OF THE FISHERY INDUSTRY—PHASES OF LEGISLATION—THE EARLIEST ACT OF PARLIAMENT RELATING TO OYSTER FISHERIES—OTHER ACTS—BRIDGER *v.* RICHARDSON—COMMITTEE OF INQUIRY, 1833—PIRATICAL DREDGING ON EMSWORTH HARBOUR—THE FRENCH CONVENTION, 1839—OYSTER BEDS—CONSERVATORS—CONVENTIONS—CONVENTION ACT OF 1844—LAWS AND REGULATIONS—POWER GIVEN TO THE BOARD OF TRADE—RESTRICTION OF DREDGING—CLOSE TIME FOR OYSTERS—“SOME REMARKS ON THE OYSTER FISHERIES ACT, 1866”—ACT OF 1868—THE THREE-MILE LIMIT—MODE OF PROCEDURE TO ESTABLISH PROTECTION—ACT OF 1877—SPAWNING BEDS, GROUNDS, AND PLACES—ACT OF 1888—CLOSE TIME IN IRELAND—TWOFOOLD OBJECT OF CLOSE TIME—PROFESSOR HUXLEY ON CLOSE TIME—DREDGING *v.* OVER-DREDGING—THE POLICY OF GRANTING CONCESSIONS OF PUBLIC GROUNDS TO PRIVATE INDIVIDUALS OR COMPANIES—CONCLUSION OF CHAPTER.

THE object of fishery legislation, as of all other economical enactments, is to make a lasting and advantageous use of the waters containing valuable food-fishes, and to place this interest in its proper relation to all the other industries.

. . . As, according to Roscher, every industry rests on scientific, technical, and economical principles, which are

combined for reaching a certain definite practical object, viz., the most advantageous carrying on of this industry, therefore must all economical legislation, with a view to the right adjustment of these, be made on scientific, technical, and economical principles.

Fishery legislation must have due regard to the teachings of science concerning the nature of fish, their different species, propagation, growth, location, migrations, &c. ; to the teachings of technology concerning the different methods of catching fish, the implements employed, the contrivances for protecting fish against hurtful influences, &c. ; but no less must it study the principles of political economy, the ways and means of carrying on business in the most advantageous manner. . . . It must likewise study the true relation toward each other of all the industries carried on by means of water. . . . Fishery legislation must also have due regard to judicial and administrative considerations ; it must be based on a thorough knowledge of the condition of fisheries in other countries, of the fishery laws of those countries, as well as of the laws and administrative regulations of all branches of industry relating to fishing ; and it must study the manner in which laws are carried out in foreign countries, and the effect of such laws on the fishing interests. . . . From the Government we must, above everything else, expect that it will strictly carry out the laws made for protecting the fisheries. . . . To the Government we must likewise look for those general, far-reaching, and therefore successful measures, which the fishing interests require from time to time, even where there is a good fishery law.

However good in principle our fishery laws may be, points can hardly fail to arise in which they are capable of

modification in detail. On the other hand, the history of the fisheries, both here and in other countries, is a guarantee that occasions will arise when groundless demands for change will have to be resisted. To meet both these contingencies, and to qualify itself for putting into practice the principle of "the greatest good of the greatest number," the State should neglect no opportunity of mastering through the agency of a duly-qualified department, armed with all needful powers, every detail, natural as well as artificial, of this great industry. Norway and the United States have taken the initiative in thus combining scientific research with practical administration, in a single department charged with the superintendence of the fishing industry. Without in any way reviving any exploded doctrines of political economy, the State might, by following the example thus set, do much in furtherance—apart entirely from "protection" or "encouragement"—of the fishery interests of the United Kingdom.

. . . . A kingdom, relative to which the Report of the Sea-Fishery Commissioners of 1879 says, "the value of the fisheries in this country may be computed in millions; the capital invested in them in millions; the persons dependent on them in hundreds of thousands." Notwithstanding this, there "are no means whatever of comparing by figures their yield now with their yield in former years."

In this respect we are behind almost every other nation, yet evidence is constantly accumulating to show the important use which could be made of such statistics. Besides serving . . . as a gauge of the effects of legislation, they might be of great service in negotiations with foreign powers—in such a matter, for example, as the misunderstanding which appears to have arisen between

this country and France, in putting in force the Convention of 1867. . . . Even if our statistics should never be required as evidence in matters of *la haute politique*, they would have many other not less useful if more humble purposes to serve in the daily administration of the Fishery Laws.

An industry in which, in the United Kingdom alone, some 150,000 persons are directly engaged as fishermen, which gives employment to at least an equal number of persons as curers, packers, &c., and, indirectly, to a still larger number as makers of nets and hooks, barrels, and other apparatus and appliances for the equipment of the boats; in which capital to the extent of not less than three or four millions sterling is invested, . . . has naturally strong claims on a large share of the attention of the State, and compels its interference, directly or indirectly, in many different directions.

The statistics on which these estimates are based are very imperfect; but from the data available the following figures are taken:—In 1881, according to the Board of Trade returns, 10,357 boats were registered as fishing-boats and vessels, under the “Sea Fisheries Act, 1868,” in England and Wales, 766 in the Isle of Man and Channel Isles, and 14,145 in Scotland; the total number of fishermen and boys employed by all these boats being given as 94,764. The Scotch Herring Board, however, in its report for 1881, states that in the Scotch herring, cod, and ling fisheries alone, 14,809 boats and 48,121 fishermen were engaged in that year. The report of the Irish Fishery Inspectors for 1881 states the number of registered fishing boats to have been 6458, and of fishermen and boys 24,528. These figures give us an approximate return of,

say, 33,000 boats, and about 120,000 fishermen and boys. The returns are, however, admittedly incomplete, and would in no case take account of the large numbers of fishermen whose boats are unregistered, and who do not follow fishing as their only occupation. The estimate, therefore, of a total fishing population of 150,000 does not seem to be excessive. The Scotch Herring Board estimate the average value of the 14,809 boats engaged in the herring, cod, and ling fisheries, at £42 each, of their nets at £45 per boat, and of their lines at £8 per boat. This average, applied to the 33,000 boats, would give a gross value of considerably over £3,000,000 sterling. Such a calculation takes no account of the large and powerful steamers engaged in the fish "carrying" trade, nor of the whaling and sealing fleet, nor of other ocean-going vessels directly engaged in the fisheries. The figures must be taken as representing merely what may be called the food-fisheries carried on in the seas immediately surrounding our coasts. Even then they probably err, if at all, on the side of moderation. An estimate of the value of the produce of the fisheries is still less easy. The quantity of fish of all kinds delivered at Billingsgate Market—mainly the produce of the British fisheries—in 1880 was over 120,000 tons. This quantity, at an average price of only 6d. per lb., would represent a value of £6,720,000 as a portion only of the consumption of the Metropolis alone. The value of the produce of the Scotch herring fisheries alone, in 1881, was probably not less than £3,000,000.

A Parliamentary return of the quantity of fish conveyed inland by railway, from each of the principal fishing ports of the United Kingdom, states that the quantity so carried in 1881 was, in England, 206,381 tons; in Scotland, 59,259

tons ; in Ireland, 7312 tons ; total, 272,952 tons, which, at 6d. per lb., would be worth £15,288,000 (nearly).

In our own country the fisheries have, from time to time, commanded the earnest attention of the State on different grounds, and legislation on the subject has passed through at least three distinct phases, which may be defined as :—1st. Restrictive or Protective. 2nd. Promotive. 3rd. Administrative or Regulative.

“ Promotive ” legislation :—The good of the people, by the preservation of a valuable property and an important source of food supply, was the ground on which the State based its legislation for the *protection* of the fisheries. The good of the people, by the encouragement of commerce and by providing employment for the poor, was the ostensible motive which prompted the later statutes, whose direct object was the *promotion* of the fisheries. Another motive, indeed, underlay that which was first put forward as the ground for this legislation, and comes more distinctly into notice as the fisheries increased in importance, and as the power of the country extended ; for we find that the Legislature frequently refers to its anxiety to keep up the supply of seamen for manning the navy, as a reason for “ promoting ” the fisheries.

The only form of directly “ promotive ” legislation now existing is in the shape of a law giving authority for the appropriation of portions of the foreshore for the purpose of oyster or mussel cultivation. But the expense attending an application for such a grant is often so great as to prohibit the very class of persons who might be expected to utilize it to the best possible advantage—viz., fishermen and others, with local knowledge of the capabilities of a particular spot,—from availing themselves of the opportunity which the law is intended to afford them.

. . . . An extension of the present system of encouraging mussel and oyster culture in the United Kingdom, not only by reducing the expense of obtaining a grant of foreshore, but by offering inducements to individual effort rather than to joint-stock enterprise, would be of great benefit to the oyster and mussel fisheries. The system might possibly even be enlarged by including areas in which crabs and lobsters could be stored, and kept till they had attained the legal size. (*a*)

The earliest Act of Parliament relating to fisheries, that I am aware of, was passed in the third year of the reign of James I., chap. 12. There was also an Act passed in the 13th and 14th years of the reign of Charles II., chap. 28. After this the next Act relating to fisheries appears to be 1st of George I., chap. 18; but none of these Acts relate, except in general terms, to oysters.

An Act of Parliament relating to oyster-fisheries appears to have been passed in the 31st year of the reign of George III., chap. 51, which has been repealed by one passed in the 28th year of the reign of George IV., chap. 29, which enacts,

“That if any person shall steal any oyster or oyster-brood from any oyster-bed, laying, or fishery, being the property of any other person, and sufficiently marked out or known as such, every such offender shall be deemed guilty of larceny, and being convicted thereof shall be punished accordingly. And if any person shall unlawfully and wilfully use any dredge, or any net, instrument, or engine whatsoever within the limits of any such oyster-

(*a*) “The Relations of the State with Fishermen and Fisheries, including all matters dealing with their Protection and Regulation.” By C. E. Fryer. (Prize Essays issued in connection with the Great International Fisheries Exhibition, 1883.)

fishery, for the purpose of taking oysters or oyster-brood, although none shall be actually taken, or shall, with any net, instrument, or engine whatsoever, drag upon the ground or soil of any such fishery; every such person shall be deemed guilty of a misdemeanor, and being found guilty shall be punished by fine or imprisonment, or both, as the court shall award, such fine not exceeding the sum of twenty pounds, and such imprisonment not to exceed three calendar months."

A trial took place at the Sussex Lent Assizes, 1814, *Bridger v. Richardson*, an action being brought to recover the penalty of £10 under the above statute, for wittingly, with a certain engine called a dredge, taking, in Chichester harbour, three gallons of oyster fry and spat, the same being sea-fish, and that of a size unfit for use. There was also a second count for a similar penalty, for wittingly, "with a certain engine called a drag, taking 100 bushels of the brood sea-fish, to wit oysters, the same being sea-fish.

On the trial it was proved that the defendant, who was a Colchester fisherman, took the brood in question for the purpose of carrying them to Colchester, to be laid down there on private lands for further growth and maturity, and to make them marketable.

Defendant's counsel objected, 1st, that the taking must be with the intent to destroy, the contrary of which was proved; 2ndly, that the Act applied only to floating fish. A verdict was, however, taken for the plaintiff for £10, with liberty to defendant to move for a nonsuit. Accordingly a rule was obtained in the Queen's Bench for that purpose, and after long arguments on both sides, the court held the case not to fall within the meaning of the statute, for that the taking could not be penal, when the object of such taking was not to destroy, but to preserve.

In 1833 a Select Committee of the House of Commons, appointed to inquire into the present state of the British Channel fisheries and laws affecting the fishing-trade of England, and to which committee petitions from Emsworth, Brixham, Havant, Langstone, Bedhampton, Farlingdon, Plymouth and Rosham, complaining of distress, were referred, report, in reference to the petitions (see Report, p. 13), that not only in these harbours, but in others, a practice generally prevails, and which appears to be of recent introduction, of persons coming in fishing-smacks to dredge for, and carry away, the young brood of oysters and other shell-fish, to the great damage and destruction of the oyster-beds and the brood of other fish there; and it appearing to your committee that such a practice is also unjust, inasmuch as the oyster-beds in those situations are generally known to have been formed by the labour and industry of the fishermen and inhabitants of the neighbourhood, or their ancestors, thus affording to them a beneficial source of employment upon which they have been accustomed to rely, and in which therefore they ought to be protected.

The committee then go on to report, that, having examined the Acts of Parliament, they do not find any sufficiently stringent to prevent the grievance complained of, and that it should be made unlawful to take or carry away any oysters from such beds of a less size than are fit for food, that is to say, of less size than $2\frac{1}{2}$ inches in width; or to fish for oysters at any time between the first day of May and the last day of August in every year, or such other time as should be fixed in reference to any particular harbour, according to the season in which the oysters there become fit for food; such seasons, and all necessary regulations for those fisheries, being determined or

approved by the magistrates of the county or district in which they are situate, and enforced by conservators (*b*) and officers locally appointed for that purpose.

(*b*) In 1873, the constitution of boards of conservators was varied by adding a representative element in certain cases, and in 1878 the provisions of the former Acts (1861 and 1865) were extended to trout as well as salmon rivers.

. . . . There are three classes of members: (1) Members appointed by the Justices in Quarter Sessions. (2) *Ex-officio* members. And (3) Representative members.

. . . . The conservators hold office for one year; after the first year the appointments are made by several counties in the proportions which have been fixed by the original joint committee. The like proceedings would still have to be taken for the formation of a new fishery district not wholly in one county. . . . A Board of Conservators, being duly constituted, may appoint water bailiffs, issue fishing licenses, acquire dams, weirs, and fixed engines for the purpose of removing them, take legal proceedings against offending persons, and generally supervise and protect the fisheries in their district, and expend funds in their hands in the improvement of them in any lawful manner. Water-bailiffs appointed by the conservators have extensive powers of search, and the same privileges and protection as constables in the execution of their office. They may also, with special authority from a magistrate or the conservators, enter on private grounds, to detect or prevent breaches of the law. Anyone authorised in writing by the conservators may also enter upon lands to inspect weirs and other obstructions. Conservators may also make by-laws as to sundry matters of detail, subject to confirmation by the Home Office. The by-laws must be printed and published, and everyone taking out a fishing licence is entitled to a copy. . . . The Thames Conservators, I need hardly add, are charged with a number of matters of public interest, of which fishery regulation is only one.—“The Fishery Laws.” By Frederick Pollock, Barrister-at-Law, &c. (Handbooks issued in connection with the Great International Fisheries Exhibition, London. 1883.)

No Act appears, however, to have been passed, putting these recommendations in force. (*c*)

Amongst several rare and valuable pamphlets, acts, reports, and manuscripts, lent to me by a friend, for the purpose of aiding my research in and information on Oyster Culture, there was one brief MS., bearing so interesting a connection with the foregoing that I venture to quote it verbatim, on the plea of its serving as a very lucid illustration of the subject in question, and also as an arithmetical curiosity of Ostracultural Literature. It bears the subscription—James Tatchell, Emsworth, December 13th, 1833, and the writer (presumed) of the MS., under the title of “Piratical Dredging on Emsworth Harbour,” holds forth as follows :—

“It was recently stated in evidence before the British Channel Fishery Committee, in the House of Commons, that there were sometimes from 60 to 70 smacks together dredging for oysters in Emsworth Harbour, long before the proper season commenced, and with a very improper description of dredges ; by which practice a considerable quantity of brood was annually destroyed, and the harbour fishermen prevented from, and deprived of the important means of pursuing their useful occupation. This useful class of men are not the only sufferers in this instance, but the numerous population of the neighbourhood generally is also extensively injured by losing a regular supply of a very wholesome and nourishing food, in addition to which the original export trade of Emsworth is entirely destroyed. Many of the smacks are from 15 to 30 tons burden.

The following remarks and calculations are attempted to explain the injurious tendency of these facts :—

(*c*) “History of the Oyster.”

Smacks of from 20 to 30 tons will catch, in a week (at the beginning of the season) 40 tubs of oysters. The smacks generally remain while they can work or catch nearly this quantity, and their stay may be calculated, on an average, to be four weeks. A little reflection will show that in this short period they do all the mischief which is so highly detrimental to the welfare of the harbour fishermen and the rights of the surrounding neighbourhood.

A tub of oysters contains 2 bushels.

An oyster bushel is a basket holding 9 to 10 gallons, heap measure.

The smacks catch and take away oysters 2 inches wide, and also many thousands of much less size, including the brood, cultch, &c.

A bushel basket, filled with oysters 2 inches wide, will contain 1000 oysters of this description.

A 2-inch wide oyster will weigh . . .	} 1 oz. gross.	
Shell without the fish		} $\frac{3}{4}$ oz.
The fish will weigh		} $\frac{1}{4}$ oz.

40 tubs are 80 bushels. 1 bushel contains 1000 oysters.

80 X 1,000

80,000

$\frac{1}{4}$

16) 20,000

112) 1,250 (11 cwt. 18 lb. of food.

130

18

If these oysters had been left in their native beds to attain maturity, they would measure, at 3 years old, each 4 inches wide.

Oysters of this description will weigh $8\frac{3}{4}$ oz.

Empty Shell $6\frac{1}{4}$ oz.

The fish . . $2\frac{1}{2}$ oz.

$$80 \times 1000 = 80,000$$

$$\begin{array}{r} 2\frac{1}{2} \\ \hline \end{array}$$

$$160,000$$

$$40,000$$

$$16) 200,000$$

112)	12,500	(111 cwt. 2 qrs. 12 lbs.	of food for oysters 4 in. wide.
	130	11 cwt. 0 qrs. 18 lbs.	of food for oysters 2 in. wide.
	180	100 cwt. 1 qr. 22 lbs.	difference in favour
	68		

of being left in the natural beds of the harbour to attain maturity.

40 tubs of small oysters, 80,000 ; supposing them to be worth to the dredging smacks, and that they fetch 3/- per tub, £6.

Say 80,000 oysters, full growth, in 3 years, if sold to the neighbourhood at 6d. per 100, £20 ; to which add one-third for injury done the brood by the smacks, £6 13s. 4d. £26 13s. 4d.

Loss to the fishery on every 40 tubs of oysters caught by the smacks £20 13s. 4d.

Loss to the community in food, as above 100 cwt. 1 qr. 22 lbs. To which add one-third for injury done the brood by the heavy and numerous dredges of the smacks 33 cwt. 1 qr. 26 lbs.

Loss of food to the neighbourhood per annum, occasioned by one smack, say 133 cwt. 3 qrs., 20 lbs. = 15,000 lbs. of food in the shape of oysters.

Now suppose we estimate 4lbs. of oysters to be equal in nourishment to 2 lbs. of bread, then half of 15,000 lbs. = 7500 lbs. $\div$ 4 gives 1875 4 lb. loaves ; being a loaf a day for 1875 persons ; instead of which, in the present exhausted state of this fishery, a man may go down the harbour and not earn half a loaf in a whole tide.

If the mischief resulting from one smack's depredations deprives 1875 persons of a loaf of bread a day, then 30 smacks must produce (30×1875) a privation equal to 56,250 loaves a day for that number of persons. Say 56,250 4 lb. loaves ; to this amount add the mischief done by the other half of the smacks, estimated at two-thirds ; now one-third of 56,250 is 18,750, and two-thirds are 37,500, and you see a result of 93,750 persons deprived of a loaf of bread a day through the imprudent dredging and the destruction caused by those pernicious enemies of the oyster fishery—the smacks.

It should always be borne in mind that the harbour boats and the smacks cannot work together at one and the same time. The smacks have, before now, run them down, thereby putting the lives of the fishermen in great danger, and they are often forced by the unwarrantable and overbearing conduct to quit the ground and lay by, losing their tide and consequently their livelihood.

It has been said that from 60 to 70 smacks have been dredging together for oysters in Emsworth harbour ; let us say 60 smacks in all, and estimate the half of them at from 20 to 30 tons each, and the other half at from 10 to 20 tons each. The large class of smacks will catch 40 tubs each per week, and they remain here about a month ; the average monetary value of the 40 tubs, at a minimum, £6 ; this sum in 4 weeks = £24 for each smack. Consequently, the amount earned by 30 smacks per month is

£720. Now assume the other 30 smacks to earn two-thirds of this amount, = £480. Add these together, and you have £1200 taken away by the smacks in 4 weeks, instead of being earned by the harbour fishermen.

This amount would treble itself in a few years were the smacks prevented from dredging.

Let us say for destruction of brood, caused by the smacks, one-third of £1200, £400—£1600: this amount in three years would be £4800; and this important sum is entirely lost every season to the harbour fishermen. This sum, divided among 100 harbour boats, would give £48 per boat for the season; or 18s. 5½d. per boat per week, annually, for oysters. Now bearing in mind that the fisherman would, in the meantime, be occupied (in other seasons) in catching other kind of fish, it must as an outcome of just reasoning follow that, were the fishery judiciously and effectually protected, he would soon be in a position to maintain himself and family without parochial assistance. He would also aid in the prosecution of his enterprising and useful pursuit; get and bring large supplies of food to market for the sustentation of other people; and if we would see the fisherman in this very proper, this most desirable, this satisfactory situation, we should see an industrious and contented individual, cheerfully relying on his own honest exertions for his support, and sincerely thankful to those who, as well-wishers of his prosperity, have endeavoured to amend and improve his unfortunate circumstances."

Several memorandums by the same writer are as follows:—

December 13th, 1833.

Weighed this day, at Mr. Aburrow's, an Emsworth oyster measuring 4 inches wide,

Gross weight of the oyster $8\frac{3}{4}$ oz.

Shell without the fish $6\frac{1}{4}$ oz.

Net weight of the oyster $2\frac{1}{2}$ oz. food.

February 1st, 1834.

Weighed this day, at Mr. Aburrow's, an Outhaven oyster from Fulding's beds, measuring $4\frac{1}{4}$ inches wide.

Gross weight of the oyster $11\frac{1}{4}$ oz.

Shell without the fish $10\frac{1}{4}$ oz.

Net weight of the oyster 1 oz. food.

Difference in favour of the Emsworth oyster, $1\frac{1}{2}$ oz.

No steam vessels, or vessel, or boat worked by steam, or attached thereto, to be permitted to fish or dredge in Chichester, Emsworth, or Langston harbours.

August 20, 1849.

New oyster-ground lately discovered in the British Channel; lies off Guernsey and Jersey; extends 40 miles in length and 9 miles in breadth.

JAMES TATCHELL.

The necessity for Conventions, in order to give an internationally effective and legal right to regulate sea-fisheries outside territorial waters, combined with the difficulty of supervising probable offenders on so wide an expanse as the sea, has always been, and will always be, an impediment to endeavours to regulate sea fisheries,

even when they are situated comparatively near our own shores. Fortunately . . . such regulation is not, on the whole, very necessary. The fish of the deep sea do not appear to decrease, whilst fishermen have to a great extent, by usage, established a law for themselves, which, although it is occasionally disturbed by the jealousy existing between trawlers and drifters, and trawlers and liners, on the whole works satisfactorily. There are, however, exceptions, and notably, among these, there is need for an Anglo-Dutch convention. An efficient maritime police, sanctioned by the nations on either side the North Sea, is necessary for the protection of our East coast fishermen. The latter have long been harassed by the thefts of nets perpetrated by the Dutch, and by the wanton destruction occasioned by "Belgian devils"—infernal machines in the form of anchors, which some foreign trawlers maliciously drag through English drift-nets, for the purpose of destroying or stealing them. Our own fishermen, in their disputes with these foreign offenders, may not invariably be in the right, but facts, so far as they are already known, certainly point to the greater wrong being on the side of the foreigners. A convention exists between France and England, and disputes between French and English fishermen are rare; no convention exists between England and Holland for the protection of sea fisheries, and disputes between English and Dutch fishermen are constant.

The mere fact of the signing of a Convention cannot, in itself, make it of any practical use, even when each signatory Government conscientiously desires its success. It is dependent on two circumstances: firstly, on the power which the combined Governments may be able to exercise in order to enforce it; and secondly, and chiefly, on the mutual forbearance of the fishermen belonging to either

country in their relations with each other internationally, and amongst themselves as fellow-countrymen. The forbearance of fishermen will regulate their conduct in proportion to their accurate understanding of what is a just usage in respect to the matters of their calling, and to their knowledge of security in the enforcement of a just usage. For this reason their remedies should be made as simple as possible. Fishermen, with the exception of salvors, who are chiefly beachmen or long-shore fishermen, are not a litigious class; the majority prefer losing their remedy to a day's fishing. Their knowledge of what is a just usage will increase proportionately as their class jealousies are dissipated, and as they learn many things over and above the present mere practical routine of their business. . . . (d)

In consequence of the French fishermen exercising their calling on the English shore, a convention was entered into in 1839, between Her Majesty and the King of the French, fixing certain boundaries, and to which a chart was appended.

The 27th of Victoria, chap. 79, entitled "An Act to carry into effect a Convention between Her Majesty and the King of the French, concerning the Fisheries in the Seas between the British Islands and France," which also applies to the whole coast, enacts:—

"Art. 9.—Empowers officers of the Coast-guard or Customs to seize dredges.

"Art. 45.—Oyster-fishing shall open on the 1st of September and close on the 30th of April.

(d) "Relations of the State with Fishermen and Fisheries, including all matters dealing with their Protection and Regulation." By F. J. Talfourd Chater. (Prize Essays issued in connection with the Great International Fisheries Exhibition. William Clowes & Sons. London. 1883.)

“Art. 46.—From the 1st of May to the 30th of August no boat shall have on board any dredge or other implement whatever for catching oysters.

“Art. 47.—It is forbidden to dredge for oysters between sunset and sunrise.

“Art. 48.—The fishermen shall cull the oysters on the fishing-ground, and shall immediately throw back into the sea all oysters less than $2\frac{1}{2}$ inches in the greatest diameter of the shell, and also all sand, gravel, and fragments of shells.

“Art. 49.—It is forbidden to throw into the sea, on oyster fishing-grounds, the ballast of boats or any other thing whatsoever which might be detrimental to the oyster-fishing.”

18 and 19 Vict., chap. 101, entitled “An Act for the effectual execution of the Convention,” enacts:—

“Art. 1.—Officers of the Coast-guard or Customs to seize dredges and oysters found on board fishing-vessels, between the 1st of May and the 31st of August.

“Art. 2.—Oysters landed between the above dates may be seized.”

In 1843 a Convention was made between England and France, for the establishment of a common set of fishery rules on the coasts of either country; the purpose being not so much the preservation of sea-fish as the prevention of strife between fishermen of the two nations, and avoidance of difficulties about jurisdiction.

On the 31st of July, 1855, was published “An Act (18 and 19 Vict.) for the more effectual execution of the Convention between Her Majesty and the French Government, concerning the Fisheries in the Seas between the British Islands and France,” the text of which is as follows:—

Whereas a Convention was concluded between Her Majesty and the King of the French, on the second day of August, one thousand eight hundred and thirty-nine, defining the Limits of the Oyster Fishery between the Island of Jersey and the neighbouring coast of France, and also defining the Limits of the exclusive Rights of Fishery on all other parts of the Coasts of the British Islands and France. And whereas, pursuant to the said Convention, certain Articles, being Regulations for the Guidance of the Fishermen of the two Countries, in the Seas lying between the Coasts of the United Kingdom and those of France, were agreed upon by Commissioners authorized in that behalf, and were approved and confirmed on the part of Her Majesty and of the French Government. And whereas by the said Articles it was provided that Oyster-fishing should open on the First of September and should close on the Thirtieth of April, and that from the First of May to the Thirty-first of August no Boat should have on board any Dredge or other Implement whatsoever for catching Oysters. And whereas an Act was passed in the Session holden in the Sixth and Seventh Years of Her Majesty (Chapter Seventy-nine), to carry into effect the said Convention, and it was thereby enacted that the said Articles (which were set forth in the Schedule to the same Act) should be binding upon all Persons, and should have the Force of Law. And whereas it is expedient that more effectual Provision should be made for enforcing the Regulations established pursuant to the said Convention as aforesaid: Be it enacted by the Queen's most Excellent Majesty, by and with the advice and consent of the Lords Spiritual and Temporal, and Commons, in this present Parliament assembled, and by the Authority of the same, as follows :—

I. It shall be lawful for any Officer or Petty Officer belonging to Her Majesty's Navy or Revenue Service, or such Officers and Men of the Coast-guard Stations as may be thereunto authorized by the Commissioners of Her Majesty's Customs, or such persons as may be appointed under the provisions of the said Act, by the Lords of the Committee of Her Majesty's Privy Council appointed for Trade and Foreign Plantations, when they go on board any British vessel employed in fishing, to examine whether the Regulations of the said Act have been complied with, to seize and throw overboard or destroy any Oysters found on board such vessel, at any time from the First day of May to the Thirty-first day of August in any year, as well as to seize and dispose of, in manner provided by the "Customs Consolidation Act, 1853," all Dredges and other Implements for catching Oysters found on board such vessel; and it shall also be lawful for such Officers, Petty Officers, and Men, and such persons as aforesaid respectively, to seize and dispose of in like manner all Dredges and other Implements for catching Oysters found sunk in or floating upon the seas, at any such time as aforesaid.

II. No Oysters taken in the seas between the United Kingdom and France shall be imported into or landed in any part of the United Kingdom, at any time between the First day of May and the Thirty-first day of August in any year, and any Oysters imported in or landed between such days from any vessel employed in fishing in the said seas shall be deemed to be Oysters taken and imported contrary to the provisions of the said Articles and of this Act, unless the contrary be proved; and it shall be lawful for any Officer of the Customs, or any Person who may be appointed under the Provisions of the said Act by the Lords of the said Committee of Council, to seize and destroy, or other-

wise dispose of, as the said Commissioners of the Customs or the said Lords of the said Committee may direct, any Oysters imported into or landed in any part of the United Kingdom, contrary to the Provisions of this Act.

III. The Master or person in charge of any British Vessel, on board which any such Oysters or any such Dredge or other Implement for catching Oysters are found, at any such time as aforesaid, or in or from which any such Oysters are landed at any such time as aforesaid, contrary to the Provisions of this Act, shall be deemed guilty of an Offence against the said Articles, and shall on conviction be liable to a Penalty of not less than Eight Shillings or more than Three Pounds, or to be imprisoned, with or without hard labour, for any time not less than two days and not longer than ten days, and if convicted more than once, then upon any second or subsequent conviction to a Penalty of not more than Six Pounds, or to be imprisoned, with or without Hard Labour, for any time not longer than Twenty Days.

IV. It shall be lawful for any British Consul, exercising his functions in any port or place in France where any person, being a subject of Her Majesty, is brought under the Provisions of the said Articles, charged with any Offence against the said Articles, or against any Rule or By-law made under the said Act, to take any Statement on oath (which oath such Consul is hereby authorized to administer) of any person who may be produced before the Consul for that purpose, concerning the facts or circumstances of the case, and to put the same into writing ; and every such Statement as aforesaid shall be taken and put into writing, in the presence of the person charged, and shall be read over to him, and, where not made in English, shall be interpreted to him ; and the person charged (by

himself or by any legal adviser acting on his behalf) shall be entitled to put such questions as he may think fit to the witness making the Statement, and shall be told that he is so entitled by the Consul; and such questions, with the answers thereto, shall be put into writing, and such answers shall be read, and where necessary interpreted, to the person charged as aforesaid; and all such Depositions shall be read over to and signed respectively by the witnesses who shall have been so examined, and shall be signed also by the Consul, who shall certify that the same were taken on oath, in the presence of and read over to the person charged, and, where not taken in English, interpreted to him.

V. Every such Deposition shall be admissible in evidence, in any proceeding against the person charged as aforesaid with any Offence against the said Articles, or against any Rule or By-law made in pursuance of the said Act, unless it be shown that the witness making such Deposition is within the United Kingdom; and it shall not be necessary in any case to prove the signature or official character of the Consul appearing to have signed any such Deposition, or the signature of the witnesses signing the same; and in any such Proceeding such Certificate as aforesaid shall, unless the contrary be proved, be sufficient evidence of the matters thereby certified.

VI. All Penalties, Fines, and Forfeitures, and the Proceeds of any Sale of Dredges or other Implements under this Act, or under the said Act of the Sixth and Seventh Years of Her Majesty, shall be paid into the receipt of Her Majesty's Exchequer, in such manner as the Commissioners of Her Majesty's Treasury may direct, and shall be carried to and form part of the Consolidated Fund of the United Kingdom.

VII. The term "British Consul" in this Act shall include any Consul General, Consul, Vice Consul, or other Consular Agent.

VIII. The said Act of the Sixth and Seventh of Her Majesty, and this Act, shall be read and construed together as one Act.

Now it appears (*e*) that these regulations (1833) were seldom enforced, partly owing to the just complaints made by the owners of private beds against a law which prevented them moving their oysters from one part of their beds to another, or clearing their beds by dredging in the summer months, and partly on account of legal difficulties in the way of prosecution for infringement of the regulations; and it was not till the year 1852 that restriction as to close time was generally enforced and observed by the fishermen of Jersey and in the Channel, the French Government having called upon the English Government for the strict execution of the Convention as regards oyster-fisheries.

"The enforcement of the close season (the Commissioners say) worked a revolution in the oyster trade. It had been the practice on the beds off Jersey, and off the South Coast generally, and in most of the bays, to dredge throughout the summer for the oyster brood; the small oysters thus taken were laid down in beds along the south coast of Langston Harbour, Chichester Harbour, Newhaven and Shoreham, and to the eastward on beds in the mouth of the Thames; and comparatively few oysters came to market which had not lain a year at least on some

(*e*) From the Report of the Commissioners on the Oyster Fisheries, which was published the beginning of 1866. I shall confine myself, as far as possible, to an abstract of this document.

one of these beds. It is alleged by many of the witnesses examined by us on this subject, that the effect of discontinuing dredging during the summer months has been to do far more injury than good; that it has allowed weeds and slub to accumulate on the ground, which under the old system were prevented from settling on the ground to the same extent; that the spat falling upon this foul ground has been choked by weeds and mud, and that consequently the oyster-beds have almost disappeared."

But whether the close time in this instance was the cause of the failure of oysters or not, it is very difficult to express an opinion. The spat has failed everywhere for the last five or six years, and even in private grounds, such as at Whitstable and Colchester, where dredging for spat in the summer has been allowed.

Of deep-sea oyster-beds, the most productive are the banks in the parts of the Channel between Dunkirk and Cherbourg; they are found in water from 15 to 24 fathoms deep; it is gratifying to be told that they show no sign of giving way; these oysters, however, are not like the real native: they are large and coarse, but improve on being laid down on beds in-shore for a time, though, from being accustomed to live in deep water, they will not stand the winter on the shallow Kentish beds. The price of "the channels" was in 1865 only 12/- a bushel, while the genuine native fetches 80/- to 90/- per bushel. The channels, however, run from 400 to 900 to the bushel, natives from 1500 to 1900. The trade in these large oysters is considerable, upwards of 300 vessels, of about 25 tons each, and carrying six men, are employed in it. The vessels hail principally from Colchester, Rochester, and Jersey, but take their produce to Shoreham, Newhaven, and to the beds at the mouth of the Thames.

“During the open months the beds are stocked with a supply sufficient to last, as far as possible, through the close season ; and during the summer months these large oysters are in great demand at fairs and races throughout the country, and the price generally rises slightly, which is the inducement to merchants to hold back. This supply only ceases when the oyster becomes sick from spawning, when they will not bear carriage ; oysters are then kept back for a month, and are not sent to market again till the spawning is over. We found it everywhere the opinion of the fishermen engaged in the deep-sea dredging that May, and even June, might be added to the open season with advantage, on the ground that the oysters are never in better condition than they are in these two months ; that if permitted to dredge then, these fishermen would be able to bring in much greater supplies, as they are often prevented during the open months of bad weather from dredging in such exposed grounds ; and lastly, they say that dredging the ground during May and June would prevent the growth of weed and prepare it for the reception of spat.”

With regard to the question of admitting the months of May and June into the open season, our own examinations of deep-sea oysters are confirmatory of those of the fishermen ; they are generally in a fine condition at this time, not becoming “sick” from spawning till later in the year.

Another deep-sea oyster-bed occurs near Great Grimsby, about a dozen miles from the shore off Spurn Point. This bed is closely worked by the Colchester boats, during the summer months. There are important deep-sea beds at Arklow, on the east coast of Ireland, but they are not fit for immediate consumption ; most of them are taken to

Beaumaris, and laid down on the beds there for a time. These oysters form the chief supply of Liverpool and the manufacturing districts during the summer months. The fishing of the Arklow beds is open in May, but in that of the Wexford beds, which join those of Arklow, May is a close month.

The oyster-beds which lie within the three-mile limit are divisible into two classes. In the first class, which comprises the beds of Kent and Essex, chiefly in the estuary of the Thames, no close season has ever been observed, and "no attempt has been made to enforce a restriction as to the size of the oyster taken from them." Dredging, for the purpose of procuring young oysters for deposition on private beds, is carried on during the summer months; but in the second class—which comprises the beds on the south and west coasts of England, in the Solent, Portland Bay, Poole Harbour, Falmouth Harbour, Milton Haven, Swansea, and Carnarvon Bays; in Ireland, those of Clew Bay, Sligo, Tralee, Lough Foyle, Belfast Lough, and Carlingford; in Scotland, those of Loch Ryan and the Forth—"the close time is everywhere strictly observed, as well within the three-mile limits as without; in some of them a restriction as to size is observed, and in most of them the fishermen are opposed to taking the brood, on the ground that it injures the bed." "It becomes," the Commissioners add, "a very material question, with a view to an increased supply to the public, which of the two systems is, in the course of a long period, likely to produce the greatest number of eatable oysters."

It is interesting to observe that the system pursued in the estuary of the Thames is a very ancient one, while that which is carried on in most of the bays on the coasts of

England and Scotland does not date earlier than the Convention Act, and in many instances not before 1852, the time when the Act was enforced. We are convinced that oyster-culture might be introduced with very beneficial results in the great sea-lochs of the western coast of Scotland, where indeed the bivalve is to some extent indigenous. The want of proper legal protection to the proprietors of oyster-beds has hitherto retarded this industry; but that obstacle is now removed. The fishermen in the estuary of the Thames dredge the open or public grounds for the "brood" (young oysters of from half-an-inch to an inch-and-a-half in diameter), regardless of "season or the age of the 'fish.'" This brood is deposited on the beds possessed by companies or individuals along the coast of Kent and Essex.

The most important of these private oyster-fisheries are the Whitstable and Faversham fisheries, at the mouth of the Swale, off the coast of Kent, and the Colchester and Burnham fisheries, in the rivers Colne and Crouch. These beds are supplied with brood from what are termed "the Flats," from near the Isle of Sheppey to Margate, and off the Essex coast from the entrance of the river Crouch to Harwich, also from the Blackwater river. In consequence of a succession of bad breeding seasons, there has been little or no brood on these beds for some time past, and full-sized oysters are very scarce. In the earlier part of 1865, the Commissioners were told that men often hauled a dredge five times without finding a single oyster, and even when there has been a good spat on these grounds for two or three successive years, the ground is, after a time, so much cleared that very few large oysters are to be found. This appears to have been always the case. These grounds have, from time immemorial, proved the sources

of supply for all the private beds on both sides of the Thames, and the same close dredging by hundreds of boats has been going on in the summer-time for generations back, and yet, with fluctuations, a supply of brood is always to be found.

The Commissioners found it to be the universal opinion of the fishermen on all these parts of the coast that, if the Convention Act were strictly enforced on these public grounds, a close time adhered to; and a limitation enforced as to the size of the oysters, it would be fatal to the general prosperity of the dredgers and to the interest of the private companies.

The fishermen assert—

(1.) That if the brood were left on the open grounds, a very small portion of it would come to maturity or reach the market as large oysters. Oysters, like all other animals, have their enemies. Of these especial mention has already been made of star-fish, called five-fingers by the fishermen. It is necessary, therefore, to work the ground in order to destroy these formidable oyster-consumers.

(2.) That oysters which have reached $2\frac{1}{2}$ inches in diameter, on the open grounds, never are so delicate in flavour as those raised from brood on the private grounds, and that, therefore, if the taking of such brood were prevented, the markets would be supplied with an inferior article.

(3.) That on the private grounds great care is taken of the brood there secured, so that one good spatting season will supply the private ground with sufficient brood to keep up a constant supply of large oysters for four or five years; thus the supply of natives is husbanded, and bad breeding seasons are compensated.

(4.) That dredging during the summer months prepares the ground for the reception of spat. That if there were no dredging during the months of May and June there would be a growth of weed and a collection of mud, and that it is not to be expected that men will dredge these open grounds during the summer months unless they are permitted to sell what they take up.

(5.) That the summer months are those in which the brood is most easily dredged. As the foreman of the Whitstable Company says, "Although one might think that under water the weather would make no difference to the ground, that is not really the case. It is only when the weather is warm that the ground is loose, and we can then catch brood in a spot where we could not catch it at all in the winter. In the winter-time the ground gets quite close and hard, and we cannot catch it at all.

(6.) That where the prosperity of the oyster-beds requires that, for a short period after the spat has been deposited, there should be no dredging, lest the young oysters should be injured by the dredge, the fishermen themselves, without any legislative restriction, abstain from working, in part from a sense of their own interest, and in part because the owners of private beds would refuse to buy the brood of them at such a time.

On the other hand, those in favour of the existing system of close time maintain :—

(1.) That during close time the oysters are unfit for food.

(2.) That dredging over the beds will crush and destroy the young spat.

(3.) That if the oysters are taken while breeding the supply must soon come to an end.

Now to these assertions the Commissioners say very forcible replies are given.

(1.) It is generally agreed that not more than 20 per cent. or thereabouts of the oysters are ever spawning at once; at least 80 per cent. even at the worst of times being eatable and in good condition. The celebrated naturalist, Kröyer, who undertook an official examination of the Danish oyster-beds, found not more than one oyster in ten spatting even in July and August.

(2.) Those who have been in the habit of dredging for marine animals, and of bringing up the most delicately organised creatures in great abundance alive, will not be disposed to attach much weight to this objection. Every naturalist is aware that the most delicate corallines and ascidians may be dredged up roughly, placed in a bucket of sea-water, and examined in full health and vigour after an hour's sail homewards under such circumstances. According to the opinions expressed by Mr. Frank Buckland and other witnesses, not only is no harm done by dredging over the spat, but positive injury is the result of not dredging over the ground before the spat is deposited.

(3.) The great argument for close time, that if oysters are taken while breeding the supply will be exhausted sooner than if they are left to breed, plausible as it seems, will hardly stand investigation. Those who employ it leave out of sight the fact, that oysters are taken before they breed as well as after they breed. If a sheep-master owns a hundred ewes, all of which will lamb next February, it will make not the slightest difference to the increase of his stock whether he destroys ten or three ewes this July, or leaves them till they are just about to bring forth at the end of next January. The increase altogether depends on the absolute number of ewes which are allowed to bring

forth and rear their young. So with an oyster-bed. Other circumstances being like, the supply of oysters in the bed will depend upon the total number allowed to shed their spawn during the breeding season.

The Commissioners further intimate in their Report that there is at present no law to prevent persons taking oysters, during the close season, from any beds within a three-mile line from the coast of England and Wales. They came to this opinion after a careful consideration of the Convention Act of 1844, which gave effect to the Fishery Convention between this country and France. The point is not free from doubt, and opinions on both sides of this knotty question have been given by successive Attorney-Generals. It appears, however, that the operation of the Act is strictly limited to the district to which the Convention itself applied, and therefore only to the seas common to the two countries, and not to those parts within the three-mile limit, which are reserved for the exclusive control and jurisdiction of either country. If this interpretation be right, the strange anomaly exists of a penal law affecting the oyster-dredgers beyond an invisible line drawn at three miles from the coast, and no law whatever within that line. Beyond, it is unlawful to dredge for oysters during the summer months, or at any time to take oysters of a less diameter than $2\frac{1}{2}$ inches; within, there is no such restriction at all.

The Government appear to have adopted the opinion of the Commissioners; for an order was issued by the Board of Trade, in 1867, that the provisions of the Convention Act relating to oysters were not to be enforced by the coast-guard or cruisers within the three-mile limit.

In the course of last winter an International Commission, agreed to between this country and France, for the

purpose of revising the Convention Act of 1844, met at Paris, and their labours resulted in a Revised Convention, which was laid before Parliament at the close of last session, too late, however, for legislation. As regards oysters, the alteration agreed upon was a reduction of the close season by six weeks. It will commence henceforward on the 16th of June and will close on the 31st of August. This restriction is further strictly limited to the English Channel, and to the seas common to the two countries beyond the three-mile limit of either country. This country does not bind itself to enforce a close season elsewhere. The regulation as to the size of the oysters permitted to be taken is removed, and henceforward it will be lawful for oyster-dredgers to take brood wherever they can find them in the open seas.

Thus much having been done as regards the oyster fisheries in the more open seas, it remains only to trace the action of the Government in respect of the near shore and bay oyster-banks.

The Commissioners, holding that there is no legal close time enforceable at present, refrained from advising that there should be any fresh legislation in this direction; but they recommended that facilities should be given to individual companies to acquire property in favourably situated portions of the sea-bottom, so as to enable them to invest capital in preparing these places for oyster-culture. There are already numerous private oyster-beds of this nature, situate for the most part on the coast of Essex and Kent. These perform a double duty in the economy of oysters. They are reserves to which the brood or small oysters, taken by the dredgers in the open seas, or on the beds open to all the world, are brought and laid down till they are sufficiently grown to be sent to

market, where they realise a far higher price than if they had been left to mature in their native beds; they also supply in good breeding seasons a considerable amount of spat, from the others lying there, a portion of which is deposited on the beds themselves, but a far larger quantity is carried by the tide beyond the limits of the private beds to the common grounds beyond, and is there deposited wherever there is anything to which the spat can attach itself.

After a favourable season, such as that of 1858-9, the quantity of brood which is found on the Flats, off the estuary of the Thames, is enormous; in that year alone the Whitstable Company bought 134,878 wash (a measure in use for oysters), at a cost of £28,711, and all the other companies and owners of private beds doubtless made similar investments; it is confidently believed by those who are interested in this harvest that it is due to the spat which has drifted from the oysters lying on the private beds along the coast.

In this view, therefore, it seems that the best and safest policy to pursue for increasing the supply of oysters is to encourage the formation of private beds, where the brood taken from the open beds may be carefully tended, where comparatively little loss will occur from the numerous enemies which attack them on their exposed native beds, and from whence the spat may be carried to fertilise the open grounds. Two difficulties have hitherto prevented advance in this direction. It has not been in the power of the Crown, since Magna Charta, to give exclusive rights of fishing or dredging below low-water mark; all the existing private fisheries below that line must owe their origin actually or presumably to grants made anterior to that event; and secondly, there has been too little security to the

owners of such property against depredators. Owing to the technicalities of our law, the taking of oysters was not till recently a felony ; the oysters could not be identified ; and in many parts of England and Scotland great losses were suffered by owners of private beds, from being unable to convict persons who had taken oysters from their beds. These difficulties have now been removed. The taking of oysters illegally from private grounds has been made a felony. The Board of Trade, by an Act passed in 1866, has been authorised to make orders for the establishment and maintenance of oyster-beds along the coast, subject to local inquiry and to the approval of Parliament ; while the rights of the Crown in the foreshores and in the soil of the sea below low-water mark have been transferred to the Board of Trade, for the purpose of facilitating the establishment of these beds. Already numerous applications have been made to the Board of Trade under these Acts, and we doubt not that a great extension of oyster-culture will take place.

From the following legal quotations from “ Stone’s Justice’s Manual,” it will be seen that the Government and Parliament have to a great extent adopted the views of the Commission ; how far in accordance with the Abstract of the Report given, the reader can judge for himself.

OYSTERS.—I.

“ Whosoever shall steal any oysters or oyster-brood from any oyster-bed, laying, or fishery, being the property of any other (*f*) person, and sufficiently marked out as such —*Felony*, punishable as for simple larceny.

(*f*) The 30 Vict., c. 18, for the protection of oyster fisheries, contains provisions as to the ownership of oyster-beds, &c. ; and 29 and 30 Vict., c. 85, s. 18, as to disturbing or injuring oyster-beds.

Pun. 2. [24 and 25 Vict., c. 96, s. 26]; or shall unlawfully or wilfully use any dredge, or any net, instrument, or engine, within any oyster-bed or fishery, being the property of any other person, for the purpose of taking oysters, or oyster-brood, or unlawfully and wilfully, with any net, &c., drag upon the ground or soil of any such fishery—punishable by imprisonment for not exceeding three months, with or without labour or solitary confinement. [Id.] (But this section is not to prevent any person from catching or fishing for any floating fish, within any oyster fishery, with any net adapted for taking floating fish only.) [Id. s. 26.]

OYSTER FISHING-SEA.

If within the exclusive (g) fishery limits of the British Islands any person, or if outside those limits any person belonging to a British sea-fishing boat, fishes for oysters, or has on board his boat any oyster dredge, within any seas and during which oyster fishing is prohibited by law, or by any convention, treaty, or arrangement to which this Act may hereafter be applied,—*Fine*, on summary conviction, not exceeding £50, or imprisonment NOT EXCEEDING THREE MONTHS, with or without hard labour. [46 and 47 Vict., c. 22, s. 4.] Fine may, if court think fit, be applied towards payment of expenses, and subject thereto is to be paid to the Exchequer. [Id. s. 21.] For the purpose of jurisdiction, a sea-fishing boat is to be deemed a ship

See 31 and 32 Vict., c. 45, and 32 and 33 Vict., c. 31, as to fishery in Langston Channel and channels in Chichester Harbour, and *R. v. Doning*, 23 L. T. 398, as to evidence of ownership of an oyster-bed in a tidal river, and *Goodman v. Mayor of Saltash*, ante, p. 530.

(g) Power is given to the Board of Trade by Part 3 of 31 and 32 V., c. 45, to make an order for constitution of an oyster and mussel fishery; the power is extended to cockles by 47 and 48 Vict., c. 27.

within the meaning of any Act relating to offences committed on board a ship, and every court is to have the same jurisdiction over a foreign sea-fishing boat within the exclusive fishery limits of the British Islands, and persons belonging thereto, as such court would have if such boat were a British sea-fishing boat. [Id. s. 18.] Service of summons is to be good if made personally or on board ship. [Id. s. 19.]

ANNUAL CLOSE SEASON.

No person shall sell, expose for sale, consign for sale, or buy for sale : (1.) Any oysters known at the passing of this Act in the oyster trade as “deep-sea oysters,” between 15th June in any year and the following 4th August ; or (2) any description of oysters other than those aforesaid, between the 14th May in any year and the following 4th August ; for acting in contravention of this sect.—*Fine*, not exceeding £2 for the first offence, £10 for the second and any subsequent offence, and *forfeiture* of the oysters. [40 and 41 Vict., c. 42, s. 4.]

EXCEPTIONS.—A person is not to be guilty of an offence under this section if he satisfies the court that the oysters (1) were taken within the waters of some foreign state ; or (2) were preserved in tins, or otherwise cured ; or (3) were intended for the purpose of oyster cultivation as here prescribed.

RESTRICTION OF DREDGING.—The Board of Trade, on application of local authorities, may by order restrict or prohibit dredging for oysters on certain banks, during limited periods not exceeding one year ; and may provide for enforcing the order by fine not exceeding £20 for each offence. [40 and 41 Vict., c. 42, s. 5.]

PROCEEDURE, JURISDICTION, SEARCH, and SEIZURE.
—As fully set out under title “Crabs,” p. 209 ; apply also to Oysters.

Having giving the Commissioners considerable latitude in airing their “Report,” (*h*) anent the Convention Act of 1839, it is but fair to give the other side of the question also, showing in what light the Act of 1866 was looked upon by the ostraculturist of that date. In order to do this satisfactorily, I insert an unabridged copy of a brief pamphlet—*too* brief, indeed, I am inclined to say, for the effectual outcome of its purpose—which, for its plain-spoken truths alone, deserves to be rescued from the destined oblivion of some of the bygone ostracultural literature advocating an all-convincing, administrative system, so beneficially developed by our European neighbours, and still more powerfully represented in its wonderful commercial prosperity by those whom it suits the British dignity to term “our American cousins.”

The copy lent me bore no author’s name or initials, and (if I remember rightly) no imprint. The title and text are as follows :—

SOME REMARKS ON THE OYSTER AND MUSSEL
FISHERIES ACT, 1866.

The intention of our legislators in passing the above Act was doubtless to aid those individuals or companies who might endeavour to increase the supply of oysters for the benefit of the public.

The Board of Trade, in their published “*Regulations for the Instruction and Guidance of Persons applying for Fishery Grants*” under this Act, state :—

(*h*) Its full title is—“Report of the Commissioners appointed to inquire into the Sea Fisheries of the United Kingdom.” 1866.

“The *only* ground for appropriating or granting exclusive fishery rights over any portion of the sea-shore is the *expectation that by these means* the supply of oysters will be materially increased, and the public thereby benefited.”

“The General Principles on which exclusive Rights of Fishery will be granted are ;—

“1. Appropriations of moderate areas of unproductive sea-bed, or fore-shore, for the establishment of new fisheries, or local depôts.

“2. Appropriations of small areas of already productive ground for oyster-layings, or depôts in the vicinity of public beds.

“3. Concessions of exclusive fishery rights to owners or occupiers of existing fisheries, but within such limits and conditions only as may make such concessions beneficial to the public.”

It will be admitted that the proposed increased supply of oysters cannot be effected by the establishment of depôts, or that oysters will be multiplied by their removal from one bed to another, from public oyster grounds to those of private owners ; the *cause* of the present scarcity *being the exhaustion of the public oyster grounds*.

There remains therefore but one way of re-establishing the equilibrium between demand and supply, and that is to induce persons to set up in suitable localities establishments where oysters can be bred and protected in their infancy from their enemies, and from these beds to restock the exhausted dredging grounds.

To be effectual, the accomplishment of this task necessitates a large outlay of capital, and the aid of the Government in the removal of all restrictions, except those absolutely necessary for the protection of the public.

In places where the foreshores are public property, Government appears willing to grant the required ground ; but the expense of obtaining such grant is such that no individual fisherman can afford to apply for one. Hence, oyster-breeding establishments are not likely to become extensively adopted in this kingdom, although continental governments enable the poorest fishermen to obtain a grant almost free of expense.

To counterbalance this difficulty, however, it may be said that in England capital is abundant, and that companies devoted to the oyster culture will be plentiful.

At the present day this science is in its infancy ; the first success being that of the South of England Oyster Company Limited, in 1866, shortly before the passing of the Act, and it does not appear that this Company will have many competitors, except where the required conditions can be obtained on private or corporate property.

The right of fishery in tidal waters generally being in the hands of the Crown, except where grants have been made to corporations, or where it exists as a manorial right, it is hard to see why any attempt to stock the *public* waters should meet with opposition, but rather should not be encouraged in every possible way. Of course no individual or company would undertake to stock the ground without a share of the benefit ; but this might be arranged by way of licence-fee or royalty. This, however, is stated to be one of the claims which *cannot be entertained* under the Board of Trade regulations, yet it is what must be done, ere the public waters are replenished with oysters.

Excluding for the present this plan as impracticable, the next case is where a moderate area of *unproductive* seabed is applied for as a several fishery. Surely where this is the subject of application, there ought not to be either

difficulty or great expense in obtaining a grant. Yet the cost under the present Act in most cases is enormous ; in that of the Blackwater it amounted to several thousand pounds. Does this look like “ facilitating ” the establishment, improvement, and maintenance of oyster-grounds ? Is it not practically a veto ?

As at the present time nearly all the public beds are denuded of oysters, every facility should be given to the fishermen in the neighbourhood of the once productive, but now exhausted beds, to combine together and form themselves into organized communities, like that of Whitstable. A sufficient area of the foreshore and sea being granted for their exclusive fishery, at a moderate percentage of their returns, powers should be granted to them to form by-laws for the regulation of the fishery, and magistrates should have power to enforce fines and penalties under such by-laws.

If this were done, capital could be raised upon this security, as was done by the Whitstable Company, who borrowed £20,000 at the commencement of their fishery.

The fishermen would then be induced to clean the ground, and stock it with brood purchased from owners of breeding-grounds, or bred by themselves. Every company or community of fishermen establishing breeding grounds has a fair claim to the adjacent public-waters (where not already productive), for the purpose of rearing and maturing their crop of oysterlings. It should suffice to prove, first, that the ground applied for is unproductive, and, secondly, that the parties applying are in position to restock the ground. Where these premises have been established, the grant should follow as a matter of course, and without any great expense, if any, to the applicants.

If this course were adopted, oyster-farms for breeding would be rapidly established, and immense tracts of seabed would yield a good living to hundreds of fishermen, and the adjacent waters, not within the grant, would also benefit by the deposit of much of the spat from the matured oysters within the fishery limits.

The harbours of Langston, Chichester, and Bosham, afford a striking example of the decayed state of public dredging grounds at the present time. When and so long as spat falls upon the private fisheries of Whitstable, and those in Essex, the coast fisheries in other parts are left to the management of the fishermen of those localities; and although there has never been any protection afforded them by Government, nor formal regulations for the working of the grounds, yet it has always been the practice of those fishermen to abstain from removing brood under a certain size from the public beds for sale, spat and cultch being always returned to the ground. This state of things, if it had continued, would always have ensured a continual supply of oysters for the public markets. But at present, as soon as, from any cause, oysters become scarce upon the *private* grounds on the Essex and Kentish shores, the proprietors of these find it pay to send their smacks to long distances, and are permitted to dredge *without restriction* over ground hitherto worked upon and *preserved by local industry*. If the dredging were conducted upon equal terms, this would not, perhaps, be a sufficient ground for interference on the part of Government. But that owners of private grounds should, whenever it pays them to do so, be permitted to remove, not only fair-sized oysters, but brood, spat, and cultch from public grounds, which have hitherto been worked upon a sound system by local fisher-

men, and, by so doing, destroy these public grounds and the living of hundreds, is neither politic nor just.

If there were simply a prohibition of the removal of any oyster from public oyster-beds of a less size than two inches in diameter, the destruction of the grounds yet remaining would be prevented, although it would not repair past damage, nor redress the injury done to our local fishermen.

The three harbours named were once noted for a breed of oysters, second in quality only to Whitstable natives, and were at one time so plentiful that they sold for 2/6 the tub of 18 gallons, and, at this low price, a man would earn from 5/- to 10/- daily. At the present date, the price is more than ten-fold that amount, and a dredger-man often sells his day's work for a shilling, or less.

From this cause only a very few men, and those only at a hard pinch, attempt dredging, and the result is the rapid accumulation of mud, weed, and silt; which is ever the case where grounds are not kept constantly worked over by dredging. Thus the nurseries have been destroyed, and without the outlay of large sums, and the employment of many hands, the local oyster trade can never be re-established. The ground is unfit for the reception of spat, should any float in from the sea, and there are no oysters remaining to replenish it.

It is a fallacy to conceive that a few oysters, lying at great distances, will be sufficient to supply a large area with spat, as the aggregation of oysters is not merely a result of their habit of attaching themselves to surrounding substances, but is also a wise provision of nature to ensure the fertilisation of the ova by a mutual diffusion of milt—

since, although oysters are hermaphrodite, they do not possess the power of self-fertilisation.

Reviewing the whole case, the chief requirements for the rehabilitation of oyster fisheries are—

1st. Ready grants of unproductive sea-bed for oyster layings, without the present attendant expense to companies or fishing communities possessing or establishing breeding grounds.

2nd. Power for local fishermen to make by-laws and regulations for the proper fishing and protection of adjacent public oyster-grounds.

3rd. A general prohibition of the practice of removing oyster spat, or brood under two inches diameter, from any public oyster-grounds, under heavy penalties.

Hitherto the history of Conventions, on the subject of the sea fisheries between this and adjoining States, has been unfortunate. Prior to 1882, the only other Convention still in existence relating to fisheries was one (as already stated) made between England and France, to provide regulations for preventing the undue destruction of fish, and more particularly oysters, in the English Channel, as well as to prevent disturbances between fishermen of the two nationalities. With this object a Convention was entered into in 1839, and confirmed by Act of Parliament in 1843. The Convention, however, for various reasons (some of which have been already given, and others into which it is needless to enter in detail), has proved unworkable, and was superseded by a new Treaty in 1867, which framed a series of regulations for the fisheries in the Channel, between Englishmen and Frenchmen. This Treaty, though confirmed by Act of Parliament in 1868, has never come into practical operation, except in one particular, on account of the objection entertained by the

French Government, among other things, to the trial of French subjects in English courts. Offences under the Treaty are clearly defined, and may be prosecuted; but English complainants must follow French offenders to French courts, and the provisions are practically in abeyance. The single exception alluded to is in regard to the question of a close time for oysters, which was fixed from June 16th to August 31st. Both Governments have been enabled to pass a law prohibiting boats from carrying dredges between those dates, and forbidding the sale of oysters taken beyond the three-mile limit (*i*) between those dates; and, as common action has been taken in this respect, these bivalves are adequately protected in accordance with the views entertained on both sides on this subject. In all other respects, in such important matters as the prosecution of offenders, the admission of English fishermen to French ports, and of French fishermen to English ports, to sell their fish, and the prevention of disputes, the Convention remains a dead letter; and, although the Convention of 1843 has been revived by an English Act, whereby

(*i*) No one individual has an exclusive property in the sea, except in "oyster beds, &c.;" it is common to all the subjects equally of the state which borders it; and further than this, when once the three-mile limit of the *mare clausum* has been passed, its enjoyment becomes an international right. By modern International Law the territorial sea extends for three miles from the shore. It is designated the *mare clausum* because it is "closed" to foreigners, and, except by implied or express permission, the right to use these waters is exclusively enjoyed by the subjects of the adjoining state. Formerly, the width from the shore was limited by the reach of a cannon-shot—*quousque tormenta exploduntur*—(vide Selden; and Bynkershoek De Dom. Mar. cap. 2); but modern international usage has fixed the distance at a marine league. (Relations of the State with Fishermen and Fisheries, &c. By F. J. Talfourd Chater.)

provisions of doubtful practicability touching some of these points have been re-enacted, so far as French offences against English fishermen in the Channel are concerned, the broad result is that no machinery exists for preventing or punishing acts committed at sea, which would never be tolerated for one moment within the three-mile limit. (j)

The thirty sections contained in the Third Part of the Sea Fisheries Act of 1868 regulate the relations of the State with fishermen in regard to spawning beds. These provisions relate only to oysters and mussels, together with their brood, ware, spat, or spawn generally, by whatever name designated. They apply to the territorial seas only of Great Britain, with the exception of those of Ireland, the Isle of Man, and the Channel Islands.

The following procedure is adopted in order to establish protection.

The promoters, having first given notice to the adjoining landowners, who may raise objections, forward a memorial to the Board of Trade, praying for an order to protect a certain portion of the bed of the sea. In reply, the Board of Trade appoints an inspector to investigate, at some place in the locality itself, the desirability of making an order, and, influenced by his report, the Board either grants the order or withholds it. If granted, the order must be published in the district, and it does not prevail until it has been confirmed by an Act of Parliament. If opposed in its passage through the House, it will be referred to a Select Committee; but the Board of Trade has limited powers subsequently to amend the order. The heavy expenses of the memorial and Board of Trade fees fall upon the pro-

(j) The Relations of the State with Fishermen and Fisheries, &c. By C. E. Fryer.

moters, and this is a great drawback to the utility of the provisions. Companies and capitalists can bear the expense, but it is beyond the capacity of a poor fisherman, who might successfully cultivate two or three acres of sea-bed. It has been elsewhere pointed out that it is less to the undertakings of companies and capitalists that the national fishing industry must look for its prosperity than to the individually small, but widely extended, successes of separate members of the fishing community.

An order, when confirmed, has an alternative result :—

1. It either makes the grantee (or grantees) the owner of a several fishery ; or
2. It gives him (or them) the right to regulate a defined district.

In the first case, the grantee has in himself alone the exclusive right of depositing, propagating, dredging, and taking oysters or mussels ; and at all seasons such a grantee would most frequently be a private individual or a commercial company.

In the second case, the right to regulate gives the grantees powers to impose restrictions, to levy tolls and royalties, and to provide improvements. Grantees of this class might be a philanthropic society or an urban or other improvement corporation.

Neither of the above grants may extend over sixty years ; if the grant is not properly or productively utilised, the Board of Trade may determine it at any time, and for this purpose inquiries will be from time to time directed. The area of the grant must be properly defined by stakes or buoys, and sufficient evidence of its unmistakeable definition will be a certificate from the Board of Trade to that effect.

If the proposed area belongs to the Crown personally or to the Duchies of Lancaster or Cornwall, the consent of the Woods' Commissioners, or of the Chancellor of Lancaster, or the Duke of Cornwall respectively, must be first obtained; whilst any shore landowners may claim compensation under the Lands Clauses Acts. The orders further will not abridge a private fishery granted by a local Act, or by Royal grant, or immemorial usage, such as are frequently weirs. To afford publicity throughout the district, the Third Part of the Fisheries Act, together with the order itself, and the subsequent Act confirming the order, must be sold by the grantees to any applicant for sixpence, and the Board of Trade is to report annually to Parliament upon the working of the grants it allows.

For judicial purposes, the area of the grant is held to be in the county to which it is opposite; and if only the bed is properly marked out, all oysters in it are held to be the property of the grantees. This must be noted as a restriction on title by "*occupancy*," (*k*) which prevails in regard to almost all other sea-fish. He who is first to catch a herring is the only lawful owner of it, but it is as illegal

(*k*) The title to fish when caught is acquired by what in the civil law was called *occupatio*, or, in other words, by the mere taking possession of those things which before did not belong to anybody. English law has borrowed but little from Roman law; title by occupancy in respect of sea-fish is, however, distinctly acknowledged, and the dictum of Gaius has prevailed to the present day. "*Itaque si feram bestiam aut volucrem aut piscem ceperimus, quidquid ita captum fuerit, id statim nostrum fit, et eo nostrum esse intellegitur, donec nostra custodia coerceatur: cum vero custodiam nostram evaserit et in naturalem libertatem se receperit rursus occupantis fit*" (Gaii Institutiones, lib. ii., § 67).—Relations of the State with Fishermen and Fisheries, &c. By F. J. Talfourd Chater.

to take an oyster from an authorised bed as a fowl from a poultry yard.

All oysters removed from a granted area remain, notwithstanding removal, the property of the grantee of the bed. The only title to such must be derived either from the owner of the bed himself or through sale in market overt; the person selling in the latter is scarcely likely to be a thief, and, if he is, it has long been a general principle of English law that the publicity he has courted gives him a title,—not as a reward for his audacity, but simply as a matter of legislative convenience and to avoid endless disputes.

In regard to the removal of oysters from an authorised bed, a novel principle of evidence is introduced into our legal system. It lies midway between the *onus probandi* (that the oysters were honestly obtained) resting upon the prisoner, and the proof (that they were fraudently removed from the prosecutor's possession) resting on the prosecutor. It is expressly enacted that, if two beds belonging to different owners are contiguous, it is sufficient to show that any oysters stolen must have been removed from one or other of the adjoining beds, if not actually from that belonging to the prosecutor.

The direct protection of spawning beds is also provided for. All fishing implements, except a line and hook, or a net adapted solely for catching floating fish, and so used as not to injure any oyster or spawning-bed, are prohibited in the defined district. Ballast, except such as is lawfully authorised for the improvement of navigation, may not be removed thence. Rubbish may not be deposited, nor may any apparatus prejudicial to the bed be placed there, except such as is absolutely necessary for anchorage. And, lastly, if the bed is disturbed in any way, compensa-

tion may be awarded the grantees, and penalties varying from £2 to £10 are incurred.

A perusal of the foregoing provisions of the Sea Fisheries Act of 1868 will show them to be so equitable and simple that, with the one drawback of the expense involved in procuring and confirming an order, modified in 1877 (by section 7 of 40 and 41 Vict., c. 42), it is difficult to perceive what more legislation can do to promote oyster culture and protect oyster spawning-beds. All vested interests are considered ; in spite of the inconvenience which it may possibly occasion navigation, private property in the bed of the sea—a most unusual gift—is permitted ; Parliament, through the Board of Trade, becomes directly interested in the matter, and ready means of convicting offenders are given to courts of law.

In the very next year the South of England Oyster Company took advantage of the Act, and The Oyster and Mussels Fishery Orders Confirmation Act, 1869 (No. 2), was passed. This confirmation Act is worthy of consideration, as it shows how the means accorded in 1868 were put to practical use. The Act itself is a short one of three sections only, with a schedule containing in ten articles the order confirmed. Its second section amends section 45 of the Sea Fisheries Act of 1868. Section 45 implied that by a certificate that a grant was improperly utilised the whole grant must be determined ; but the amending section 2 enacted that a certificate might apply to part only of a grant. This in itself is a matter of but trivial importance, but it proves that these confirmatory Acts may from time to time be utilised for the amendment of our sea fishery laws generally, without, now that the question of fishery legislation is on a clearly defined basis, either passing express amendment Acts on the one hand, or re-opening the whole

subject of 1866 on the other, for the sake of a new enactment to supersede that of 1868.

The company in question obtained by their order 200 acres in Langston Harbour and round Hayling Island, and deposited plans with the Board of Trade. They acquired a several fishery, which was to be marked by poles and beacons at intervals not exceeding 100 yards. Obliterated marks were to be replaced at once, and notice was to be given at the first establishment of the fishery to fishermen and others by placards in the harbour and at Hayling Bridge. The grant was for sixty years only, and no works other than the marks and beacons mentioned were to be erected on it without the express sanction of the Board of Trade.

1875 was a year of legislative activity, and the Sea Fisheries Act of 1868 was materially amended by a short express Act (38 Vict., c. 15). Any oyster company, established by any local Act passed since 1863, and subject to the control of the Inspectors of Fisheries under the Salmon Fishery Act of 1861, was thenceforth deemed to have obtained an order under the Third Part of the Sea Fisheries Act of 1868. It became subject to the Board of Trade, as if it had been originally established by the Act of 1868, and the powers over such a company vested in the Salmon Inspectors ceased; whilst any provisions in the local Act at variance with the control of the Board of Trade given by the Sea Fisheries Act were repealed. . . . The second section enables an Inspector of the Board of Trade to examine upon oath when he considers the desirability of the cesser of a several oyster fishery, in the same way that he may (under section 32 of 31 and 32 Vict., c. 45) when he holds an inquiry as to the desirability of establishing a grant. . . .

The Act of 1877 (40 and 41 Vict., c. 42), which repealed the Norfolk enactment (1876) amended the oyster, crab, lobster, and other sea-fishery laws generally. It treated, firstly, of oysters, unlike the Norfolk Act, which concerned crabs and lobsters only ; secondly, of crabs and lobsters ; and thirdly, it regulated the procedure necessary for the enforcement of its provisions.

In Great Britain, under a £2 penalty, persons are prohibited from selling deep-sea oysters between the 15th of June and the 4th of August, and other oysters between the 14th of May and the 4th of August, unless the oysters were either taken in foreign waters, or preserved in tins or removed for cultivation within certain districts. One of these districts was the Thames estuary west of a line drawn from Orford Ness to the North Foreland. The next provision is of great importance. By it the Board of Trade, on application, and after inquiry and notice, may prohibit the taking of oysters during any period less than a year. The Board of Trade may, in addition, renew its prohibition from year to year, vary its orders, and enforce them by penalties ranging to £20. This part of the enactment does not, however, apply to grants of oyster rights under the Third Part of the Act of 1868. The application for a prohibition on oyster-taking may be made by any persons "appearing to the Board of Trade to represent the fishermen of any locality, or others locally interested in the fisheries." Justices, town councils, urban or rural, sanitary authorities, bodies corporate, or persons regulating a harbour, are examples of the possible applicants. By the seventh section, the expense of obtaining the confirmation of an order under the Third Part of the Sea Fisheries Act of 1868 is reduced. If for an area of less than 5 acres the grant of a several oyster-fishery does not exceed twenty-

one year for its duration, and if no objections are raised in the locality against the order, the latter may be confirmed by Her Majesty in Council without the expense of a special Act. . . .

. . . The 15th section . . . is of great Anglo-French international importance. The Convention in the Act of 1843 is revived so far as it regards the jurisdiction of British courts over French fishermen. It will be remembered that the Act of 1868 repealed the Convention in the Act of 1843, and also that the Convention contained in the Act of 1868 never came into operation, because the day to be fixed for its commencement was, in fact, never fixed at all.

The enactments briefly noticed above embody the only legislation which now prevails for the protection of either spawning-grounds, spawning-places, or spawning-beds.

I am afraid that these terms may appear somewhat ambiguous to some of my readers, and for this reason alone venture to draw a distinction between them.

Although a fishing ground is not necessarily a spawning ground, it is obvious that those parts of the sea are most fished which are *believed* to contain the most fish, and the most fish will naturally be found near spawning grounds. Little, however, is known of the exact locality of spawning grounds, and it is probable that many of them vary in situation from year to year. The knowledge of the site both of fishing ground and spawning ground is acquired by experience alone; and experimental knowledge increases very slowly amongst fishermen. Directed by prudence, they naturally prefer using the same known grounds year after year to the risk of seeking entirely new ones, although it is

of course possible that many localities much more profitable than any of those known may exist. When more is understood of the migration of fishes, it is possible that bad seasons may be entirely prevented by learning how to follow the fish systematically from place to place. Shoal-fish are already followed round the coast, but our whole system of fishing may be said to consist more in passively waiting for fish on their presumed grounds than in actively hunting them down.

A distinction may be drawn between spawning grounds and spawning beds. The former would include all those vast and indefinable spaces where fish instinctively breed, and the latter those limited portions of the sea which have been artificially established for fish propagation. Examples of spawning grounds would be the districts between Egmont in Holland and the entrance to the Cattegat, where it is believed soles breed; the district between Specton Cliffs and Robin Hood's Bay off Yorkshire; and the rocky pits scattered through the North and other Seas surrounding the United Kingdom.

Spawning beds may be exemplified by the small portions of districts near the coast or in estuaries which, under the Third Part of the Sea Fisheries Act of 1868, or by other enactments, may be allotted by the Board of Trade to private individuals, and which are principally devoted to the rearing of oysters.

Intermediate between spawning grounds and spawning beds are a third class of spawning spaces, which are near the shore or partially enclosed by headlands, but which are not artificially managed. Swansea Bay and numerous other bays in which fish spawn, but which legislation is almost powerless to directly protect, are instances of this

class. The exceptional enactments affecting St. Ives' Bay must not be considered as in protection of a spawning place of fish, but only as regulating the use of a resort of pilchards.

From these considerations the threefold division of spawning fields into—1, Spawning grounds ; 2, Spawning places ; and 3, Spawning beds—is reached. (*l*)

The Sea Fisheries Regulation Act, 1888, (51 and 52 Vic., c. 54), will, it is hoped, prove of great advantage to the fisheries of all kinds. It enacts that the Board of Trade may, on the application of a county or borough council (or if they refuse to apply, on the direct application of twenty rate-payers) create a "sea fisheries district" and provide for the constitution of a "local fisheries committee" for the regulation of the sea fisheries carried on within the district. Due notice of the proposal is to be given beforehand, and an inquiry, if necessary, to be held on the spot. The "local fisheries committee" is to be a committee of the county council, or the borough council, or a joint committee of both, "with the addition in each case of such members representing the fishing interests of the district." The committee is empowered to make by-laws regulating the methods and instruments for fishing, for creating a district of oyster cultivation, "prohibiting or regulating the deposit or discharge of any solid or liquid substance detrimental to sea fish or sea fishing" but not "affecting any power of a sanitary or other local authority to discharge sewage in pursuance of any power given by a general or local Act of Parliament, or by a Provisional Order confirmed by Parliament."

(*l*) Relation of the State with Fishermen and Fisheries, &c. By F. J. Talfourd Chater.

The by-laws are to be approved by the Board of Trade. The committees may also impose penalties for breach of their by-laws, and appoint fishery officers with power to stop and search suspected vessels or vehicles within the limits of the district. A meeting for consultation with the Board of Trade, to which each committee may send at least one member, is to be held annually. Special regulations define the relations of the committee to boards of salmon conservators and harbour authorities; and they may not pass by-laws prejudicially affecting any rights of several fishery, any by-laws of salmon conservators, or any powers of sanitary authorities mentioned above.

In Ireland the Act 5 and 6 Vic. cap. 106, prescribes that no oysters may be taken between 1st May and 1st September, though this close season has been varied by the Inspectors of Fisheries in the following cases:—

Cork Harbour 2nd May to 31st Aug.

Tralee Bay 11th Mar. to 31st Oct.

Galway Bay 1st Jan. to 30th Nov.

Strangford Lough 1st Mar. to 31st Aug.

Wicklow Head to Carnsore Point 1st May to
31st Aug.

Achil Sound, Clew Bay, and Blacksod Bay

2nd April to 30th Sept.

Taking oysters from licensed beds is made larceny.

By the Sea Fisheries Act of 1868, a close time for oysters was imposed within the irregular parallelogram comprising the English Channel, and defined by the Land's End and the North Foreland at its angles on the British side, and by Dunkirk and Ushant on the French. The period (as previously stated) extends from the 16th June to the 31st August, and during this time no boats may carry an oyster dredge, unless it has been

previously sealed by the Customs House authorities in order to preclude its use.

It may here be observed (says Professor Talfourd Chater) that a confusion has sometimes arisen between the close-time for, and certain precautions enforced to prevent the premature destruction of salt-water fish.

. . . . (Thus we may regard) close-time both as defining the period during which fish may not be actually caught on the one hand, and as defining the period during which they may not be offered for sale on the other. Ardnamurchan herrings may not be caught between the 1st of February and the 31st of May, and oysters may not be sold between the 15th of June and the 4th of August. Close-time is thus two-fold; it either relates to time of catching or to time of sale. (*m*)

As to the general policy of regulating oyster fisheries by close times and otherwise there is much difference of opinion.

. . . Mr. Huxley delivered a discourse on this question at the Royal Institution (May 11th, 1883), in which he called attention to the fluctuations in the supply of oysters from the principal French beds. These have long been under a system of restrictions far more severe than anything that has been or could be proposed in England; but the increase or falling off in the number of oysters taken (and in many years the variations have been very great and sudden), appears to have no intelligible relation whatever to the rules imposed by the State. In fact, there have been violent fluctuations both ways, while the rules and their administration were unchanged. Mr. Huxley's conclusion is that the abundance or scarcity of

oysters depends on causes which cannot be sensibly affected by any restrictive legislation. All such legislation is in itself objectionable, inasmuch as it creates new offences, and tends to make the administration of justice odious, and the burden of proof is always on those who advocate it to show that its utility is so great and manifest as to outweigh the inconvenience. If Mr. Huxley's inferences from the French statistics are right (and I do not myself see the answer to them), the improvement of the oyster fisheries is to be sought, not in multiplying penal laws, which at best are troublesome to enforce and uncertain in their working, but in the judicious encouragement of oyster cultivation. (*n*)

I will conclude this chapter with a somewhat lengthy, but very instructive and readable extract from "Oyster Culture," by Commander C. V. Anson, R.N., and E. H. Willett, F.S.A., convinced that its comprehensive grasp of the subject in question, combined with its valuable suggestions and additional information, will atone for its length and insertion.

Under the heading "Laws and Suggestions for the Protection of Oyster Fisheries," the able and experienced authors write as follows upon Oyster Fishery Legislation, beginning with

DREDGING *v.* OVER-DREDGING.

Oyster culturists and experts are divided into two schools with regard to this question. The views of one party are fairly represented by the Report of the Select Committee appointed by the House of Commons in 1876 to inquire into the scarcity and consequent high price of

oysters ; whilst the other side are represented by the Royal Sea Fisheries Commission Report of 1866.

The desirability of keeping oyster-beds clean by dredging is so intimately connected with the general question as to whether their productiveness is injured in the process, that it is impossible to discuss the matter without going into the controversy fully, and before summing up the evidence, we think it desirable to state briefly both sides of the case as fairly as we can.

The opponents of over-dredging contend that a close time should be observed, because—

1. Overwhelming evidence is forthcoming in condemnation of excessive and reckless dredging.

2. The oyster-beds of Poole, Granville, and Cancale, amongst others, have been totally destroyed by over-dredging.

3. Several beds in the Channel have been destroyed shortly after discovery, being pounced upon by dredging-boats, who, working with the wind abeam, with their boats almost touching one another, have dredged up nearly every oyster on these beds.

4. That as on deep-sea beds the oysters lay in streams, any that are by chance left after a visit from the dredging-boats must have been disturbed, and will not afterwards spat productively.

5. That on the public grounds fishermen invariably throw overboard again the enemies of oysters that are not either eatable or saleable ; thus dog-whelks, cliona, and five-fingers are neither destroyed or brought away from the beds, the undiminished supply of “wolves” being left to prey upon the few “sheep” that remain.

6. The constant operations of dredging cannot be necessary, because extensive layers of oyster-shell, many feet

thick, are found in various parts of the world, proving that oysters flourished prodigiously long before dredging was thought of. If they had been then subject to the disastrous results which are stated to arise from abstaining from dredging, they could never have survived. The great ocean beds, which have never been dredged, also support the theory that oyster grounds can thrive without any aid from man.

7. Laws are necessary for the preservation of any animal which serves as food for man, whose habits compel it to live in a confined area to which man has access.

8. Over-dredging is the cause of the scarcity of young oysters on public grounds, the brood being taken before it is fit to be removed, the shell being as yet so soft that it is injured in the process.

9. If the Boston oyster-beds were spoilt, as some people say, by being closed, it was because, after being overworked, they were closed for too long a time. If they had been subjected to periodical inspection, it would have been found necessary to clean them, but not to dredge up any oysters.

10. Dredging diminishes the number of oysters, and hence there are less to spat. How can dredging be productive of tranquillity?

11. The native grounds have been over-dredged since the great spatting year of 1858, hence the present scarcity.

12. On restrictions as to a close time being enforced at Emsworth, the takes by the Oyster Merchants Company there increased from 32,210 in the year 1871-72, to 380,744 in the year 1874-75.

Now the advocates of dredging at all times argue that all restrictions should be removed, because—

1. Over-dredging has *not* been the cause of the decreased production of oysters. The decrease has not arisen from any cause over which man has control, but from a general failure of spat occasioned by the inclement seasons of the past twenty years.

2. The beds at Poole, Cancale, Granville, &c., are special cases acted on by local circumstances only, and do not prove the rule.

3. Oyster grounds cannot be dredged *out*. One bushel only left on a ground during a good spatting year would be sufficient for an enormously increased supply.

4. That it does oyster grounds good at all times to be cleansed from weeds, mud, and vermin.

5. That in the estuary of the Thames five-fingers are always kept and sold for manure. That dredging disturbs and disperses the enemies. In fact the injury inflicted by allowing the enemies to prey unrestrainedly on the oysters is greater than that which any amount of dredging can accomplish.

6. From the fact of the layers of oyster-shells being superimposed one on the other, it may be assumed that each bed only lived a short time comparatively. The deposit of sand and clay, &c., which is frequently seen between the layers, points to the cause of death, and judicious working might have removed this. Further, each bed must have been defunct before the next could have been deposited.

7. Man's influence is so slight when compared to the immense operations of nature either for beneficial or destructive purposes, that it may be practically left out of account when considering the question of the supply of fish and molluscs.

8. As spat is always deposited in an over-crowded state, if some of the young brood are injured by removal, those that remain are benefited by the increased space given them.

9. At Boston the corporation obtained an order from the Board of Trade empowering them to close the beds for three years. Before the clôture took place, the boats had been able to get as many as 1000 oysters a day. When the beds were re-opened, a boat could with difficulty get fifty in a day's dredging, and the grounds were found to be ruined by the accumulated rubbish.

10. During the five years which followed the great spatting season of 1858, there were more "Natives" dredged off the grounds than were ever known before, although during these five years there was a general failure of spat. Therefore the supply of oysters has nothing to do with the failure of spatting, provided that a few are left to breed.

11. In 1857 there was a large fall of spat on the Native grounds, and a great many boats dredged every day, weather permitting; yet in 1858 double the quantity of spat fell. At Swansea fifteen miles of ground has been shut off for a nursery, except for three months of the year, under a regulating order of the Board of Trade; but oysters have decreased there by more than a third.

The foregoing evidence might be amplified on both sides, but we have said enough to show that there are difficulties in deciding the question satisfactorily to all parties; as in most other debateable points, there is a good deal of truth in the views of both disputants. The essence of the matter appears to us to lie in the fact that the same system of cultivation and treatment cannot be applied to all oyster beds. There are many beds that certainly require

human care and attention, whilst others can be trusted to take care of themselves.

If the grounds are situated where they are liable to become rapidly silted up, as in the case of most of the beds in and about the estuary of the Thames, it would be folly not to keep them constantly worked, as they would otherwise become useless in a very short time. On the other hand, where the grounds are so situated that they keep clean by the scour of the tide and the absence of deposits, the less interference they meet with the better. Lost fertility *may* be restored to an oyster bed by a close season being rigidly enforced, whilst constant dredging is not only desirable, but absolutely necessary where weed, mud and vermin accumulate rapidly.

It may seem hardly intelligible why, if at one period oyster beds were productive without artificial aid, they should require it afterwards ; but there are various reasons why this is so. When beds have been abandoned by dredgers, owing to their being able to obtain a greater number of oysters elsewhere, they may and do become ruined by the collection of mud and weeds that is formed ; the soil having been once disturbed by dredging, becomes looser and more liable to shift, and thus weed, "slub," &c., drifts easily into the depressions caused by the abstracted oysters, or the drift of mud, organic matter, &c., attracts vermin in large numbers, just as a fisherman rakes the bottom to attract fish. In whatever way it may be accounted for, the facts that beds once worked have been ruined are certain—witness the examples of the Jersey and Granville beds.

All cultivated beds vary between the two following conditions : of being overcrowded with oysters, ware, and brood, &c. ; and of having only a few parent oysters left on them.

In the former case, harrowing and dredging at any time of the year will do good in preventing the oysters from becoming overcrowded, for as there is only a certain proportion of oysters' food in any given quantity of water, redistribution over a larger area increases their food supply.

When, however, there are but few parent oysters left, dredging, especially during the spatting season, is most destructive. The iron rings and edges of the dredge must destroy some of the spawn and disturb the parent oysters to their disadvantage whilst they are breeding. Skin-back dredges are, we believe, seldom or never used on public grounds; whilst it is an almost if not quite universal custom for the fishermen to return the enemies to the water on such beds. It may be taken for granted that an oyster dredged up during its spatting season will not produce fertile spawn, and it is doubtful whether it will ever do so afterwards.

Although it is known that oysters produce an enormous quantity of young, it is very unsafe to count upon the actual number produced when considering the question of the future fertility of beds; calculations based on the actual number of spawn emitted by say a bushel of oysters, although represented by a long array of figures, are practically valueless; though it has been proved over and over again that the proportion which the number of young brood on a bed bears to the quantity of old oysters upon it is a pretty constant quantity. Mr. Pennell stated in his evidence before the Commission of 1876, that his experience at Herne Bay and Whitstable showed him that, apart from special cases where an eddy or current might tend to carry floating spat to one particular spot, the more old oysters that were left on the bed, the more young brood you would find.

Experience at Arcachon, Auray and Vannes, supports this: there the number of young oysters found on the collectors is always found to correspond to the quantity of old ones on the public reserves and in the neighbourhood.

Further, when the writer of this was dredging off Cancale last year, he found that on the beds which have lately become productive again, the proportion of young oysters (i.e. oysters under three years old) to old was as ten is to one, the result of two dredges full being 251 young and 25 old.

The small bed of oysters discovered in 1870 in the Queen's Channel on the Whitstable Flats, which was destroyed in so short a time, afforded the same testimony to the rate of increase of oysters when left undisturbed.

The great success of the breeding establishments at Auray and Arcachon may be said to be due almost entirely to the determination of the authorities to keep up an abundant stock of oysters of all sizes, as shown by the limited time allowed for public fishing. During the last eight years only seven hours have been allowed in the Bay of Arcachon; on the Cancale grounds public dredging is only allowed for six days during the year. Whether due to restricted dredging or not, there is no doubt that reproductiveness has been restored to these beds.

Private owners and companies very naturally object to any restrictions being placed on dredging on their own grounds or on public grounds. It is not at all likely that in their own interests they will allow over-dredging on their own grounds, whilst they would be only too pleased to be allowed to dredge as much as possible on the grounds of the public. An increase in the number of advocates against any restrictions being placed on the few public grounds that are left is the natural outcome of the policy of granting concessions of public grounds to companies, of

which we will treat presently. If this course proceeds without let or hindrance, the goose that lays the golden egg will be slain, and oyster culturists will at last be rudely awakened to the folly of their policy, by finding that the remaining public breeding grounds are *barren*.

It is more than probable, however, that the cause of the failure of some private owners and companies has been a want of dredging rather than over-dredging. Bad spatting years and perhaps bad management have resulted in a want of the wherewithal, and thus their grounds have not been sufficiently worked.

2. THE POLICY OF GRANTING CONCESSIONS OF PUBLIC GROUNDS TO PRIVATE INDIVIDUALS OR COMPANIES.

Before making any suggestions as to advantageous alterations or additions to the existing laws on oyster-culture, we are led to inquire whether the policy of granting concessions of the foreshore or sea bottom to private owners and companies has been successful or not.

This system, inaugurated by the Herne Bay Company Act in 1864, and more fully carried out by the Sea Fisheries Act of 1868, has resulted in about thirty different orders being made by the Board of Trade and confirmed by Parliament. Further than this, the Herne Bay and Roach River Companies possess powers from special Acts of Parliament, though also subject to Board of Trade inspection.

The objects of these grants were no doubt the increased production of oysters, the stimulation of the industry of oyster-farming, and the decrease in price of a most desirable kind of food. That these results have not been obtained is very evident, but whether the failure can be fairly attributed to the policy which dictated the grants is an open question.

We may fairly presume that another object the authorities had in view in granting concessions was the success of the concessionaires. Old-established corporations and private layings, though they have not perhaps done so well of late years as formerly, appear to have been fairly prosperous, but in those instances where companies have attempted by a large expenditure of capital to start flourishing concerns, the result has been a lamentable failure.

In 1864 nine square miles of the foreshore were granted to a company, and consequently taken away from public fishermen. Those who had charge of its affairs spent nearly half the capital before they earned a penny, and after having for some years maintained a precarious existence by selling off their stock, or in other words "living on their capital," they at length exhausted their resources. This was in 1877, but meanwhile the Board of Trade had in 1874, at the appeal of the fishermen of the neighbourhood, ordered an inquiry, which resulted in the nine square miles being reduced to a trifle over four. Another inquiry was held in 1881, when it was again found that the grounds were not properly cultivated, through the financial embarrassments of the company, and the four square miles were reduced to one. To sum up the results of this concession up to the end of 1881: it appears that for seventeen years a right has been taken away from public fishermen to fish on eight square miles of ground without any compensation being given to them, or any apparent advantage being derived by the public, whilst the experiment was attended by a dead loss to the concessionaires.

The absence of any but very small dividends to the shareholders of other companies who have received grants

since 1868 gives us the impression that, generally speaking, companies have not as yet been successful ; whilst there is no doubt that sea fishermen who do not belong to any company, private owners, and the companies themselves are all at variance with each other. Independent fishermen loudly complain both of owners and companies, whilst private owners have a grievance against companies, and also against the actions of the fishermen on the common grounds that are left.

The rights of fishing in the territorial waters of the kingdom were confirmed to the sea fishermen of England by a provision of Magna Charta : these rights have been undoubtedly interfered with by the enclosure of certain waters. Whilst we are ready to grant that when the deprivations were sanctioned by the Legislature the promoters of the policy were able to hold out good prospects of advancing the general good, those prospects have not been fulfilled. We therefore think the time has come for a general investigation into the complaints of public fishermen against the concessionaires under the Sea Fisheries Act of 1868, with a view to a reversal of the policy that constitutes a direct infringement of the privileges conceded to our ancestors more than six centuries ago, without apparently any compensating advantage having accrued to the public.

As recently as September 1, 1879, Messrs. Buckland and Walpole recommended that inspectors should be empowered, with the authority of the Board of Trade, or the Secretary of State, to allot small portions of the foreshore or sea bottom to fishermen for oyster and mussel cultivation ; to ascertain by inspection the result of such allotments, and to withdraw or continue them to the allottees as might seem desirable, reporting their decision

in each case to Parliament. If this recommendation were widely carried into effect, the result would be that on those grounds where spat happens to fall, the grantees would be in a state of prosperity so long as the supply lasted ; whilst where no spat falls, and brood unattainable, except at exorbitant prices, as is the case this year with " Natives," both proprietors and fishermen would be in financial straits, and the latter deprived of one of their principal sources of living. It is well known that spat sometimes falls at one place and then at another.

It is to the interest of oyster merchants, whether single individuals or corporate bodies, to keep up the price of their wares ; capitalists can afford to do this by refusing to supply the market when there is any probability of its being glutted, whereas the poor fishermen have not the means of storing their oysters during a time of plentiful supply, or of living in the interim if they are stored. They are therefore obliged to sell what they have caught on public grounds to the companies at whatever price the latter choose to give, or else hawk them about the country offering them for sale at reduced prices ; though they well know oysters are kept quite long enough out of water when first brought on shore from the deep-sea beds, and great risk is run if they are transported elsewhere.

Further, the fishermen, who generally live a " hand-to-mouth " existence, can only afford to take a very small share in a company presumably got up to benefit them ; a bad year, sickness or improvidence, causes them to part with the small share they possessed, and the company drifts into the hands of one or two capitalists.

This is no supposititious case, as we feel convinced that in some of the companies now existing by far the greatest number of shares are in the hands of " long-shore moneyed

men," who are quite indifferent to the fishermen's interest, and who manage the business as they like. The fishermen, instead of being partners, find they have exchanged their former freedom for hard task-masters and a "tale of bricks."

In defiance of the opinion of experts, who stated in 1877 "that the continued grants or concessions would result in the price of oysters being raised from £10 to £15 a bushel," concessions have continued to be made, and this year the price is £16 per bushel; thus their predictions have not only been realised, but exceeded.

If the price continues to increase at the same rate for the next twenty years, *Native oysters will be eighteenpence each*, and will be shortly after relegated to the same class of food as Chinese birds'-nests, which are sold for their weight in silver to make soup.

Another thing to be remembered is, that the higher the price the greater the inducement will be for excessive dredging on the public beds, hence the greater necessity there seems to be to introduce some measure for the preservation of these grounds.

No doubt the demand for oysters has largely increased in England of late years, but we question whether the great increase of price is wholly chargeable, either to the demand or to the failure of spat, and whether unwise legislation has not in a measure been the cause. At any rate, if the existing policy of granting concessions be continued, the logical deduction is that in the course of time there will be no public grounds inside the three-mile territorial limits, and outside of those limits we cannot enforce any laws except by international conventions.

It may be argued that the State or Board of Trade retains the power of withdrawing concessions in case the grounds are not properly cultivated, and that in at least

one case this has been done ; but in that case the company had powerful, if not jealous, neighbours to look after them. In other cases the weakest will go to the wall, and unless almost impracticable safeguards are instituted the fishermen will continue to suffer, and the policy of granting concessions will not by any means do the greatest good to the greatest number. The preliminary expenses are *very* heavy, and a rent is charged for these concessions which, though moderate, is a good deal for the poor fishermen to pay ; they are also granted without prejudice to any question of doubtful or disputed claim or right to the foreshores ; these are facilities for the rich, and not for the poor.

Of the natural breeding grounds which yet remain public, those which are in proximity to private layings require the most active surveillance. The inspectors should see that no interference with the public right of free fishing takes place that will favour any particular owner or company, the percentage of oysters that die in transit varying directly as the time they are out of water.

If the Board of Trade continue to grant concessions, it will be necessary to considerably increase the number of inspectors to do justice to all parties. With the present inspectors we think it would be impossible to supervise the concessions already granted. Enquiries now only follow complaints frequently repeated ; but none the less, when these complaints are well founded, injustice has been done, and surely legislation should have a higher aim than the *cure* of injustice.

We now see some of the same people who opposed concessions in 1877 applying for them in 1882 and 1883. "If some one must get it, why not we as well as others ?" say they ; "the Board of Trade will have their own way : we know that it is bad for oyster-culture generally, but as

the cake must be cut, we may as well share it; so '*sic transit gloria ostreae*.'” By these remarks we do not mean to suggest that owners of private freehold or copyhold oyster grounds should in any way be interfered with; they should be allowed to cultivate and manage their property in such a manner and at such times as they may judge best and most advisable for their own interests, dredging for buying, selling, and laying down oysters when and how it seems best to them.

Any interference with these holders would entail compensation for vested interests, and it should be borne in mind that local conditions and requirements are best understood by those accustomed to them, who have in many cases the accumulated experience of several generations to guide them.

In the early part of this year two applications were made for 3000 acres of the Blackwater to the eastward of the 2000 acres that were granted to the Mersea and Tollesbury Company some five years ago—one from Mr. John Smith, an applicant for various other concessions; the other from the dredgermen of Brightlingsea, Wyvenhoe and East Donyland.

Mr. John Smith was non-suited. The evidence, as usual in such cases, was very conflicting. Dredgermen from other places deposed to the harm it would do them were these grounds closed; whilst the dredgermen of Brightlingsea, Wyvenhoe and East Donyland complained that the ground, formerly free to them, had been granted to the Mersea and Tollesbury Company, and that now in their turn they ought to get at least 2000 acres granted them for their exclusive use.

Evidence was also given that large quantities of the brood that was spatted in 1881 had been sold this year from

the Blackwater and Pont, three millions having been purchased by the Whitstable Company. And if the 3000 acres were enclosed there would be but little of the Blackwater or Pont free to the public.

At the time we write we do not know what Mr. Holland, the inspector before whom the case was argued, has recommended or advised the Board of Trade to do.

With regard to future legislation, we would most strongly recommend that—

1. Dredging for oysters on natural or deep-sea beds should not be allowed between the 16th of June and the 16th of September, unless an inspector has certified that such dredging will not be harmful to *the future prosperity* of those particular beds.

2. The dredging for, consignment, or exportation for sale, or exposure for sale, for the purposes of consumption only, between the 15th of May and the 15th of September, should be made illegal, and punishable by fine, as between these two dates oysters are breeding.

It is necessary to note that unless the convention with France is modified or repealed, the permission referred to in the first suggestion cannot be granted outside the international territorial limits between the 16th of June and the 1st of September.

Were these suggested laws enforced in England, Wales, Scotland, and the Channel Islands, we believe that great advantages would ensue.

Ireland appears to have always been left alone in fishery matters, and not interfered with. Whether this is or is not “another injustice” to that country, we have no space or time to inquire, but it is a step towards what they desire so much—Local Government or Home Rule. The Irish

Fishery Commissioners have far greater powers than those suggested to be conferred on the inspectors in our first recommendation, the Irish Commissioners having the power to close or open the beds at their discretion; whilst the English inspectors would only have the power of opening them if they considered they required working.

The effect of the second recommendation would be that all dredging for the market for consumption would cease for four months; but to allow of the breeding establishments being stocked, deep-sea oysters would be dredged for an extra month, i.e. from the middle of May to the middle of June, and thus artificial breeding encouraged. There is nothing in our suggestions that interferes with any international obligations, excepting that as already stated, between the coasts of England and France dredging cannot take place between the 16th of June and the 1st of September.

If a natural bed was dredged during the summer months, the oysters taken therefrom would be used for breeding if the proposed laws were enforced.

There is a consensus of opinion that this large industry should be guided and protected. The value of oysters annually consumed in England is enormous, yet there is no inspector of oyster fisheries.

We hope to see the time when there is a permanent Fishery Commission, of which body the Inspector of Oyster Fisheries will be a member; the Inspectors of Salmon Fisheries, an Inspector of Trawling Fisheries, and two of Net Fisheries, would probably complete the Board. The interests of each class of fisheries, which so often clash with one another, would then be fairly represented, and some attempt be made to prevent the immense waste of fish that now takes place.

Lastly, in matters of fishery, the coastguard should be utilised much more than is the case at present. They should be directed to refer to the Fishery Commissioners, through the Board of Trade, in the same manner as they now do concerning wrecks and life-saving apparatus.

If this was done, we submit that not only oyster, but all other fisheries, would receive both protection and benefit. (*o*)

We have now gone through the substance of one of those bodies of special legislation which, though their existence is hardly known except to the persons interested in their subject-matter, are of considerable extent and intricacy, and may raise important questions of general legislative policy. Thus it is evident that in the case of the fishery laws the question of interference with private discretion by the authority of the State has constantly to be decided one way or the other. In dealing with freshwater fisheries, the tendency of modern law-making has been to impose new restrictions, in dealing with sea-fisheries to remove old ones. There is not necessarily any inconsistency in this, for the circumstances and the purposes of the law are widely different.

. . . A lawmaker who thinks and speaks as if he were dealing with a nation of fools will never make good laws; a passion for formulas is the mark not of an exact but of a petty mind, and is capable of becoming the ruin of legislation and politics. It is enough for us, as regards the matter in hand, to know that our fishery laws, since their improvement was seriously taken up some twenty years ago, have on the whole worked well, and prevented much mischief. From a lawyer's point of view

(*o*) Prize Essays issued in connection with the Great International Fisheries Exhibition, London, 1883. (William Clowes & Sons.)

(and, I should think, from the point of view of anyone who desires to understand them), there is much to be mended in their form. But with all their faults, they are a fairly creditable specimen of the manner in which that complex and overburdened instrument of government, the Parliament of the United Kingdom, contrives as it were from hand to mouth, and almost without knowing it, to keep abreast of the multifarious wants and grievances of a state of society which its founders could never have imagined.
(p)

(p) The Fishery Laws. By Frederick Pollock.

CHAPTER XL.

CONSERVATION OF DEEP SEA BEDS.

TEMPERATURE—THE GULF STREAM—THE EFFECTS OF TEMPERATURE—DEPTH AND DENSITY—TIDES AND CURRENTS—NATURE OF THE SEA-BOTTOM—DREDGING—HARROWING AND TRAWLING—RINGS FOR MEASUREMENT—REMOVAL OF CULCH FROM PUBLIC GROUNDS.

A.—NATURAL CAUSES.

IN the early chapters of this work I have already treated of some of the conditions which affect the growth, condition, and production of oysters; but there are certain active causes influencing the formation of deep-sea beds which, under the above head, form a necessary introduction to Artificial Oyster Culture, of which it is indeed a part subject, and to which I will now refer.

TEMPERATURE.

Temperature acts in the greatest degree at the time of spatting; its after-influence gradually lessens as the oyster grows and becomes more robust. In an early, warm summer, deep-sea oysters have been known to get "white-sick" about the end of May, and "black-sick" a fortnight or so later. If the season is late, they may not become white-sick until August or September. (*a*)

(*a*) Anson & Willett's "Oyster Culture."

As the action of the Gulf Stream is an important factor in considering the temperature of the Channel and the Bay of Biscay, the following lucid account thereof may prove both instructive and interesting :—

The western shores of these islands are washed by the great north-easterly current or drift of the Atlantic known as the Gulf Stream, to which, as is well known, we are indebted for a geniality of climate, especially on our western coasts, such as is not elsewhere enjoyed in similar latitudes. The Gulf Stream is part of the general oceanic circulation of the globe. It may be traced all the way from the Indian Ocean. From the regions of the South Atlantic, near the western coast of Africa, it follows the north-westerly trend of the land, passing into the Caribbean Sea, thence sweeping round the Gulf of Mexico, and rushing through the Straits of Florida as a great contracted river, 30 miles broad and 350 fathoms deep, with a velocity of 4 miles an hour and a temperature of 85° Fah. The stream is continued north-eastward at first, nearly parallel with the American coast. As the flow is continued the warm stream becomes outspread, its temperature lowered, its speed slackened, and portions of it are separated and deflected from the main course. The prevalence of south-westerly winds, and the natural effect of the rotation of the earth on its axis, serve to maintain the north-easterly flow after the original impulse has abated. The stream is continued past the British Islands into the Sea between Iceland and Norway, where its speed, it has been calculated, does not exceed $1\frac{1}{2}$ to $2\frac{1}{2}$ miles a day, and on to the Arctic regions about Spitzbergen, where its presence has been manifested by the casting ashore of West Indian seeds. Even in those high latitudes it is still appreciable as a distinct and moving current. On the eastern side of Spitz-

bergen its course appears to be changed by some blocking or modifying agency. Here it was found to carry the Austrian exploring ship *Tegethoff* towards the north-west, and Mr. R. H. Scott, the secretary of the Meteorological Council, in a work just issued, records the discovery, in 1881, on the coast of Labrador, of glass fishing-net floats, of a pattern used only by Norwegian fishermen, and which, it would seem, must have been washed away from the coast of Norway, and have made the circuit round the north of Spitzbergen and along the Greenland coast to the spot where they were found. It thus appears that a portion of the warm Gulf Stream becomes lost in the ice-cold Labrador current which skirts the American shore, and passes southward beneath the heated river that flows into the open Atlantic from the Gulf of Mexico.

Of the Gulf Stream a feeble wave passes up the English Channel and through the Straits of Dover; its volume, force, and warmth, however, being insufficient materially to affect the general temperature of the North Sea, or to affect it at all except within a limited area at the extreme south. By the deep-sea explorations carried out by the *Lightning* and *Porcupine* in 1868, 1869, and 1870, under the scientific direction of Dr. Carpenter, Mr. J. Gwyn Jeffreys, and the late Sir Wyville Thomson, it was established that along the western side of Ireland and the Hebrides the heated water, some little distance out, has a thickness of some eight hundred fathoms. A portion of this warm water washes the shores of Orkney and Shetland, and curves round into the North Sea by the Pentland Firth and the channels between these islands. Thus it comes about that the surface water of the northern section of the North Sea is during winter and early spring higher in temperature than that of the middle and southern sections.

To counterbalance this north-eastward flow of heated water from the tropics, there is believed to be a constant creeping southward, in the depths of the sea, of water from the Arctic regions. This southward movement proceeds very slowly, and receives the name not of a current, but of an "indraught." The late Sir Wyville Thomson, a man of unique experience in deep-sea exploration, spoke of the investigation of the currents in the neighbourhood of the British Islands as being attended by "singular difficulty." Surface currents are often easily detected, but other oceanic movements of the greatest importance, involving the transfer of enormous masses of water, are so sluggish in their operation, and so liable to be masked by the drift of variable currents, that their course and progress cannot be traced. (*b*) We have, however, the broad fact that all over the ocean, even under the equator, below a certain depth, there is a great substratum of water of about the temperature at which fresh water freezes (and not 39.5° Fah. as was once supposed). Beneath the Gulf Stream, in situations where the ocean deeps are uninterrupted by shallows, the two strata are well marked—that of the surface exceptionally warm (for the latitude), that of the bottom of icy coldness. Dr. Carpenter reports (*c*) that at one sounding station near Faroe it was found that the thickness of the two strata were nearly equal, each being about 2000 feet, "the lower an Arctic stratum flowing in a south-westerly direction beneath the upper stratum of comparatively warm water moving towards the north-east."

One reason for believing that there is a southward indraught of water from the Arctic regions is found in the distribution of Arctic fauna. Reasoning as a naturalist,

(*b*) "Depths of the Sea," p. 361.

(*c*) Proc. Royal Society, xvii. p. 441.

and with the results of a most extensive series of dredging operations before him, Sir Wyville Thomson concluded that "there is a direct movement of cold water from the Spitzbergen Sea into the North Sea." (*d*) The North Sea slopes to the north, becoming gradually shallower towards the south. There is great abundance of animal life in the Arctic regions, and great abundance of Arctic types of life in the deep water in the neighbourhood of the Shetland Islands. (*e*) The influence of the indraught of cold water from the north becomes less and less apparent as we proceed southward towards the shallower waters between Scotland and Denmark. By the time we reach the Dogger bank the northern fauna has entirely disappeared. On the western side of the British Islands, however, northern species are to be found down to and beyond the southern limit of the British area. For this reason Sir Wyville Thomson suspected that the water of the Gulf Stream amalgamated, before touching these islands, with a portion of the northern water. (*f*)

Let us next consider the effects of temperature. Currents are an agency in the distribution of temperature as well as of animal forms. Warm water has a fauna of its own, cold water another and entirely distinct fauna. The former, as we have seen, is brought to these shores by the Gulf Stream; the latter by the great submarine indraught from the Arctic regions. The surface temperature of the

(*d*) "Depths of the Sea," p. 112.

(*e*) See Reports of British Association, 1862-68. Reports by Mr. Gwyn Jeffreys, Rev. A. M. Norman, &c.

(*f*) The Currents, Temperatures, and Physical Conditions of the Sea, in relation to Reproduction, Growth, and Migrations of Fish. By W. Watt. (Prize Essays issued in connection with the Great International Fisheries Exhibition, London. 1883. William Clowes and Sons.)

sea is also affected to some extent by the temperature of winds. Mainly, however, it is determined by the direct heat of the sun. Accordingly, surface-temperature varies with the seasons, while the temperature of the depths is uniform throughout the year. In temperate regions the heat of the sun does not penetrate many fathoms, and as the heated water is of less specific gravity than the cold water below, it remains on the surface as a distinct stratum, not sharply defined, but gradually merging in that on which it is superimposed. Mr. Scott, of the Meteorological Office, in giving a general account of the sea surface-temperature round the British Islands, for the months of February and August, states (*g*) that in February the temperature never reaches 50° , but closely approaches that degree at the entrance of the Channel, ranges about 45° round Ireland, and does not much exceed 40° on the east coast, from the Thames to Shetland. In August the temperature round Ireland is about 55° , and in the Channel and southern part of the North Sea, as far as the Wash, about 60° ; while along the remaining British coasts the mean is again about 55° . Thus it appears that in the track of the Gulf Stream the variation between the summer and winter temperature is only about 10° , whereas on the East Anglian coast it is 20° , and on the east coast of Scotland 15° , all of the Fahrenheit scale. The physical conditions of the North Sea were thoroughly investigated some twelve years ago by a German Commission, headed by Dr. H. A. Meyer, of Kiel, for which purpose the Government vessel *Pomerania* was placed at their disposal. The results of these investigations, as regards temperature, were to this effect:—In January the surface temperature is highest in the extreme south and in the north, by reason of the Gulf

(*g*) "Elementary Meteorology," 1883, p. 319.

Stream waters poured in through the Straits of Dover and by the Orkneys, while on the German coast it is exceptionally low, on account of the masses of water bordering on freezing point received from the Rhine, the Weser, the Elbe, and the Baltic. This state of things continues till April, in which month the temperature of the coast waters begins to rise. The rivers warm as summer approaches, and during July, August, and September, the southern parts of the North Sea are considerably warmer than those further north. In April, May, and June, when the coast temperature is gradually rising, the Dogger remains cool, and after the beginning of October the cooling process sets in rapidly on the German coast, until the state of matters that existed at the beginning of the year is restored. (*h*) Generalising these observations still further, it may be stated that in winter, with the exception of a small area near the Straits of Dover, the shallow southern part of the North Sea is cold, while the surface waters of the north are relatively warm; whereas in summer the southern waters are warm and the northern surface waters relatively cold. The temperature of the northern part of the North Sea is much more equable than that of the southern part.

It was held by naturalists so experienced and observant as Edward Forbes and Sir Wyville Thomson that the distribution of marine animals is determined almost exclusively by temperature. Currents act as means of transport, but temperature fixes the limits of habitableness.

Sir Wyville Thomson was of opinion that distribution of marine animals was probably determined by extremes of

(*h*) Karsten, in Report of German Commission (trans. in U.S. Commissioners' Report for 1879.)

temperature rather than by means. The extreme cold of winter in the southern part of the North Sea, as contrasted with the heat of summer, may explain why it is that fishes that prefer moderately warm water, such as the mackerel and pilchard, are not more plentiful there. We have seen that the mean variation of surface temperature in East Anglian waters is 20° , but the extreme variation, especially in seasons of exceptional severity, is considerably greater. In winters of severe and protracted frost the fauna of the intertidal zone suffers not a little; and even oysters not subject to exposure by the recession of the tide occasionally perish in great numbers. Certain fishes are also highly sensitive to cold. In times of biting north wind, with very low temperature protracted for days, congers in the genial waters of the south-west of England—both North and South Devonshire—have been found in shoals floating helplessly numbed on the surface of the water. Surface-swimming fishes at such times take refuge in comparatively deep water beyond the range of these meteorological fluctuations. In shallow water of less than twenty fathoms the effects of storms would be considerable even at the sea-floor, but in the deeper water of the “pits” the conditions would be much nearer those of a normal season.

In deep water there is protection against extremes or even serious changes of temperature, and also against the fury of the gale.

Low temperature has been supposed to retard the spawning of fish. If, however, for the reasons connected with surface food just indicated, the shoreward movement is delayed, all that can be said with certainty is that the spawning fish are not met with so early as usual. Food is no doubt obtained in greater abundance when compressed into a smaller thickness of water, and it is possible, of

course, that the superior nutrition of the banks may have an influence in expediting the ripeness of the spawn which is missed when the arrival on the banks is delayed.

The process of incubation is much affected by temperature. The period required for hatching herring ova varies from a week, when the temperature is 54° , to six weeks when it is 38° . In the case of cod, a range of from thirteen to fifty days has been observed, and so on with other fishes.

Lastly, there are the effects of temperature on the relative scarcity or abundance of food. In this branch of the investigation little progress has yet been made. There is reason to suspect considerable differences from year to year in the supply of surface food—entomostraceans, crustaceans, &c.—corresponding to the differences in the swarms of locusts, flies, and other insects on land. The precise effects of heat and cold on the production of the different marine invertebrates, have still to be determined. The ova of molluscs and annelids have been found in the Baltic at all seasons of the year, but seasonal variations and intermissions of the reproductive process seem to be the all but universal rule, and there is at least probability in the remark of Prof. Möbius, that “the periodical increase and decrease of nutritive matter in the different parts of the sea depend on the degree of warmth and light which during the changing seasons they receive from the sun.” (*h*)

In their thoroughly practical and excellent pamphlet on “Oyster Culture,” (from which I gratefully acknowledge having quoted largely in the latter portion of this work,) Messrs. Anson and Willett evidently disagree with the foregoing authority on the effects of temperature, and give the following reason:—

(*h*) Ibid.

It has been said that alterations of temperature have not any great effect on the inhabitants of the bottom of the sea, owing to the supposition that no great amount of cold can possibly be experienced there, sea-water being at its greatest density at about 40° Fahrenheit.

Here, however, theory and practice do not agree. Mr. Polley, a dredgerman of forty-two years' experience, when examined before the 1876 Commission, said that "he knew a nice bed of scallops which existed a year or two previously, to the westward of the Straits of Dover, and which showed at once, when the fishermen drifted on to them, that they were to the westward of the oyster grounds. One spring, after a severe winter, he was dredging on this bed, and he found that all the scallops had been killed by the cold. The same spring he found all the spider-crabs near Jersey to have been destroyed from the same cause, so that, whereas in former years they had no difficulty in getting a large basketful in a day, that year they could not find one."

This shows how the bottom of the sea can be affected by temperature; other dredgermen and deep-sea fishermen express similar opinions confirming this view.

They say also that cold breaks up the ground below the water, and renders everything there brittle in the same way, though perhaps to a less degree, than it does above water.

DEPTH AND DENSITY.

In the inter-tidal zone, when high water occurs about noon during the spatting season, the action of the sun is greatest, and development of life most active, about high-water mark. (Professor Sullivan.)

It is the reverse of this in the zone below low-water mark. When low-water spring-tides occur in the middle

of the day, as is the case on the coast of France between Cape La Hogue and Cape Frehel, and around the Channel Islands, the spat of those oysters that are laid in the shallow water outside of low-water mark have the best chance of existence, as the warmer the water, up to certain limits, the greater the activity of the very young oysters in moving, feeding, and growing. The rise and fall of the tide is also of importance; in the above-named localities there is a rise and fall of over forty feet. The alternation of comparatively deep and very shallow water exposes the oysters to successive alternations of temperature and to the effects of the variation in the amount of gases in the water, which are by no means favourable to successful reproduction.

Although oyster culturists differ on the subject, we think it has been proved by actual experiment that the spat when first emitted in the black-sick stage is of less specific gravity than the water surrounding the parent oyster, and that it rises towards the surface for a time. (*i*) How long this condition lasts has not yet been satisfactorily determined; it may be only a few hours, but it is possible that several days elapse before it descends in a sticking humour. If it has been drifted into very deep water, the pressure will have a retarding influence on the development of the germs as they descend, and at a certain depth, which as yet is unknown, the spat is destroyed.

Again, as it appears probable that both young oysters and spat have a better chance of living under conditions of pressure which are natural to them than under new con-

(*i*) One oyster culturist says that "last year he never saw so much spat floating, yet not one did he breed." Another says: "Yes, that's true; but the year before last they had just as much floating, yet they had a capital fall of spat."

ditions, a knowledge of the elevations and depressions of the sea-bottom are of importance, as affecting the distribution of oysters, and the directions in which the banks extend.

Besides affecting pressure, depth influences the amount of light, aëration of the water, and its temperature.

Oysters dredged up from greater depths than twenty-five fathoms are generally thin and coarse; thin, because the amount of alluvial deposit containing certain kinds of infusoria necessary for their food is mixed with so much sea-water that their food is weak and scarce; and coarse, because they have to feed on foraminifera, which has much the same effect on oysters as a meat diet has on pigs!

The large shallows in the estuary of the Thames, where the banks are just covered at low-water neap-tides, the Kentish flats, &c., become unduly heated during the long summer days, and there appears to be no reason to doubt that this is the cause of the Burnham, Roach, and other rivers thereabout, being very favourably situated for the production and deposit of spat, the tide as it rises bringing in the heated water and raising the temperature of these rivers.

TIDES AND CURRENTS

Exercise great effect on oyster culture by running away with the spat until it dies, or is deposited in localities unfavourable to its continued existence. Mr. Buckland said that the young oyster in its first stage of life moved easily about in the water—"as thistle-down in a field is carried to and fro by light airs." He also thought that the cilia enabled the spat to guide themselves to a certain extent, but of course they could not make headway against

the course of the current, and he likened them to Virgil's boatman :—

“ Si brachia forte remisit,
Atque illum in præceps prono rapit alveus amni.”

Currents also form eddies, both in rivers and in the open sea : where there is a bend in a river, an eddy generally forms on the inside of the curve, and here the spat can float up and down, and, being thus detained, has a better chance of resting.

Upon a large scale this eddy theory is very important ; one of the reasons why oysters breed, or rather used to breed, so abundantly in the deep bays on the west coast of Ireland—Kilkerran and Birterbuy bays, county Galway, to take two examples, is that innumerable eddies and currents are formed by the many islands in these bays.

In Cancale Bay, and on the west side of the Ile de Ré, there are natural beds of oysters outside in the sea, and the spat is brought inshore by the currents and deposited either on the *parcs*, which are made on the foreshore, as low as possible, or in very shallow water, from whence it is dredged up by hand.

NATURE OF THE SEA-BOTTOM.

The nature of the sea-bottom involves another question than that already treated of under the head of enemies, in relation to deep-sea beds ; it is that if oysters fall on rocky or uneven bottom, and survive, they are practically lost, as it is impossible to dredge them up from these grounds, the bottom being called too “ fasty ” to be worked, *i.e.*, that the dredges catch fast at the bottom, and are either capsized or lost.

If the sea-bottom round the Channel Islands were but as smooth as the North Sea, and the North Sea had as

strong scouring tides, and water as well suited for the food of oysters as that of the Bay of St. Malo, deep-sea oysters would be better and more plentiful.

B.—ARTIFICIAL CAUSES.

DREDGING.

Oyster fishing is pursued in a very different manner in different countries. Round Minorca, divers, with hammers attached to the right hand, descend to the depth of a dozen fathoms, and bring up in their left hand as many of the bivalves as they can carry, two fishermen, usually associating for the purpose, diving alternately until the boat is filled.

On the English, French, and German coasts, the dredge is employed. This operation is also necessary to keep down the marine vegetation, which would stifle the oysters; the engine is of iron, and very heavy (from 20 to 22lbs). It is thrown overboard, and descends to the bottom of the sea, which it ploughs and scrapes up, detaching the oysters, and throwing them into a net attached to the dredge. In this process oysters, large and small, are torn from their native bed, some going into the net, but a larger number are buried in the mud. It would be difficult to imagine a more destructive process; and when the habits of the oyster are considered, it is evidently one admirably contrived to destroy the race. In France oyster dredging is conducted by fleets of thirty or forty boats, each carrying four or five men. At a fixed hour, and under the surveillance of a coast-guard in a pinnace bearing the national flag, the flotilla commences the fishing. In the estuary of the Thames the practice is much the same, although no official surveillance is observed. Each bark is

provided with four or five dredges, each resembling in shape a common clasp purse.

These dredges are formed of network, with a strong iron frame, which serves the double purpose of acting as a scraper and keeping the mouth open, while giving it a proper pressure as it travels over the oyster-beds.

Different descriptions of dredges are used, according to the depth of water and character of the bottom. Dredges are made on nearly the same plan on all parts of the coast; the only difference being in their breadth and consequent weight, and in the character of the body of the dredge.

Deep-sea dredges for rough bottoms have the under part of the bag made of iron rings, from two to three inches in diameter; the upper part is made of strong netting, as it is not exposed to the wear and tear of being dragged over the ground.

Deep-sea dredges for muddy bottoms have the bag made of stout canvas, with numerous small eyelet-holes in it.

Where it is desired to bring up brood uninjured, a hide net is substituted for the iron rings; in the Blackwater they use "half skin-backed" dredges, the other half of the lower side being made of wire network.

The largest deep-sea dredges are used in St. George's Channel; they are frequently 12 to 15 feet broad. They are towed astern of the boats, and are left overboard for a much longer time, as they have a large carrying capacity.

Dredges that are worked on the side of boats vary between 16 and 17lbs. as used on the Whitstable grounds, to the 70lbs. deep-sea dredges. Whatever their weight, their framework is constructed in the same manner; the lower part of the frame is flattened and turned forwards at such an angle as to enable it to scrape the surface; this

scraper is called the "bit" or "knife," and to its ends are welded two iron rods; these, after curving to form the narrow sides of the mouth, are united together and form two sides of a triangle, which is bisected by a strengthening piece, the base of the triangle being made by a piece of iron called the "warbin;" this is welded into each side, its apex fitted with a shoulder for convenience of working on the gunwale, and with a ring to which the dredge-rope is made fast.

The free ends of the bag are fastened to three pieces of wood, the "side-sticks" and "catch-stick;" the side-sticks help to distend the bag, and the catch-stick gives a convenient hold when the bag is turned out.

A great deal of skill is necessary in using the dredge, and the greatest attention must be made to the force and direction of the wind and tide; but of that more hereafter.

The size of the iron rings forming the under side of the bag are regulated by the size of the ring which in certain localities is used for measuring the oysters; those that pass through the ring being unmarketable.

The meshes of the netting forming the other side are of about two inches square.

Where the grounds are occasionally rocky, or where large stones are sometimes found, the dredge-rope is first shackled into the left lower edge of the framework; it is then brought along the middle-bar, and a clove-hitch taken round it with a strong, thin piece of hide, about six inches below the ring; the rope is then stopped to the ring with a piece of spun yarn, leaving a few inches of slack between the hide and the ring. The dredge, thus fitted, hangs square until it meets an impediment; on it "setting" fast, the spun yarn breaks, the rope slips through

the hide, and the dredge is recovered capsized, a few oysters or culch only remaining in the lower end.

French fishermen do not appear to use this contrivance, and they therefore dread working where English dredgermen can work with impunity.

Large dredging cutters can work six dredges at a time, three forward and three aft, on the side of the boat, the weights gradually diminishing from forward aft—that is, the dredge worked nearest the stern should be the lightest, say 45lbs., the next 50lbs., the next 55lbs., next 60lbs., the next 65lbs., and the one nearest the bow 70lbs. The reason of this is obviously that they should all dredge in diverging lines, the foremost dredge, having the least rope, is the most perpendicular, and therefore requires to be the heaviest.

This plan prevents the dredges from dragging together. If the dredges “jump,” they require more rope; the men occasionally feel the rope; if “working” well, they can feel the dredge scraping smoothly along, the only irregularities being caused by those of the bottom itself.

The direction of the wind makes a very great difference to the “catch” of the boats.

Where the oysters lie in streams in the direction of the tidal currents, as is generally the case on deep-sea beds and banks, the wind is most favourable when it is at right angles to the stream of oysters; the boats then lay to, and drift with the tide. If the wind is blowing parallel to the stream of oysters, the boats can only dredge across them, and the difference in the result is very great. A boat will get 1000 oysters in an hour in one case, and will be lucky to get 200 an hour in the other.

Steam Dredgers.—We have not entered into the question of steam dredgers. We do not think they will pay their

way in competition with the cheaper sail-power. It is very difficult to regulate the speed of the engines, and the dredges do not *bear* so well when worked from a steamer. Still they have two great advantages, one of being able to work in any direction, irrespective of the direction of the wind, and the other in not being delayed by calms and contrary winds in proceeding to and coming from the fisheries. Steam dredgers with sail-power would probably be the most advantageous, but we have not yet seen this class of vessel employed.

Hand dredges are allowed by the French Government to be used at some places on the coast. The fishermen and fisherwomen are allowed to use these dredges as far out as they can walk, and they tow them along by a band round the shoulders or waist; the young oysters thus caught are laid down on the fattening beds; and cleaning, sorting, &c., gives employment to many hundred people. There are no pits, so called, though the ground being composed principally of mud, the oysters are kept wet, even at extreme low water.

M. le Commissaire de Marine at Cancale told us that they had lately to imprison and fine one of the fishermen. The man was very tall and powerful, and at low spring tides he would go seaward until his chin was level with the water, and would then seize the dredge-rope between his teeth, and thus almost do the work of a dredging boat. As the oysters are most plentiful on the edge of the bank, in about six feet of water, the man by using this means obtained a far greater quantity of young brood than the other fishing people. At first there appeared to be no law to prevent this, but the difficulty was overcome by prosecuting him for using a dredge which was not a *hand* dredge.

Before we conclude this portion of our chapter, there are two points which deserve consideration, *i.e.*, the difficulties attending dredging at night and during moderately rough weather; these have been exaggerated, whilst the difficulty of dredging during the prevalence of winds from unfavourable quarters has not received its proper share of recognition.

When the Oyster Bill of 1876 was brought forward, there was an outcry among dredgers that, if the Bill passed, they would only have April, September, and October in which they could catch and sell deep-sea oysters, as, from the beginning of November to the end of March the weather would practically prevent dredging on the North Sea and Channel beds. It is true that occasionally a spell of very bad weather will prevent our well-found boats from going out in the winter, as well as in the spring or autumn; but, if their catch will pay for the wear and tear, it would have to be very bad weather indeed that would keep such a boat, for instance, as a Jersey dredging cutter in port. October, 1882, was an exceptionally bad month, and the Channel boats could scarcely go out at all, but in November there was but one gale of wind, and in January of this year (1883) one Channel oyster boat alone obtained over 50,000 oysters!

These remarks do not apply to open dredging-boats or to ill-found or ill-favoured smacks, but to the real Channel dredging boats, that will keep the high seas in any weather. The kind of craft that have in years past left Jersey, on a dark winter's eve, with a falling barometer, and a south-west gale blowing, sailing down to Granville on the coast of France, and working all night on a dead lee shore—they have returned to Jersey next morning, laden with the spoil poached from the French grounds; on these occasions they

have dredged for oysters when the sea was running so high that they could only work one dredge at each extreme end of the boat, as they were rising and falling so much that each dredge only worked alternately with the other. Even then they used to bring back sufficient to pay them better than a month's more honest work on their own grounds. But those beds off Granville exist no longer, and a French Government steamer lies there now to protect the Reserve beds off Point de Champeaux, and the Granville and Cancale beds farther off. We mentioned the subject to endeavour to prove that *where oysters are plentiful, fishermen will soon find boats and means to work for them.*

As to "Dredging during the prevalence of winds from unfavourable quarters," we respectfully venture to submit these remarks to those who think, with the Royal Commission of 1866, that "but little skill is required in working the dredge" (page 7, Appendix of their Report), and to inspectors who examine grounds, and see not what there is to be seen, but what the fishermen please to show them!

To render our meaning clearer, let us put a suppositious case: Supposing we are the managing men of a company whose ground is going to be inspected by a gentleman who, however clever as a scientist and unbiassed as a judge, has no practical knowledge as a dredger or a seaman. If we wish to show our ground at the best, we take him to those parts of it where we can work the dredges along the "stream" of the oysters; if we, however, wish to show but few oysters, we would take him to a part of our grounds where the wind would compel us to work across the "stream;" or perhaps, if less honest still, we would by a very little manipulation of the dredge, that would be unobservable to any but a practised dredgerman,

arrange the towing-rope so that the dredge should apparently "work" well; but if oysters were in heaps down below, not one would it bring up!

HARROWING AND TRAWLING.

Most owners of oyster grounds use harrows for removing the weed and slub, thus cleansing the beds and giving young oysters more room to grow in. Harrows are about four feet square, they have on their under sides a number of small wooden pegs four to six inches in length; these pegs should be so placed that, when the harrow is used, each peg should work over a different line to the others. The size of the harrow and the weight on its back is regulated by the nature of the ground, the hardness of shells of the oysters, and the quantity of accumulated mud, weeds, &c. The French authorities use the harrow on the Government Reserve beds, and have lately paid the *gardes jurés* to work the harrow on the Cancale beds, where there has been a deposit of mud.

Harrowing is particularly useful on deep-sea beds during the early summer months, as it will help to prepare the beds for the reception of spat, by disturbing the silt, &c., which is then carried away by the tide.

We have coupled harrowing and trawling together, as they appear to have much the same effect on deep-sea beds. Both tend to keep down weeds and to disperse oysters. Trawlers say that they endeavour to avoid oysters, as they tear their nets, though the English trawlers often bring into port large quantities of oysters, brought up, we are bound to suppose, unintentionally! French trawlers are so carefully looked after under the minute inspection of their authorities, that it would be impossible for them to bring any

oysters on shore, and therefore trawling is permitted all the year round on the French coast, as it is on the English, except where protective rights are enforced.

Trawlermen think, and rightly so in our opinion, that every grant or concession of oyster grounds made by the Board of Trade is a direct invasion of their rights ; for as soon as the grant is confirmed, it becomes illegal in the appropriated fishery to use any other instrument than hooks and lines and nets for catching floating fish. Inshore trawling for soles at night, for example, on these grounds—one of the most profitable sources of their living—is prohibited.

In the Bay of St. Malo the line of Government Reserve beds divides the Granville from the Cancale fisheries. In one part of this ground oysters have become again very productive, whilst on other parts there are hardly any. As trawling is strictly prohibited on the beds, those that contend that it is beneficial to oysters point to one part, whilst their opponents instance the other ! Practically the question seems to us to be simple enough. Trawling for flat fish on oyster grounds with vessels having *beam* trawls will do more good than harm, provided that the majority of the oysters that are dredged up are thrown overboard again, and returned to their beds. It is true that the iron ends of the trawl beam will crush and destroy the young brood or spat that it happens to drag over ; but weed, mud, and other enemies are disturbed by the trawl, and the ground rendered more fit for the reception of spat.

But chain trawls are a different thing. Instead of a hemp rope, the trawl is then fitted with an iron chain at the bottom of the net ; this chain adapts itself to the inequalities of the bottom, and is most destructive to oyster

beds ; during the autumn, when the shells are most tender, the heavy iron chain will break off the young shoots and do great harm.

Trawlers have lately found oyster beds in the North Sea. The huge "Skelling Bank" off Heligoland consists of numerous patches of oysters ; other great oyster beds have been found off the Dutch coast by trawlers.

A trawl has a beam which spreads about 40 feet, and, especially in very deep water, where dredges will not work nicely, it picks up a great many oysters. If trawling is made into dredging on a large scale, it should be subject to the same laws.

RINGS FOR MEASUREMENT.

The object of ring measurement is to prevent fishermen removing immature oysters from the deep-sea and other beds. Where "ring" laws prevail—and they are widely enforced in France—all oysters that pass through a ring from two-and-a-half to three inches in diameter are supposed to be unsaleable and unmarketable, and should be immediately returned to the sea.

We, have, however, no hesitation in saying that these ring laws are frequently honoured more in the breach than the observance, and that the expense and trouble of enforcing them are greater than any benefit that arises where they are always infringed. Fishermen will always give themselves the benefit of the doubt, and when the oyster is declared to be unsaleable, in many cases, such as on deep-sea beds, it is too late to put it back again ; the boats may be away four or five days, or even longer, from port, Sunday intervenes, and the immature oysters are half-killed before the possibility of re-laying them occurs. Prac-

tically they are eaten by the fishermen or their friends, or thrown away.

In framing rules and regulations on fishery matters, it is most desirable that the interests of the public and the interests of the fishermen should run together; with this object in view, it was suggested to the States of Jersey by Commander Anson, late of H.M.S. *Dasher*, that it would be advisable to allow the dredgers five per cent. on the value of all oysters brought on shore, provided that they would agree to return to the beds all immature oysters, whether they were able to pass through the ring-gauge or not.

The percentage, Captain Anson stated, was arrived at from calculating the proportions of young and old oysters, by taking the average catch of the Jersey boats in one month, and reducing the immature oysters to one-fourth their number, old oysters fetching four times the price of young ones.

The States of Jersey appointed a Committee to consider the matter, and we believe it is still "left sitting." The wheels of the Jersey legislature are, however, old, and it requires a long time to overcome their inertia!

A ring for measurement is entirely a fallacious test as to the age and condition of an oyster. A native "Tom Thumb," or dwarfed oyster, will pass through a ring two inches or even less in diameter, though it may be five or six years old—and such as are sold by retail for 3s. 6d. a dozen—whilst young "thrifty" North Sea or Channel oysters, containing not half the quantity of the fish in Tom Thumbs, will frequently not go through a ring of $3\frac{1}{4}$ or $3\frac{1}{2}$ inches in diameter, and are dear at 1s. a dozen.

We have seen deep-sea oysters which have been considered only sixteen months old unable to pass through a

2½-inch ring. Inside they were thin and watery, whilst the shell was so fragile that the outer shoots could be easily broken by slight pressure between the finger and thumb, and in some cases the shells were so friable that it was impossible to open the oyster in the usual manner.

REMOVAL ON CULCH FROM PUBLIC GROUNDS.

The removal of culch from oyster beds is extremely prejudicial, and in many parts of England complaints are loudly made that private owners remove culch from the public grounds on to their own layings. If these complaints are well founded, such a detrimental practice should be made illegal, and punishable by heavy fine.

It would be far wiser if, instead of putting the old shells into the dust-bin, or burning them for lime, they were collected and returned to the beds; but whilst people can get them on public grounds for nothing, they will not pay for the trouble of collection even by the dust contractors. In this respect the French, in some places, are even behind us, for we have seen their dredging boats at Cancale and Granville unload shingle, culch, brood, half-ware and ware, all mixed together, and the lots sold on the beach by auction just as they stand; the practised eye of the buyer detecting whether there is more culch, &c., than oysters, or *vice versâ*. The young brood may be laid down to grow and fatten or die, as the case may be, but actual harm is done to an oyster-bed by every old shell that is removed. On deep-sea beds there are often large detached stones; a mistake that dredgemen always make is that when, after a good deal of difficulty, one of these "small Gibaltars" is hove up, overboard again it goes!—on to the same ground, to be probably the cause of similar hard work, and perhaps

unmellifluous language, again and again, if not to the same men, to some of their dredging companions.

It would be very easy to put these encumbrances on one side, and to deposit them elsewhere, and thus really work the beds cleanly. (*d*)

(*d*) Anson and Willett's "Oyster Culture."

CHAPTER XLI.

PRELIMINARY OBSERVATIONS ON ARTIFICIAL OYSTER CULTURE.

PREAMBLE—LIFE ON AN OYSTER BANK—FATTENING OYSTERS—
GAS IN BEDS—OVERFISHING—THE OBJECT OF OYSTER CULTURE
—DESCRIPTION OF A “NATURAL OYSTER BED”—LAKE FUSARO
—THE FRENCH METHOD OF OYSTER CULTURE IMPOSSIBLE IN
GERMANY—THE OLD ENGLISH METHOD BETTER THAN THE
FRENCH NEW ONE—FRANK BUCKLAND’S OPINION—THE CLI-
MATIC THEORY—FAILURE OF BASIN CULTURE IN ENGLAND
AND FRANCE—DUTCH OYSTER CULTURE—LORD MONTAGU’S
EXPERIMENTS AT BEAULIEU—SUSPENSION AND DISAPPEAR-
ANCE OF SPAT—DR. HOEK’S OPINION ON ENGLISH OYSTER
CULTURE—NUMBER OF OYSTERS WHICH MAY BE TAKEN FROM
A BED WITHOUT INJURY TO ITS PRODUCTIVENESS—SCHLESWIG-
HOLSTEIN BEDS—HOW TO ESTIMATE THE THICKNESS OF OYSTERS
UPON A BED BY THE DREDGE—ARCACHON—REFUTATION OF
THE CLIMATIC THEORY—IRELAND—CAUSE OF THE FAILURE IN
BASIN CULTURE—REGNEVILLE—ADVICE TO THE BRITISH PUB-
LIC—THE MARQUIS OF LORNE ON “OYSTER CULTURE”—COST
OF A PROVISIONAL ORDER—PROFESSOR LANKESTER ON STATE
AID—THE MARINE BIOLOGICAL LABORATORY—REARING OF
OYSTERS FROM ARTIFICIALLY-FERTILIZED EGGS—THE ZOOLO-
GICAL STATION AT NAPLES—THE DUKE OF ARGYLL ON THE
GOVERNMENT—THE BOARD OF TRADE.

“Under a good government the land brings forth its fruit, and the
sea yields its fish.”—*Homer’s Odyssey*.

IN London, on the 4th of May, 1876, Mr. Blake, the inspector of fisheries, made, before the Commission for the investigation of the oyster-fisheries, the astounding statement that every oyster grown by means of artifical culture near Reculvers, at the mouth of the Thames, cost £50 sterling; that everyone grown in Herne Bay cost £100; and in a third place about £500; and that he was prepared to furnish several other examples of a like character. Mr. Blake, who is very well acquainted, from personal observation, with French and English oyster-culture, considers artificial oyster-breeding, according to the French method, impossible along the British coast, on account of the unfavourable character of the climate.—“The Oyster and Oyster Culture,” by Möbius.

1st Player : I hope we have reformed that indifferently with us, sir.

Hamlet : O, reform it altogether.—*Shakespeare*.

At the risk of being accused of repetition, I begin this chapter with the hope of fulfilling a purpose, the practical outcome of which must alone exonerate me from all probable blame.

In bringing this book and its subject before the British Public, I have been considerably swayed by the desire to give an impetus to the artificial cultivation of the oyster in England, on the French or American system, so far as that of either can be accommodately followed. And I believe that the experimental trial of such an undertaking, under the oyster legislative policy hitherto pursued by our Government, cannot possibly have a successful issue until the enormous expense incurred by such a mercantile venture is lowered to the highly beneficial and prosperous standard of one or other of those nations.

To say nothing of my own few and scattered opinions throughout these pages, I believe that those of other and

far abler writers which I have advanced, and, in this final chapter, other such that I do advance and urge in support of my theory, even if they are not overwhelming in proof thereof, will go far to confirm the practical utility of the suggestions subsequently to be detailed for the instruction of, and in the interest of the British ostraculturist ; opinions which (despite any weak points seen—and seen *only* by opponents) are yet consistent enough to await their triumph in the verdict of the general public upon their common sense-dictated appeal for practical application.

Upon the whole, taking into consideration my above-mentioned object in writing these chapters, I may say, almost in the very words of Möbius, that—"I believe I have already demonstrated that true oyster-culture must be conducted according to the same principles that are employed in the extensive cultivation of any other living commodity. If I have done so, then I have accomplished what should not have been necessary ; for what is more natural than that both oysters and oyster-culture should be subject to the same universal, controlling, biological laws. And yet an explanation was necessary, for not only the ignorant in natural science, but men also who teach and write upon biological subjects, have, even in our day, expected the most impossible results from the artificial breeding of oysters. The investigator has seldom to seek for new facts and ideas alone ; generally, in the first place, he must be able to recognize and expunge from the system any errors which may exist in the knowledge previously acquired, and in their places establish those facts and ideas which he has found to be true. And while I am aware that the book hereby presented to the world contains but a very modest share of what we wish to know with certainty concerning oyster biology and oyster culture ; still I have

allowed it to appear because, incomplete as it is, it will give welcome information to many biologists and oyster-breeders, and will serve as a safe basis for the operations of those governments which have within the limits of their territories natural oyster-banks, which they desire to have managed in the best interests of the general public. (a)

. . . . *In theory*, oyster culture seems so simple a thing, that the wonder is there are so many failures at it. But when we come to put our theory into practice, we begin to find how many local circumstances there are, apparently trifling in themselves, but which really exert a powerful influence on our calculations; and it is only by many watchful observations that anyone can acquire sufficient experience to be able to understand, and to cope with the numberless difficulties which will beset the path of an oyster grower. (b)

The territory of an oyster-bed (as the reader has already been informed) is not inhabited by oysters alone, but also by other animals. Over the Schleswig-Holstein sea-flats, and along the mouths of English rivers, I have observed that the oyster-beds are richer in all kinds of animal life than any other portion of the sea-bottom. As soon as the oystermen have emptied out a full dredge upon the deck of their vessel, one can see nimble pocket crabs (*Carcinus maenas*) and slow horn-crabs (*Hyas aranea*) begin to work their way out of the heap of shells and living oysters, and try to get back to the water once more. Old

(a) Introduction—"The Oyster and Oyster Culture." By Karl Möbius.

(b) "Oyster Culture." By Commander C. V. Anson, R.N., and E. H. Willett, F.S.A. (Prize Essays, issued in connection with the Great International Fisheries Exhibition. William Clowes & Sons, London. 1883.)

abandoned snail-shells begin to move about, caused by the hermit-crabs (*Pagurus bernhardus*), which have taken up their residence in them, trying to creep out of the heap with their dwellings. . . . Here and there a ring-worm (*Nereis pelagica*), of a changeable bluish colour, slips out of the mass of partially dead, partially living, animals. . . . Even the shells of the living oysters are inhabited. Barnacles (*Balanus crenatus*), with tent-shaped, calcareous shells, and tendril-shaped feet, often cover the entire surface of one of the valves. . . . Upon many beds the oysters are covered with thick clumps of sand, which are composed of the tubes of small worms (*Sabellaria anglica*). These tubes, called "sand-rolls," resemble organ-pipes, and are formed from grains of sand cemented into shape by means of slime from the skin of the worm. The shell forms a firm support upon which the worms can thus live close together in a social community. Upon certain beds near the south point of the island of Sylt, where the finest flavoured oysters of our sea-flats are to be found, there lives upon the oyster shells a species of tube-worm (*Promatoceros triqueter*), whose white, calcareous, three-sided tube, is very often twisted about like a great italic *S*. The shells of many oysters upon these beds also carry what are called "sea-hands" (*Alcyonium digitatum*), which are white or yellow communities of polyps, of the size and shape of a clumsy glove. . . . Within the substance of the shell itself animals are also found (such as the *Clione celata*), and in the spaces between the layers of the shell in old oysters is found a greenish-brown worm (*Dodecaceraea concharum*), armed with bristles, and bearing twelve large tentacles upon its neck. I once took off and counted, one by one, all the animals living upon two oysters. Upon one I found 104 and upon the other 221

animals of three different species. . . . Very few plants grow upon the banks. Upon only a single one of the oyster-beds of the sea-flats has eel-grass (*Zostera marina*) taken root. (c) Upon other beds reddish-brown algae (*Floridiæ*) are found, and, floating in the water which flows over the beds, occur microscopic algae (*Desmidiæ* and *Diatomaceæ*), which serve as nourishment to the oysters. If the dredge is thrown out and dragged over the sea-flats between the oyster-beds, fewer and also different animals will be found upon this muddy bottom than upon the sand. Every oyster-bed is thus, to a certain degree, a community of living beings, a collection of species, and a massing of individuals, which find here everything necessary for their growth and continuance, such as suitable soil, sufficient food, the requisite percentage of salt, and a temperature favourable to their development. Each species which lives here is represented by the greatest number of individuals which can grow to maturity, subject to the conditions which surround them, for among all species the number of individuals which arrive at maturity at each breeding period is much smaller than the number of germs produced at that time.

. . . . Science possesses, as yet, no word by which such a community of living beings may be designated ; no word for a community where the sum of species and individuals, being mutually limited and selected under the average external conditions of life, have, by means of transmission, continued in possession of a certain definite territory. I propose the word Biocoenosis (*d*), for such a

(c) This weed grows in great quantities on the French beds, and proves very useful in protecting the oysters at low tide from the heat of the sun.

(d) From *Bios*, life, and *koinôein*, to have something in common.

community. Any change in any of the relative factors of a biocönose produces changes in other factors of the same. If, at any time, one of the external conditions of life should deviate for a long time from its ordinary mean, the entire biocönose, or community, would be transformed. It would also be transformed if the number of individuals of a particular species increased or diminished through the instrumentality of man, or if one species entirely disappeared from, or a new species entered into, the community. When the rich beds of Cancale, Rochefort, Marennes, and Oléron were deprived of great masses of oysters, the young broods of the cockles and edible mussels which lived there had more space upon which to settle, and there was more food at their disposal than before, hence a greater number were enabled to arrive at maturity than in former times. The biocönose of those French oyster-banks was thus entirely changed by means of over-fishing, and oysters cannot again cover the ground of these beds with such vast numbers as formerly, until the cockles and edible mussels are again reduced in number to their former restricted limits, because the ground is already occupied and the food all appropriated. The biocönose allows itself to be transformed in favour of the oyster, by taking away the mussels mentioned above, and at the same time protecting the oysters so that the young may become securely established in the place thus made free for them. Space and food are necessary as the first requisites of every social community, even in the great seas. . . . Even upon the best beds the oysters will remain poor if they are allowed to lie too thick upon the bottom ; but if a portion of these poorly nourished oysters are taken away, those which remain—as has been found out by experience upon the Huntie Bank, the largest and most fruitful of all the

Schleswig-Holstein beds,—will soon become fatter, that is, their generative organs will become larger because more eggs or spermatozoa are produced than with poorer oysters. . . . Thus it is with oysters as with all other animals: their increase in size and numbers depends upon the quantity of food which they get and consume. . . . I do not consider it practicable to fatten oysters by artificial means, although in North America and Europe an effort should be made to fatten planted oysters upon corn-meal. The food of oysters consists of very small organic particles which float in the water, and if one should attempt artificial feeding by carrying to the oysters of a bed water containing pulpy pulverized flesh, bone-meal, fish-guano, or corn-meal, it would be necessary to prevent the water from flowing off from the bed until all the organic matter had been eaten. But by so doing a large quantity of foul gas would certainly be generated upon the bed and remain there, so that the oysters, instead of fattening, would become sick and die. Among the external life conditions of a biocönose, temperature plays an important part.

. . . . A large number of the most productive oyster-beds upon the west coast of Europe have been devastated by overfishing, and many fresh waters have, through the incessant catching of half-grown fish, been almost entirely depopulated. It is very natural that those years during which a large number of herring, salmon, or sturgeon are caught upon a certain stretch of territory, should be followed by years when fewer fish appear, because in the years when large catches are made very many breeding individuals are destroyed.

. . . . People have experienced a thousand times that the best flavoured and most agreeable animals and plants are brought to perfection only under entirely definite

external conditions of life, yet they wish an exception to this law of nature in favour of the oyster. They wish for miracles in order that oysters may be supplied to the many who are now oyster-eaters, as cheaply and plentifully as they formerly were to the few who at that time appreciated their value.

The object of a good oyster industry is to gain from the territory cultivated the greatest possible profit, and at the same time to render the industry permanent. . . . A breeder of cattle who would maintain a certain definite degree of productiveness in his herd, must keep a definite number of breeding animals. . . . A profitable permanent system of oyster-culture is also dependent upon the same law. Hence its foundation is the preservation of a stock of mature breeding oysters. No artificial system has yet succeeded in bringing to maturity, in inclosed parcs, generation after generation of oysters, and the most clever breeders are obliged to rely upon the natural banks in order to obtain breeding oysters, or young, for their fattening-ponds. Hence the foundation of all oyster-production, whether artificial or natural, is the preservation of a stock of full-grown breeding oysters upon the natural oyster-banks. . . . The preservation of oyster-beds is as much a question of statesmanship as the preservation of forests. (*e*)

Before I proceed any further it were as well, perhaps, if I describe what is properly a "natural oyster-bed." Very few people know what is and what constitutes one. Indeed it is only a matter of opinion at the best, and opinions are likely to be influenced largely by self-interest. A large number of persons make a distinction between oyster-beds that ebb dry and those that are covered at all

states of the tide—a distinction which, it is needless to say, does not have any sound foundation to rest upon. Many also appear to think that a natural bed is not a “natural bed” in the meaning of the law, because it is a little one. On the other hand, there are some whose definition of a natural bed is so liberal that it not only covers all places where oysters were in the past or are in the present, but includes any area where they might, could, would, or should grow in the future. Arguments have been made to the effect that, as the drifting spat was evidently a product of nature, wherever the spat attached or oysters grew that spot became a natural oyster-bed. Evidently such a view would preclude any and every system of oyster culture. On the other hand, it has been argued that small groups and bunches of oysters, separated and distinct from any considerable area were not natural beds within the meaning of the law. A legal decision (by Judge Goldsborough, of Maryland,) defines a natural bed as one not made by man, and of sufficient area to have been profitably worked by the general public, as common property, within some recent period of time. This decision has been practically adopted by the shell-fish Commission of Connecticut in defining the natural beds of that State, and their course has been approved by legislative enactment. Useful as a guide, however, it would not be proper to be strictly governed by the Goldsborough decision in defining the natural beds of North Carolina.

In North Carolina the oyster industry is yet in its infancy. The population is too sparse, and the present demand too slight, to have caused any continuous fishery or even any general knowledge of the positions or areas of the natural beds. Mere testimony as to previous fishery or non-fishery would not, therefore, in all places, be con-

clusive, and it was necessary to supplement such testimony by actual examination of all the adjacent area. Such has been the course adopted. (*f*)

Dr. Brooks, describing a natural bed, says:—An examination of a Coast Survey chart of any part of the Chesapeake Bay, or of any of its tributaries, will show that there is usually a mid-channel or line of deep water, where the bottom is generally soft and where no oysters are met with, and on each side of this an area where the bottom is hard, running from the edge of the channel to the shore. This hard strip is the oyster area. It varies in width from a few yards to several miles, and the depth of water varies upon it from a few feet to five or six fathoms, or even more. But there is usually a sudden fall at the edge of the channel where the oysters stop, and we pass on to hard bottom; and a cross-section of the channel would show a hard, flat plane, with oysters on each side of the deep, muddy channel. The oyster bottom is pretty continuous, except opposite the mouth of a tributary, where it is cut across by a deep, muddy channel. The solid oyster rocks are usually situated along the outer edge of this plateau, although in many cases they are found over its whole width, nearly up to low-tide mark, or beyond. As we pass south along the bays and sounds of Virginia and North Carolina, we find that the hard borders of the channel come nearer and nearer to the surface, until in the lower part of North Carolina there is on each side of the channel a wide strip of hard bottom, which is bare at low tide and covered with oysters up to high-water mark, although the oysters are most abundant and largest at the edge of the deep water, where they form a well-defined

(*f*) Report on the Sounds and Estuaries of North Carolina, with reference to Oyster Culture. By Lieutenant Francis Winslow.

reef. In our own waters there is usually a strip along the shore where no oysters are found, as the depth of water is not great enough to protect them in winter. The whole of the hard belt is not uniformly covered with oysters, but it is divided up into separate oyster rocks, between which comparatively few can be found. . . . When such a bed is carefully examined, it will be found that most of the rock is made up of empty shells, and a little examination will show that the crowding is so great that the growth of one oyster prevents adjacent ones from opening their shells, and thus crowds them out and exterminates them. . . . The most significant characteristic of a bed of this kind is the sharpness of its boundaries. . . . and between these beds are areas where not a single oyster can be found. The intervening area is perfectly adapted for the oyster, and when a few bushels of shells are scattered upon it they are soon covered with young, and in a year or two a new oyster rock is established upon them ; but when they are left to themselves the rocks remain sharply defined.

What is the reason for this sharp limitation of a natural bed ?

Those who know the oyster only in its adult condition may believe that it is due to the absence of powers of locomotion, and may hold that the young oysters grew up among the old ones, just as young oak trees grow up where the acorns fall from the branches. This cannot be the true explanation, for the young oysters are swimming animals, and they are discharged into the water in countless numbers, (*g*) to be swept away to great distances by the currents. (*h*) As they are too small to be seen at this

(*g*) Oyster spat may be said to swarm like bees, and it has been said to be as uncertain in its choice of locality.

(*h*) See the account of Lim Fiord.

time without a microscope, it is impossible to trace their wanderings directly; but it is possible to show indirectly that they are carried to great distances, and that the water for miles around the natural bed is full of them. They serve as food for other marine animals, and when the contents of the stomachs of these animals are carefully examined with a microscope, the shells of the little oysters are often found in abundance. While examining the contents of the stomach of *lingula* in this way, I have found hundreds of shells of the young oysters in the swimming stage of growth, although the specimens of *lingula* were captured several miles from the nearest oyster bed. As *lingula* is a fixed animal, the oysters must have been brought to the spot where the specimens were found; and as *lingula* has no means of capturing its food, and subsists upon what is swept within its reach by the water, the presence of so many inside its stomach shows that the water must have contained great numbers of them.

It is clear, then, that the sharp limitation of the area of a natural oyster bed is not due to the absence in the young of the power to reach distant points. There is another proof of this, which is familiar to all oystermen—the possibility of establishing new beds without transplanting any oysters. The following illustration of this was observed by one of your commissioners.

On part of a large mud flat, which was bare at low tide, there were no oysters, although there was a natural bed upon the same flats, about half a mile away. A wharf was built from high tide mark across the flat out to the edge of the channel, and the shells of all the oysters which were consumed in the house were thrown on to the mud alongside the wharf. In the third summer the flat in the vicinity of the wharf had become converted into an oyster

bed, with a few medium-sized oysters and very great numbers of young, and the bottom, which had been rather soft, had become quite hard; in fact, the spot presented all the characteristics of a natural bed. Changes of this sort are a matter of familiar experience, and it is plain that something else besides the absence in the oyster of locomotive power determines the size and position of a bed.

Now what is this *something else*? If the planting of dead shells will build up a new bed, may we not conclude that a natural bed tends to retain its position and size because the shells are there? This conclusion may not seem to be very important, but I hope to show that it is really of fundamental importance, and is essential to a correct conception of the oyster problem. Why should the presence of shells, which are dead and have no power to multiply, have anything to do with the perpetuation of a bed?

. . . . The young oysters feed upon the floating organic matter which is brought to them by the water, and this food is most abundant where the water flows in a strong current over soft organic mud. When the bottom is hard there is little food, and this little is not favourably placed for diffusion by the water, while the water which flows over soft mud is rich in food. . . . The young oysters which settle upon or near a soft bottom are therefore most favourably placed for procuring food. . . . and have the habit of fastening themselves to solid bodies, such as shells, rocks or piles, or floating bodies, whereby they are enabled to profit by the soft bottoms without danger.

Owing to the peculiar shape of an oyster shell, some portions usually project above the mud long after most of it is buried, and its rough surface furnishes an excellent

basis for attachment. . . . but there is still another reason. As the flood-tide rushes up the channels, it stirs up the fine mud which has been deposited in the deep water. The mud is swept up on to the shallows along the shore, and if these are level much of the sediment settles there. If, however, the flat is covered by groups of oysters, the ebbing tide does not flow off in an even sheet, but is broken up into thousands of small channels, through which the sediment flows down to be swept out to sea. The oyster bed thus tends to keep itself clean, and for these various reasons it follows that the more firmly established an oyster bed is the better is its chance of perpetuation, since the young spat finds more favourable conditions where there are oysters, or at least shells, already, than it finds anywhere else.

Now what is the practical importance of this description of a natural bed? It is this: Since a natural bed tends to remain permanent, because of the presence of oyster shells, the shelling of bottoms where there are no oysters furnishes us with a means of establishing new beds or of increasing the area of the old ones. (i)

The oyster dredgers state, with perfect truth, that by breaking up the crowded clusters of oysters and by scattering the shells, the use of the dredge tends to enlarge the oyster beds. The sketch just given shows the truth of this claim, but this is a very rough and crude way of accomplishing this end, and I shall devote the rest of this chapter to a description of the means which have been employed, in different places, to accomplish the same result more efficiently and methodically.

Although the development of the oyster industry on a large scale is quite modern, seed oysters for planting have

(i) The Development and Protection of the Oyster in Maryland.

been raised upon a small scale in Italy for more than a thousand years, by methods probably the same as were used by Sergius Orata, who (as already stated), according to Pliny, first attempted parcing oysters at Baia, and, finally, brought the art of oyster culture to a high state of perfection, really creating a new industry which is still practised in thousands of places much as he left it. This is especially the case in the Neapolitan Lake Fusaro—the terrible Acheron of the poets—which is a great oyster-parc, in which Art is made effectually to aid Nature in the multiplication of its products. This famous oyster-bank lies in the neighbourhood of Baia and Cumae, and forms one of the most interesting spots in that beautiful bay. It is a salt pond, shaded with a girdle of magnificent trees. It is about three miles in circumference, and about a fathom in depth at its deepest part ; its bottom is muddy and black, like the rest of this volcanic region.

It will be understood, from what has been said, that the chief obstacle to the reproduction of oysters is the absence of any solid body to which the young spawn can attach itself, and the means of shelter from animals which prey upon them. The fishermen living on the shores of Lake Fusaro have long realised this, and provided against it by warehousing, as it were, in the lake near the sea, the oysters ready to discharge their spawn, while retaining the young generations captive in the protected basins, where they are sheltered from various causes of destruction to which oysters are exposed in the open sea.

Upon the bottom of the lake, and all around it, the proprietors of Fusaro have here and there constructed hillocks, with stones heaped up, and artificial rocks, raised sufficiently to shelter the dépôts from mud and slime. Upon these rocks they deposit the young oysters gathered

in the Gulf of Tarentum. Each of these rock-works is surrounded by a girdle of piles, driven close to each other, and raised a little above the surface of the water. Other piles are distributed in long lines, and bound to each other by a cord, from which are suspended fagots of young wood. In the spawning season the oysters which have been deposited on the artificial rocks discharge the myriads of young fry which have been nurtured in the folds of their mantles. The fagots suspended from the piles arrest the fry before they are driven away by the waves. By these precautions the proprietors of Fusaro have provided for the preservation of the young fry, besides removing many of the natural enemies of the young oyster. In other places the piles are distributed in long lines and bound together by strong cords, from which fagots of brushwood are suspended, on which the young spawn lay hold. By means of these arrangements the pregnant oyster deposits its very numerous progeny in quiet repose; the young fry are intercepted by the fagots and bundles suspended between the piles, where the young oysters develop themselves under the favourable conditions of repose, temperature and light. When the fishing season arrives, the piles and fagots which surround the beds are removed, and the oysters are gathered suitable for market. The oysters thus selected for sale are packed loosely in osier baskets, and sunk, while waiting for purchasers, into a reserve or *parc*. This *parc* is established on the shores of the lake. It is constructed of piles, which support a gangway, provided with hooks, from which the baskets, filled with living oysters, are suspended, ready for sale. Writing on the above subject, a French scientist says:—The industry at Lake Fusaro, which has prospered for centuries, employs, as can be readily seen, only methods of great simplicity. . . . and it teaches for our benefit,

that by careful and skilful management, aided by suitable means of collecting the spawn of the oyster, all of which is neither difficult nor expensive, one can indefinitely multiply this bivalve, while the processes employed by us at present lead only to the ruin of our naturally excellent beds. (*j*)

Although these Italian breeding grounds are so very old, no extension or development of the industry seems to have been attempted until about fifty years ago, when some unknown fisherman, in the East River, in New York, began practical experiments in this line. The famous French naturalist, Coste, soon after began his investigations and experiments in France. (*k*)

The original plan of Coste to line the entire coast of France with a network of oyster-beds has indeed not been carried out; but in consequence of his exertions and experiments, many oyster-parcs have been established in favourable places along the coast, from Normandy to south of the mouth of the river Gironde. The French, favoured with innumerable bays and with a mild sea temperature along their coast, have, by diligence, perseverance, and the invention of new methods, brought oyster-culture to such a high degree of perfection, and given it such wide range, that now, in that favoured land, it is to be reckoned as one of those cultured industries in which man converts to his service vast numbers of plants and animals. The large number of oysters produced, as a result of the French system of oyster-culture, has been held up very often to the inhabitants of the German coasts, in order to incite them to establish in their seas similar places for the artificial

(*j*) *Guide Pratique de L'Ostréiculteur*, par M. Felix Fraiche, translated by H. J. Rice for the Report of the United States Fish Commission for 1880.

(*k*) *The Development of the Oyster in Maryland*, p. 91.

harvesting of oysters. The writers who did so knew neither the nature of the oyster nor the character of our seas. They might just as well have said to the inhabitants of the lower portion of the Elbe: "Lay out vineyards, for in 1874 the department of the Lower Loire produced 1,914,427 hectoliters of wine, and the department of Gironde 5,123,643 hectoliters." In Egypt there is nothing lacking, except water, in order to produce dates and wine in abundance, upon the desert which stretches from Cairo to Suez. So it is with us: all we lack in order to carry on successfully artificial oyster-breeding upon the mud flats of the North Sea are mild winters, with no ice, and security against the force of storm-floods. There is food enough there to feed billions of oysters.

The old English method of oyster-culture was much simpler than the new French method. The work consisted chiefly in transplanting young oysters from the natural banks along the coast to suitable beds in the mouths of rivers, where they became fat and well flavoured. They also removed the mud and plants from these new beds, destroyed as many of the enemies of the oyster as possible, and improved the ground by scattering over it the shells of oysters and other molluscs. This industry is carried on in a much better manner at Whitstable. . . .

In the year 1864 there were brought to the London market alone more than 495,000,000 of oysters, which were worth over £2,000,000 sterling. The culture of oysters being thus of so much importance to Great Britain, it was very natural that attempts at artificial oyster breeding in France should be watched with intense interest, and imitated at various points along the British coast. It was carried on most extensively upon the coast of the small island of Hayling, east from Portsmouth, by the South of

England Oyster Company, organized in 1865 with a capital of £50,000. Inside of a dike upon the west side of the island five oyster-beds were prepared, having an extent of sea-bottom of about 32 hectares (about 80 acres). May 11 and 12, 1869, when I visited these beds, several of them had not been overflowed. The natural bottom, which was a sticky mud, had been covered with gravel and mussel-shells, and upon the largest bed hurdles, each 2.4 meters long by 75 centimeters broad, and composed of birch twigs, had been placed so as to rest horizontally at about one-half a meter above the ground. Besides these hurdles, laths, with oyster-shells and bundles of small rods nailed to them, were stuck about over the ground, so that there should be plenty of objects of attachment for the young oysters. The inward and outward flow of the water was regulated by means of a sluice and gate. The mother oysters are generally placed in the beds just before the breeding season.

In 1869 they expected to place upon the beds 50,000 breeding oysters. The water is generally changed every day, except during the winter months, when there would be danger of freezing the oysters, and also except during the swarming period, when the young would be liable to escape into the sea with the changing water. In 1867, 600,000 mature deep-sea oysters were placed on an oyster-bed, which covered a surface of 7.3 hectares, and over which 10,000 hurdles were placed as objects of attachment. Upon an average over 12,000 young oysters were found attached to each hurdle, making for all the hurdles a total of more than 120,000,000. In these and other experiments at artificial oyster-breeding in England, all the experiences of French oyster-breeders were made use of as far as possible; but notwithstanding this, at no

single breeding station were the expectations of a great yield of marketable oysters ever realized. (*l*)

Having thus far advanced my theory for the adoption of the French or American systems of Oyster Culture in England, I fear some friendly opponent may, banteringly, attempt to check the ardour of my hopes in such—

“A consummation devoutly to be wished,”

by quoting the above extract from Möbius point blank against its practicability. In other words—it being presumed that I look upon the work of the great German Biologist as, pre-eminently, the “Guide, Philosopher, and Friend” of my ostracultural knowledge, faith, and opinions—I will be accused of self-contradiction, and (still harping on my opponent) over-zealous in attack, he twits me further with a quotation from some bygone newspaper, to the effect that the late Frank Buckland—“In comparing the

(*l*) “The Oyster and Oyster Culture,” p. 20.

Attention in England was first drawn to the subject in 1865, by a magazine article describing M. Coste’s experiments on the French coast, and the original attempts to imitate them were made at Hayling Island by Mr. G. F. Hart, to whose intelligence and enterprise must be attributed whatever measure of success has been attained in Langston Harbour. After visiting the French beds, and being convinced that one of the great causes of failure of many of the experiments was the exposed situation selected, he proceeded to apply the same system to the quiet waters surrounding Hayling Island. The results were at first very satisfactory, over 128,000,000 of oysters being deposited on the 10,000 hurdles placed in the old salterns as collectors. The breeding establishment is still kept up, though the result originally expected has not been attained.

Nurseries have also been tried at Herne Bay, Reculvers, Brading, Newport, Lymington, and at Nacton; but the use of collectors as employed in France does not seem to have taken root in England, and most cultivators seem to depend mainly upon their culch for catching the spat.—Anson & Willett’s “Oyster Culture,” p. 48.

French and English systems of artificial culture. . . . again dwelt on the point, declaring the French system, though so much lauded, to be in reality no better than our own. There could be no doubt that, as a rule, oysters spat much more freely on the west coast of France than they do at the mouth of the Thames; but the reason he considered was obviously that oysters required heat in their young state. Those, therefore, who said, 'These things are better done in France, why cannot they be likewise done here?' might as well wonder why the farmers of Essex do not grow grapes as well as the vine-growers of Southern France."

Still feeling assured that he is right and that I am wrong, my opponent triumphantly continues:—

The difference in temperature between England and France no doubt handicaps our English breeding grounds. In July, 1865, the temperature was taken on the same day and at the same hour on the coast of France and on the coast of Essex, when it was found that there was as much as 11° (Faht.) difference between the two places.

The climate of the estuary of the Thames is always more or less unfavourable for a heavy fall of spat, though occasionally, as in 1858, it has happened. . . . In July, 1866, the temperature at Hayling Island for six days averaged 78° , the maximum temperature being 81° : the highest point reached during that month in Essex was only 72° .

I do not know how far my imaginary opponent may proceed in refutation of my theory, but I must cry with Laertes—

"A hit, a very palpable hit."

I readily admit as much; it was well-thrust, well-timed, and, apparently, telling; but—to drop metaphor—apt and

irrefutable as his argument *may*, and even *does* appear, it lacks *proof* before Science or even practical Experience can lend to such a hasty conclusion recognised authority.

To all, then, who hold the above mentioned opinions against the strong possibility of success in, or (what I really believe to be) the not-sufficiently-proved practicability of the adoption of the American or French systems of oyster culture in England, and the latter in particular, my reply—in spite of what I have brought to bear, seemingly, against it—is that :—

In England there are breeders of oysters, and others who are well versed in oyster economy, who maintain that the oyster banks have become impoverished because of a long series of seasons which have been unfavourable as breeding years, and not because of overfishing upon the beds. According to their observations, there have been no large broods of young oysters since 1857, 1858, and 1859. This may be the case in regard to a number of localities, but it has no significance in the management of a permanent, profitable oyster-culture, since such culture is not conducted according to an unusually favourable summer, but according to the average of climatic conditions. And that these conditions have not changed in the west of Europe in our century, and thus during the time of the impoverishment and exhaustion of many beds along the west coast of Europe, is proven by the temperature observations which have been made at the Observatory at Paris since the year 1806. According to these, the mean yearly temperature of Paris during this century has remained, up to present time, at 10·8° C., from which it follows that the climate is the same now as before any impoverishment took place. In 1859 there were many young oysters spawned upon the beds along the west

coast of France. In 1860 there were many young broods upon the beds near the island of Ré and near Rocher d'Aire, and but few broods at Arcachon; 1861 was a good brood year for all three places; 1862 bad for the island of Ré and good for both the others; and in 1865 there were very many young in the Bay of Arcachon, and but few near Rocher d'Aire and the island of Ré. These facts show that local conditions can either favour or prevent the production of broods of young oysters in one and the same year.

On the 6th of April, 1876, Mr. F. Pennell made a communication to the Commission for the investigation of the British oyster-fisheries, and at the same time remarked that, according to his experience, the number of young oysters in each brood period was dependent upon the number of breeding oysters, but that, nevertheless, at times, extraordinarily large numbers of young were produced. Whoever has followed thus far the detailed statements which I have made must be obliged to confess that Nature is not to blame for the impoverishment of the oyster-beds along the western coast of Europe during the last century, for neither have the external conditions of life for the oyster become less favourable nor has the fecundity of single animals become less. (*m*)

Armed with such an opinion, based upon incontrovertible facts, from so eminent an authority as Möbius, I may proceed in giving my reasons for assuming that at least the French, if not the American system of oyster culture could be successfully followed in England.

When M. Coste visited Lake Fusaro the plan of the oyster breeders there struck him as "being eminently practical, and suitable for imitation on the coasts of France."

(*m*) "The Oyster and Oyster Culture," p. 47.

How far he was successful the reader has already been informed, suffice it, here, to say that, although very promising at first his original plan has only been partially carried out.

When, in 1876, at Brénéguy-en-Locmariaquer, M. d'Argy laid down (see Basin Culture, further on) six millions of oysters within a vast basin containing 900,000 cubic mètres of water, his efforts seemed—in the beginning at least—to have been crowned with complete success, for in October, 1877, the quantity of spat attached to the collectors in the basin was estimated at forty millions.

When M. d'Argy's method was adopted at Hayling Island the quantity of spat collected in the first summer was estimated at 120,000,000. Whether M. d'Argy's 40,000,000 spat individuals produced a sufficient quantity of marketable oysters, we know not, French Ostracultural History is silent on that point. But we *do* know (and to our shame and sorrow be it said) that in regard to the brilliantly-promising speculation at Hayling Island, the culture proved a failure, for the quantity of marketable oysters reared from this immense quantity of spat was of no consequence whatever.

With respect to the cause of this failure the reader will find full information in subsequent pages; at present I am only dealing with results relative to the climatic theory.

Climate? Dr. Hoek (*n*) tells us "that Dutch oyster culture probably differs in no essential regard from French culture," and that (with the exception of the universal crime of over-dredging) it is a success.

Climate? If there is any truth at all in the climatic theory with respect to oyster culture it should at least reveal itself at the German coast, where, Möbius believes

“that it is the low temperature of the water in winter, and the violence of the waves during high spring-tides, increased by tempests which oppose themselves to oyster culture after the French method,” and thinks that “the oyster production of the German waters cannot be augmented by culture ; but that this can be effected in the first place by keeping a sufficient stock of full-grown oysters on the existing oyster-beds, and in the second place by ameliorating and enlarging the places fit for the fixing of the oyster spat.”

But still further to confirm my argument, I quote from the “Discussion” following Professor Hubrecht’s “Oyster Culture and Oyster Fisheries in the Netherlands,” already quoted from in chapter 30.

Mr. Fell Woods said when the somewhat imperfect report of Professor Huxley’s address at the Royal Institution was published he was impressed with some fear whether henceforth Professor Huxley must not be classed amongst the enemies of the oyster ; but the inaugural address he had since delivered to this Conference somewhat re-assured him, because he had indicated plainly that there was a possibility that certain restrictions on oyster-dredging might produce some valuable results . . . It was true, of course, that if a large amount of dredging went on during the other periods of the year the effect of the close time during the spatting period could not be so great as it otherwise would be ; but in proportion as any oysters were left on the ground owing to the restrictions of close time so must the probability of an increase in the oysters be favoured. . . . Another matter which was constantly urged was the question of granting what were called “several” fisheries—the allotment of certain grounds to private parties, who undertook the custody and working

of them, on a similar plan to that adopted in Holland. To effect this our present arrangements were scarcely what they ought to be, and measures more just to the neighbours should be provided in all these cases, and careful arrangements made with those who undertook them.

Captain Anson remarked that Professor Hubrecht said these beds in Holland had suffered from over-fishing, and while of course he was willing to accept that, he should have been glad if a little further information on the subject had been given. He would also say that what was sauce for the goose was not sauce for the gander, and that if the oyster beds in the Thames or near the Mersey were allowed to remain undisturbed for two months they would be simply ruined, mudded up and covered with ooze, and the oysters would all be eaten by crabs. He should also like to ask what was the depth of water on the Dutch beds, and also whether, as the result of his experiments, he could say the temperature altered the spatting. He believed that this matter had the greatest possible effect. He would mention one fact which perhaps tended to further the view that had been put forward, namely, that between Cancale and Grenville the French Government had established a permanent reserve, where no dredging was allowed. He went there dredging last year, and the oysters were certainly most numerous ; they appeared to exist in millions.

Captain Austin said he represented a large oyster company which had large beds at Whitstable, and also in Ireland and Scotland. He should second the suggestion of Mr. Fell Woods that there should be discussion on this oyster question, so that some practical conclusion might be arrived at. But as far as he gathered from Professor Hubrecht, he said it was nothing but the old oysters that bred, whereas at Arcachon they dredged every old oyster

off the ground, but would not allow the small oysters to be taken. With regard to close times he quite agreed with Professor Hubrecht that no kind of restrictions would do any good. A little fact was worth a good deal of theory. They had a large bed in Scotland where no oysters were dredged for five or six years, and a boat could go there and catch 2000 in a day, which any one would agree was a fair sprinkling of oysters, but there was no vestige of spat to be seen in the place of any sort. That was entirely contrary to the over-dredging theory. On the beds of Whitstable, which were about two miles square, there were from 25 to 30 millions of old oysters, but there had practically been no spat there since 1858 or 1859. There was a little, of course, every year, but nothing to speak of. If the over-dredging theory were right, why was there no spat there? Two years ago there was a large fall of spat, but, probably owing to the cold August, it disappeared and died off after getting to about the size of peas. In Ireland the Fishery Commissioners closed their beds absolutely for three years, but at the end of three years the fishermen could not catch as many oysters as they were catching when the beds were closed. The only fact that the over-dredging theory had to go upon was that the oysters were not there, and of course it might be said that if those which had been dredged had not been taken they would have remained. In his opinion there never would be cheaper oysters until there was a natural reproduction, and that would only come when the weather was favourable. With regard to breeding, he should like to have a little further information. With regard to artificial breeding in Holland, he was inclined to think that it was a loss to those who undertook it. At Arcachon he had asked several of the great breeders, and they all told him that breeding oysters

artificially did not pay. It paid individual fishermen who worked themselves, but it did not pay to breed on a large scale even at present prices. He thought the rents named in the papers were fancy prices, and should like to hear further particulars as to whether the matter was a commercial success, and he hoped there would be a further and more complete discussion on the whole question.

Mr. F. G. Browning (Whitstable) said that in the neighbourhood of Whitstable, for the last 50, 60, or 80 years, there had been more parent oysters than any person would think of stocking a new ground with, consequently it was not the want of parent oysters which caused the scarcity. But during the memory of man there had not been more than six or seven spatting seasons, and when there was abundance of spat it had been when the stock of parent oysters was reduced to the lowest ebb. He should also like to ask what was meant by ripe oysters carrying eggs, because he was under the impression that the spawn for all oysters was eggs.

The Chairman said they were all very much indebted to Professor Hubrecht for his very interesting Paper; but there were still several points left a little obscure, on which further light would be welcomed. Some of the remarks which had been made tended in some degree to a doubt as to the success of oyster-culture; but there was no doubt that beginning at Arcachon and finishing off in Holland, whatever were the methods adopted by the French, Belgians, or Dutch, they could claim at any rate the merit of success, for they had enormously re-stocked their ground and replenished their oyster-beds, and he could not think that, as regards climate, tides, and the possession of the estuaries on the coast, we were in such a totally different position that we could not, with the greatest advantage,

imitate some of the methods by which this success had been obtained. It seemed desirable to separate the question of regulation from that of cultivation. With regard to that of regulation, foreign governments possessed a great advantage over our own: they could do many things which we could not do, and which it would be impolitic on our part to attempt, unless thoroughly supported by the great fishing industries of the country. With regard to all these questions, the first thing to do was to impress on the minds of the fishing population the necessity for these regulations, and that if carried out, although they must be irksome for a time, they would be eventually for their benefit. It was also very desirable that there should be further discussion on this point; but that hardly came within the scope of the present meeting. With regard to the cultivation of oysters, they had evidence of success in the quantity of breeding which took place on the coast of France, and he was rather surprised to hear from Captain Austin that it did not pay. He was aware that several companies had been established, and that a good many of them had been wound up, and therefore it was no doubt true that the smaller men had been the most successful commercially; still, the nett result was a production of a great mass of oysters, large reserve beds were kept, on the idea that from them a great portion of the spat was produced; but it must be remembered that the climatic resources of the country were considerable, and there was no doubt that owing to the higher temperature of the water at the critical period, oysters there had not the same difficulty to contend against as they had in England. In Holland, however, the climate could not be better than our own; but he believed the spat fell much later in the year, towards the end of July or August, and at that time, as he understood, the temperature of the

water in the basin of the Scheldt would reach 70° Fah. If that were the case every year, it might have an important bearing on the production of oysters. He did not see that it could be the result of the climate; but it might be the result of currents of water—perhaps a portion of the Gulf Stream, which touched that part of the coast. The great advantage of the method pursued in Holland seemed to be this, that every year there was a fall of spat, filling the great basin which had been described, and the cultivators had nothing to do but to place their collectors above and below low water mark, in order to collect this natural floating spat. Now it must be admitted that for many years past there had been no natural floating spat on the English oyster-beds at all. The question was, did that arise from the small stock of oysters, or was it entirely climatic? He could quite understand what had been said by Professor Hubrecht about the enormous advantage of leaving portions of the shore undisturbed where a large stock of oysters was maintained, and it was a well-known fact that the water near the shore was warmer than that further out. He had known the water in his river at Beaulieu from 75° to 78° , that temperature being produced by its water being so shallow. If, therefore, the breeding oysters lay within a short distance of the shore, he could perfectly understand that the warmth of the water would bring them forward to maturity, and thus this large quantity of spat might be derived. The breeding of oysters artificially in ponds had been tried in this country, and he had tried it himself; but whether from want of experience or carelessness, had not been successful in bringing any large quantity of the oysters which were bred to maturity. In 1878, he bred two ponds quite full of oysters, probably eight to ten millions: but he believed from 25,000 to

30,000 was as many as were ultimately realised. He could not attribute that to any failure of the climate ; but he believed it was due to inexperience and mismanagement. In 1880, a large quantity of oysters were bred in ponds at Newtown, in the Isle of Wight, and certainly, up to the season of 1881, they were in a most excellent condition, and if they had been properly cared for must have been saved and brought to maturity ; but other matters interfered which prevented their being so. He did not believe there was any great difficulty in breeding oysters in ponds in this country, except that they were really at the mercy of the climate, because in shallow ponds the changes of temperature were so rapid that the passage of a hail-storm over it would utterly destroy the whole of the spat that would be falling there. He had never thought it necessary to aerate the water ; but let it in and out every day with the tide. The state of the oyster, when in embryo, would rather lead to the conclusion that in the day it naturally floated to the surface towards the warmth of the sun, and at night, when it was dark, sank to the ground ; so that it was not difficult, by an arrangement of upper and lower sluices, to arrange for a continual flow of fresh water into the ponds. The greatest difficulty of all in breeding oysters was the uncertainty of the fecundity of the spat itself. He had seen ponds perfectly full of spat, with every prospect of coming to maturity, and then found in a short time that it had all disappeared. There was a good deal of truth in what had been said about the collectors. There was nothing to which oysters would adhere in greater quantities than a smooth piece of slate, so that actual roughness did not appear to be a necessity ; what they heard most about was perfect cleanliness ; if anything grew on the collectors when the oyster-spat

was forming, he was satisfied that the oyster would not fix on it, and finding the ground already covered by some other organism, it would die. That was one of the difficulties in pond culture, because the growth of seaweed itself in pools was much more rapid than in the sea, and if you were not fortunate enough to have the oyster-spat soon after the ponds were filled, the result was, that when they did spat, weeds were grown, and there was nothing for them to fix upon. Another great difficulty was the expense, and unless you could really secure a good fall of spat, it would not pay, unless you were fortunate enough to collect such a quantity in one year as would pay for several. The mortality in the oyster-spawn was one of the most remarkable features in the whole natural history of the oyster. The European oyster would produce over one million of eggs, and American oysters nearly five times as many, so that it was evident an enormous proportion must die. If by any knowledge they could acquire with regard to the regulation of the oyster fisheries, they could get a large reserve—not of course on muddy ground where they could not be left without moving—there seemed no physical difficulty in following the example of their friends in Holland, and collecting artificially the natural fall of the spat. If they took the area of the Solent or the mouth of the Thames, and thought of the enormous number of oysters which there ought to be in those districts, and how the tides must, owing to the natural eddies, flow backwards and forwards, one could hardly doubt that the spat might be collected, and it seemed to him that we might with advantage follow the system carried on there, and so do something to replenish our native beds. The British native oyster was the best that grew, though he was ready to give great credit to the Dutch oysters, which probably came next to-

it, but it was a great mistake for anyone to suppose that by bringing a French or Dutch oyster, and putting it into English beds, that it was converted into a native. . . .

. . . His Excellency Count Bylandt said he was very glad that some gentlemen present had touched one important subject in regard to artificial oyster-culture, viz., the temperature of water, but unfortunately that was a fact beyond human control. It was different in different countries, and we must all submit to the consequences. Some doubt had been expressed as to the success of the artificial oyster beds in the Netherlands, but it seemed to him that that question must be left to those who were willing to pay every year increasing rents to the Treasury for the beds they leased, and as to the figures which had been given there could be no doubt. One gentleman touched on an interesting subject when he referred to the desirability of international convention with regard to fishing. No doubt that was a matter of great importance, but how it could apply to oyster fishing he was at some loss to understand, because if he was not much mistaken oyster-culture meant the creating of artificial beds which were generally established within the territorial waters of every country, and where he did not believe foreigners were allowed to fish. For all other purposes the mutual interest of all nations was guaranteed by conventions, and he was quite sure his country would be ready to join in any convention for that purpose.

The vote of thanks having been carried unanimously,

Professor Hubrecht, in reply, said that with regard to the question Mr. Browning had brought forward as to the age at which the oyster produced eggs, he would remark that the eggs formed so to say the commencement of the spat, and only in a later stage of the development of the

eggs, when they had been impregnated, they gradually changed into a state of larvæ, and these larvæ, which were afterwards set free in the sea water, formed what was called the spat of the oyster. The spat was nothing but the impregnated eggs, having become larvæ, swimming about freely a certain time, and afterwards fixing on to some object where they could grow into oysters. The age had been carefully investigated at which oysters produced eggs out of which spat could be evolved, and now it was quite clear that in the Scheldt only oysters of three or four years old contained such eggs. There was no instance of any oyster larvæ produced at an earlier age. The investigations of Dr. Hoek on this subject were published, and to them he would refer Mr. Browning. As to the question of certain oyster beds in Arcachon, as stated by Captain Austin, not having a vestige of spat, although there were a large number of mature oysters, he quite agreed with the possibility. The great question was, where had the spat that had been produced on this oyster bed gone to? As he had already stated, they did not know how long spat remained suspended, and it was generally believed that this might be three or four days, and thus the spat which had been set free out of the shells of the ripe oysters forming a given bed, might have been carried away by currents miles from the native place, and deposited elsewhere, or drifted away to sea without even growing to mature oysters. Next came the important point with respect to the "fall" of spat on the beds which were leased for the purpose. There was in all probability no region so favourable as the inland bay of the oyster Scheldt of which he had spoken. On many of the English beds situated on the coast, the moment the spat had been produced it might easily be carried away

either to some distant point of the coast, or out to sea ; but what happened in the Scheldt was somewhat different, and had been investigated very carefully. Each tide taking about six hours to ebb or flow, a floating object which also registered the deeper under-currents—at least approximately—and which was set afloat above the oyster beds, had been carefully noticed at the beginning of the ebb. It of course went seawards ; but it had not yet reached the ocean when the ebb was exhausted, and it was brought back again by the flood tide. It was greatly to this oscillating movement of a large bulk of water, which did not allow of the spat being so easily carried out to sea, that in his opinion must be ascribed the fertility of this region as an oyster producing locality. He feared that if the arrangement contemplated were carried out, and they were going to have oyster beds established in the Zuyderzee, they would have greater difficulties to contend with, similar to those from which England and France were suffering, and they would have to look out carefully for some spot which in that respect more nearly resembled the situation of the Scheldt. As to whether the artificial oyster-culture had been a success, he could not deal with that point at length, Count Bylandt having already referred to the figures. In addition, he might say that whereas in 1870 the neighbourhood of these beds only consisted of very poor hamlets, at present they were most flourishing villages, and some of the old lessees who had from 1870 to 1885 held allotments there had re-invested their money in the new leases beginning in 1885. Fancy prices might have been given in individual cases, but on the whole the increase from £1,700 to £28,000 as yearly rent for the same 8000 acres was perfectly genuine. With regard to the observation made by the Chairman as to the disappearance of the spat,

he could well conceive that when the spat had been produced in enclosed parcs great mortality was observed, so that no real results were obtained; it was to a great extent caused by the water not containing enough oxygen. He had been occupied to some extent with embryological researches on various marine animals, and he had found that if he only took care that a fair supply of oxygen were pumped into the water, he could develop many marine forms of animal life, and keep them healthy for a period of eight weeks and longer, in no greater space than a large tumbler, without ever changing the water. With regard to temperature, it had always been observed that it was necessary for the water to be 68° or 70° in order to get a large number of spat on the tiles.

Are the advocates of the climatic theory satisfied? If not, I can produce more unanswerable authorities in proof of my argument; but I think, for the present, the foregoing will suffice. Taking the sufficiency for granted, I will, before "summing up," reply to a statement made by one of my "witnesses," in an extract from Möbius.

What, Möbius again?

Certainly; why not? I would quote as frequently from any other writer were he a Möbius. When an author is good, a little license in frequency of quotation is surely allowable, and especially so in a work of this class, wherein antagonistic theories and conflicting opinions have to be clashed together, in order to show the reader both sides of the question, and to make him familiar with all matters relative and of interest to the subject; so that if, after perusal, should he, in doubt as to who is right or who is wrong, be prompted to exclaim—

"Who shall decide when Doctors disagree?"

the solution of the knotty problem may serve as a healthy exercise for his judgment, experience, and wisdom.

And is not that a boon to the oyster culturist? It certainly ought to be considered as such, but it may or it may not be, according to the character of the reader who favours me with his attention. Some persons like to have the trouble of exercising their judgments spared them. An oyster culturist (or anyone else for that matter) should never be guilty of such an abuse of his reasoning powers; and whenever his judgment halts between two opinions, let him defiantly answer Pope's famous line with "I will decide for myself!" and he will feel the better for it. Let him remember that at the same time Coste meditated his plans, oyster culture was already successfully and independently started on the French coast, namely, on the Ile de Ré, by the stonemason Lebœuf. That seldom-mentioned, useful, but not-sufficiently-appreciated member of French Society—that humble ostracultural benefactor to his country—that strong-reasoning stonemason was a fine specimen of the "I will decide for myself" class of human beings, whose example it will do no harm to the English ostraculturist to follow. By the way, I need hardly remind the reader (of course with all due respect to the memory of Coste) that although Columbus discovered America, the vast continent is named after Americus.

Of difference of opinion this book contains a plentiful but necessary sprinkling; I doubt, however, whether its contents present a difference of opinion, or a deliberate assertion so startling at first sight, or hearing, than the following of Dr. Hoek relative to English oyster culture.

Oyster culture, of course, means the creating artificial beds within the territorial waters of any country. There can be no possible difference of opinion upon that point;

but, in speaking of our "tight little island," Dr. Hoek (o) says: "England wants yearly an immense quantity of oysters. They are partly supplied by America, partly by France, partly by the Dutch oyster culture. By far the greater part, however, is produced by the English oyster industry. We do not say English oyster culture, for if taken in the real sense of the word, we must confess that it does not exist on the English coast. Yet there is perhaps no other country where such costly measures have been taken to introduce a true cultivation of oysters as in England."

There! the reader has it as I have found it, and as he can see it for himself. I will make no comment, but simply leave the solution of this ostracultural *Pons Asinorum* problem as an exercise for his reasoning capacity, as an example of the difference of opinion, and as a well-meaning inspiration towards a hearty and indignant—"I will decide for myself!"

But where is Möbius? Möbius, the Philosopher and Scientist!—the truth-telling, far-seeing, all-impartial, and irrefutable Möbius! Let us return to and hear him. Listen to and ponder well his words of profoundest wisdom in Oyster Lore.

"Those who delude themselves with the belief that, by means of artificial cultivation, oysters can be bred in great quantities wherever there may be sea-water, will scarcely agree with my book, and it is indeed quite certain that it will not convince them of their error. But the most dazzling error does not become transformed into truth, however long and firmly one may believe in it." (p)

(o) "Oyster Culture," p. 29.

(p) "The Oyster and Oyster Culture." Introduction.

“Perhaps so,” exclaims the reader, “and I will even grant that it *is* so, if that will please you ; but although the above sentence, with all that it bears upon, may suit Möbius’ theory, what has it to do with yours in regard to the subject in question ?”

Since I am bound to reply, I will say much that will confirm both his and mine. Much that will tend to inspire the reader with the *scientific* trust in the deservedly-famous Biologist which I and others of far superior scientific attainments to myself, have in his teachings. If, therefore, I am guilty of a slight digression, it is, as I have said, knowingly, and with the above-mentioned object in view, part of which, in the *present* instance, is to point out the *tenacity* of prevalence—the metaphorically “unconscionable time in dying” of a “dazzling error.”

In the opening of the foregoing “Discussion,” Mr. Fell Woods remarks : “It was true, of course, that if a large amount of dredging went on during the other periods of the year, the effect of the close time during the spatting period could not be so great as it otherwise would be ; but in *proportion* as any oysters were left on the ground, owing to the restrictions of close time, so must the *probability* of an *increase in the oysters be favoured*.”

I have italicised the words of the above quotation, serving as an example of the prevalent and “dazzling error,” which Möbius speaks of as follows :—

Learned authorities had said that every mature breeding oyster produced from two to three millions of young. They believed, then, that if they left upon the beds only a hundred breeding oysters, they would be doing all that was necessary in order, in a short time, to find upon the over-fished beds two hundred to three hundred million descendants of the same. Up to 1854, the oyster-beds of Roche-

fort, Marennes, and the island of Oléron, were fished with some regard to their preservation, since their oysters found a market only in those places which were situated along the neighbouring coast. But in 1854 Rochefort was placed in connection with the interior by means of the network of railroads, and the market for these oysters, and the profits from them, increased so much that they were taken until these beds were almost entirely depopulated. From 15,000,000 in 1854-'55, the catch fell off to 400,000 in 1863-'64.

. . . . It is, therefore, not enough to regulate the time of catching and the size of oysters, if, at the same time, care is not used to prevent too large a number of oysters from being taken from the beds during any one fishing season. *But what number is too great?* A foundation for an estimate of the number of oysters which may be taken away from the beds without injury to their productiveness can be obtained, for the Schleswig-Holstein beds, by means of the inquiry in regard to their productiveness. This productiveness is, upon an average, 421 per thousand; so for every 1000 full-grown oysters which are now upon the beds not more than 421 ought to be taken away annually. Upon a number of banks where the productiveness is less than this the number taken should be less. Upon the Huntje bed, where the production is more than 421 per thousand, as many as 484 for every thousand can be taken yearly, without endangering or lessening the productiveness, since that number of medium oysters grow into marketable oysters every year. But although the productiveness is thus expressed by a proportional number, yet the absolute number of full-grown oysters which may be taken from a bed during any one season cannot be arrived at without further consideration.

One must know how thick the full-grown oysters lie upon the beds ; whether, in fact, there is a sufficient number to secure an average fecundity to the bank. Upon banks such as those in the Bay of Arcachon and near Cancale, which are left dry during spring-tides, it is not difficult to observe the number of oysters necessary per square meter, in order to maintain the fecundity of the bank at its highest point, for at such times they are so exposed that they can all be counted. But those beds along the German and English coasts, and in the open North Sea, which, on the contrary, remain continually under water, are much less favourably situated for the purposes of these inquiries.

(Möbius then proceeds to give an ideal picture of the life of an oyster bank, in order to show that one may become really very well acquainted with an oyster-bed by means of a dredge, and says of the latter that) . . . It can also be used to estimate the thickness of oysters upon a bed, if the distance passed over by the dredge while it is taking oysters be measured. In the inspections of the Schleswig-Holstein banks, during the last few years, this has been accomplished in the following manner: At those points where the dredge is dropped upon the bed, an empty cask, attached by means of a rope to a heavy weight, is cast overboard. The weight sinks to the bottom and holds the cask securely anchored, floating upon the surface of the water. Connected with the rope of the cask is a measuring-line, which is wound upon a roller, and which runs off as long as the vessel is going forward, and the dredge drags over the bottom. The mouth of our larger dredges is one meter in width. Thus, if we let the dredge drag over the bottom until 100 meters of line have run off, and find that we have then 50 oysters in the bag,

we can conclude that one oyster came from every two square meters of bed-surface ; and if an oyster-bank, the length and breadth of which are known, is dredged over in this manner in different directions, a foundation is obtained from which to estimate the number of oysters upon the bed with certainly as much accuracy, and with far greater speed and ease, than a diver ; and when the proportional productiveness of a bed thus examined is ascertained, we can estimate the number of oysters which can be taken from the bed without injury to its productiveness.

Practical persons will object to these methods as being too detailed, and yet not leading us to a sufficiently high estimate of the number of oysters ; but they will be obliged to admit that there is no better means of finding out, with any degree of certainty, the number of oysters upon these banks. A skilful oysterman, one who has been acquainted with the beds for a number of years, will notice, without the use of a measuring-line, whether the oysters lie upon the banks in sufficient numbers for the prosperity of the banks, or whether the beds have become impoverished. He will reach this conclusion from the number of oysters which he can catch with a certain speed of his vessel, and during a certain definite time through which his dredge drags over the bottom.

Those authorities who have control of the inspections of the oyster fisheries might, therefore, be able to avail themselves of the services of skilful dredgers to find out the condition of the banks before they decide, each season, the particular places which can be fished, and the number of oysters which can be taken from each. The inspectors at Arcachon, after observations extending over many years have arrived at a definite conclusion in regard to the

number of breeding oysters which it is absolutely necessary to retain upon the banks, in order to maintain them at that stage of fruitfulness necessary for a permanent and profitable oyster-culture.

The report of January, 1877, upon oyster-culture in France, says: "Although the natural oyster-beds in the Bay of Arcachon are regarded as breeding-beds, yet, nevertheless, the government allows them to be fished for some hours every year, in order to remove the surplus of oysters." This is a fundamental proposition which a judicious oyster-breeder must carefully consider if the greatest amount of profit would be gained. In accordance with this proposition, oysters should never be allowed to remain upon a bank after they have passed the period of their greatest growth and fecundity, or until they die of old age; but we should anticipate nature, which demands the death of the old and weak as an indispensable condition for the production and bringing to maturity of the greatest number of young upon any bed. (*q*)

And now, having so far, both by previous and present citations, endeavoured to gain the reader's respect for, if not belief in Möbius as an irrefutable authority; having even, in his description of the attempts to introduce the French system of artificial oyster-breeding into Great Britain, quoted him, as it would seem, point blank against my very argument, I will briefly sum up the evidence *pro et con*.

Möbius tells us that . . . "The old English method of oyster culture was much simpler than the new French method."

Frank Buckland assures us . . . "that the French system, though so much lauded, is in reality no better than

(*q*) "The Oyster and Oyster Culture," pp. 49, 63, 64.

our own." (Events since then have proved the wisdom and partial truth of that observation.)

Dr. Hoek repeats the well-known fact that . . . "the French oyster culture is based on the same principle as that of Lake Fusaro" . . . and also . . . "that Dutch oyster culture probably differs in no essential regard from French culture."

Mr. Fell Woods informs us that . . . "Another matter which was constantly urged was the question of granting what were called 'several' fisheries—the allotment of certain grounds to private parties who undertook the custody and working of them on a similar plan to that adopted in Holland."

Captain Austin . . . "With regard to artificial breeding in Holland, . . . was inclined to think that it was a loss to those who undertook it," and he very much surprised us by stating that at Arcachon artificial oyster breeding did not pay.

The CHAIRMAN (Lord Montagu) . . . "was aware that several companies had been established (in France), and that a good many of them had been wound up. . . . but it must be remembered that the climatic resources of the country were considerable. In Holland, however, the climate could not be better than our own. . . . The breeding of oysters artificially in ponds had been tried in this country, and he had tried it himself; but whether from want of experience or carelessness, had not been successful in bringing any large quantity of the oysters which were bred to maturity. . . . Another great difficulty was the expense, and unless you could really secure a good fall of spat, it would not pay, unless you were fortunate enough to collect such a quantity in one year as would pay for several.

Surely I have, in abridgement at least, brought together sufficient evidence to justify my belief and substantiate my theory? And thus, not to bore the reader with repetition, if the "climate" of France (coupled, of course, with the aid of culture) can produce 40,000,000 of spat, and that of England, by the same method, 120,000,000, so far as the word "climate" applies, what difference is there between the two countries? For (taking the word in the sense implied by my opponents) if the English climate were like that of the German coast, where, as Möbius tells us, the French method *cannot* be pursued, it must naturally follow that the attempt at Hayling Island would have been productive of *no oyster spat whatever*.

So, then, Möbius *must* be in the right, and, with regard to Great Britain, the climatic theory falls to the ground.

Climate is—well, it is a very convenient word, and covers a multitude of Ostracultural Sins, especially legislative ones. There are English Ostraculturists so blinded by the "dazzling error" of the Climatic Theory, that they cannot think and see otherwise than that "the climate of Ireland" even "is becoming too cold for the cultivation of oysters."

As I have had little to say about Ireland heretofore, and as what I have now to add bears strongly upon the matter under review, I need make no apology for extracts from two writers of practical experience. The first is from the pen of Mr. Fennell, giving a slight sketch of the past and present state of oyster culture in "the Emerald Isle," and serving also as a kind of introduction to the second extract, which, although only an abridgment of a "Paper" read at a meeting, is especially worthy of the reader's par-

ticular attention, and the ostraculturist's most serious reflection.

Writing upon Oyster Culture in general, Mr. Fennell, describing the causes of oyster reduction in Ireland, says : At Arklow and Wexford, in Ireland, the beds have shown an annual improvement from a low state after over-dredging, the change being consequent upon the adoption of a close time, at the request of the fishermen themselves. Still cases are not absent even in Ireland, where positive injury had arisen from want of sufficient dredging, as in the estuary of the Shannon, near Scatterry Island, and at Clew Bay, large accumulations of weeds and dirt having arisen. It is lamentable to read that out of 100 grants or licenses, comprising in the aggregate nearly 17,000 acres of some of the most desirable oyster ground in Ireland, all have, as a whole, fallen very short of realising the expectations of those who promoted legislation on the subject. Hardly one of them has proved a commercial success, whilst most of them must be regarded as total failures, so far as the production of oysters—the greatest object of all—is concerned. In many cases the oysters laid down have fattened, and the grants have thus proved advantageous to the grantee ; but this is a small object in comparison with the main object—increased production. The Commissioners attribute these failures almost entirely to not adopting adequate means to promote breeding, though there may be other causes yet to be discovered. The grantees, on the contrary, have satisfied themselves by reaping the benefit of the oysters already on the ground, and the fattening of those placed there. The Legislature never contemplated such a monopoly of the shore or seabottom for such a purpose : and where the undertaking upon such really exclusive privileges is not fulfilled, it

should be withdrawn. Yet, "diminished as the supply of oysters is in Ireland, and suffering as this branch of fisheries is from exhaustion, there can be no doubt that the banks, both as regards stock and other conditions, are for the most part in a more satisfactory condition than those of the other portions of the kingdom, or of France." And this comparatively favourable state is unquestionably due to the salutary regulations framed and enforced by the Board of Works, whilst the fisheries were under that department, the observance of close time, and the efficient service rendered by the coast guard in carrying out these regulations.

From what has been written, it is not at all intended to prejudice the cultivation of oysters, when properly conducted. On the contrary, the cultivation of crassals (mud-lands) and ebb-dry foreshores is available for either associated bodies of fishermen or individuals. Indeed, it is especially adapted to the wants of a poor population, on a rocky coast, partly fishermen and partly farmers, such as we find in many parts of Ireland, and where the shores are suitable and the requisite materials abound on every side, only requiring labour to make them available. Oysters are not, as yet, so far destroyed at most of these places, but they are obtainable by dredging; and if laid in the months of April and May would probably deposit a valuable spat in the parc cleared and prepared for them. From July to the following May no care or attention is necessary. (r)

I cull the following "Development of Oyster Culture in Ireland," from *Land and Water*, Nov. 22, 1890.

(r) "Fish Culture." By Greville Fennell. (*Cassell's Technical Educator*.)

The following Paper on the subject of "Oyster Culture" was recently read at a meeting of the Irish Industrial League, Dublin:—

"Oyster culture is a subject to which I have given a great deal of attention, and, from practical experience, believe it to be a natural Irish industry, capable of enormous development, with adequate profits, and giving employment to the coast population during the winter time of year, when it is much wanted.

"It is an undoubted fact that within living memory oysters of the finest quality were grown in Sligo, Ballysodare, and other bays. In Ballysodare there are solid masses of shells, 10ft. thick, remains of ancient beds, in my opinion unique of their kind, but their age is unknown. The same food that fattened these enormous quantities is still in the waters, unutilised, as I can show by oysters in existence growing on my beds.

"At the commencement of this century, and up to the advent of railways, oysters were so plentiful in Sligo that the market price was 2s. 6d. per 120, and the supply seemed inexhaustible, being subject to the local demand only. Oysters used to be purchased in Belmullet, for fattening in Ballysodare Bay, at 4s. 2d. per 1000, the selling price being 20s. 10d. The advent of railways put an end to this state of things, as they brought London, Manchester, and all the large towns of England, as well as Paris and the Continent, into direct contact with our beds, and even Arcachon was partly stocked from here. The quality of the oysters was such that the demand became unlimited; the titles to the beds were not as well defined as now, and they were dredged by the public, 100 to 200 boats working at one time, the result being the beds became exhausted, and have remained so up to now, that is of 'fat oysters,' quite equal to the 'Whit-

stable natives,' which I maintain these bays are able to produce.

"The practical question now is, can the state of things existing forty years ago be here produced? I emphatically say the quality can, as I have produced, and am producing them myself. The extraordinary thing is, how it is that when such an article can be produced, demand has failed to produce the supply.

"In the first place, I think the general apathy may partly account for it, as, for instance, the salmon fisheries have not been handled by ourselves but by Scotchmen. Next, the false ideas popular about oyster culture, as for instance that the parent oyster laid something like a million of spat, so a few would stock a bed, not knowing that fixing spat may be compared to a man trying to catch birds by throwing his hat at a passing flock. Next, people starting in the business with wrong ideas of 200 per cent. per annum being the ordinary profits to be made. And lastly, that any stock would do, and that a good bed would make them good oysters.

"The problem I had to solve when I commenced their culture in 1882 was to produce a small oyster attractive to the English palate. I planted four different kinds experimentally, two were a complete failure, one a partial success, and one a complete success. Now had I confined myself to the first three, and gone in for any of them on a large scale, I might have blamed the business, and this has been a very common occurrence. It has taken me eight years to produce a perfect oyster, so far as the English taste is concerned. Convinced that nature had provided all the requisites on my Ballysodare beds, I persevered at my own expense in overcoming all difficulties, but with the ultimate hope of making Ireland attractive to English

capital, which goes to every corner of the world, but shuns Ireland. I maintain that Irishmen, if properly paid, are not lazy. . . .

“Our oysters are infinitely better than the French or Dutch, and nothing but our own apathy prevents our producing similar results. The water on our coast, thanks to the gulf stream, is warmer than the Dutch, and our sand banks are bare at midday during the spring tides, thus getting the advantage of the sun’s rays, and being well warmed, and so warming the water during the spatting season.

“The action of our Fishery Board has not been quite judicious. Some years ago there was a craze for oyster culture, and owners applied and got licenses for large tracts of foreshore, much of which never was, and never can be utilised.

“I suggest the formation of a company to get hold of proper fattening beds, some of which I know can be had for a mere trifle. Breeding beds can be had in many places.

“With the co-operation of the Fishery Board the expenses would be very small ; but the acquisition of the proper beds would require judgment and skill, and no dividend ought to be looked for for two years, at the end of which time the company would have a very valuable property, paying good dividends.

“I am at your disposal if I can be of any use. In order that the superior quality of the oysters fattened here may be tested, on receiving a postal order for 2s. 6d., I will forward one dozen, carriage paid, to any part of the United Kingdom.

“VERNON COCHRANE.

“Glen Lodge, Sligo.”

I have not the pleasure of knowing Mr. Vernon Cochrane, but I think that a man who can spend eight years in perfecting the taste of an oyster is deserving not only of commercial success, but also of the respect and praise of every oyster culturist at home or abroad. He is certainly one of the self-deciding class of society of which it were well there were a more plentiful sprinkling among "all sorts and conditions of men."

So, then, the Climatic Theory fails even with regard to Ireland.

Well, we must end this matter, resume the broken thread of our discourse, and endeavour to find out the cause of failure in the marketable qualities of the oysters reared from the fall of spat both in Brénéguy-en-Locmariaquer and Hayling Island.

To produce a healthy and resistive progeniture, an oyster must be itself as vigorous and healthy as possible. If an oyster be grown up in an enclosure, let it be large and in communication with the ocean in the usual way: it is evidently very difficult, if not impossible, that this oyster should be of the same strength and health as those which are placed in the open ocean. The two reasons which must necessarily bring about this difference are: in the first place, that the aeration of the water (its oxygenium-quantity) is not sufficient, and in the second place, that there cannot be abundance of food within an enclosure. No doubt the changing of the water can to a certain extent make up for this disadvantage; but there is sure to remain a very notable difference in strength between the oysters grown up within such an oyster-tank and those found in the open ocean.

And this difference will in the first place affect their reproductive power; a smaller percentage of those oysters

will come to maturity, this will take place at a later age, the quantity of spat produced by one of them will perhaps be less considerable, and finally, what is to be feared most, the spat itself will not be healthy. To prove the correctness of this statement, I need only refer to what has been shown by observations on the Dutch concessions of the East Scheldt. The oysters distributed over the different concessions are by no means in such unfavourable circumstances as those placed in enclosures; yet for a great part they do not grow up in the natural way; nor do in many places the bottom they inhabit and the depth at which they are found quite correspond to that of the natural oyster-beds. And what is the consequence of this? That everybody who bestows his special attention on the matter is struck by the small percentage of mature oysters. The great bulk of the spat which attaches itself to the collectors on the East Scheldt concessions is not produced by the cultivated oysters, but by the natural beds. These belong partly to the concessions: they are the places where, long before oyster culture was introduced on the East Scheldt, oysters were dredged; partly these beds are found on the rock-masses at the foot of the dykes.

Whilst it is not possible, I think, to bring the oysters within a tank or basin under conditions similar to those of the natural oyster-beds, there seems to be another way to avoid this inconvenience. We have only to wait till the oysters of the natural beds are mature, to collect a sufficient quantity of them, and to bring them in the basin where the collectors are placed. This method, however, seems to be more effective than it is in reality. Oysters taken from the deep do not endure transplantation in shallow water, and soon die; but, even when taken from water of about the same depth as that in the enclosed basin, they will not

propagate at all, or only after having been in the basin for some months. Nor has the experiment to transplant an oyster containing brood within its gills ever led to a noticeable result ; and I think it hardly recommendable to continue experiments in this direction.

In case basin-culture in general should be tried again (in England), the enclosures should afford all possible means to renew the water. A constant aëration of the water is not only to be kept up, but also an abundant supply of food is to be acquired. Moreover, the bottom of the basin must resemble, as much as possible, that of the natural oyster-beds ; and this will not be an easy matter, for an abundant supply of food will necessarily bring with it plenty of mud, which within the enclosures will not be carried away again with the current, as is the case on natural oyster-grounds. Now it is evident that, whereas a small quantity of mud is by no means disadvantageous to an oyster, and even may be of great advantage where the fattening of the oyster is aimed at, yet a too large quantity of mud will even endanger its life. To prevent this by arranging a fore-basin for the water to clarify before the one in which the oysters are put, is of no use ; for in that case the oyster will also lose a great amount of the food-particles contained in the water and among the mud-particles.

Another danger arises from the renewing of the water in the basin, viz., that it is not to be got without free circulation, which enables the spat, when in the water, to escape from the basin. I think it impossible to prevent this by filtering apparatus placed before the sluices. The only way would therefore be to control every day in summer the condition of the oysters, and to prevent any circulation and renewing of the water in the basin during a short

time (one or two days), when there is a considerable quantity of spat in the water. As soon as it has fallen down and the attachment has been achieved, the sluices should be opened again to allow renewing of the water. How to protect the young spat against the danger of suffocation in a basin, where a considerable quantity of mud must gradually fall down, is a last difficulty for which there will hardly be found a remedy. (s)

Now to show that the French oyster breeding beds are just as liable to failure (as Lord Montagu puts it) "from want of experience or carelessness," as our beds have been and are, I will state on the authority of Mr. Fennell, (t) that "The only instance of importance of enclosed or tank cultivation in France, which was visited by Mr. Francis Francis and his coadjutors was that of Madame Felix, at Regneville. Her experiments proved most successful. The enclosure is about ten acres in extent. In this 11,000 oysters were placed and 11,000 tiles. The first year, 1864, the tiles were covered with spat, some of them having as many as 103 oysters, and the least of them about 20."

In the opening (and, herein, omitted) portion of the above quotation from his learned pamphlet, Dr. Hoek, writing on "Oyster Culture in England," asks "Is basin-culture possible or not; and if so can it be practised from an economical point of view?" The three already mentioned attempts together with his own valuable opinion, will *partly* answer that question.

So far as regards failure, Dr. Hoek's explanation of the cause may be accepted as reliable. But in connection with Hayling Island there *was*—and, through our present

(s) "Oyster Culture." By Dr. P. P. C. Hoek.

(t) "Fish Culture." *Cassell's Technical Educator*.

system of oyster legislation, unfortunately, there *is*—*another cause*, more potent in its ruinous influence than the natural one described, which, if it does not directly lead to failure, does indirectly forbid its possible amendment, and that is the enormous expense entailed in such a venture.

M. d'Argy was not successful ; Madame Felix was :— at least Mr. Fennell leads us to believe so— and, had the former hit upon a better choice of locality, in all probability his daring and praiseworthy attempt would have been rewarded in a more fortunate result.

The same remark will apply to Hayling Island. But when, in connection with the latter, we take into consideration the astounding statement that the price of an oyster, when obtained by the culture practised here, in Herne Bay, near Reculvers, and in the estuary of the Thames, amounted to £50, to £100, and even to £500 (!) we cannot wonder at the Ostracultural *fiasco*, or that the gentlemen who formed that hapless and now historical Company should shrink in terror from all further attempts at Basin culture, or any other culture connected with oysters.

“ ’Tis true ’tis pity, and pity ’tis ’tis true.”

But is it not at the same time monstrous that we should so outrageously burlesque the teachings of common sense in submitting apathetically to an Ostracultural administration which (*perhaps* (?) in a well-meaning, but, unfortunately, a most deplorably short-sighted spirit of benefitting the people) draws with such extremely absurd exorbitance upon the wealth of our Capitalists, crippling their enterprise, and tending in every way to weaken the energetic character of a people pre-eminently endowed with universally-famed capacities for Industrial pursuits or Mercantile ventures.

An Oyster Fishery Company is but formed of Men, not Alchemical automaton, each with the exhaustless purse of Fortunatus ; and men, however wealthy they may be, are *not* iron-nerved enough, after *one* such failure (as those mentioned) to venture on a second.

Who can blame them ? Indeed, they were, and are worthy of all praise for their British Pluck in pinning their faith upon the Legal Charter of their Financial Ruin ; and whatever over-sanguine, or, say even, avaricious expectations of gain they had built their airy castles upon at the outset of their speculation, we cannot but respect them for their bravely-suffering and money-squandering perseverance in those unfortunate undertakings, and regard them as monetary martyrs to a maladministration deserving of no better fate than to be the scornful jest of the Foreigner. And rightly so, too ! for, think of it—just give it one minute's serious reflection ; if our oyster cultivators could work on the administrative plan of the French or Americans, what a boon it would prove to the general Public ?

There is no difficulty in the way to its attainment ; none whatever.

“ 'Tis as easy as lying.”

I will expound it in a nutshell ! I will show you the way in a word ! I will tell you the “ Open Sesame ” to a bright ostracultural future for England. It is nothing more nor less than “ Abolition and Concessions ! ”

Let the Public take up *that* cry and the country will be the *better* for it ; ay, and *healthier* and *richer* too.

Let the Public see that cry *fulfilled*, and we will easily prove Frank Buckland's assertion, “ that the French system though so much lauded is in reality no better than our own.”

One of the saddest spectacles on earth is the spectacle of misdirected energies and wasted resources. Which is also one of the commonest, the most provoking, and the most disheartening. There is activity in abundance, there is ability, there is zeal to overflowing, there is industry, there are good intentions, philanthropy, and wealth adequate to the extirpation of many of our social miseries, and the mitigation of many more, if only they were rightly applied, and worked with ordinary vigour and ordinary sense. But—what with want of philosophy and want of thought, want of patience and want of courage, prejudice which stops one road, fear which bars another, and the defects of administrative capacity inherent in our clumsy and stupid way of managing public business—all these means and resources of rectification are thrown away, and social miseries spread, deepen, and gangrene as before. Simple and obvious remedies are scouted and neglected, while the silliest and wildest ones are propounded, and, amongst these, our legislative system of Oyster Culture is one that clamours for reform. In this, as in so many other matters, we endure so much evil and do so little good, because we manage so badly, and are so constantly sailing on the wrong tack.

The great central truth which lies at the root of these miseries, and the oyster question in particular, is that, with few exceptions and slight qualification, the mischief under which the people suffer, and which *some* of them call for legislation to remove, lies at their own door, and are remediable by and through themselves, and themselves alone. It is this doctrine which it is essential to convince them of, and to ingrain fixedly in their minds, and this object once fulfilled, the rectification of the present evils of the oyster question will speedily follow.

As if to illustrate and verify the above paragraph the Marquis of Lorne (*u*) asks :—

“Why should oysters often cost 4/- to 5/- a dozen in London, and about $2\frac{1}{2}$ or 3 francs for the best in Paris, where the expensive hotels or boulevard restaurants only can be found to charge a higher price? Excellent ‘Marennes’ with the green gills,—valued among the French, at least, if not here, more than any other kind,—can be had for the lower sum; while at Arcachon, if not at other seaside places, three dozen may be had for a franc, or even less.”

Now let us for a moment glance at English prices; say those of Whitstable or Burnham. As I have already stated with reference to the English market, a large trade in “relaying” is done. The Whitstable Company relays nine millions of French oysters each year. They are sent by sea, and relaid at Hayling Island. In the trade these oysters are discriminated from the real natives, but in some London oyster shops no doubt they are palmed off as natives, the average purchaser not being able to distinguish between the two. The only way in which the dealer identifies them is that there is a mark on the heel of the oyster showing where it has affixed itself to the oyster bed. It is only just to add that the Whitstable Company does not sell the relaid oysters as natives; but it is beyond denial that retail dealers do so, and the profit is considerable, the price of “seconds” being 6/- per 100 and the retail price being 2/- per dozen.

With regard to the price of oysters a careful inquiry seems to show that they are retailed in London at a substantial profit. The price at Burnham of “natives” is 1/6

per dozen ; and the growers complain that the retailer for opening them in the London shops gets as much as the grower does for giving them five years' attention. And those who have followed me thus far, know very well that this is no small thing, for the oysters require it constantly.

Now, in allusion to these prices, I think that the above statements corroborate the Marquis's facts and figures with a vengeance. And that unheeded complaint of the Burnham oyster cultivator anent the London shopkeeper's profit, speaks loud as Neptune's horn that—

“There's something rotten in the State of (England), and that it needs but little of

‘— our philosophy (to) find it out.’”

To this also, I think the reader will agree ; and, for the present, having said quite enough upon this matter, I will resume the broken thread of his Lordship's valuable discourse, assuring him that where any digressions may occur, and whatever their tone, I esteem his article more highly than to think and speak of it in any other manner but that of sincere respect.

With the candour of a true Briton, the Marquis makes an assertion which should be written in letters of gold over the entrance of the department where the Board of Trade officiates.

It is true there is nothing of a remarkable nature in this assertion, for it is daily quoted in the social litany of the proverbial long-suffering and patient British Public, and for many years has been

“Familiar to our mouths as household words.”

But, coming from so high an authority, this echo of a well-known fact trumpets its self-evident truth and serves to arouse and alarm our un-English-like ostreological

phlegm to so much more a desirable pitch of interest, that it is a pity its import did not proceed from a still higher source of authority, whose wishes are looked upon and fulfilled as commands.

What the Marquis says is that :—"The English and Scotch oyster beds (and he might well, without fear of contradiction, have included the Irish also) do not now produce a sufficient number to supply even a fraction of the consumption, and thus we are dependent on foreign food supplies for these molluscs, of which our own shores are probable capable, if properly used and fairly treated, of affording an ample supply. (*v*)

The bitterest opponent of our Government could not in this respect, give a more forcible, and at the same time, humiliating proof of its defective application, and its insulting persistency in continuing a crab-like-walking-backward on the road to commercial ruin, instead of that of prosperity, being guided thereon by the sign-posts of common sense, duty, and legislative rectitude in the people's welfare.

Indiscriminate fishing, (continues the Marquis) the full use of that "human agency" which we are so often told cannot really influence for harm the illimitable harvest of the sea and of the shore, is responsible for this. The poor with us cannot afford to buy oysters, nor are they given encouragement to cultivate them. There is a lack,

(*v*) At the "Practical Fishermen's Congress," held in connection with the International Fisheries Exhibition, October 26, 1883. Mr. Welfare, (Worthing), said : . . . "In 1862 England exported oysters to France, but later on, through the discretion of the Emperor Napoleon in preserving oysters, the tables were turned, and we were now almost depending on France for our supply." History repeats itself—even ostracultural history.

also, of the commoner kinds which the French workman can afford to buy. The Parisian "ouvrier" is not so well off as is the British artisan in respect of "a free breakfast table," for butter, bread, sugar, tea, and coffee, cost more than they do here; but he has a far larger choice in the purchase of "extras," such as vegetables, mollusca (of both land and sea species) not because he is less taxed, but because his countrymen utilise far more cleverly the natural resources around them. It is partly owing to the desire of the French Government to encourage all industries that tend to foster a love of the sea, that oysters are cheaper than with us. It is the same desire which makes our neighbours so keen to keep their hold of the Newfoundland fisheries. The fisheries breed seamen, and that is what is wanted. So, likewise, any coast industry that may make a man enter a boat, hoist a sail, or become even in the least degree amphibious is wisely encouraged.

We in Britain have not the same necessity or temptation to foster "marins," or frequenters of the sea and sea-shore. They are necessarily numerous among us, who are a people crowded on an island so small that an American is said to have confessed himself as quite afraid to move around for fear that he should fall off. It is the people who are crowded on shore who take to the sea, and Britain has so many who are squeezed into the salt water, that it is not necessary for her to encourage her sea-coast dwellers to exist by the fosterage of seamanship. (w) But it becoming increasingly important for us to

(w) With all due respect to his Lordship the Marquis, I think he is somewhat rash in his conclusion, for, according to Talfourd Chater, "The rating of Fishermen was regulated in 1880. In the Merchant Service, a seaman to be rated A.B. must have served four years before the mast (43 and 44 Vict. c. 17, s. 7). Fishermen who have been

nourish what food resources we may have independent of the foreigner, and among these resources fish and shell-fish take a front place.

Yet in England and Scotland, instead of a payment of thirty or forty francs, we have to pay as many pounds sterling at the very least for a Protection order ; and as the visit of the inspector deputed by the government to report on the application and the fitness of the place has also to be paid for, the British oyster-planter must, as a rule, pay £50 to £60 at the least before he begins his useful work.

To obtain a "Provisional Order" the Board of Trade demand £70. Of this £35 is retained as a fee. The remaining £35 is retained in case of an Inquiry being made ; if there is no Inquiry the £35 are returned. The average cost of an Inquiry is £15. Besides the payment of these sums the applicant has to advertise in the *Times*, the *Shipping Gazette*, and all local newspapers, in addition to which he has also to affix as many large posters as possible in places contiguous to the grounds ; and, finally, large posters again to notify that the sanction of the Board of Trade has been given. With regard to the fee, the *size* of the grounds is no object, the same charge being made for 1 acre as for 100.

employed for three years or longer in a registered decked fishing vessel may be reckoned A.B. if, in addition, they serve for one year only in a trading vessel. The proof of service consists in certificates of discharge, whilst, in order to cast no pecuniary impediment in the way of fishermen, the fee for a certificate, if the proof has to be supplied by the Registrar-General of Shipping, must not in any case exceed sixpence. The above is a practical recognition of the fact that our fisheries are a "fruitful nursery of able seamen" for the Navy and Mercantile Marine. —"Relations of the State with Fishermen and Fisheries, &c." pp. 34 and 35.--See also Chapter 39.

That there are discouragements to oyster-breeding is true, and it is only just to tell what those discouragements are. A company certainly lost a great deal of money in Ireland in trying the experiment. Gentlemen have also on the west coast of Scotland had melancholy experience that even in places where old beds existed, oysters will apparently now no longer thrive. The enterprising cultivator has tried Portuguese oysters, the American kinds, as well as those native to the west coast waters, and has failed to get good results, for all which the bad seasons, and the cold summers are blamed.

. . . . The mere laying down for fattening will probably be the safest thing to try for the present. But the first requisite to prompt people to do this is to afford by law good protection, and that the protection order also be issued at a fee of £1, instead of £35 as at present. Experiment can alone show why it is that disappointment has often dogged the steps of the British oyster-grower, and experiments will not be made if the government persists in exacting so heavy a fee as that now demanded for protection against the freebooters, who call themselves free-fishermen.

And all this is borne with phlegmatic patience and timid murmurs at "high prices," but nothing more save milk-and-water remonstrances—few and far between—of the Press. The fear of losing literary caste in overstepping the borders of newspaper decorum, magazine prestige, or review reputation.—the dread of offending the Legislature and "Society,"—the horror of being ostracized for indulging in "Radical vituperation" deters, and has deterred many an Editor from doing his duty.

Of course there are a few exceptions, and from among these (outside the Editorial class) we cannot otherwise

than welcome the Marquis of Lorne, who, loyally anxious for the extension of England's commerce continues thus in his able article, already mentioned.

“Lord Montagu's fishery is one of the few English breeding and rearing places prepared by private owners. Whitstable, to which so many of the ‘Frenchmen’ are sent to be fattened, is the largest field for this industry. It is a pity that there are so few. But in France there are now many places where large crops are grown. All along the Brittany and Normandy coasts these exist, and the names of ‘Cancales’ and ‘Marennnes’ are familiar to everybody. The great multiplication on the French coast is entirely due the wise initiative of the Government in granting ‘concessions,’ or ground at a very low rent. Would that we could persuade our Government to follow such an admirable lead.”

And what, in the name of common sense, is to prevent us from “persuading” the Government to do so, were but the public taught the inestimable value of this great edible and commercial benefit?

Is it too Quixotic to hope for this in the near future? or too Utopian for practical outcome in our ostraculturally-neglected country? “Quixotism” or “Utopianism” is one of the pet words of an optimist Legislature. And, in the words of a celebrated writer, “I believe the quiet admission which we are all of us so ready to make, that because things have long been wrong it is impossible they should ever be right, is one of the most fatal sources of misery and crime from which this world suffers.” So that, whenever a man, or any body of men representing a government, dissuades you (the latter by the misapplication of their duty) from doing well, because perfection is

“Utopian,” beware of either.

And here, perhaps, I may be opposed by some optimist, who, conscious of the truth of my argument, sneeringly replies,—“Good Sir, forbear! Let not what little prudence you possess so far imbibe the spirit of your ambition for reform, as to prove its intoxication by your verbosity. And, with all due respect, permit me to add that a good and loyal subject—an English gentleman—will not lower his dignity by indulging, against those in authority, in a tirade that borders on Radical vituperation. As for your boasted French and American exemplars in oyster culture, England has hitherto done, and can still do without them: a matter of considerable importance to those nations, since our government’s ‘maladministration,’ as you call it, involves an annual outlay of great advantage to the exchequers of these aliens. Consequently, were your theories put into practice, rest assured that you would not be looked upon by either of them with a friendly eye, especially by the French, of whose country (according to some author whose name I forget) ‘the rivers partake of the national character. Many of them look broad, grand, and imposing; but they have no depth. And the greatest river in the country, the Rhone, loses half its usefulness from the impetuosity of its current.’ And to bear out the comparison, I will quote that from the Marquis of Lorne’s article which, in your partiality, you have evidently wilfully evaded. The passage alludes to the benefit accruing to the poor by these ‘concessions,’ and is as follows:— ‘When any person obtains permission to ‘cultivate’ within a certain area, he is bound before a year has passed to have commenced the works necessary, and he is told that no right of property is given to him in respect of his marine allotment, but only a right of use, ‘essentially precarious,

and revocable at the first requisition by the administration, without compensation.' ”

Spoken like an optimist, and quoted *equally* in the partial spirit of which he accuses me. Had he continued the quotation he would have found that—“The 30 or 50 francs per ‘hectare,’ or $2\frac{1}{2}$ acres, paid, is also liable to be diminished, or brought up to those figures, according to the value of the ground for breeding, and it is let in terms of five years. Practically, these reservations do not apply, unless there be proof that the first ‘concessionaire’ has been useless, when his neighbour can step in and farm successfully where the first has failed ;” and thus have answered himself. But the best reply to the optimist (and even to the pessimist in some instances) is that—“The mind is like a sheet of white paper in this, that the impressions it receives the oftenest, and retains the longest, are black ones.”

However, it were perhaps as well for me to take a hint even from an opponent, and moderate my censure against the Legislature, or cease censuring altogether, for attacks of this nature, however agreeable to himself, or forcibly expressive of the feelings of an author, they are seldom or never successful unless stamped by genius, or favoured by the force of circumstance. And so, this truth being self-evident, I can only exclaim with Hamlet—

“The time is out of joint ; O cruel spite,
That ever I was born to set it right !”

Nevertheless, if, with respect to our inefficient system of oyster culture, my humble endeavour to rouse public attention thereunto cannot succeed in setting the ostracultural dislocated joint of time, I have at least the hope of teaching other and abler men than myself to make the attempt.

But is there no hope, then, that the attention of the government may be drawn to his Lordship's sensible remarks respecting the £1 fee for a protection order, and the wisdom of a trial thereof urged upon its representatives? Is there not the slightest hope for this? Apparently none.

To censure the government for this culpable neglect of the public's benefit—this reprehensible ignoring of its highly valuable outcome—this “wilful-waste” and “woful-want” kind of constant stubborn refusal to cheapen a universally esteemed and valuable food product by the extension of the cultivable area adapted to its growth—is utterly useless. And why? Because our present government and its predecessors up to the last generation were and are aware of the facts in question. They are also cognizant of the truth that by the adoption of the methods detailed in the pages of this book, France is happy in the employment of 200,000 people; and America (in the United States alone) of a far greater number than even that; and so, they knowing this, I repeat, it were useless to censure the government,

“For it must follow,

As the night to day, the day to night,”

that if our wise rulers cannot, or (more justly, perhaps,) *will* not see the practicability of this matter of general interest, then, I repeat once more, censure is powerless to aid where *will* is not forthcoming, and there's an end on't, so far as they are concerned.

What then can be done?

Appeal to the public!

Agreed; but how?—in what manner? Promulgate the hygienic doctrine of ostraculture amongst them.

Inform them upon every point necessary to their knowledge. Unceasingly ply their memories with lectures on the subject. Stimulate their energy by quoting statistics of their successful French neighbours, and tell them that if "imitation is the sincerest flattery," it were a nobler and more beneficial sincerity to themselves, and an honest piece of flattery to their neighbours, would they but copy their ostralogical wisdom and practise their thrift, rather than to slavishly imitate their fashions, their theatrical foibles, and minor frivolities.

To this attained, and the vanity of their national honour pricked into consciousness of their folly, and roused to a lively comprehension of the *necessity* for oysters and oyster culture—then, and not *till* then, you may have the joy of reading about an "Oyster Bill" in Parliament.

One *faint* beginning of this much-to-be-desired fulfilment—one little gleam of hope (?) for its accomplishment, throws a beam of comfort athwart this vexatious question, and that is the formation of a Marine Biological Association, and, in connection therewith, the establishment of a laboratory. As I shall be enabled to point out the fact that even the possession of such an institution cannot rouse our government from their *fishy* apathy, I will give a brief sketch of its rise, and, with a leap over its few years of very indifferent progress, touch slightly upon its present state in relation to the support it receives.

At the Conference on Friday, July 20, 1883, held in connection with the International Fisheries Exhibition, Professor E. Ray Lankester rightly complained that:—

The value of zoological science in relation to fisheries is not, I think, so fully appreciated in this country as is desirable in the interests of the public, and of those who make profit by enterprise in fisheries.

There is a very general tendency among men whose occupations are of a commercial character to undervalue the work of scientific inquiry, not only in regard to such matters as fisheries and fish-culture, but also in relation to manufacturing industries, agriculture, mining, and even in relation to medicine. To a large extent this arises from a misconception as to the real nature and character of what is called "science." Science is the knowledge of causes ; its method and purpose when strictly pursued lead to the accumulation and arrangement of thorough and accurate knowledge of any given subject to which it may be applied, with a certainty and an abundance which no other method and no other purpose can give. Undoubtedly the latest scientific knowledge of a subject is very usually not *immediately* useful to those who are engaged in applying commercial enterprise to the same subject. It is however to be noted, over and over again, that the scientific discovery of one generation becomes the necessary foundation of some valuable commercial enterprise in the next : what was at one time a curiosity and of little interest, save to men of science, becomes after fifty years the pivot of some great industrial manufacture.

Accordingly commercial men, and those who place the material well-being of this country beyond all things as an object to be continually striven for, should have patience in the presence of what seem to be the useless accumulations of knowledge ; they should have faith in the ultimate utility of science, for already throughout the length and breadth of the land this cause-reaching knowledge, which we call "science," has proved its enormous power of aiding commerce, and has amply established its claim to not merely toleration but to eager and generous support from those

who are reaping golden harvests through the science of a past generation.

When we remember that science is really no more nor less than such accurate and full knowledge of this or that class of natural things as enables us actually to understand "the causes of things," then it becomes obvious that the distinction which is sometimes drawn between the "scientific" man and the "practical" man is founded upon some kind of error. If there is the antithesis which fashion causes many persons to assert as existing, let us see what becomes of it when we say, as we are justified in saying, that the scientific man is the man who knows thoroughly and accurately. The contrast insisted on between the scientific and practical man becomes, then, simply the contrast between the man who knows and the man who does not know, but acts in ignorance.

As a matter of fact there is no such antithesis. Your man of science is, or should be from the nature of his pursuits, more thoroughly practical than any one who affects to despise scientific knowledge, for he is accustomed to insure success in his experiments and investigations by taking every means in his power to that end; above all, and chiefly, by guiding himself by reasonings based on the most accurate and extensive knowledge. So, too, indeed, every so-called practical man who is not a mere adventurer—a happy-go-lucky tempter of Fortune—makes use of accurate knowledge to aid him in his commercial ventures and speculations; so far as he can get it, he makes use of science, though he often calls it by some other name as soon as 'it becomes useful knowledge.

The fact is, that a large part of the indifference to science in this country, and the notion that science is dreamy, vague, untrustworthy, and useless to practical men,

has arisen from the fact that these worthy practical men have very often allowed themselves to be imposed upon by mere quacks and pretenders, who assume the language and authority of science without any credentials whatever, and lead the practical men astray. Such quackery in science has been by no means unusual in this country, owing to the almost complete destitution of the wealthy classes in respect of scientific education. Practical men have, as a rule, not even a smattering of scientific training, and cannot distinguish true from false science, cannot tell which is the quack and which the man of real knowledge. Equally unfortunate, in this respect, in former times, have been the members of the executive and deliberative branches of our successive governments, so that—in days' which we may hope are past—ignorant pretenders to scientific knowledge have been, in good faith, placed in responsible positions, and have helped to justify the notion that modern science is a wind-bag of theories, and of little use to the practical man.

Such causes—namely, a general mistrust of so-called science, and to a small extent a painful experience in especial connection with fisheries, of the results of placing confidence in quacks who have falsely pretended to scientific knowledge—seem to me to be accountable for the fact that in the British Islands, neither publicly nor privately, has there been any attempt to make use of the services of scientific men in relation to our fisheries. The recent appointment of the distinguished naturalist who is at present Inspector of Salmon Fisheries, is evidence of a new disposition to seek the aid of the highest authorities in science in connection with this subject; but it must be remembered that salmon fisheries form but a very small part of British fisheries in their entirety, and that a large staff of experienced

naturalists would be required to deal satisfactorily, within a reasonable time, with the many important problems presented by the British Sea Fisheries.

The Governments of some foreign States, notably of France, but also on a smaller scale of Norway and Sweden, Holland, Prussia, Saxony, and in a special, and in many respects very noteworthy manner, that of the United States of America, have concerned themselves to obtain the aid of zoologists in developing and managing the resources of the fish industries of their respective territories. The results of the application of accurate knowledge concerning fishes, and such shell-fish as oysters, mussels, pearl-mussels, lobsters and cray-fishes, have been in some cases strikingly successful ; in other cases time has yet to show what advantages may result from the attempts which have been made. In all these countries, however, one very distinct result of the appreciation of the possible value of scientific knowledge of fishes and shell-fish by the State authorities has been this, namely, that zoologists are occupying themselves independently, and with increasing earnestness, with the investigation of all that relates to the life and growth, the food and the enemies, of the marine and freshwater organisms which form the material basis of fisheries.

In the present Exhibition, accordingly, we see not a few of these scientific results exhibited in the courts assigned to foreign exhibitors ; whilst, on the other hand, in the British department, there is very little which comes under the head of zoological science at all, that is to say, which illustrates the results of exact inquiry into the natural history of the fishes and other animals which are such an immense source of wealth and industry to our seafaring population. . . . (And, towards the conclusion of his very interesting lecture, the eminent Professor says :)—

I think that it has been made very apparent, not only by the class of objects exhibited by foreign contributors to this Exhibition, but also by the original papers and the discussions which the Conferences connected with the Exhibition have produced, that there is nothing which is so much needed in connection with all kinds of fisheries, river or sea, shell-fish, true fish, coral or sponge—as more knowledge, more science—in fact, more zoology; and not only that, but that there is nothing which is more desired and recognised as needful *by all those who are best informed in their own particular branches of fishery.*

Improved machines for catching fish, new legislative restrictions, State aid to fisher-folk—all such desiderata are, I believe, admitted to be less urgently needed, less likely to prevent our various fisheries from deteriorating or disappearing altogether, than the one desideratum—more accurate knowledge.

It is admitted on all sides that many British fisheries are suffering, or are in a precarious state—others are actually destroyed. It is also admitted that our only chance of bettering this state of things is an increase of scientific or accurate knowledge.

If this is the case, there will be one grand scientific result of the International Fisheries Exhibition, and that will be an increased attention to, and adequate provision for, the carrying on of zoological studies in relation to fishery-animals.

I can picture to myself the shape which this scientific result might take, and I should be very glad were it to commend itself to the many influential men connected with fisheries who have organised this Exhibition, and will have the direction of its final outcome.

If it is demanded that more accurate knowledge of fishery-animals shall be provided for the public use, then arrangements must be made to enable skilled zoologists to carry on the investigations required. To make such investigations, continuous residence for weeks or months at a time, by the sea-shore, is necessary. In France, Holland, Italy, and the United States, sea-side laboratories have been constructed, which are provided with working tables, glass apparatus, aquariums, &c., and a staff of attendants and fishermen—to which naturalists can resort who desire to carry on investigations upon the life-history of marine organisms. Very valuable researches have been made through the agency of these institutions, and there can be no question as to the facilities which they afford, and the inducement which their existence offers, to naturalists, to occupy themselves with these particular studies.

By offering free accommodation in such a laboratory to competent investigators, you may obtain a large amount of valuable results, at a minimum of expenditure. In any such laboratory there would probably be one or two permanent officials who would be competent zoologists, charged with special subjects of investigation and receiving salaries—but in addition to these, the laboratory would throw open its resources to voluntary workers (as do the foreign laboratories of which I have spoken), and thus the working power and the general interest of the scientific world in these institutions and their work would be enormously increased.

I can imagine a National Fisheries Society or Association, such as may come into existence in connection with this Exhibition, building such a laboratory for the study of marine zoology in relation to fisheries, somewhere on the coast not too distant from London. Such a laboratory

would stand near the shore, possess its own jetty and small harbour, with steam-launch for dredging and trawling, and other boats. Adjacent to it would be marine ponds for experiments in the culture of oysters, mussels, and whelks, and of various fish. The director of the laboratory and his assistant would be provided with houses forming part of the laboratory building. The basement of the laboratory would consist of large well-paved rooms fitted with tanks, and an apparatus for the circulation of sea-water. Here animals would be kept for observation, and the produce of a day's dredging or trawling would here be sifted and sorted. On the ground-floor and first-floor would be spacious rooms, with large windows giving both north and south lights, and fitted with tables suited to the requirements of the microscopist. Small aquariums and pumping apparatus would also be provided in these rooms. Accommodation for ten workers, in addition to the director and his assistant, would thus be provided. In another room a complete zoological and piscicultural library would be established, and the means for writing and making drawings would be provided.

The naturalists permanently and temporarily working here would in the course of a few years provide us with much-needed knowledge. For instance, some would study the reproduction of the sole, and devise means for increasing its numbers in the market ; others would ascertain how best to deal with oysters ; others would find out the whole history of the mussel. Bit by bit a new and thorough knowledge of fishery-animals would be built up, and come into use as the basis of new legislative enactments, and of new methods of capture and culture.

Such an institution would no doubt be costly. A valuable laboratory of the kind might be set going and

carried on for a smaller sum ; but a really creditable and efficient laboratory of the kind, with a first-rate man of science for its director, would cost £15,000 or £20,000 to establish, and some £3000 a year to maintain.

These figures and the whole suggestion may appear extravagant to some persons, who are not aware of what has been done elsewhere.

The “Zoological Station” of Naples, founded and directed by Dr. Anton Dohrn, is no less costly and efficient an institution than that which I have briefly sketched. Elsewhere, at Trieste, at Concarneau, at Roscoff, at Beaufort in North Carolina, less costly institutions have been set going, which are doing most valuable work.

The British coast is entirely destitute of any such home of research. No zoologists are employed by the Government or other authorities in this country, to investigate our fishery-animals : those zoologists who do carry on such work on the coasts of this country, do so at their own expense. There is not even a laboratory, a boat, or a dredging apparatus, provided by any public body, to assist them. Naturally enough, their work has not been hitherto specially directed to problems connected with fisheries ; but it is only needful to offer to the many isolated investigators the use of a good laboratory and a well-considered organisation, in order to obtain through their co-operation the new knowledge which is so urgently needed.

I cannot but think that it will be a matter for profound congratulation to those who have brought this Exhibition into existence, to the Legislature, to men of science, and to those concerned in fisheries, should we be able in future to point to a “National Laboratory of Marine Zoology” as

THE Scientific Result of the London International Fisheries Exhibition. (x)

In the course of reply to the above, His Grace the Duke of Argyll, who presided on the occasion, implied that although he did not agree with *all* that Professor Lankester had advanced, he certainly did in what follows: Now the suggestion made by Professor Lankester, and he suspected the whole of his paper led up to this, was that the Government of this country did too little in these matters, and he was quite willing to plead guilty that the Government had done far too little for science. The system in England was for everything to be done by private enterprise, and hitherto it had been relied upon almost entirely. It was true we had our national geological surveys, but not even those were conducted on the scale which they were by the Government of the United States, whose splendid publications they were sometimes good enough to send him, illustrated by every species of drawing and section. He thought we did too little in the matter; but it was not very easy to know exactly where to begin. Professor Lankester had made a practical suggestion, which he said had been warmly taken up by some of the most distinguished men of science; Sir John Lubbock, Professors Sclater, Michael Foster, Burdon Sanderson, Flower, Romanes, Sedgwick, Mosely, Williams, Marshall, Thistleton-Dyer, and Allman, and their recommendation was that a scientific observatory should be set up; a scientific aquarium, with fully equipped rooms for investigation and dissection of all kinds, as it had been at Naples, at the

(x) "Scientific Results of the Exhibition." By Professor E. Ray Lankester.—Papers of the Conferences held in connection with the Great International Fisheries Exhibition. London, 1883. (William Clowes & Sons, Limited.)

expense of the Government, for scientific investigation, and to the propagation of the life of fishes. This was a most important suggestion, which he hoped would be brought before the Government, with all the influence and authority which these great names would undoubtedly carry with them. How far it was likely to be accepted he could not say, not being a member of the Government: but he should be very glad to give any help he could in the matter. He understood that the establishment at Naples, which had produced very valuable results, was set up, not by the Neapolitan or Italian Government, but by several Governments in Europe combining. He did not know why they should have fixed on the Mediterranean for such a purpose, because the fauna of the Mediterranean was essentially different from the fauna of the Atlantic and the Northern seas, and observations made there, although they might be of use for the Mediterranean, were not likely to be of such practical value as observations made on the fishes of our own shores. He believed to some extent the establishment at Naples paid its own way, because tables were hired out to various scientific persons, who came from all parts of Europe, and hired a table and tank for the investigation of particular phenomena. It was quite possible that such an establishment might be set up in this country, and that after all the ultimate cost to the Government might not be very large.

The document referred to by the Duke of Argyll is as follows:—

“PROPOSAL FOR THE FOUNDATION OF AN OBSERVATORY ON THE BRITISH COAST, FOR THE STUDY OF MARINE ANIMALS AND PLANTS IN RELATION TO FISH AND FISHERIES.

“The value to the FISH INDUSTRY of an increased

knowledge of the habits and life-history of fishes, has been proved by the experience of the American and French commissions. Without such knowledge we cannot improve our fisheries commercially; with it, there is every probability that a great deal may be done in the way of controlling and extending them.

“In order to gain accurate knowledge as to the circumstances which affect the life of fishes, and the various molluscs, shell-fishes, corals, and sponges, which are important commercially as well as interesting from the scientific point of view, it is necessary that continuous observations should be made upon their growth from the egg onwards, upon their food and its natural history, as well as upon their enemies and the conditions favouring, or injurious to their life.

“Such observations can only be successfully carried out by persons resident on the sea-coast.

“In order to enable competent observers to spend such time as they can afford for these studies to the greatest advantage, Zoological Observatories have been established on the sea-coast of foreign countries, but at present there is no such observatory on the British coast.

“The first observatory of the kind is ‘the Zoological Station’ established by Dr. Dohrn at Naples, which is frequented by naturalists from all parts of Europe. Its buildings and aquaria represent an expenditure of £20,000, and its annual expenditure is over £4000.

“Similar observatories have been established by the Austrian government at Trieste, and by the French government at Concarneau, Roscoff, and Villefranche.

“It has been for some years the desire of English naturalists to establish a zoological observatory on the British coast, which would be in charge of a competent

resident superintendent, and fitted with aquaria, laboratories, and apparatus, and possessed of boats and dredging apparatus. Two or three fishermen would be kept in the pay of the observatory. The institution thus organised would be frequented at all times of the year by naturalists desirous of carrying on original investigations relative to the life-history and structure of marine organisms. Accommodation for as many as six such naturalists might be provided.

“The affairs of the observatory and the granting of permission to make use of its appliances might be entrusted to a small committee consisting (for example) in the first place of the Warden of the Fishmongers’ Company, the Professors of Zoology, Botany, and Physiology, in the Universities of Great Britain and in the London Colleges, and the Secretaries of the Linnean and Zoological Societies of London.

“Were such an observatory once established there is every reason to believe that funds could be raised annually for the purpose of extending its operations and of carrying on special work in it by grants from scientific societies, the universities, and such sources.

“The obstacle hitherto to the establishment of a British Zoological Observatory has been the difficulty of obtaining the large sum necessary to launch the institution.

“It is calculated that £8000 would be sufficient to secure a site and erect and furnish a suitable building—whilst £500 a year should be secured as a minimum income for the purpose of paying a salary of £250 a year to a resident superintendent, minor salaries to fishermen and attendants, and of meeting the small current expenses.

“The income of the institution might be materially aided by the payment of a fee (say £5 a month) on the

part of those naturalists making use of its resources.

“The opportunity for securing the £20,000 necessary for the inauguration of such a Zoological Observatory has presented itself in connection with the International Fisheries Exhibition. Should there be, as there is reason to hope, a large surplus fund in the hands of the Committee of the Exhibition, at its close, it is proposed to bring the suggestion of the establishment of a Marine Zoological Observatory before the Committee, and to endeavour to obtain the support of that body for the scheme. It is proposed that a deputation of scientific men should interview the Committee of the Fisheries Exhibition, in order to explain the importance of a Marine Observatory and the close relationship of the work done in such an institution, to the interests of our fisheries; and the Committee would then be asked to consider the propriety of handing over the sum of £20,000 (or if possible a larger sum, this being a minimum) to Trustees, for the purpose of building and endowing such an Observatory, provision being made as to the future government and occupation of the Observatory, as above suggested.

“The following gentlemen have expressed their approval of the general tendency of the above proposals, and their desire to co-operate in any further proceedings directed towards the accomplishment of the plan of action here suggested:—

“SIR JOHN LUBBOCK, BART., M.P., President of the Linnean Society.

P. L. SCLATER, M.A., F.R.S., Secretary of the Zoological Society.

F. JEFFREY BELL, M.A., F.Z.S., Professor of Zoology in King's College, London.

MICHAEL FOSTER, M.D., Sec.R.S., Professor of Physiology in the University of Cambridge.

J. BURDON SANDERSON, M.D., F.R.S., Waynflete Professor of Physiology in the University of Oxford.

W. H. FLOWER, F.R.C.S., F.R.S., Conservator of the Hunterian Museum and Hunterian Professor.

GEORGE J. ROMANES, LL.D., F.R.S., Secretary of the Linnean Society.

ADAM SEDGWICK, M.A., Fellow and Lecturer of Trinity College, Cambridge.

E. RAY LANKESTER, M.A., F.R.S., Jodrell Professor of Zoology in University College, London.

H. N. MOSELEY, M.A., F.R.S., Linacre Professor of Anatomy in the University of Oxford.

A. MILNES MARSHALL, M.D., D.Sc., Professor of Zoology in the Owen's College, Manchester.

W. T. THISELTON DYER, C.M.G., M.A., F.R.S., Assistant Director of the Royal Gardens, Kew.

W. B. CARPENTER, M.D., F.R.S.

G. J. ALLMAN, M.D., F.R.S., Emeritus Professor of Natural History, Edinburgh.

JOHN MURRAY, F.R.S.E., Director of the Challenger Expedition Reports." (y)

A brilliant array of names! A noble staff of scientific men, which, anyone would suppose, a government would welcome with delight, and find a pleasure in favouring their suggestions, aiding their investigations, and munificently supporting their self-sacrificial labours. And did not our Government do so in this case? Certainly! Does the intelligent reader think for one moment that I would ruffle the feathers of his national pride by allowing him to indulge the "impossible" belief that our rulers

would permit themselves to be beaten by such an insignificant State as Naples? (2) Not for a moment. Perish the thought! No sooner had Professor Lankester and the Duke of Argyll appealed to the patriotic principles of our enlightened government than—Hey! Presto!—a wondrous Scientific Palace arose—a Marine Biological Laboratory; and what could you wish for more? A Laboratory, concerning the practical value of which a correspondent of the *Times* (July 9th, 1884), writing to the Editor, says:—

Sir,—The practical importance of the results which can be obtained by providing duly-trained scientific men with a biological laboratory on the sea-coast, where they may be enabled to study fully and carefully the history and habits of sea-fishes and shell-fishes, cannot be better shown than by a reference to the results obtained by Professor Brooks and his associates, in the Marine Biological Laboratory founded by the Johns Hopkins University of Baltimore. By careful study, such as can only be carried out successfully by a qualified naturalist, Professor Brooks has elucidated the history of the American oyster, and has enabled others to undertake successfully the artificial cultivation of oysters. Professor Brooks has given a summary of his observations and the applications to which they have led in a recent report to the Johns Hopkins University, which is so interesting that I venture to ask you to reproduce it in full.

The recently-established Marine Biological Association of the United Kingdom is proceeding rapidly in its task of collecting funds for the erection of a sea-coast laboratory on the English coast. When this has been

(2) See an interesting article on this subject—"The Zoological Station at Naples"—in *The Century Illustrated Monthly Magazine*, New Series, Vol. X.

effected it proposes to erect similar laboratories on the Irish and Scotch coasts. The Association comprises all the leading naturalists of the country. His Royal Highness the Prince of Wales has signified the special interest which he takes in its objects by becoming its patron; Professor Huxley is its president, and among its officers and council are such names as those of the Duke of Argyll, the Marquis of Hamilton, Lord Dalhousie, Lord Walsingham, Sir John Lubbock, Professors Moseley, Flower, M'Intosh, Lankester, Milnes Marshall, Günther, Thiselton Dyer, and others. At present the men of science have been the largest contributors to the building and maintenance fund. Ten thousand pounds are needed, of which two thousand have already been subscribed. Public spirited men, whether specially concerned with science or not, should surely come forward to help the Association with the needful money. A donor of £500 to the Association becomes a "governor" and permanent member of its council. Smaller sums entitle the subscriber to life-membership of the Association. The public cannot expect naturalists, who are by no means a wealthy class, to provide themselves all the money required to carry out the great national enterprise which the Marine Biological Association has taken in hand. Naturalists will do the work and have done their best to help in finding the money, but it is for those who have larger pecuniary resources to back up the efforts of the scientific specialists, and to follow the example of the Prince of Wales in contributing to the realization of the objects of the Marine Biological Association, which promises to be of the utmost importance both to the science of natural history and to practical fishing industry. The treasurer of the Association is Mr. Frank Crisp, 6, Old Jewry, E.C.

The following is the text of Professor Brooks's report as to his researches on oysters :—

“During the past year experiments which have been carried on in France and in this country have resulted in the practical application of the methods of artificial oyster propagation which were discovered at the laboratory five years ago, and the great economic importance of the subject will justify a short review of the history of these experiments.

“Previously to 1879 our knowledge of the breeding habits of the oyster was entirely based upon the study of the oysters of Northern Europe, and nothing whatever was known of the life history of the American oyster, as our writers had accepted without question the statements of foreign authorities. The oyster of Northern Europe is hermaphrodite, and as the eggs are hatched inside the shell of the parent, and the young are thus carried and protected until they are ready to fasten themselves, good authorities had stated that it is not possible to rear oysters artificially.

“In 1879 I found that the sexes are separate in the American oyster, and that the unfertilized eggs are thrown out in immense numbers into the water, where they are fertilized, and develop without the need for any protection from their parents. I also showed that it is possible to fertilize the eggs artificially, and to rear the young oysters until long after they have acquired their shells, though I did not succeed in keeping them alive until they became attached. These experiments showed the perfect practicality of rearing oysters in unlimited numbers, as soon as the practical difficulties should be overcome.

“A full account of my experiments and of the methods employed was published, with figures of the early stages of

the development of the oyster, in the first volume of the 'Studies from the Biological Laboratory.'

"While I was engaged in these experiments, Lieutenant Winslow, U.S.N., was engaged in surveying the oyster beds near the laboratory, which he visited in order to learn my methods. The next year, while stationed at Cadiz, Spain, he repeated the experiments with Portuguese oysters, and found that their breeding habits are exactly like those of the American species; that the sexes are separate; that the unfertilized eggs are thrown out into the water, and that the young can be reared from artificially fertilized eggs.

"An account of his experiments was read before the Maryland Academy of Sciences in November, 1880, and it was afterwards published in the *American Naturalist*.

"The next step which has resulted in the solution of the practical difficulties, and the rearing of oysters of economic value from artificially impregnated eggs, is due to experiments which were carried on by M. Bouchon-Brandely, under the auspices of the French Government.

"In a paper entitled 'Rapport relatif à la Génération et à la Fécundation artificielle des Huitres, adressé au Ministre de la Marine et des Colonies, par M. Bouchon-Brandely, secrétaire du Collège de France,' and published in December, 1882, in the *Journal Officiel de la République Française*, this author states that he was encouraged by the experiments which Brooks, of the Johns Hopkins University of Baltimore, had made upon *Ostrea-virginica*, to attempt similar experiments with the Portuguese oyster, *Ostrea angulata*. He was ignorant of Winslow's experiments with this oyster, but after two years of experiments he succeeded in independently establishing the fact that the sexes of the Portuguese oyster are separate; that the eggs

are thrown out into the water; that the young are independent of parental protection, and that they can be reared from artificially fertilized eggs.

“The methods by which he succeeded in rearing these young oysters are described in his report, as follows:—Two oyster-planting ponds, separated from each other by a straight massive wall of earth, and having an area of about 100 mètres each, and an average depth of about one mètre, were placed in communication by means of a pipe which was closed at each end by a sponge to filter sediment from the water and to guard against the accidental introduction of spat. The outlet from the ponds was guarded by a dam of fine sand confined between boards, and thus allowing the water to escape, but retaining the swimming embryos. Artificially impregnated eggs were then poured into the lower pond in great numbers during the latter part of June and the month of July. The pond was furnished with tiles for the attachment of the spat, and on July 24 each of these tiles was found to have attached to its surface 20 or 30 young oysters, about two-fifths of an inch in diameter. Finally, during the early part of October, he states that he had the honour of presenting to the Minister of Marine a tile upon which 2,000 young oysters could be counted, measuring from two-fifths to four fifths of an inch in diameter.

“This interesting paper, which has been translated into English by J. A. Ryder, and published in the *Bulletin of the U.S. Fish Commission* for April 19, 1883, shows the practicability of the economic application of the more purely scientific experiments which were carried on at our laboratory in 1879. The author acknowledges that he was incited by these experiments and our own share in the work is therefore exactly what we should wish—the dis-

covery of a new scientific truth which has, in the hands of practical economists, contributed to the welfare of mankind.

“Mr. John A. Ryder has this summer repeated these experiments in Maryland, and has shown that they are as successful here as they are in France. An account of his apparatus and of the results obtained has been published in the *Bulletin of the U.S. Fish Commission* for September 6, 1883, under the title of ‘Rearing Oysters from Artificially Fertilized Eggs, together with notes on Pond Culture, &c.,’ by John A. Ryder.”

I am, Sir, your obedient servant,

A NATURALIST.

P.S.—An important suggestion arises in connexion with the above report. The Fishmongers’ Company have largely contributed to the new “Technical College” at South Kensington, but no provision is there made for the study of marine biology, as, indeed, it would be hardly possible to do. The sea-coast laboratory should be the technical institute of the Fishmongers’ Company; nothing could be more appropriate than that they should take the Marine Biological Association by the hand and identify themselves with it by building the required laboratory. And since the Fishmongers have generously contributed to the Technical College of the other Guilds, they in turn, we may hope, will be willing to help the Fishmongers in building the Marine Technical Institute or Sea-side Laboratory.

Commenting upon the above interesting letter, the same paper, in a long (but by no means exhaustive) leader, says—

“We print this morning an appeal from ‘A Naturalist’ on behalf of a Marine Biological Laboratory. The idea of such a laboratory is not a new one, and it has already taken

practical shape in this country. As we mentioned some time ago, an association has been formed which is collecting funds for the purpose of promoting marine biological study, and we cannot doubt that its objects only need to be widely known in order to receive the encouragement they deserve. The harvest of the sea is only less important to the people of this country than that of the land, and the study of marine biology is to the one what the study of agricultural science is to the other. At present the success of our sea fisheries depends almost entirely on the mere bounty of nature. We take our fish where we find them, just as the savage lives on the uncultivated fruits of the field. The fisherman does little or nothing to aid the operation of natural agencies, though he often does a good deal to counteract them. Yet a little reflection will show how vast a field the sea affords to observation, and how closely that observation may be brought to bear on the comfort and welfare of our daily life. The life and habits of the fish on which we feed are still for the most part shrouded in mystery. Fishermen go mainly by tradition and the rule of thumb. They know empirically where certain fish are to be found at certain seasons, and provided they secure a good haul they trouble themselves as little as possible about the causes which produce it or the conditions which favour it. They cannot be persuaded that science has anything to tell them which they do not know already, and they have the common distrust of practical men for scientific methods and conclusions. The man of science, on his part, is often a little impatient of practical knowledge and utility. It is his function to know, and he leaves it to others to turn his knowledge to practical account. 'A Naturalist,' however, judges his public better. He knows how to stoop to conquer. No doubt, if he

were so minded he would find it easy to abound on the purely scientific advantages of a Marine Biological Laboratory. But he condescends for once to read us a lesson as effective as that which, according to Aristotle, Thales once read to his contemporaries. The story runs that the father of philosophy, foreseeing an abundant crop of olives, bought up all the olive-presses in the neighbourhood, and when his prediction came true he let out his presses at an enormous profit. This shows, says Aristotle, that the philosopher can beat the practical man on his own ground when he chooses, only, as his object is knowledge and not profit, he does not generally care to do so. We have no doubt that 'A Naturalist' is very much of Aristotle's opinion; but the countryman of Bacon does not permit himself to forget that science should produce fruit as well as light, and therefore he recommends a scheme for a Marine Biological Laboratory by showing us how the researches pursued in similar institutions established elsewhere have already resulted in promoting the supply of oysters.

"The whole story is full of interest and instruction. . . . Professor Brooks was not so successful as Thales, however; he did not himself make a fortune out of his discovery. He succeeded in showing the possibility of fertilizing the eggs artificially, and of rearing the young oysters until after they had acquired their shells; but he failed to keep them alive until they were able to take care of themselves. The next step in practical discovery was taken by Lieutenant Winslow, of the United States Navy, who had followed the experiments of Professor Brooks, and, being afterwards stationed at Cadiz, repeated the experiments with Portuguese oysters, and found that they also exhibited habits of breeding identical with those of

the American oyster. It appears, moreover, that a French *savant*, M. Bouchon-Brandely, the Secretary of the Collège de France, was encouraged to similar experiments by the observations of Professor Brooks, and that having reached the same conclusions as Lieutenant Winslow, though quite independently of that officer, as to the breeding habits of the Portuguese oyster, he has overcome the practical difficulties, and has succeeded in producing oysters of commercial value from eggs artificially impregnated. Similar results have since been obtained by Mr. Ryder, in Maryland, so that the artificial breeding of oysters may now be regarded as a practical undertaking on both sides of the Atlantic. We cannot but congratulate 'A Naturalist' on this triumphant demonstration of the practical value of marine biological research. The commercial importance of the discovery of Professor Brooks and M. Bouchon-Brandely is obviously immense, and it opens up a prospect of unlimited extent to the whole gastronomical world. The possible extinction of the unaccommodating 'native' may now be regarded with comparative equanimity. Its marsupial habits, so to speak, unfit it for the struggle for existence. Its parental affection is its ruin. Its place will be taken by the less philoprogenitive but not less delicate bivalve of Baltimore or of Portugal. Meanwhile the contrast between the two may well serve to point the moral of scientific research, and to promote the establishment in these isles of Marine Biological Laboratories.

"What science has already done for the oyster it may well be expected to do in time for many another of our sea-fishes and shell-fishes. The field of research is almost inexhaustible, and science would be perfectly ready to cultivate it if once it could obtain the means and opportunities, even if no practical object were in view. Science, indeed,

would probably claim for itself that its pursuit is an end in itself, and that it has little or nothing to do with objects of practical utility. It may condescend to show on occasion, in order to convince an unbelieving world, that an extension of knowledge is also an extension of human opportunities and capabilities; but to the ardent votary of science it is the knowledge, and not the utility, that is the main object of pursuit. We have no fault to find with the promoters of a Marine Biological Laboratory on this account, but they are certainly wise in their generation to make their appeal to the commercial instincts of Englishmen. For ourselves, we are perfectly willing to recognise the force of their appeal whether it is based on the higher ground of knowledge or on the lower ground of utility. In such a case as that of marine biological research the two grounds are inseparably connected. It is impossible to doubt that the study of the structure and habits of the fishes which frequent our coasts will result in an accumulation of knowledge which must in the end direct and inform the practice of our fishermen. But of course 'A Naturalist' does not intend us to suppose that this is the sole, or even the main object of such a Biological Laboratory as he desires to see established; it is not merely for the increase of the supply of oysters, or even for the improvement of our fishing industries in general, that the eminent men whose names are given by our correspondent have formed the Marine Biological Association. Their object is the scientific study of a branch of natural history which has hitherto been neglected for want of adequate means and opportunities for its prosecution. The undertaking is necessarily a costly one, and, so far, the funds have not been very freely forthcoming. Naturalists, says our correspondent truly enough, are by no means a wealthy

class; they will do the work, and they will help to find the money; but if the undertaking is to prosper, it must obtain support from classes who are a good deal more wealthy than naturalists. How these classes can best be appealed to is the question which 'A Naturalist' seems to ask, and probably his letter furnishes the most effective answer. If the advancement of science is too remote and abstract an object to touch the imagination of the wealthy, surely they cannot refuse to give when the appeal is made in the name and on behalf of the oyster."

Well, we must find that out. We must endeavour to learn the truth of that last sentence and how best to answer it. I think the most straightforward way will be to contrast the brilliant promise of 1883-'84 with the *present* state of the affairs of our grand laboratory.

To begin with, take the following paragraph from the *Athenæum*, November 22, 1890:—

" On the whole, the Association appears to be displaying a considerable amount of activity in spite of rather limited income. As was reported at the time in these columns, a deputation waited upon the Chancellor of the Exchequer to request an increase of the present grant of £500, and it is much to be desired that the Association should be enabled to undertake more elaborate investigations, and to cover a larger coast-line than is at present in its power."

That certainly does not look very promising, does it?

Now let us look at the Zoological Station at Naples.

The Naples Station was equipped, and is now supported, it is manifest, at no little expense. Its annual income is derived from admission fees to the public aquarium, the sale of its publications and its microscopic preparations and preserved animals, governmental subsidies,

and "rented tables." By an annual payment of four hundred dollars the right is obtained to send an investigator to work at the station, for ten months of the year. This right has been obtained by universities, governments, and societies. (a)

Of course I could quote a deal more to that effect, and inform the reader that the Neapolitan Station " . . . has quite a little fleet of its own,—sail-boats, row-boats, and two steam-launches," &c., &c.; but I am anxious to show fair-play even in the length of paragraph assigned to each extract.

I will go further even than that, and show fair-play to our Government by quoting a portion of the Duke of Argyll's reply to Professor Lankester's Lecture, cited a few pages back, in order to show the difference between the "after-dinner" kind of speech, full of promise, of 1883, and the "what we've come to" result in 1890, and to prove therefrom that

"The best laid schemes o' mice an' men
Gang aft agley."

Now let us hear the Duke's reply.

"Professor Lankester had also said a few things in respect to Government which were no doubt to some extent true; but in regard to them also he would put in a word in favour of the class of public men to which he belonged. It had been said that Government in this country hardly ever consulted men of science. That might have been so in former years, but it was not so now; for, with regard to this very matter of fisheries, it was not many years ago that the Government committed a most important investigation to the hands of his distin-

(a) *The Century Magazine*, New Series, Vol. X.

guished friend, Professor Huxley, as the head of a commission that went to Scotland to inquire into what was the practical application of the laws then in force for the regulations of that kind of fisheries, and on the report of that distinguished Professor, very considerable alterations were made in the laws then in force."

Really it was very kind of the Government to confer such honour upon Professor Huxley ; possibly they did so because they could not find any one better suited for their object ; and, as to making "very considerable alterations in the laws then in force," on the Professor's report, surely there are no thanks due to the Government for *that* ; for, whatever beneficial alterations there were at the time alluded to, the public's gratitude is due to Professor Huxley and not to the Government ; and, moreover, what did the Government appoint him head of the commission for, if they did not mean to go by his advice ?

As His Grace the Duke of Argyll has (in the pamphlet relative to Professor Lankester) advanced no better plea in favour of the Government than the above, it is a pity he alluded to the Government at all. But, in order to make good my charge, I must have a basis more solid than this. Yes, I feel I cannot be too serious in the assertion of the principle that science pursues truth for its own sake ; that scientific men delight in the ascertainment of truth for its own sake ; and feeling this I scorn to show, or even feel, the least triumph at the too easy puffing away of the flimsy verbiage of a mere platform apology for governmental inefficiency. And so, for that reason alone, as Hamlet says,—

I'll have grounds
More relative than this :

whereon, following the impulsive thought, I refer the

reader again to the *Athenæum* of Nov. 22, 1890, in the "Science Gossip" items of which that staid, respectable, and valuable Journal, writing in a tone of bitter, national regret, says:—"History, with its usual monotony, has again repeated itself. The Marine Biological Association, at a loss for a suitable director, has had to cross the Tweed and select Mr. W. L. Calderwood, who was for four years connected with the Scotch Fishery Board. The Act of Union will not, we believe, prove disadvantageous to the Marine Biological Association."

Was there no one at Home?

Seemingly not; and the Government's Abroad.

Ah! Professor Lankester *was* right, and the glossed over assertions of a *wilderness* of Dukes cannot contradict him.

And now, as we look from the promising 1883 to the mournful 1890, we can see the Marine Biological Association, lacking that recognition from the Government which it ought to receive, fretting at and envious of the better fortune and well-merited fame of the Zoological Station at Naples, and awakening to the fact that (in regard to their own case and others too) "*Apathy*" is the badge of all the Governmental Tribe. Yes, British Public, "APATHY" is the only word.

Now, in all probability, the reader, having followed me thus far, will say—"Sir, all that you have said against the Government may or may not be correct, but our Legislators have empowered the Board of Trade with the sole control of the Fishery Industry, and therefore you have been attacking the wrong party."

Very well, for the sake of argument let it be so. But I hardly think that—having found the *Masters* so remiss in

their legislative duties—the *Servants* will be any better. But let us see.

A very able, thoroughly practical, and most experienced writer, (*b*) in the course of detailing the inefficiency of the Fishery Laws, says:— . . . All these blunders could have been avoided had we, like other nations, an organised fisheries department. The Board of Trade, which legislates for the fisheries, has not on its staff a single practical fisherman, or even anyone who knows the common rudiments. What would be the result if a man trained as a fisherman was chosen to practically advise a department on shipping matters? The reply is—Blunders. The same argument then may be employed vice versâ.

. . . . It is all very well for the Board of Trade, as the present system is, to hold inquiries, when it wants information, from fishermen, but these cannot afford to lose time, or make experimental trips and hauls for the benefit of the community at large. This should be the work of the Government, and is one which has been undertaken by other Governments long ago, with the result that we are behind-hand in our knowledge of fish and fisheries.

. . . . In reply to questions put to them when being examined by the select committee (on the question of Lights) afterwards appointed, one gentleman said he had no experience whatever as regards fishing in trawlers or drifters. The second said, that not being a sailor he could not answer nautical questions. The third admitted

(*b*) The effect of the existing National and International Laws for the Regulation and Protection of Deep Sea Fisheries, with Suggestions for Improvements in the said Laws. By W. Morris. Pp. 68, 70, 71, 136, 138. (Prize Essays issued in connection with the Great International Fisheries Exhibition, London, 1883. William Clowes and Sons.)

that he had not been in fishing vessels, and that after the evidence had been received he had taken no further interest, as he had other occupations, but signed the report as drawn up by the gentleman from the Board of Trade after he had "*run it over.*" And yet it is given in evidence that these three gentlemen were appointed by the President of the Board of Trade as a committee of experts. What a delusion! and what a careless way for a Government department to deal with a matter affecting such momentous interests, involving the risk of thousands of lives and enormous property. These gentlemen visited various ports, and informally enquired of persons interested in the fisheries the grounds on which they had based their objections to the new rules. . . .

. . . This brief allusion to the lights question will show that, however willing and anxious a department may be to legislate for the benefit of this most peculiar trade, it cannot do so successfully and beneficially without first consulting and securing advice from persons who have practical knowledge of it, whether ashore or afloat. One nautical gentleman who was concerned in one of the committees, on being shown a trawling smack, asked the question, "Where are the yards?"—things entirely unknown in our English trawlers. Again, when the latter part of article 7 of the existing Regulations is considered, which runs as follows: "Fishing vessels and open boats when at anchor or attached to their nets and stationary shall exhibit a bright-white light," how absurd it appears; for what craft are there that are ever stationary when attached to their nets? for even in a calm a trawler will have her gear at her side, and a drifter will be drifting with the tide; it would only occur in the exceptional case of a trawler fast to a wreck or rock or otherwise; and this article is the

only one referring to fishing vessels, and was evidently intended originally to apply to them when at work and perfectly helpless. It was evidently meant to convey that all vessels under command must avoid them. . . .

And of many more similar paragraphs are composed the legislative records of the Board of Trade.

And this Governmental department has within its unpractical grasp the unlimited control of the British Oyster Industry!

Is the reader satisfied—convinced? I hope so, and pause for a reply.

In concluding this somewhat long but sternly necessary preamble to the better comprehension of the deficiencies in our oyster cultivating methods, which will be minutely described in my next chapter, I cannot allow the reader to indulge the thought that the foregoing strictures upon the Government have afforded me any personal satisfaction, or that I have taken any vicious pleasure in writing that which, in truth, has been expressed by me

“More in sorrow than in anger.”

I would have rejoiced had there been no occasion for me to write thus; and I am grieved to think that I or any other British loyal subject should be forced to cast reproaches on the maladministration of a Government, which, although from time to time, it has been censured by the Press—all too mildly—I bitterly regret to say shows no sign of amendment.

CHAPTER XLII.

ARTIFICIAL OYSTER CULTIVATION.

CHOICE OF LOCALITY—SUMMER LAYINGS—BREEDING—COLLECTORS
—THE COATING OF TILES—COCKLE-SHELLS—CULCH—DISTINC-
TION BETWEEN PARCS AND CLAIRES—FATTENING—CULTIVA-
TION ON THE ESSEX CREEKS—TANK SYSTEM OF CULTIVATION
—RULES FOR THE PRESERVATION OF OYSTER BEDS—PRINCIPAL
ESSENTIALS NECESSARY FOR SUCCESSFUL OYSTER-CULTURE—
CONCLUSION.

THE oyster culturist should in a great measure be guided in his choice of locality by the presence or absence of natural beds of oysters in the neighbourhood.

In many instances, both in England and France, thousands of pounds would have been saved if the promoters of the various enterprises had recognised the fact that, where oysters are not naturally present, it is probable some important conditions necessary to their development must be wanting in the soil, temperatures, or water of the place.

The best places for the industry are estuaries of rivers, the arms of harbours and protected bays, and ebb-dry shoals and foreshores. Where there are disused salt-terns or salt-pits, oyster-ponds are almost ready made. In the first successful attempt to breed oysters artificially in

England a saltern was used, in which salt had been made the previous summer, but which had been cleaned out and shingled.

A little practice in oyster culture is better than much theory, so a few oysters should be laid down and carefully watched. If they gain in flesh or "fish," as it is called, the place is suitable for fattening ; and so on as to experiments in spatting, wintering, &c.

Some flat ground near the shore having been selected, the next condition is that it should be capable of holding water naturally or artificially. If already water-tight, as it were, so much the better, but if not, a coating of clay or blue mud must be laid down sufficiently thickly to prevent the water from escaping, a few inches of sand must then be placed on the clay or mud, and a layer of shingle, cockle-shells, or old oyster-shells, for a "top dressing."

The ground having been thus prepared, means of ingress and egress for water must be provided by the erection of banks and sluices. A model oyster farm would comprise about twelve or sixteen acres, half devoted to breeding, and half to pits or ponds for wintering and for the young brood and last year's spat.

The shape of the wintering ponds should be *oval*, so that the water may more easily run off than it would if they were rectangular ; the number of ponds should be as few as possible, in order to reduce the expenses of constructing sluices.

Besides this farm, there should be growing or summer beds, where they will have a fresh supply of water each tide, an acre of these beds being provided for each half-million oysters. They will then grow well and can be easily cleaned. When it is necessary to clean these ponds, the water is allowed to run off during the ebb-tide until only a

few inches remain; the men will then work the harrows, allowing the inlet and outlet sluices to remain open; the running water will take away a good deal of the weed, slub, &c., and the rest can be easily removed by working a brush-harrow in the same manner.

The supply canal should be of sufficient depth to always retain water, the bottom of the ponds should be about the same level as low-water mark (neap-tide).

SUMMER LAYINGS.

All brood, ware, &c., that are not going to be used for breeding, should be taken out of the ponds and placed on the summer layings before the end of May; the bed must not be subject to land drainage—a good plan to prevent this is to have a barrier across the stream, which will prevent the tide and river outflow, after the last quarter's ebb, going over the layings, as it will be then diverted into two side canals, the banks of which are the same height as the barrier.

A former writer has given eight men per acre as the number required to work an oyster-farm, but an estimate of this sort depends too much upon varying circumstances to be anything more than approximate.

The following are some of the conditions affecting this number:—

1. The quantity of oysters laid down to fatten.
2. The fertility of the year in spat.
3. The cleanliness of the grounds.
4. The market demand.
5. Necessity of removal to winter quarters.

The breeding-pond should be left dry all the winter, and water not admitted until the commencement of the breeding season. The breeding oysters should be placed in

trays, so that they can easily be removed without disturbing the others. We do not recommend any fixed posts, wires, or other similar contrivances in the breeding-pond, as they collect weed, slub, &c. Channels should always be left between the rows of collectors, to allow a boat to pass when necessary to work at them. The collecting trays and frames may be of any moderate size, but about 2 feet 6 inches by 6 feet will be found the most convenient.

All the collectors should be ready before spatting time. Wooden collectors can be made, so that the water can pass freely through them ; they should also be coated with tar, and, after being dried, with a lime solution ; they should be placed together, as a lean-to roof, at an angle of about 45° , secured by strong stakes driven into the ground on either side, and fastened together at the apex.

At Hayling Island. Mr. Dilnot showed us some canvas collectors made out of the stuff used for sugar-bags prepared in this way, which, he said, had been successful in 1881.

The canvas, after being dipped in tar, is carefully dried, to preserve it from the water, and, if used for a collector, is spread on a rough frame, and then coated with a solution of lime, clay, and sand, well stirred up together ; lime and sifted earth would probably do as well.

For young oyster-holders or ambulances, Mr. Dilnot, at Hayling Island, has used the same canvas, when tarred and dried, nailed to the sides and bottoms of the battens which form the trays or boxes.

The advantage of wooden and canvas collectors over tiles, as used in England, is that the standing posts and wires are rendered unnecessary, and the operations of cleaning the weed and slub they attract are thereby dispensed with.

If tiles are used in stacks, as on some French breeding-grounds, it is obvious that all the ground between them is unoccupied by collectors, whereas the roofed collectors can be placed with their ends touching one another. Bearing in mind the immense fecundity of the oyster, one cannot have too many collectors on any given space of ground, consistent always with their being easy of access.

During the breeding season, the temperature of the water should be constantly observed. If the weather is too warm, the inlet sluices should only be opened during the night tides; if not warm enough, they should be opened during day high-water.

During spatting time, it is an absolute necessity that water should be let in as much as possible, but as little as possible let out. Double sluices should therefore be fitted to each port of inlet, or outlet, which will allow the water to pass one way and not the other, as necessary. Before entering into the more general questions of breeding and fattening, we will give a list of some of the materials for the model oyster farm.

FOR COLLECTORS.—Coarse canvas, wooden frame-works, tar, wooden trays, stakes for securing collectors, tiles for filling up corners. A few wires and posts to rest tiles against, lime, clay, and sand, mixed together in a thick solution when used.

AMBULANCES.—Top and bottom trays fitting closely together, covered with coarse canvas and tarred, or similar trays, made of perforated zinc, &c.

Flat-bottomed boat, rakes, harrows, brush-harrows, dipping-tubes, for tarring and coating with lime, &c., cul-tacks, oyster-spuds, hand-distributors, tubs, wash-measures, dredging-boat complete for summer grounds, &c.

Oyster culture may be broadly divided into the two branches of breeding and fattening, which are distinct from one another. Each occupation requires peculiar conditions of site, climate, and soil, and it is rare to find the circumstances favourable to both operations in one locality. The reasons for this are that breeding oysters require heat and tranquillity above everything, whereas the presence of the right sort of food in sufficient quantity is a *sine quâ non* for fattening purposes. When laid for breeding, oysters are not required to be fat; they want but sufficient nourishment to support life, which is always to be obtained in salt or brackish water. The physical conditions of a locality suitable to fattening purposes—*i.e.*, where there is a strong scour of the tide or a frequent inrush of river freshets—are most unsuitable for breeding, as the spat from oysters placed in such positions is frequently carried away and lost.

Speaking in general terms, we may say that the conditions prevailing in the districts devoted to oyster culture in France are most suitable for producing and rearing the young brood; whilst the English beds have the character of not only bringing lean oysters into condition for the market in the shortest time, but of producing better and more delicately flavoured oysters than any others in the world.

There are of course many oysters bred in England, and some fattened in France; but there seems to be little doubt that, whilst the colder temperature of an English winter contributes largely to the esteemed flavour alluded to, the higher temperature along the west coast of France is more favourable for the reproduction of oysters, and for the preservation of young during the first few weeks of their existence.

The main objects which the oyster breeder has in view are—

1st. To catch the spat, which would otherwise either perish or be swept away elsewhere.

2nd. To transfer the young oysters, as soon as possible after they are caught, to a place where they will be protected from their many enemies.

The oyster fattener does not trouble himself with the artificial means adopted for securing a large quantity of spat, although he is glad enough if spat happens to fall on his own grounds; but he generally looks to other layings, more favourably situated for breeding, to supply him with young oysters and those that require fattening for the market.

The growth and well-being of the oyster is then his especial care; and we shall endeavour to describe the various systems of oyster culture adopted, as local circumstances require special precautions.

The qualifications of a locality for successful oyster farming greatly depend upon the nature of the soil, both as regards its mechanical character and its chemical composition.

As regards its mechanical character, the best kinds of grounds are those where sand, marl, and clay are mixed in about equal proportions. If the locality be devoted to breeding purposes, the sand and marl may be in excess of the clay, as the grounds under these circumstances will be more readily kept clean. If they be required for fattening, the minute organisms which highly organic mud contains are so necessary for bringing the oyster into condition, that it is desirable to have the clay in excess of the marl and sand. Pure sand is prohibitive, and pure mud and pure lime are both disadvantageous for oyster culture, for reasons

which we have more fully entered into under the head of "Inanimate Enemies." (a)

As regards chemical composition, the soil of a locality, to be employed successfully as a fattening place, must contain more or less flocculent silt, highly hydrated, and rich in organic matter, *i.e.*, in those microscopic organisms which are known as *Diatoms*, *Infusoria*, *Foraminifera*, *Rhizopoda*, &c., as the presence of these animalcules and *Algæ* are the true test of a good oyster ground. The soils of those places which have been successful as breeding stations always contain this hydrated silt in some proportion or other, but not necessarily in such large quantities as those places used as fattening stations. There is a general similarity to be observed in good oyster soils from various parts of the country.

Their usual appearance is that of a loamy alluvial mud, or calcareous plastic clay of a greyish-blue externally, but which, when caked and broken open, appears intensely black inside. Exposed to air, they oxydize rapidly, and turn of an ochreous tint, and when dry they form a friable mass. If washed, the materials of the rocks from which they have been derived are readily discernible: spangles of mica, felspar, and hornblende bespeaking an igneous origin, as fragments of shell and particles of sand point to the Eocene beds for their origin, whilst a preponderance of *Foraminifera* and *Globigerina* indicate a cretaceous derivation.

In some places, as at Marennes, there is a shelly loam, called in France *sable vazal coquillé*, which possesses excellent fattening properties. In Mesozoic times the Purbeck beds must have been wonderful oyster grounds. The influence of the soil upon both breeding and fattening, as

(a) See Supplement.

shown above, is complicated by many other circumstances, some of which we have entered into in our chapter on deep-sea cultivation. Velocity of tide, angle of dip of shore, temperature and depth of water, are amongst the most important of these.

BREEDING.

The starting point of the oyster-breeder is obviously the act of laying down mature oysters to spat. It might appear to the superficial observer a very simple thing to dredge up oysters from other beds and lay them down to breed, but nothing is easier than to commit grave mistakes at the outset.

It used to be considered that oysters would not spat after having been moved any distance, but the latest information received on the subject leads us to think this is an error. Removal may hinder, but need not prevent subsequent fecundation. The after-health and well-doing of the oyster depend in a great measure on the time of year at which it is moved; the best time being between November and March, as it may be taken as a general rule during the period of reproductiveness that, with one exception hereinafter mentioned, *the longer the period between the time that oysters are laid down and the time of their spatting, the greater will the chances of reproduction be.* Nothing can be more injurious to the oyster than to move it whilst it is sick, as, apart from the loss occasioned by the death of the young about to be produced, the damage to the constitution of the fish itself is so great as to make it improbable that oysters so treated will ever spat again. It may seem extraordinary to state after this that it has been lately found advisable to place *deep-sea oysters* in breeding ponds as short a time before spatting as can be arranged. The reason for this may be that the difference in pressure

between a few feet and perhaps thirty fathoms is so great, that if you gave the oyster time to think about it, it would, under these conditions, refuse to spat at all. But being taken up in an advanced stage of pregnancy, it cannot help itself, and rids itself of its burden as soon as it can ; of course a much larger proportion of immature spat is produced under these circumstances than under normal conditions.

Secondly, great care should be taken of the oyster during removal, by protecting it from wind and consequent evaporation whilst it is out of the water. When first dredged up, oysters should be picked out of the accompanying rubbish, cleaned, and covered with sea-weed in a cool place. No longer delay than can be avoided should take place before they are relaid, and when they are out of the water for more than twenty-four hours, sea-water should be thrown over them occasionally.

Deep-sea oysters spat most freely in shallow water, *i.e.* in water of which the average depth at half ebb is from four to six fathoms ; below this depth the difficulties of reproduction increase with the distance from the surface, and it is doubtful whether spat is ever *produced* at a greater depth than thirty fathoms, though of course it may drift and fall there from shoaler water. The change, therefore, from deep to shallow water should be accomplished gradually (except in the one instance already mentioned), so as to accustom the oysters to the new conditions.

This gradual acclimatization should be carried out further with oysters which have to be moved any distance. If unaccustomed to be left uncovered at low water, they should be raked or dredged in, and dropped first to a point between low spring and low neap-water mark, and later on to above the latter line, being moved a few feet further inshore every

third or fourth day. After the oyster has been left uncovered for an hour or so every day for a week, it begins to know when the ebb-tide commences to run, that the time for its exposure is approaching, and it takes in an extra quantity of sea-water to last it till the flood begins to make. If the distance from high-water mark be gradually decreased, the oyster gets accustomed to remaining out of the water longer and longer every day, till at length it will imbibe and retain sufficient salt water to enable it to keep alive during a journey of a fortnight or more, if proper care be taken during transit. To travel any distance successfully, oysters require careful packing. All dead and diseased ones should be removed, and the healthy ones, after being well cleaned from outer growth, should be placed in a tub or barrel, with the *round shell downwards*, packed tightly, and covered with a layer of fresh sea-weed. If practicable, sea-water should be thrown over them once every twenty-four hours.

Supposing that a fair stock of parent oysters has been secured on the breeding beds, and laid down at the proper time with the precautions we have recommended, the next thing that will occupy the attention of the breeder is how to secure the greatest number of young during the ensuing summer.

The absolute necessity of providing the young spat with some clean substance to adhere to soon after it leaves the parent shell, has given rise to the custom, from time immemorial, of placing collectors in the water near the parent shells. The shapes, sizes, positions, and arrangements of these collectors have been countless, as are the materials of which they have been made. Stones, tiles, wood, faggots, shells, furze bushes, hurdles, hampers, slates,

wattles, &c., have all been used indiscriminately and with varying success.

The actual composition of the collector has very little to do with its attractive power for oysters, as it appears that they do not derive any nourishment, even in a shell-constructing point of view, from the material to which they are affixed.

COLLECTORS.—FASCINES.

It was from Lake Fusaro, where they have been employed from time immemorial to intercept the spawn, that M. Coste first obtained his idea of faggots as collectors. He introduced them to the French fishermen, and they were used, with great success at the outset, at several places on the coast of Brittany; they have also been tried at Herne Bay, Brading, and other places in England.

The “fascines” should be slung on ropes or wires, attached to posts, and fixed in rows along the foreshore, the bundles being supported some two or three feet above the oysters which are scattered beneath them. The wood composing the faggots should be hard and dry, and cut at least twelve months before it is used for this purpose. Furze has also been tried, and has been found to answer fairly well. Its cheapness is a recommendation in its favour.

The advantage claimed for fascines as collectors when first introduced in modern times, was the ease with which the oysters could be detached from them. At this time stones were the only available substitutes, but now that improved collectors have been introduced, fascines are rarely if ever used.

They are totally unsuited for any place where there is a tideway running, as in such localities they act far more

effectually as collectors of weed and floating rubbish than of oyster spat, even when the resistance they offer to the current does not result in their being carried away altogether. Another disadvantage is the rapidity with which they become slimy and covered with weed; when in this state they are utterly useless, as the spat will not adhere to the wood unless it be perfectly clean. Probably this is one of the causes of the failure of the extensive experiments carried on in the Bay of St. Brieuc. Those who had charge of the undertaking do not appear to have paid sufficient attention to keeping the culch and collectors clean, and defective falls of spat resulted.

It has been said that oysters have a tendency to conform their shape to that of the object to which they are attached, and those fixed on twigs certainly appear to grow in a somewhat elongated mussel-shape. This malformation corrects itself, however, when the bundles are broken up and the young brood separated.

Another great disadvantage attaching to all wood collectors uncovered by cement is that it is impossible to remove the young oysters from them without great risk of damage to the shell, until the latter has become hardened by at least two winters' growth.

HURDLES

Are used in some places to catch spat. They are supported in a horizontal position by a stake at each corner, and placed about two feet above the oysters. Their use, however, as well as that of sides of hampers and other makeshifts, has been superseded by cemented tiles, and in the most advanced oyster farms by other forms of collectors, coated with a solution of lime.

SLATES,

Arranged in parallel horizontal layers, and kept apart by bricks, are used in some parts of France ; they, like tiles, can be covered with cement, but their expense is against them.

STONES,

At the Ile de Ré, and at Oléron slabs of stones, from 18 inches to 2 feet long, by 9 inches or 10 broad, are placed in rows canted up one against the other. Series of stones so arranged are made about 100 feet long, and four or five of them are grouped together, within a space of about 30 yards square. The walls of this enclosure, called a " parc," are constructed of slabs of stone placed upright, and made watertight by being coated with a coarse cement made from mud found close by. The cost of a parc of the above dimensions is about 800 francs.

Stones are about the worst sort of collectors that can be used. They are heavy to move, difficult to clean, and the oysters are liable to injury when being removed from them ; but as they are not expensive, entailing no cost but that of manual labour, they are suited to the exigencies of those districts where labour is cheap.

Similar constructions are erected at Oléron ; but here, contrary to the custom adopted at Ré of laying down parent oysters in the parcs, they trust entirely to the spat being drifted in from the natural banks outside. Like arrangements of collectors, slightly modified according to local circumstances, may be seen in work at Chatellion, and at a few places on the west coast of Ireland.

TILES.

After long experiment it has been found that a good kind of collector is the common house-tile covered with a

coating of lime. This form was first suggested by Dr. Kemmerer, and consequently the name of "Kemmer tiles" has been given to them. His invention consisted in laying a piece of damped paper on the tile which, when covered with cement, was easily protected from sea-water; both paper and lime was then easily removed by the "cultack" (a knife used for the purpose of separating oyster bundles and detaching them from collectors), the tile being thus preserved for future use. Before Dr. Kemmerer's invention, the tiles used to be broken up by pincers, it being deemed preferable to sacrifice the tiles rather than risk damaging the young oyster by removal. This plan is not yet wholly abandoned; as in the Morbihan, where the authorities do not, as at Arcachon, put an embargo on the sale of oysters under five centimeters in diameter, it is the custom with some cultivators to break up their tiles into four or five pieces and sell them thus, with brood attached, for laying down elsewhere. These potsherds are called *huîtres à tessons*, and are eagerly bought by many owners of fattening establishments, as they partly dispense with the use of ambulances for the protection of the young brood; crabs and other vermin being unable to attack them with the same facility when attached to tiles as when they are single. Oysters grown in this fashion are not exposed to the danger of injury during removal from the tiles, but, being crowded together, do not become so well formed afterwards as their earlier liberated brothers. The idea of these *huîtres à tessons* originated with Dr. Gressy.

Dr. Kemmerer's invention of applying paper before the cement has now given way to an easily detached mixture. The tiles are coated with common lime and water, and with hydraulic cement. At Auray the hydraulic lime is applied first, at Arcachon the reverse. Tiles are cheap in France,

hence their widely extended use. The average cost is £2 per 1000, or about a halfpenny each, and there are more than ten million in use on the *crassats* at Arcachon.

The time for placing them in position varies according to climate and locality. At Arcachon they are laid down about the 1st of June. At Auray the spatting season is fully a month, and sometimes six weeks later; so the tiles are not in position much before the middle of July. But these dates, of course, depend a good deal on the season. The bottom of the sea in the immediate vicinity of the tiles is generally strewn with clean culch.

The methods of arranging the tiles depends upon the position in which they are placed. In the large flat parcs at Arcachon they are placed in rows or patches, on the beds which are dry, at low spring tide. The tiles are laid in stacks, crosswise one row above another, till the height of three or four feet is reached; they are then secured from the run of the tide by stones and stakes. The weed around them is hoed away for a few yards, and the oysters are laid down. The greater portion of the spat is found adhering to the under surface of the tile. It is an unsettled question as yet whether this is merely because the concave surface is cleaner, or whether the oyster does or does not spat most often on the flood tide, in which case the spat would adhere in rising.

The tile crates are erected about every twenty yards, and arranged alternately, or, as the French say, *en quinconce*, so as to break the flow of the tide evenly, and thus catch most spat. The top of the crate is often protected by planks coated with pitch, on which culch has been strewn before it is dry; these coverings often catch a lot of spat. Where there is no tide, or the ebb and flow are equal, it is recommended that the tiles should be placed at an angle, as they

have then been found to attract the greatest quantity of spat. The system of laying down tiles has been abandoned at Auray on account of the rapidity with which they become covered with mud.

M. Leroux has substituted a plan of suspending the tiles on an iron wire, which is firmly strung between two posts fixed in the ground. This seems to answer well, and has the further advantage of being easily taken up and laid down; twelve or fourteen tiles are thus placed on one wire. (*b*)

Writing on tile collectors, Dr. Brooks says: . . . Those which are used in France are much like a common drain pipe, sawed in two longitudinally. . . . Each tile is about 18 inches or 2 feet long, 6 or 8 inches wide, concave on one side and convex on the other. The shape of the tile is important, as nearly all the oysters fasten themselves upon the concave surface. They adhere so firmly that it is difficult to detach them without injury, and to avoid this the French oyster breeders coat the tiles with a thin whitewash, which can be scaled off with the young oysters when these are large enough to be distributed upon the planting grounds.

The following is an account of the method of coating the tiles as employed in France:—

“What is most remarkable concerning liming is the fact that both quicklime and hydraulic cement are decomposed by sea-water. Hydraulic cement hardens in fresh water; but salt water, although it permits of a first hardening, in the course of time produces complete decomposition. This change is favourable to the removal of the young oyster, and to the assimilation of lime by the young.”

(*b*) Anson & Willett's "Oyster Culture," pp. 65-80.

“ . . . Quicklime,” says M. Alphonse Martin, “always retains a little moisture, thus placing at the disposal of the oyster all the materials which it needs.”

“ . . . The tiles covered with lime will give three times as many oysters as those without it. This principle being admitted, the liming is done in two very different ways at Morbihan, according to whether it is intended to entirely free the oysters from the tile, or to allow a portion of the tile to remain attached to each shell.

“ . . . Some of our culturists . . . cover their tiles with a slight coating of hydraulic cement. The young oyster attaches itself to the cement, but the coating being very thin is soon worn away, leaving the oyster quite firmly fixed to the tile. Others, on the contrary, who, six months after the collectors have been set, prefer to separate the oysters entirely from the tile with the blade of a knife, generally cover the tile with two layers, and proceed in a different manner. We cannot do better than to give their method of procedure in their own language :”—

“M. Eugene Leroux says : ‘I procured some quicklime, which was slacked just as it was to be used, and was put, while still in a state of ebullition, into a large vat, where two-thirds the same quantity of sand had been placed. My men stirred the mixture until it had attained the consistency of clear broth. The collectors had been made ready, and, held by the lower end, were dipped into the vat. One immersion sufficed, after which the women took them in hand-barrows and exposed them to the air to dry before setting them up. This excellent coating should be prepared with fresh water only; sea-water prevents its adhering for any length of time to the tiles, and if it comes off the labour is of course lost.’ ”

“M. Liazard states: ‘It was necessary to find a substance which, placed between the outer coating of the tile would decompose after remaining long in the water, and thus leave the coating almost free. I tried different pastes, all of which gave good results, but it was necessary to select the most economical. I was satisfied with a mixture made of flour and a small quantity of the scrapings of potatoes, boiled in a sufficient quantity of water to produce a thin paste. The tiles were dipped in this, and after they were dry they were passed through a bath of hydraulic cement. I have always succeeded with this mixture; it is quickly made and costs but little. Every time I have neglected to use it I have regretted it.’”

“M. Alphonse Martin says: ‘I first plunge each tile into a milk of quicklime, and when this coating is quite dry I again dip the tile into a bath of hydraulic cement.’”

“M. de Wolbock generally uses two layers of hydraulic cement.”

“It seems to us rational that, when not intending to leave the oyster attached to the tile, we should resort to two layers, the first of quicklime, which will not adhere very firmly, and the second of hydraulic cement. The first facilitates the removal of the oyster and the second the adherence of the young.”

Tiles may be used as spat collectors in either deep or shallow water. On the French coast they are chiefly employed above low tide mark, or very shallow water, and they are then spread out on a considerable area. In some cases lines of stakes are driven into the ground, about a foot apart, transverse string pieces are fastened to them about a foot above the bottom, and a row of tiles is laid upon the latter, concave surface down, another row of tiles is placed at right angles upon the first layer and the whole

is weighted with stones. Another method is to place them in rows like card houses. The tiles should be placed in position while the oysters are spawning, as they soon become slimy and covered with dirt. As soon as the oysters are large enough to handle they should be removed and distributed over the planting ground, as they are often so crowded together on the tiles that they have no room to grow. When used in deep water the tiles may be fastened to a frame, which may be sunk upon or near a natural bed. (c)

RUCHES

Are arrangements of tiles round a stake, and serve the same purpose of keeping them off the mud as that already described. In addition to the various modes of spat collecting already mentioned, I may state that cockle-shells are used as culch for the oyster spat to adhere to; they are thrown on to the breeding-beds; and they sow them during the time the oyster spat are floating about in the sea. Frank Buckland, in his examination before the Select Committee on Oyster Fisheries, 1876, adds that "Spat are especially fond of cockles, and that the great advantage of cockle-shells cultch is, that the oysters will grow up in handsome bunches, they can be broken off, and they will grow into proper size and shape, and become handsome and fit for market."

Major Hayes, Inspector of Irish Fisheries, in his report on the principal Oyster Fisheries of France, made in 1878, noticed at Arcachon, a new form of collector for spat, viz., cockle-shells strung closely together upon wire, a hole being made in the shell near the hinge; the wire is run through, and when strung they are placed at the

proper time in situations favourable for catching spat. They are kept about three inches above the mud by means of pegs placed at intervals, to which the wire is attached, and they appeared to succeed admirably, as when a long string, or *chaplet* as it is called at Arcachon, was lifted, every shell was covered with young oysters.

CULCH (SOMETIMES SPELT "CULTCH")

Is the name which is given to the débris of shells, stones, &c., which is found at the bottom of the sea, on or near oyster beds. It has been the practice from time immemorial to supplement the natural supply by throwing down deposits of this sort on oyster grounds. Oyster and cockle-shells make the best material for this purpose; in default of this, stones and pebbles may be used, the great point being that the culch, whatever it is composed of, should be clean, and for this purpose the shorter the time it is laid down before the spat falls the better. *Cultch-boards* are two pieces of wood, generally from the head of a cask, which are used by dredgermen for taking up and throwing overboard the old shells, débris, &c.

The collectors are left with the young oysters upon them until the latter have attained the size of sixpence, when they are removed and placed for protection in boxes called "ambulances." These cases are generally wooden frameworks, with wire or perforated zinc covers and bottoms, of which the meshes must be small enough to protect the young oysters from the depredations of their enemies.

From 2000 to 5000 oysters are placed in each ambulance, which varies in size according to the fancy of the grower. When filled, they should be placed in the water at varying depths, but always supported a few inches

off the bottom so as to allow a free circulation of water to go on round the box. Some proprietors place them in their parcs, others on the shore, as near low water-mark as possible. It is considered desirable to place them in a current, or as near to one as possible, as their growth is much more rapid under these conditions. In fact it is astonishing how quickly oysters will grow when placed in favourable circumstances. The wire-covered ambulances referred to above cost about twenty francs each. The canvas ones probably about four shillings.

In France, when oysters are old enough to be moved, i.e. when they are about eighteen months old, they are transferred from the breeding parcs and laid down to fatten in the "tidal" *claires* or *crassats*. And here we ought to explain that the term "parc" is more strictly applied to a shore or bank where the parent oysters are laid down and collectors are placed to arrest the spat. A *claire*, on the other hand, is a tidal enclosure, provided or not with sluices, where the young oysters are put to grow and fatten; and a *crassat* is an ebb-dry foreshore mudland, corresponding to the banks of some of our creeks. *Claires* or *clears* are not employed so frequently in the United Kingdom as in France, their place being supplied by foreshore and creek beds, the latter producing some of our best native oysters.

The oysters are moved into ambulances from the parcs at Arcachon in October, i.e. about fifteen months after they are born. At Auray they are allowed to remain till the following March or April before being taken into *claires*. When the transfer takes place, they are taken off the tiles by women, who can easily remove them with a cultack.

The result of our inquiries and experience is, that young oysters should be removed as soon as possible after the spatting season has ceased. *The earlier they are removed, the better their chances of growth and healthy existence.* With the present easily friable coating of lime, &c., there should be no difficulty in removing an oyster from its first bed after it has lain there three months.

FATTENING.

The system of working beds which are never uncovered is much less laborious than that required on ebb-dry mud-banks, inasmuch as the oysters do not require to be moved in the winter for protection from frost. There is, however, constant employment on a large oyster farm of any kind, as an account of the operations of the Whitstable Company will show.

The Whitstable Free Dredgers' Oyster Company is managed on co-operative principles, and affords employment to a large number of people who must be free dredgers of the town, born and bred. The members themselves number about 400, though the collateral industries to which the business of the company gives rise afford employment to over 3000 men, women and children. The actual business of the company consists in purchasing brood, half-ware and mature oysters, and laying them down to fatten. Very little is done, as in France, by way of breeding, for Whitstable, though undoubtedly one of the best oyster-fattening grounds in the world, is not a good breeding place, being too much exposed to the effects of easterly gales for heat and tranquillity to prevail at the critical time of year.

From August to May the boats are employed dredging for the market two or three days in each week, in which

operation a certain quantity called a "stint" is assigned to each boat; this it must complete, but not exceed. The other days are devoted, as necessary, to cleaning the ground of vermin, laying down, and shifting oysters from one part of the ground to the other.

From the 12th of May to the middle of June the boats are busy for five or six hours every day, removing all oysters that will be ready for the market by the end of the summer from the breeding and growing beds to the fattening grounds. At the same time the ground is cleaned and prepared as far as possible for the coming fall of spat.

From the middle of June to the 4th of August, i.e. during the spatting season, the beds remained untouched, and the fishermen are employed yachting and in other seaside vocations.

In former years the company trusted greatly for its supply to the spat of its oysters floating on the common ground, known as "The Flats," where the small oysters were dredged up and sold to the company to be redeposited upon their grounds; but of late years this supply, although continued, has become wholly insufficient, and they have been obliged to seek their brood, &c., elsewhere.

The principal sources of the present supply are the Pont, the Essex rivers, viz. the Blackwater, Crouch, Roach, and their tributaries; the basins of Arcachon and Auray in France, Schleswig in Holland, the Skelling Bank off Heligoland, and various places in Scotland and Ireland. The prices paid to dredgers for oysters found on the Flats were last year as follows:—

All mature oysters of whatever kind, 13s. per hundred (1800 to 2000 to the bushel); brood or half-ware (which run from 3000 to 6000 to the bushel), 6s. per hundred.

The cost of oysters from other parts varies with the state of the market.

Oysters, both mature and immature, from Arcachon and Auray are laid down at Whitstable in large quantities. They are locally called "pearls," and after a short time become almost identical in flavour to the native. Twenty-eight million were imported in 1880, and there is no reason to suppose that the supply has fallen off during the last two seasons. It may, indeed, be shrewdly suspected that the true British native, if not doomed to extinction, is, like the black rat, becoming rarer and rarer every year, its place being supplied by French oysters which, when placed under the same conditions as natives, rapidly acquire both the flavour and growth of the indigenous variety—appearances which, if not exact, approach the mark nearer and nearer each generation.

All oysters, other than natives, laid down in the Thames Estuary rapidly strike out a fresh growth, the new shell being plainly discernible from the older growth; and whatever the "*provenance*" of such oysters be, they all more or less resemble natives after a time, in shape, flavour and texture of shell, the resemblance being greater the longer the oyster remains in the beds. And it is now affirmed by some persons that it requires but a few generations to turn not only ordinary oysters but also Portuguese Gryphæa into natives. This statement, however, remains yet to be proved, and we believe that it is as difficult to eradicate the "mark of Cain," i.e. the black spot out of the shell of the Gryphæa, by natural selection as it is to make the leopard change his spots.

A large number of the oysters originally imported from Arcachon and Auray, and laid down to fatten at Whitstable in February or March, are removed during the ensuing

autumn to Hayling Island and other places on the south coast, where the climate is milder, to winter, as it has been found by experiment that the French oysters are less hardy than natives. Most merchants try to sell their stock before the winter ; but where they are unable to do so, they are obliged to take these precautions to preserve them. It is as yet undecided whether French oysters are sufficiently hardy to stand an average winter at Whitstable, Faversham, &c. The loss from them is undoubtedly greater than from natives, but the question is whether the cost of removal is compensated for by preservation of life. It is a risk : in such a winter as the last it would probably not be worth while to move them, but in such a winter as that of 1880-81 the saving would be enormous. It must be borne in mind that after a hard winter the frost often breaks up with a gale of wind, and the oysters, being then weakened by the cold, either succumb to the sand, or get broken by being knocked about by the ground swell.

Another company of dredgers which is self governed is that of the Colne Fishery. It consisted in 1876 of about 400 members, and about 200 fishing and dredging smacks were either hired or owned by the company. The fishery is about six miles in length, and at the lower part two miles in width. The quantity of oysters obtained from the company bears but a small proportion to the yield from private layings in the Colne and Blackwater. There are more than a hundred of these layings, some freehold, others copyhold and held from the lords of the manors.

The Colne company used to pay a higher rate of wages than the private owners, on the principle of the larger the fishery, the more it can afford to pay its workmen.

All the Colne and Blackwater oyster grounds were more or less successful in obtaining spat in 1881, the clean-

est beds of course obtaining the greater share, whilst the uncultivated beds obtained very little. About ten per cent. of these oysters may be marketable in 1883 when the oyster season commences, and, though the price may increase, there ought then to be a fair supply of real natives in the market.

As an example of the second class of laying, viz. that which is uncovered at low spring tides, we will describe the system of cultivation adopted on the Essex Creeks ; and to illustrate the tank or enclosure system we shall refer to the celebrated establishments on the river Seudre.

CULTIVATION ON THE ESSEX CREEKS.

On the Roach, Crouch, Blackwater, and their tributaries, oysters are stored during the winter in pits at the side of the river, the different sizes and qualities of oyster being kept separate. The pits are roughly constructed dams, about 10 feet square, and are covered only at spring tides. They are from 15 to 18 inches deep, and are provided with sluices, by which they can be emptied at low water for cleaning purposes. At some places these sluices are made self-acting, permitting an inflow of water, but barring its egress, and arranged so that the water shall be changed every tide. Oysters are generally moved into the pits in October and November, for protection from frost, and also that they may be obtained conveniently when required for the market.

The protection thus afforded to oysters is very considerable. They are not exposed, either to being left uncovered by the tide or to the danger of cold currents coming down the river. Floating ice does not ground in these protected spots, though of course it forms over the pits during severe frosts. Ice has been known to be 6

inches thick and the oysters beneath uninjured, in fact it is then a protection.

One of the most necessary and arduous duties in oyster culture in winter is keeping the ground which is uncovered at low springs clear from oysters. Merchants generally shrink from the labour of moving all their stock into pits, even when they have enough accommodation for them, and those which are left in the river are liable to be killed by frost, or "carted away" by floe ice. If there happens to be a continuance of easterly winds and a high barometer during spring tides in winter, the water in our estuaries will frequently fall below the low spring-tide water-mark; then the oysters laid there will get nipped by the frost unless quickly removed into deeper water.

Floods from melted snow are particularly dangerous; fresh river-water alone is sufficient to kill oysters, and so, of course, fresh water and cold together are doubly disastrous. Many hundreds of pounds' worth of oysters have been destroyed by being placed too far up a creek, where the land floods were so powerful that the flowing tide could not dilute them. At Paglesham, Mr. Wiseman says he has known the water of the Roach sweet enough to drink during strong freshets.

The oysters are taken out of the pits in March or April, and laid in the bank of the river to grow and spat. If kept in the reservoirs during the summer, but little spat is secured from them, as there seems to be too great a variation in temperature, during the summer, between day and night, in these shallow pits. In the pits at Brightlingsea, an attempt was made to get the oysters to spat, but very little fell, and that which did fall was all found on the shells of the parent oysters, by which it seems that animate

culch is less affected by the variations of temperature than inanimate matter.

When laid again in the bed of the river at Brightlingsea, the oysters are distributed on the mud, between low neap and low spring water-marks. They are deposited by hand, being shot out of flat trug baskets without sides, and it requires no little dexterity to strew them evenly in this manner. Dredging and harrowing are then carried on during April, May, and June, and in some places proprietors continue this work right through the summer. It is as yet an undecided question amongst oyster farmers on the east coast whether the increased cleanliness imparted to the culch by continued dredging through the spatting season compensates for the loss of tranquillity to the breeding oysters. It probably depends upon the amount of mud in suspension in the water at any particular locality. There is a doctrine prevalent amongst a number of oyster growers that dredging is good for the oyster during the time it is spatting, as they say that it requires oxygenating at that time, which effect dredging produces. We very much doubt, however, whether any of the higher animals would care to be dredged upon during a similar interesting state.

Oyster breeding on the Roach river promised to be very successful at one time, but the laying down collectors had to be abandoned owing to the damage done to them by passing barges grounding on the sides of the river. All that is now done is to strew clean culch along the sides of the river, both above and below low-water mark, oyster-shells and cockle shells from the Nore being most in repute.

During the process of dredging the contents of each haul is carefully picked over and sorted: the bundles are separated, the dead and diseased oysters removed, or

cleaned if only affected by outside growth, and mussels, starfish, and vermin of all kinds brought ashore and thrown away. When returning the healthy oysters to the water, they are sorted as far as possible, so as to be more readily got at during the coming season. Oysters separate much more easily in summer than in winter. If the cultack be freely or carelessly used during the cold weather, oysters are apt to rob one another, *i.e.* to tear away pieces from each other's shells.

The Whitstable people have an idea that constant dredging tends to fatten oysters by bringing them into contact with a wider food area, and this opinion, we think, is not contrary to that of the most experienced Essex merchants.

TANK SYSTEM OF CULTIVATION.

The parcs at Marennes are situated on both sides of the river Seudre; they are not, like those at Arcachon, submerged every rise and fall, but only at high spring-tides. Each *claire*, or tank, is about thirty yards square, and they are so arranged that a certain number can be laid aside for cleaning whilst the others are in use. The walls for retaining the water are low banks of earth about five feet thick and three feet high. The tide is admitted by water-tight sluices, as it is considered most essential to be able to regulate the inflow and outflow of water with the greatest exactitude. A trench is cut on the inside of each pond so as to collect the green slime necessary for the production of the green fins, and some considerable trouble is required before the tanks are fit to receive the oysters.

The preparation of a reservoir for the reception of oysters, called in French *le parage*, takes place in March. It consists of two operations: 1. Called *le gralage*, which

when converted into an English agricultural term, means the *lying fallow*; and, 2. *La mise en humeur*, or the after-cultivation. The object of allowing a pond to lie fallow is to purify the soil by evaporation and oxidation.

The water is allowed to run out of the reservoirs, which are then quite dry, except at high spring-tides. Under these conditions the mud dries and cracks in the same way that a ploughed field breaks up after a winter's frost. The protoxide salts get turned into peroxides, and any decaying organic matter that may be in the mud is rendered innocuous. As the result of two months' exposure of this kind, the surface is covered over with a new layer of fine desiccated mud of a fresh and purified nature. The second part of the operation is then undertaken, and a small quantity of water is admitted into the enclosure, just enough in fact to cover it entirely. The dry crust at the top of the mud then slakes and, as it were, effervesces in doing so; the final result being the deposit of a fresh layer of mud of uniform thickness over the whole of the basin. This creamy layer the French call *humeur*, and the diatoms contained in it are supposed to be rendered more digestible by the operation. The whole operation occupies from six weeks to two months. The oysters are then placed in the tanks thus prepared, and begin to turn green in about a fortnight, though the longer they are left the better flavour do they acquire.

The number of oysters laid down depends upon the time it is intended to keep them; for as the food supply is limited in those ponds where the water is not changed very often, of course a small number will fatten more rapidly in a given space than a large number; the average number is about 6000 on an acre.

The oysters are generally from twelve to eighteen months old when placed in these greening claires, and they remain there for two years or so, growing and fattening; during this time they should be shifted from one pond to another to ensure successful results. Many, however, remain in the ponds a much shorter time, as it is often the practice to place mature oysters in these parcs for a few weeks to acquire the green beards, which they do at a comparatively cheap rate, though they do not acquire the flavour of those oysters that have been in the ponds their usual time.

We have already referred to the cause of the green-finned oysters under the head of Natural History, but in consequence of the groundless prejudice which exists against them in England, and which is the cause of the exportation of all our Essex green beards to Ostend, we think it desirable again to state that this colour is caused solely and entirely by vegetable matter, and is not only quite harmless, but imparts an exquisite flavour to the oyster.

Oysters and other molluscs undoubtedly do absorb and retain copper in their tissues when placed in solutions containing it; but in every case that has been looked into, and many experiments have been conducted by competent analysts with reference to this matter, the copper has been found in the body only of the oyster which is coloured bluish-green, and not in the beard which was not green. In green-bearded oysters the body of the fish is of the usual or of a very slightly greenish tint, and has never been found to contain a trace of copper.

Before leaving this part of our subject, we are tempted to remark that, *in theory*, oyster culture seems so simple a thing, that the wonder is there are so many failures at it.

But when we come to put our theory into practice, we begin to find how many local circumstances there are, apparently trifling in themselves, but which really exert a powerful influence on our calculations; and it is only by many years of watchful observation that any one can acquire sufficient experience to be able to understand, and to cope with the numerous difficulties which will beset the path of an oyster grower. If, however, we were asked to sum up the principles of oyster culture in as few words as possible, we should say—Keep your culch clean, keep down the vermin, separate from the collectors as soon as possible, protect from frost during the winter, keep the oysters quiet during the spatting season, and pray for calm and warm summers! (*d*)

As an appropriate companion to the foregoing abridgment, I hereby give, as a foundation for all oyster culture, the most important rules for the preservation and improvement of natural oyster-banks.

An oyster-bank will give permanently the greatest profit if it possesses such a stock of full-grown oysters as will be sufficient to maintain the productiveness of the bank in accordance with its biocönotic conditions.

Whenever the natural conditions will admit of it, the yielding capacity of an oyster-bed may be increased by improving and enlarging the ground for the reception of the young oysters.

The natural banks should be improved by removing the mud and sea-weeds with dredges and properly constructed harrows, and by scattering the shells of oysters and other molluscs over the bottom. When circumstances will permit, all animals which are taken in the dredge, and

which kill the oysters or consume their food, should be destroyed (after being brought on shore).

It would be much more judicious, and much better for those who eat oysters, if the close time could be extended until the 15th of September or the 1st of October, so as to allow the oysters sufficient time, after the expulsion of the contents of the generative organs, to become fat before being brought to the table.

If it is desired that the oyster banks should remain of general advantage to the public, and a permanent source of profit to the inhabitants of the coast, the number of oysters taken from the beds yearly must not depend upon the demands of the consumers, or be governed by a high price, but must be regulated solely and entirely by the amount of increase upon the beds. (*e*)

Thus far, in the scientific development and practical outcome of this Chapter, I have held aloof from interrupting the ably expressed and valuable theories of those writers whose observations adorn these pages, and whose names honour them. I have so done not from an assumed feeling of modesty, but from motives of respect for the said authorities, and consideration for the reader's mental ease and comfort, in not clashing my humble suggestions with the deeply studied and most learned opinions mentioned; inasmuch as, had I done so, it might have tended to render my purpose in writing this chapter less explicit to the reader's intelligence than the order adopted. And so, with all due respect to those Masters in Science, I respectfully venture to state that from my own observations I am led to think that—

The principal essentials necessary for the insured success of Oyster Culture are :—

1. The selection of the best kind of oysters to breed from.

2. The preservation of the spat after its exudation from the parent shell ;

(1.) In preventing the tide from washing it away.

(2.) In guarding it from frost, sand, mud, bad weather, sudden changes of temperature, and diseases of infancy.

(3.) In supplying suitable objects for it to adhere to, such as fascines, culch, tiles, &c.

(4.) In purifying the element in which it lives, and, since it is in continual danger of being devoured by its numerous enemies, the water shall be composed (in equality of mixture) of the necessary ingredients, not only with regard to the food of the oyster, but also to the requirements FOR THE FORMATION OF SHELL.

It is to this plentiful commixture of carbonate of lime in Lake Fusaro that that famous oyster bed owes its never-failing and considerable productivity. And, “among the many reasons why certain artificial oyster-farms soon become exhausted and barren, may be the fact of their being placed in waters where the calcareous supply is not equal to the demand made upon it by these lime-loving bivalves.” Thus writes Mr. J. Lawrence Hamilton, in the *British Medical Journal*, Feb. 15, 1890, and the experiments of Drs. Pouchet and Chabry (*Brit. Med. Journal*, Jan. 25, 1890,) undeniably confirm that gentleman’s conjecture.

The Professors mentioned recently conducted some experiments of great biological interest. “They have reared larval germs of sea-urchins in artificial sea-water

and in sea-water deprived of all, or more or less of its lime, in order to observe the influence of the composition of the water on the development of the larvæ.

Normally a distinct skeleton should develop. It was found that when the larvæ were reared in sea-water deprived of about nine-tenths of its lime, not even a rudimentary skeleton was developed.

A very trifling diminution in the normal amount of lime, effected by careful precipitation by chemical reagents, was found sufficient to interfere markedly with the growth of the skeleton in the larvæ, hence the medium in which some marine germs of life exist would appear to act as a nutritive agent as well as an atmosphere whence oxygen may be obtained for respiration." (*f*)

This, again, is confirmed by the fact that the cove lobster (usually found near the shore in sheltered places and small harbours, where the bottom is soft and richly covered with dense growths of sea-weeds), has a dull coloured shell containing so little calcareous matter that it yields everywhere to slight pressure, except about the claws.

(*f*) As an item of interest in connection with this scientific fact, I call the following from *Public Opinion*, October 31, 1890 :—

ARTIFICIAL SEA-WATER.—Professor Edward Perrier lately communicated to the French Academy of Sciences the results of some experiments made by him at the zoological laboratory of the Saint Cloud normal school, upon the use of artificial sea-water for the preservation of marine animals, and especially of oysters, in large aquariums. The solutions employed have been reduced by him to the following formula for from three to four quarts :—Chloride of sodium, 81 grm.; sulphite of magnesia, 7 grm.; chloride of magnesium, 10 grm.; chloride of potassium, 2 grm. During the exposition this solution gave as good results as natural sea-water, with very much less expense.

Or the coast lobster (feeding in the deep waters of open bays, where the ground is covered with thick kelp and other substantial marine weeds, rich in lime and other salts), which has a dark shell, often prettily variegated with green and other colours, but is less brittle, being largely composed of calcareous matter.

Or, finally, the larger, powerful deep-sea lobster, which (frequenting calcareous bottoms, where the water and plants are still more highly charged with lime,) has a hard, thick shell, well developed all over its body, whilst its flesh is more delicate than that of the coast lobster, illustrating the usual rule that the flesh of fish and shell-fish improves in proportion to the depth of the water habitually frequented by the animal.

To impress the great importance of this upon the reader's mind, I may say that if a child is not supplied with proper nourishment,—notably lime,—for the proper formation of bone, development is arrested, inanition ensues in the form of rickets, and probably consumption, which, possibly conveyed to others, creates eventually a colony of disease.

Is it too much, then, to ask or believe that this may apply to the lower scale of animals. It is natural to the oyster to develop a shell, the only protection it has against the multitude of surrounding life, only too eager for devouring such luscious food.

(5.) By the removal of its many enemies, such as cliona, star-fish, mussels, dog whelks, &c.

(6.) By analysing the water.

(7). By having clean beds, for it is better to have a slight excess of carbonate of lime than a diffusion of weeds, or objectionable matter.

(8.) By laying different varieties of oysters, and of different ages, in the same bed ; because, according to Davaine, oysters produce only male sexual products towards the end of the first year, and it is only later, from the third year onwards, they become females and produce ova.

Step by step, in chapter after chapter, have I led the reader to perceive, to understand, and appreciate the wonder-working-powers of Nature, in the natural history of the oyster. I have shown him how impossible it were to narrate in the brief space of two or three chapters a tenth part of what is known of the life and habits of this "breedy creature." He has seen how every stage of its growth has been made the stand-point for a wrangle of some kind. He has listened to the disputes whether or not oysters are male and female like other animals, and, having heard both sides of the question, sits bewildered at the fact that this singular animal is hermaphroditical, and then (a few pages further on) his "confusion worse confounded," he finds that, with the exception of the Portuguese and American, this extraordinary fact relates only to European oysters. He has seen it made a matter of controversy on which of its shells it rests, the convex or the flat one ; whether it emits a sound, whether it has sight or hearing, whether it has any mode of progressing from place to place, how long it is growing, when it becomes reproductive, and other controversial particulars needless to mention here.

It is true that the glorious sunburst of Nineteenth-Century-Science has dispersed the leaden-hued vapours of ignorance, and curled back the mists of credulity from about the temple of knowledge ; that the disputations have apparently been settled ; that the keen eye of experi-

ence, the teachings of patient investigation, and the trumpet-toned triumphant voice of discovery have done much and rendered valuable service towards the education of mankind ; but it is also true that much more remains to be done. We are only beginning to learn and appreciate the educational attractions of zoological observation, and the revelations, wonders, and possibilities of exploring science in the ocean world.

But, after all, when the sum of our acquirements in intellectual advancement is reckoned up, we find ourselves possessed of but a rudimentary knowledge at the best—mere fragmentary records of Nature's revelations writ by the hand of man with the pen of research, in the book of science, and revealed to our wonder-stricken gaze by the aid of the microscope.

Yes ! we are only poor scholars in the school of life, and only in the A B C class of zoology ; and, derogatory as it may be to our learning, or hurtful as it doubtless is to our vanity, nevertheless it is true that the zoological facts which hitherto we have been enabled to glean, and are so proud of knowing, are not yet verified, the doubts are not yet dispelled, the opinions do not yet harmonize, and the disputants are not yet silenced ; nor *will* they be so long as Nature's ceaseless round of evolutionary toil aids the metamorphoses continually occurring in the organic as in the inorganic world ;—that transition everlasting, in which life transforms the unorganised into organised matter.

For why ? Because the life of a man is not long enough to master the wonders of Nature, and when some superior intellect flashes for a moment, the mental sublimity of its piercing vision upon the chaos of ignorance enveloping her secrets, time's flight, though swift, is long

ere he brings forth another paragon of science, who, by his discoveries, doth

“ — blaze the comet of a season,”

and then disappears, leaving behind his shining track of mind-illuminated wisdom glowing in the glorious galaxy of scientific fame, until some new appearing star outshines its predecessor.

Thus has it been from the earliest times to the present day; and, without marshalling the long list of men of science from antiquity upwards, my purpose is served in naming a few, at random, of the present generation, such as Chambers, Lyell, Darwin, Wallace, Jeffreys, Huxley, Möbius, Brooks, and Winslow.

Science is essentially progressive, and to each of her master-minds is given the task of revealing but a *portion* of her powers for the good of mankind; for never yet has science had a Shakspeare. And, as each apostle preaches her all-potent, mind-expanding, soul-exalting gospel of man's place in nature, so petty factions of opposing thought—liliputian copies of the power of intellect, and animated abridged editions of common sense, that think not as he thinks, nor speak as he speaks—spring up, mushroom-like, of which each pedagogue in his turn airs his dissent in such a manner

“ — as who shall say

I am Sir Oracle, and when I speak

Let no dog bark.”

Man is an inconsistent and disputatious creature—a warring animal; and—whether his wars be political, social, or scientific,—“the survival of the fittest” is a law of necessity in *his* nature as irrefutable as Euclid. The war of opinion—political, social, or scientific—goes on for ever; and, varied in its causes and changes, which range

from the sublime to the ridiculous, it has often in the past been the fate of the devotees of science to suffer martyrdom, or, in more recent periods, to be punished with cold neglect, or, as Pope has it, be—

“Damned with faint praise.”

This, on the surface, may appear to be a sweeping assertion, but, given a moment's reflection, it will be found, alas! but too true with respect to our men of science, who, for years past, have unavailingly urged upon the Government a State Legislation for oyster culture, and upon private companies the adoption of the best foreign system, or at least a better one than that at present so discreditable to our commercial fame, and detrimental to the public good.

However, in some slightly improving degree for the success of future prospects, it is fortunate that for the last decade or two men of science have become more popular, and a better and more beneficial understanding has existed between them and the public, but by no means—so far as oyster culture is concerned—anything approaching the harmony existent between the same in other countries.

I need not recapitulate the causes of this deplorable fact, of which, indeed, the reader has had ample illustration in other chapters of this volume; but I venture respectfully to add that I think the British public are not altogether exempt from blame in this matter, for I feel assured that, were the public but a little more determined, the Government would soon yield to the pressure brought to bear upon this desideratum, and be tempted to aid in cheapening a universally esteemed and valuable food product by the extension of the cultivable foreshores and areas adapted to its growth, with all the assistance thereunto in its power.

It has been well said that—The value of scientific research systematically carried on by the State, or under State supervision, would lie not only in the assistance it would afford to the servants of the State in administering the law and in directing its amendment, but also in the opportunity it would afford to the fishing population of satisfying themselves that the State was right in any action it might take, based on the results of its scientific information. The dissemination among the fishermen, on State authority, of information which they could hardly be expected to acquire themselves, but which they could, when properly directed, prove for themselves, would reconcile them to many decisions about the correctness of which they would otherwise prove sceptical. The State already undertakes the direction of “art” education, and acts directly as a teacher of “science” generally, with special application to mining and engineering pursuits. It could hardly render greater service to the great national fishing industries than by affording facilities to the fishermen for applying the teachings of science to the practical operations of their craft. This might be done by encouraging the creation of local museums and libraries having a special bearing on the fisheries, by giving prominence, in the schools under State regulation in the great fishing centres, to matters connected with this important subject, and by countenancing a National Society devoted to the interests of the fisheries. (*g*)

In concluding this work, I can only say in the somewhat altered words of a literary celebrity (*h*) that I offer

(*g*) “The Relations of the State with Fishermen and Fisheries, &c.” by C. E. Fryer, p. 82.

(*h*) “Wanderings in South America,” by Charles Waterton. Preface.

this book about oysters with a hesitating hand. Judged as a compilation—a gathering of many beautiful literary and scientific flowers, culled from the gardens of others—it may not be denied that it has some pretensions to merit, and it will be only to *my* part of the labour, the task of arranging these flowers and tying them together, which will have assigned to it the righteous condemnation of possessing “little or no merit,”—a verdict in which I heartily join. But whatever merit it possesses, it must make its way through the world as well as it can. It will doubtless receive many a jostle as it goes along, and perhaps is destined to add one more to the number of slain, in the field of modern criticism. But if it fall, it may still, in death, be useful to me ; for, should some other writer or compiler take it up, and, in turning over its pages, imbibe the idea of exploring “The Ocean World,” in order to give the public an enlarged description of Oysterland, I shall say, “*fortem ad fortia misi*,” and demand the armour ; that is, I shall lay claim to a certain portion of the honours he will receive, upon the plea that I was the first mover of his discoveries ; for, as Ulysses sent Achilles to Troy, so I sent him to show the wonders of Oysterland. If critics are displeased with it in its present form, I beg to observe that it is not totally devoid of interest, and that it contains something useful. Should the reader have found the instructions and the information contained herein too tedious, let the wish to give him every scrap of relative knowledge plead in their defence. They might have been shorter ; but Horace says, by labouring to be brief you become obscure.

“And now, patient reader, having fairly sent round the plate, it is high time to say farewell. Together we have experienced the hardest test which can befall a friendship.

All the world admits—and here at least experience confirms the verdict of all the world—that nothing so greatly tries and tires sympathy as fellowship in a long and indefinite journey. Even those heaven-born twins of travel—the Pylades and Orestes of tourists to the youth of a former generation—Lumley Ferrers and Ernest Maltravers, found a few years of desultory wandering almost too much for their mutual forbearance. Their parting was a mixture of fire and ice. ‘Is this fair to me?’ cries Lumley, for once angry in reality. ‘Trouble me no more,’ replies the haughty Ernest, as his late companion in not unnatural dudgeon turns to leave the room. Let us hope that no such stormy ending may attend the conversational stroll which we have taken together through some ten or twenty thousands of miles, and over a range of two or three dozen of centuries.”

SUPPLEMENT.

REPRODUCTION AND EMBRYOLOGY—THE CHEMICAL CONSTITUENTS
AND THE FLAVOUR OF THE OYSTER—ENEMIES TO OYSTERS—
PROFESSOR HUXLEY ON OVERDREDGING—VALUABLE ITEMS
CONCERNING OYSTERS AND FISH—ARTIFICIAL OYSTER CULTURE
— THE OPENING OF OYSTERS—CHEMICAL ANALYSIS OF SEA-
WATER—COMPLETE LIST OF THE SPECIES AND VARIETIES OF
OYSTERS.

ALTHOUGH in the preceding pages of this volume the accumulation of interesting facts and general information relative to "OYSTERS, AND ALL ABOUT THEM," has already exceeded the paginal limit originally intended, I have felt it to be a duty towards the reader to make it as complete as I possibly can, and for that reason have added a suppletory chapter. But even with this thrown in there is a source from which I have anticipated some degree of disappointment. It is the impossibility of giving to the public, in this work, many facts not already in their possession.

For any inattention to composition an apology ought never to be necessary. A work of any importance ought never to be submitted to the public till it has been sufficiently revised and corrected. Yet this work goes into the world under circumstances which might bespeak, from

candour, less severity of criticism than it will probably experience. The books, pamphlets, manuscripts, newspapers, and correspondence from which it has been composed, have been very voluminous, and the public was already looking for the work before the writer was fixed on, and the papers, &c., from which it was to be compiled placed in my hands. The impatience since discovered by many of my subscribers has carried the following (and even many of the earlier) sheets to the press much more precipitately than my judgment would have permitted me to part with them, and I cannot flatter myself that they are free from many defects which, on a reperusal, will attract even my own observation.

THE REPRODUCTION OF THE OYSTER.

If the surfaces of all the Schleswig-Holstein oyster-beds should be united together, they would not cover a space equal to the one-hundredth part of that portion of the sea-flats which remain under water. Why is this? Is it because, from a lack of oyster broods, all the places between the banks are yet to be peopled? I cannot accept this view, for the following reasons: The entire number of full-grown oysters existing upon the Schleswig-Holstein beds I estimate to be not far from five millions. According to my observations, 44 per cent. at least of these oysters will bring broods of young oysters in the course of a summer.

The data from which I arrived at the conclusion that at least 44 per cent. of full-grown oysters spawn during each spawning season were derived from the following observations:—

I opened on—	Oysters.	These contained—		In all.	Per cent.
		White Germs.	Bluish Germs.		
June 16, 1873.....	112	5	4	9	8
July 6, 1873	63	7	6	13	20·6
August 12-17, 1869	480			72	15·8
Total.....	.....	.....	.....	.....	44·4

I do not know the length of time of development, from the beginning of segmentation of the egg until all the embryos have passed out from the mother animal, but it is probably less than four weeks; for while, in the last weeks of May in the years 1871 and 1874, from June 4 to 6 of the year 1873, and June 6 to 9 of the year 1876, in hundreds of oysters which I opened, I found no embryos in the beard, yet of 112 oysters dredged on the 16th of June, 1873, five contained germs of a white colour, and four contained germs already bluish, and possessed of shells and vela.

If by the end of the first week in June no eggs have been laid, but by the beginning of the third week germs are found of a bluish colour, then the transformation of the white germ into blue cannot consume more than a week, and these germs will hardly remain in the beard for an additional period of more than two weeks. Those oysters, then, which are found with eggs during each of the following months, must be different individuals from those which spawned during the earlier periods; hence it is right to add together the percentage of egg-bearers for the entire summer. And since many oysters are found

upon the Schleswig-Holstein beds with germs of a bluish colour in the mantle, even in the beginning of September, then the percentage of 44·4 per cent. surely cannot be too high. Oysters are hermaphrodite. In a large number of oysters which I examined I found ova in the generative organs, but no spermatozoa; in many others I found spermatozoa, but no ova; and in seven oysters which bore embryos of a blue colour upon the beard, I found spermatozoa in the generative organs.

Three oysters with embryos of a white colour attached to the beard had no spermatozoa in the generative organs. Most mature oysters produce either ova or spermatozoa, and not both at the same time. Of 309 oysters which were dredged on the 25th of May, from four different beds along the east side of the island of Sylt, and which were examined from the 26th of May to the 1st of June, the sex of 18 per cent. could not be determined; of the remaining 82 per cent., one-half were males and one-half females. In none of them were the generative products completely matured. From these results I conclude that the ova and spermatozoa do not arise in the generative organs of the oyster contemporaneously, but that one follows the other. The spermatozoa can arise very soon after the expulsion of the ova, and probably one-half of the oysters of a territory during any spawning period produce eggs only, the other half spermatozoa only.

. . . . If an oyster in which the embryos are in this condition (ripe for expulsion) is opened, there will be found upon its beard a slimy coating thickly loaded with grayish-blue granules. These granules are the embryo oysters, and if a drop of the granular slime be placed in a dish with pure sea-water, the young animals will soon separate from the mass, and spread swimming through the

entire water. When the embryos are at this stage their number may be estimated in the following manner:—The whole mass of embryos is carefully scraped from the beard of the mother oyster by means of a small hair-brush. The whole mass is then weighed, and afterwards a small portion of the mass. This small portion is then diluted with water or spirits of wine, and the embryos portioned out into a number of small glass dishes, so that they can be placed under the microscope and counted. Thus, knowing the weight of the small portion and the number of embryos in it by count, we can estimate the total number of embryos from the weight of the entire mass, which is also known. In this manner I estimated the number of embryos in each of five full-grown Schleswig-Holstein oysters, caught in August, 1869, and found that the average number was 1,012,955. (a)

Dr. Brooks tells us that if several oysters are opened during the breeding season, . . . a few will be found with the reproductive organ greatly distended, and of a uniform opaque white colour. These are oysters which are spawning or ready to spawn, that is, to discharge their eggs. Sometimes the ovaries will be so gorged that the ripe eggs will ooze from the openings of the oviducts before the mass is quite at the point of being discharged. If the point of a knife be pushed into the swollen ovary, a milk-white fluid will flow out of the cut. Mixing a little of this with sea-water, and placing it on a slide underneath a cover, a lens of 100 diameters will show, if the specimen is a female, “that the white fluid is almost entirely made up of irregular, pear-shaped, ovarian eggs, each of which contains a large, circular, transparent germinative vesicle,

surrounded by a layer of a granular, slightly opaque yolk." Perfectly ripe eggs will be seen to be clean, sharply defined, and separate from each other. If the specimen be male, a glance through the microscope shows something quite different from the fluid of a female. "There are no large bodies like the eggs, but the fluid is filled with innumerable numbers of minute granules, which are so small that they are barely visible when magnified 100 diameters. They are not uniformly distributed, but are much more numerous at some points than at others, and for this reason the fluid has a cloudy or curdled appearance. By selecting a place where the granules are few and pretty well scattered, very careful watching will show that each of them has a lively dancing motion, and examination with a power of 500 diameters will show that each of them is tadpole-shaped, and consists of a small, oval, sharply-defined 'head,' and a long, delicate 'tail,' by the lashing of which the dancing is produced." These are the *spermatozoa*, or male cells, whose union with the eggs or *ova* of the female is necessary to the fertilization of the latter, and the consequent hatching of living oysters.

The number of male cells which a single male will yield is great beyond all power of expression, but the number of eggs which an average female will furnish may be estimated with sufficient exactness. A single ripe egg measures about one five-hundredth of an inch in diameter, or five hundred laid in a row, touching each other, would make one inch; and a square inch would contain five hundred such rows, or $500 \text{ by } 500 = 250,000$.

. . . . Oystermen believe that the male may be distinguished from the female by certain characteristics, such as the presence of black pigment in the mantle; but microscopic examination shows that these marks have no

such meaning, and that there are no differences between the sexes except the microscopic ones. It is not necessary to use the microscope in every case, however, for a little experience will enable a sharp observer to recognize a ripe female without the microscope. If a little of the milky fluid from the ovary of a female, with ripe or nearly ripe eggs, be taken upon the point of a clean, bright knife-blade, and allowed to flow over it in a thin film, a sharp eye can barely detect the eggs as white dots, while the male fluid appears perfectly homogeneous under the same circumstances, as do the contents of the ovary of an immature female, or one which has finished spawning. When the eggs are mixed with a drop of water, they can be diffused through it without difficulty, while the male fluid is more adhesive and difficult to mix with the water. By these indications I was able, in nearly every case, to judge of the sex of the oyster before I had made use of the microscope. (*b*)

Professor Huxley, in his "Anatomy of Invertebrata," states that "in the common oyster the genital cœca in any given individual are found to be either almost all ovigerous, or almost all spermigerous, and it appears probable that the predominantly male precedes the predominantly female condition."

M. Coste, speaking of the reproduction of oysters, says that "the minutest researches show that, without any exception, there are to be found spermatozoids and eggs in the same organ, where they develop themselves side by side. The capsules (or sacs) in which the spermatozoids are formed arrive in the first place at maturity, and then

(*b*) "The Development and Protection of the Oyster in Maryland," pp. 121-122.

the mobile small bodies destined to affect the fecundation are seen emerging from them when the ovules, or small eggs which they are to vivify, begin to make their appearance. These molluscs are consequently hermaphrodite. This is now an incontestible fact."

Oysters may therefore be considered as being of one sex, and producing eggs that are already alive, though until quite lately this has been disputed.

The most conclusive proof that fertilisation takes place within the parent shell, and without contact with any other agency, was that undertaken by the late Mr. Buckland.

Some of the spat from a white-sick oyster was placed in a test tube. It had been previously examined, and seen to be in the immature shell-less state which the product of white-sick oysters always shows under the microscope, and it was kept at a temperature of 68° Fahrenheit for several days. Gradually it passed through the yellow and slate-coloured stages that spat is known to undergo, and it ultimately became black. The darker it became, the more fully was the young oyster developed, until at last the spat appeared fully vivified, and exactly similar to that taken from a black-sick oyster—in fact a perfect animal.

The holders of the theory that oysters are of two sexes considered the black-sick oyster to be the male, and the white-sick oyster the female. Now the former are always found thoroughly vivified, the latter never. Then, as impregnation must have taken place in some way, if the diœcious theory is correct, it must be the female which has fecundated the male, a state of things totally opposed to the general rule of nature. We have dwelt at some length on this subject, as it is of the greatest importance that oyster-culturists should understand the mode of reproduction. In artificial breeding there is always a large propor-

tion of spat which is exuded in an immature state, and floats about on the surface of the water at times in greenish mucous masses. This is white-sick spat, which has escaped before its time, owing to the inability of the parent to contain it. This is apparently an unnatural occurrence arising probably from a change of condition or a change of temperature. This kind of spat forms a considerable portion of the whole; it is possible that a very small portion of it may ultimately become sufficiently mature for attachment, if not carried away or devoured by fish, but the proportion of immature spat that ultimately attains maturity is so small that it may be practically ignored.

The parent oyster goes on producing and hatching its ova for some time, as these may be seen oozing for several days from the same oyster. In fact, from the time the ova are first produced to the time the last germ of black spat is emitted, a period of from three to six weeks probably elapses, the process being accelerated by a continuance of warm weather.

The age at which reproduction commences has never been exactly ascertained; it is supposed, as a general rule, to be from three to six years or more, though instances are known of oysters being in a "milky" state at a much earlier stage. Mr. Frederick Wiseman has stated that he has known an oyster white-sick when only a year old, but it is highly improbable that the ova produced from a year or two-year old oyster would ever come to maturity.

It is believed by some that oysters do not breed every year. Mr. Buckland held the opinion at one time that, like salmon, they breed in a cycle of three, five, or six years. The Irish Commissioners in 1870 formed an opinion that they bred only once in ten years, but this was based upon the examination of a bed during the breeding time, when

only ten per cent. of the oysters were found to be white or black-sick. We think that these conclusions were hastily arrived at, for the reason before mentioned, that oysters do not breed exactly at the same time. Mr. Buckland examined a bed in 1875, and, we think, he stated that he found one in six spatting.

Deep-sea oysters appear to spat earlier in shallow water than at a greater depth. Oysters in eight fathoms of water have been known to spat fourteen days earlier than those in eighteen fathoms of water.

The time of spatting is entirely dependent on local conditions, such as temperature, warm currents, and general climatic influences. Currents which affect one part of a bed may not affect another part only a few hundred feet distant.

In 1878 an oyster was found at Whitstable, white-sick, on the 17th of June, and the same oyster was black-sick ten days later, the temperature of the water being at that time from 58 to 60 degrees (Fahr).

Oysters have been known to spat as late as October, and even November, during a mild season, but in these cases it is exceedingly improbable that any of their progeny survived.

Thus it is seen that oysters breed all through the warm months, though the time at which the spat falls depends as much on the temperature during April and May as through the later months.

The internal development of germs commences in one or other of these two months, and although the 1st of May is the date fixed by custom for the prohibition of the sale of oysters, they may or may not be fit to eat at any time of the year between the 1st of April and the 1st of November.

The number of young produced by each oyster has been variously stated to be between 300,000 and 60,000,000, but the approximation made by Mr. Eyton of 1,800,000, was probably a pretty correct estimate of the total number of young English oysters contained by the parent.

American oysters are said to be more prolific, the fish and its ovaries being larger, whilst its eggs are less than one third as large. Mr. Coleman, of Whitstable, estimated that an American Blue Point could produce 125,000,000 if there was no loss of space, based on the calculation that a single ripe egg measures about one five-hundredth of an inch in diameter.

The conditions requisite for breeding are—

1. Clean collectors.
2. Heat and tranquillity.

CLEAN COLLECTORS.

If the collectors are not clean, the spat cannot adhere; we have therefore placed this condition first.

It has been known for some time that culch should be clean, but the primary requirement of clean collectors and grounds has not been generally recognised, nor has the fact that the cleaner the collectors the greater the number of oysters they catch.

At an oyster breeding establishment, Dr. Soubenan observed the following, what he called "curious," fact, but he did not point the moral of his tale. It ran thus:

In consequence of a rupture in the sluice, the water in a basin where oysters had been placed to spat escaped into a neighbouring basin which was in preparation, but in which there was not a single oyster of any kind. All the stones of this basin were subsequently found covered with spat which had been brought in by the water, and the rails

of a little submerged iron railway, lying in the pond connected with the works, were so covered with young oysters that they were not used as rails any further on account of the value of the oysters settling on the rails being greater than the value of the rails themselves !

And now for the conclusions we draw from this :

Firstly, the basin in the course of preparation was quite clean, that is clear from weeds or deposits from water, and therefore in a condition best suited for the adherence of spat. Secondly, the rails of the basin in course of preparation were absolutely clean, having been probably almost bright from the traffic along the little tramway. Hence their being so covered with oysters that they were more valuable for collectors than rails !

Another instance of the benefit arising from clean collectors is that related to the writer by an owner of one of the Mersey layings. In the year 1881 he had a much better fall of spat on his grounds than his neighbours, who were equally favourably situated. The preceding winter he had purchased from France some 40,000 oysters that had died during the passage, their clocks and separated shells had been allowed to bleach for some months.

When spatting time arrived, these clocks, &c., were thrown overboard on his grounds on a Friday. The following Monday some were dredged up covered with spat, subsequently the great majority of the young brood he took up were attached to these shells.

HEAT AND TRANQUILLITY.

The conditions necessary for the development of insect life are also those which are favourable for the production of the young oyster. To the late Mr. Frank Buckland belongs the credit of first drawing attention to the impor-

tance of this condition : High and even temperature by day and night, and quiet atmosphere. He summarised these conditions as "Heat and tranquillity," which words have acquired some considerable degree of notoriety, and have from first to last led to a good deal of argument, not tranquil but heated, between oyster-culturists.

The opponents of the tranquil theory say that the water must be well oxygenated, so as to be in the most favourable condition for the reproduction of oysters ; they admit the necessity of some heat, but do not want anything above 68 degrees (F.)

The balance of the evidence we have been able to collect is that warm and tranquil summer days and nights, if undisturbed by bad weather and night frosts, will as assuredly result in a heavy fall of spat, as a cold ungenial summer will occasion an oyster famine. It appears that in the English waters young oysters must have the water at a temperature of from 65° to 72° , to put them in the best condition to adhere. If the spat is in a sticking humour, it will adhere to anything that is free from weed or slime—old oyster-shells, cockle-shells, stones, glass, old tobacco-pipes, iron slag, old shoes—in fact anything that offers a clean hard surface will satisfy the young oysters in warm weather, though their after development greatly depends upon the ease with which they are separated from the substances to which they are primarily attached.

In Buckland's Museum there is a large collection of various materials on which spat has been deposited ; amongst them is an ordinary flat iron, concerning which poor Mr. Buckland quaintly remarked that the spat was in such a sticking humour that "if the washerwoman who had used the flat iron had been at the bottom of the sea, the spat would have stuck all over her."

THEORY OF FATTENING.

It has long been known that in order to fatten oysters properly, they should be laid down in brackish water, and many estuaries of rivers have long been famous as localities for high-class oysters. Recently the microscope has shown us that it is not the specific gravity of the water that is essential, but the presence of diatomaceæ and infusoria, upon which the oyster lives and thrives. On the Whitstable grounds there is, more or less, according to the tides, an eddy over the spot where oysters are laid, and into this eddy are drifted the minute creatures on which the oyster feeds.

A study of the differently situated oyster grounds will show that there are well-marked differences in the character of the oyster, according to the quantity and quality of the plants and animals which form its food.

The soil itself has great influence on oyster life, as it affects the production of the organisms which at the various stages of growth are best adapted to the constitution of oysters.

The green colour of the Essex and Marennes oysters is due to living on a kind of *navicula*; the green chlorophyll is digested and decomposed; the soluble colouring matter passes into the circulation of the animal, and the branchiæ, being the most vesicular portions of its structure, are the most highly coloured. Experiments made by MM. Puysegur and Decaisne proved that if, after oysters had turned green, they were laid in ordinary sea water for a few days, their greenness disappeared altogether.

The Essex oysters, from the Roach and Crouch rivers, are only green when there is an "r" in the month, that is from September to April, during which time the weed, or

crowsilk as it is locally termed, is found to preserve its colour in the river.

The following is copied from *Nature* of May 1st, 1890: At the meeting of the Royal Society of Queensland, July 17th, 1890, Mr. W. Saville Kent presented some interesting Notes on the Embryology of the Australian Rock Oyster (*Ostrea Glomerata*).

He mentioned that, in connection with the investigation of this subject, he had been carrying on a series of experiments with the view of accurately determining the influence upon the embryonic brood that is exercised by the advent of fresh-water floods, or other sudden changes in the salinity of the water.

Some important results had been obtained from a series of oysters recently purchased in the market; a fully matured male and female were selected for experiment. Portions of milt and ova from these two individuals were abstracted and commingled with precisely the same conditions, and placed respectively in water of three different degrees of salinity.

The first admitted was placed in sea-water of the full ordinary strength. In the second there were equal proportions of salt and fresh-water, and in the third, one part of salt-water to three of fresh.

As a result, the ova placed in the equal admixture of salt and fresh-water exhibited active vitality, and were quickly speeding in their developmental career. Of the ova placed in pure sea-water but few were fructified, and these developed very slowly. Those finally placed in the water containing only a one-fourth proportion of sea-water were entirely deprived of life, and soon began to disintegrate. To this last circumstance Mr. Saville Kent called special attention. It indicated, he said, the pernicious

effect upon breeding oysters that might be exercised by heavy floods, and opened out a wide field for further enquiry.

THE CHEMICAL CONSTITUENTS AND THE FLAVOUR OF OYSTERS.

The heaviest portion of an oyster is its shell, and this, on an average, constitutes about 84 per cent, of the total weight of an ordinary Holstein table-oyster. . . . The dried shells of very old oysters weigh from 250 to 320 grams. In such heavy, thick-shelled oysters, the soft portion is generally very poor, and the body-space is smaller than at the time when it first attained its complete maturity. From this it follows that the edges of the last-formed shell-layers do not pass over those which were formed earlier, but lie under them. The principal constituent of the shell is carbonate of lime, which forms about 96 to 97 per cent. of the whole weight. The shell also contains 1·2 to 1·3 per cent. of sulphate of lime, 0·09 per cent. of phosphoric acid, 0·03 per cent. of oxide of iron, and traces of magnesia and aluminum. If these inorganic constituents of the shell are dissolved in acid, there will remain undissolved brownish bits and flakes of an organic substance which has been named *conchyolin*. This contains the elements oxygen, hydrogen, nitrogen, and carbon. The left or arched valve of a Holstein oyster contains from 1·01 to 1·025 per cent. of conchyolin, the right somewhat more, from 1·10 to 1·15 per cent. This increase in the percentage of conchyolin makes the right valve less brittle than the left.

. . . . Nearly all mussels have more beautiful shells than that of the oyster, but in delicacy and fineness of flavour the oyster surpasses every other mollusk. Only

those materials can be tasted which, dissolved in fluids, come in contact with the organs of taste. Hence the flavour of the oyster depends upon substances which are either in solution in the juices of the body of the oyster, or which become dissolved in the mouth of the eater. Fresh, living oysters, as is the case with all sea-animals, contain very much water. In order to estimate the proportion of water, the greatest care must be taken in removing the oyster from the shell, especially when the shell-muscle uniting the two valves is cut. The exterior of the body must first be dried with blotting-paper, the body then weighed, and finally placed under the air-pump and all the water drawn out. Two Schleswig-Holstein oysters which were taken from the shell and dried, weighed together 14.70 grams, and after all the water had been drawn from them they weighed only 3.05 grams. They thus contained 79.25 per cent. of water, and only 20.75 per cent. of solid material. Two other large oysters, which had been previously deprived of their gills and mantles, weighed together 20.55 grams; after being thoroughly dried they weighed 4.809. Thus their edible portion contained 76.64 per cent. of water and 23.36 per cent. of solid material.

A large number of investigations upon Schleswig-Holstein oysters demonstrated that the entire animal contained from 21.5 to 23 per cent. of solid material, while the body, without the gills and mantle, contained from 23 to 24.5 per cent. of solid material. (c)

(c) I am indebted to Professor O. Jacobson, of Rostock, for all the information that I have given in Chapter 12, in regard to the chemical constituents of the Schleswig-Holstein oysters. In June, 1871, when he lived in Kiel, he analyzed at my request a number of oysters which I had received fresh from the Schleswig-Holstein beds.

Making due allowance for size, there is a somewhat greater difference in the proportion of solid material between oysters and fish than between oysters and birds and mammals, for—

	Per cent. of solid material.
Trout-flesh contains.....	19·5
Carp flesh contains	20·2
Pork contains	21·7
Veal contains	21·8
Beef contains	22·5
Fowl-flesh contains.....(d)	22·7

One hundred parts of dried oyster-meat contain 7·69 to 7·81 parts of nitrogen, and 100 parts of fresh oyster-meat contain 1·85 to 1·87 parts of nitrogen. By burning the dried oyster-meat we can obtain the amount of inorganic material which it contains. By this method it has been found that the meat of completely dried Schleswig-Holstein oysters, when deprived of the beard, contains 7·45 per cent. of inorganic substances, while in those which have not been dried the amount is only 1·79 per cent. According to these determinations, 100 parts of the bodies of fresh edible Schleswig-Holstein oysters contain—

77·00 parts of water.

21·21 parts of organic material.

1·79 parts of inorganic material.

The principal inorganic substances are salt (*sodic chloride*) and phosphoric acid. The proportion of salt in fresh oysters is 0·58 per cent., and of phosphoric acid 0·38

(d) The figures quoted in the comparison of the amounts of solid materials in different kinds of flesh are based upon the analyses of Schlossberger and Von Bibra. They were taken from the Elements of Physiological Chemistry of Gorup-Besanez, third edition, 1874, p. 682.

per cent. In fresh beef the proportion of salt is 0·49 per cent., and of phosphoric acid 0·22 per cent. From these results it is evident that the oyster contains as much food substance as the better sorts of meat used for food, or even somewhat more. In addition to this, it is still further distinguished from the greater number of animal foods by being more easily digested. . . . The value of an oyster does not depend principally upon the amount of nourishment which it contains, but chiefly upon its delicacy and uniformly fine flavour.

. . . . What particular constituent of the oyster it is which gives it its flavour is as little known as the origin of the flavour of various other kinds of food. The liver and the generative organs contain glycogen and grape-sugar. Pure glycogen has no taste, and it is composed, as is grape-sugar, of carbon, hydrogen, and oxygen. Probably the fatty matters aid greatly in giving flavour to the oyster. I have repeatedly found that in May and the first half of June, when the generative organs are very much developed, the females have a much finer, nut-like, and full flavour than the males.

I have repeatedly placed fresh oysters, whose sex I had previously ascertained by means of the microscope, before different people, in order to get their opinions of the flavour. They also, without knowing anything about the difference in sex, found the female superior in flavour to the male. Those females which are well developed are generally somewhat thicker and more cream-like in colour than the males, whose bodies are more transparent and watery. In the middle of winter these differences are not so apparent as shortly before the breeding season. Immediately after the emission of the generative products,

oysters are poorest, and they are more watery then than at any other time.

After the breeding period their size increases from month to month, and, in case their nourishment is not interrupted by long-continued severe cold, their flavour becomes fuller and richer in proportion to the rapid development of the generative organs. From this it follows that winter, but more especially spring, are the periods of the year for the enjoyment of oysters. I have repeatedly heard people, who rated themselves as genuine oyster-eaters, say that "oysters ought never to be bitten, but should be swallowed whole." If this were so, then one might better use, in the place of the high-priced oyster, a succedaneum made of tasteless thin paste, and having merely the form of the oyster.

As with all other kinds of food, the flavour of the oyster is more effective, and can be better appreciated, the more intimately its constituent elements come in contact with the surface of the organs of taste. Therefore, if one would obtain the full flavour of the oyster, it must be bitten to pieces and chewed, in order that all the constituents may be free to produce their greatest effects.

. . . . the very finest oysters are found upon the beds near Hörnum. The oysters of these beds are especially distinguishable by the large growth of their organs of generation. Their flavour is very delicate, and never bitter and watery, as is the case with the oysters of many other beds. This superiority in form and flavour must be the direct result of the action upon the oysters of these banks of the external conditions of life under which they exist. The oysters upon the beds near Hörnum lie deeper and nearer the open sea than those farther in upon the flats. The water, also, which flows over them during the

course of the day and year, is less subject to fluctuations in temperature than that which flows over the beds lying nearer the mainland, and there is here a somewhat greater percentage of salt than in the water over the beds in the shallower portions of the sea-flats. To these external physico-chemical properties of the Hörnum banks are also united faunal peculiarities.

. . . . In Paris the green oysters of Marennes and Tremblade are especially prized, on account of their delicious flavour. This cannot come from the green constituents of their body, for if old oysters are taken there during the winter months, and placed in a fattening pond, they will indeed become green, but by no means so well flavoured as those oysters which were placed there when young, and have lived there several years.

The flavour of oysters is best at the banks themselves, if they are opened very carefully, and all the seawater which is enclosed in the shell when shut is allowed to escape. This can be done most judiciously if the oyster is placed upon the flat right valve, after the loosening of the shell-muscle. This valve is a superior natural plate for the oyster, since it has no cavities like those of the left valve, filled with disagreeably smelling water, which flows out when the shell is opened, and contaminates the flavour of the oyster. The oyster can live for days, perfectly dry, without dying; but it gradually loses its softness, and soon begins to smell, from the dying of the animals which inhabit the outside of its shell. It is very seldom that these can be entirely removed by the usual means of purification, so that the flavour of the oyster inland is almost always affected by these contaminating odours. (c)

ENEMIES TO OYSTERS.

The enemies of oysters are numerous and indefatigable. They may be divided into two classes :—

A. Living.

B. Inanimate.

The living enemies may be further divided into :—

A. Those which are directly injurious.

B. Those which are indirectly injurious.

Class A.

LIVING ENEMIES.

Subdivision A (*directly injurious*).

1. Skates and Rays.
2. Octopods.
3. Echinodermata (starfish, sea-urchins, &c.)
4. Crustacea (crabs, prawns, &c.)
5. Whelks, &c.

Subdivision B (*indirectly injurious*).

1. Mussels.
2. Cliona.
3. Weed, sabella, acorn-barnacles, annelids, polyps, poch, blubber, &c.

Class B.

INANIMATE ENEMIES.

1. Sand.
2. Mud.
3. Fresh water.
4. Frost, ice, and snow.
5. Sewage and other poisonous contamination of the water.

1. SKATES AND RAYS.

Among this tribe of fish, the eagle-skate or sting-ray is the most destructive; and where it is a frequent visitor, as on the French coast, it commits sad depredations on the oyster-beds. The French call it "*le thère*," and they protect their beds from its ravages by means of palisades of short pointed stakes firmly fixed in the mud under water, and sloping outwards at an angle of 45° . If these protections are not made use of, the rays will swoop down obliquely on the young oysters, and crunch them up in their powerful jaws, fitted, as they are, not with teeth, but with compound crushing-machine palates, in which the shells of a young oyster are ground apart as between two millstones, and the ray can thus easily possess himself of the succulent contents. The male sting-ray is furnished at the tail with two daggers having barbed edges, the female having only one of these formidable weapons.

2. OCTOPODS.

Cuttle-fish and other octopods are determined foes of the oyster. Deep-sea fishermen tell us that wherever octopods are dredged up in considerable numbers, a bed of oysters will probably be found not far distant.

Octopods are found in quantities around the submerged rocks and reefs in the English Channel. The Channel Island fishermen have partly attributed the decadence of the oyster and scallop fisheries of late years around Guernsey to their depredations, though they admit that many other causes have been at work besides octopods to account for the scarcity. The method of attack of these animals is to seize the oyster in their powerful tentacles, and force an entrance through the thinnest part of the shell

by means of the horned beak that they can protrude at will.

3. ECHINODERMATA (STARFISH, SEA-URCHINS, &c.)

Starfish are probably the most pernicious and persistent enemies of oysters. In the estuary of the Thames they are locally known as five-fingers, and they abound on many of the Kentish beds, in fact, in greater or lesser numbers, they may be said to be constantly found attendant on all oyster-beds. . . . Though known as "five-fingers," starfish are found frequently with only three arms, at other times there are as many as ten, and foreign varieties have from twenty to forty tentacles.

. . . . The arms are covered on the upper sides with a tough skin, so tough indeed that, when a "clock" which had a five-finger as an inhabitant was stamped on, the shells were broken to pieces, and, though one of the five-finger's arms was outside the edges of the shell, it was not separated, and only slightly indented. (a)

. . . . Starfish are sometimes of use on an oyster-bed, from the preference they show, already mentioned, of attacking mussels, annelids, and even acorn-barnacles, before oysters. So that, when there is much of this kind of vermin on a bed, the five-fingers may be allowed a little "law"; but their employment in this manner should be carefully and judiciously watched, and certainly not allowed on grounds where the owners have not the means of promptly exterminating them as soon as they have eaten down to the oysters.

Five-fingers are much more plentiful on the south banks of the Thames than on the north side, whilst whelk-tingles

(a) Clock is the name given to the double oyster-shell after the fish is dead and has become removed.

are more troublesome on the Essex than on the Kent oyster-beds. When dredging off Whitstable last year, we had frequently thirty or forty five-fingers in a haul; this we were told was a mere "nothing," and our attention was drawn to a fleet of some thirty or forty boats which were dredging on the flats for five-fingers alone. When brought on shore they are sold for manure; they command, however, but a small price, £1 per ton.

Nine out of every ten clocks brought up by the dredges were occupied by these pests, who were evidently the evictors of the rightful tenants.

Mr. Gann, the manager of the Sea Salter and Ham Company, described to us the following manner of dredging for five-fingers without bringing up any oysters:—

The instrument employed for the purpose is an ordinary dredge, with the thong that is attached to the skin or ring-back loosened, so that there is an interval of about six inches between the bit or knife and the lower network. When dredging the oysters slip over the bit, and are not brought up; but the five-fingers, being of but little greater specific gravity than water, are lifted up, and before they have time to fall are caught in the bag of the dredge.

Five-fingers do not like to be disturbed or to be rubbed on the back, and it has been found that a large dredge, with light iron rings for the back net, will cause them to disappear, at any rate for a short time, from the grounds where it is used.

SEA-URCHINS.

Sea-urchins—or, as they are called in some places, shepherd's crowns, burrs, &c.—have also been accused of destroying oysters, though it has not yet been clear how they manage to grasp their prey, whilst using their hard

powerful beaks for perforating the shell. We think that a burr would have to pound away for a long time without gaining any admittance to an adult oyster's closed doors, but they are possibly capable of destroying the young brood.

CRUSTACEA (CRABS, LOBSTERS, PRAWNS, SHRIMPS).

At different stages of an oyster's life all these animals are more or less enemies to it: the worst are undoubtedly *crabs*; they will eat oysters whenever and wherever they get a chance.

Fishermen have a superstitious regard for the cunning and cleverness of the wily crab, and marvellous stories are told of its "legal" qualities. The two following examples of such tales will suffice. A friend told us that a crab in his aquarium would take up young oyster brood, which had lately been removed from the layings, turn them over one by one, and examine them narrowly to see whether they had been injured by removal. If uninjured, the crab dropped the oyster with an apparently disgusted air, and seized another. Should this one by chance show marks of abrasion, the crab pounded away with his heavy claw at the weakened spot until the shell gave way, when the other claw was immediately inserted, the fish dragged out and devoured. Was this instinct or reasoning power? may well be asked; the latter, if we are to believe the yarn of another *raconteur*, who gravely informed us that he had seen a crab hovering above a feeding oyster, holding in one claw a small stone, which he poised over the unconscious bivalve. When a favourable opportunity occurred the crab let go, exactly plumb the entrance of the gaping shells; the stone fell, "wedging them open," and the crab descended into his oyster *bar*!

Without pronouncing an opinion as to the quality of our friend's pun, or the accuracy of his observation, there is no doubt that crabs will watch oysters like a cat does a mouse-hole, that they will climb over banks, enter drains, and squeeze themselves through traps, to obtain the food they are so fond of.

A writer on the subject, referring to the French grounds, lately stated that the most deadly of the oyster's enemies there were crabs, called by the French *cancres maudits*, for they may be seen prowling about everywhere seeking for young oysters to crunch and devour. "At times they seem to do it for the pure pleasure of destruction ; they have been watched taking the infant oysters in their pincers, and cracking them one after the other as fast as they could. Or, if the oyster is too big and strong to be crushed to death, a crab will lie quietly by until the valves open, when, quick as lightning, in goes his big claw as a wedge, to be followed by the smaller one, with which the oyster is pinched out and eaten piecemeal. Then, when crabs have nothing else to do, they get together in bands to dig holes, carting away the sand or mud on their backs. This buries the oysters, and kills them in great numbers." The same writer adds in another place, that "the black worms silt up the mud, and crabs scratch it over the oysters." It is a fact, that during a short time of neglect a million of oysters were thus smothered in one preserve in Brittany.

In most oyster-culture establishments the young brood are placed on trays in a sort of cage, which is covered with wire gauzework, or close network, to protect them from the crabs. The French call these cages "*ambulances*," and they were instituted in France on account of the depredations of *les cancrs maudits*.

Lobsters, prawns, and shrimps, as well as crabs, do a vast amount of damage on an oyster laying. Their ravages are committed during the warm months of summer and autumn, when the shell is growing and the spat is floating about in the sea. It is at this time they are most active, and the amount of oysters destroyed before their shell has time to harden is enormous.

Besides crustaceans, many fish feed on the spat of oysters. Mullet, whiting, mackerel, gobies, and all insectivorous fish, will eat it greedily if it comes in their way.

Shrimps and small fish lie under the shell of a breeding oyster, waiting for the spat to be ejected. When this has taken place, they dart out and devour it with great avidity.

Prawns will attack very young oysters with great success; rushing at the tender shell with their serrated beak, backing well before they make each rush, they soon make a hole sufficiently large to enable them to obtain an entrance and consume the young fish.

WHELKS AND WHELK-TINGLES.

Whelk-tingles are also called dog-whelks or boring whelks (*Purpura lapillus*). They are one of the greatest, if not *the* most destructive, of the oyster's enemies.

This shell-fish has the power of protruding a rasp-like borer out of the cylindrical apex of its shell. Under a powerful magnifying glass the borer can be seen to be a most formidable weapon, and the way they use it is as follows: Crawling over the oyster until seated with its borer immediately above the heart, the most vital part of the victim, the dog-whelk protrudes its head and body downwards to hold on and balance itself by, and then works away with its borer until a hole, like that made by a drill,

is cut into the shell. This hole is cut quite clean, as if bored out with a jeweller's diamond. It is astonishing what amount of devastation these innocent-looking molluscs will do in a very short time : the softer the shell the more rapidly does the dog-whelk do its work. The oyster being thus killed, the adductor muscle relaxes, and the whelk feasts itself at its leisure. If game is plentiful, the whelks, like some other voracious animals, will only eat the most succulent parts of the fish, leaving the beard, &c., to the less fastidious crabs that generally follow in their wake ; passing on, on their errand of destruction of the nutritious food that might well belong to their betters.

Dog-whelks were at one time such a pest in the Black-water—the year before last, we think—that fishermen were paid by the owners of beds 6d. a hundred for bringing them on shore. It is greatly to be regretted that, as these animals are now useless, they are invariably thrown overboard again when dredged up on common grounds. It is thought that the Tyrian dye mentioned frequently in the Bible was extracted from a shell of a somewhat similar kind. Perhaps if the very strong dye that can be extracted from the dog-whelk were made into a fashionable colour like peacock-blue, for æsthetic ornamentation, a market might be found for this extremely objectionable shell-fish. . . .

COMMON WHELKS.

Till quite recently it was not thought that the common or edible whelks were enemies of the oyster, and even now we must admit that for every oyster a common whelk kills a dog-whelk will slay a hundred.

The common whelks have also a weapon of offence that proceeds from the apex of their shell, which they can use

with considerable effect against a young or weakened oyster, and we believe that they will attack and easily kill. At any rate, we have no fear that the fisherman will throw the common whelks overboard again on to the oyster grounds, as they can find a ready market for them on shore, being generally allowed to keep them as a perquisite by oyster companies.

Whelks' eggs are often dredged up attached to oysters and culch. In winter they may be frequently met with thrown up on the foreshore. We have observed them all the year round. Mr. Buckland stated that he found the greatest number about the end of February.

Class A. Subdivision B.

WEED, SABELLA, ACORN BARNACLES, &c.

We have classed all these together, their action as indirect enemies of oysters being very similar, except the crowsilk, &c., on fattening grounds. Weed of any sort on oyster-beds is objectionable, from the fine green slimy weed that grows in the pits, on whose roots the common periwinkle lives, to the cat-tail on cultivated grounds, and the huge *Fucus fusiculosus* that is dredged up from the deep-sea beds.

Some fishermen believe that weed does not do any harm: we have even been told that a weed called "cat-tail" does good, and in support of this a theory has been advanced that seaweeds, like vegetables and plants on land, exhale oxygen and consume carbonic acid gas. If living seaweed thus tends to oxygenate the water, no doubt the theory is sound; but until this be more clearly proved by practice, we are bound to state our opinion that, with the above exception, *all weed is objectionable*; firstly, because it increases the work of dredging, and covers up the oysters;

secondly, because at the period of spatting it covers the culch, so that the spat that settle thereon is lost ; weed collects mud, which smothers the spat, and generally makes the ground foul.

Sabella is a tube-inhabiting annelid, with an arenaceous covering that accumulates round the cylindrical tube. Sand thus deposited is a coarse, brown, friable substance, commonly called "ross." If it contains the worm, it is called "live ross," if not "dead ross." It is objectionable because it grows extremely rapidly on and around the oysters, tending to smother them ; and when the worm dies, it turns black and poisons the young spat. It can easily be scraped off an oyster-shell, but of course increases the trouble of preparing them for the market. The oyster underneath the sabella will be found quite intact, proving that it is not a direct enemy.

Acorn barnacles, called in the Thames estuary "chitters," are very small barnacles which appear to prefer calcareous substances on which to attach themselves. They are the least harmful of any of the previous enemies we have mentioned, but they form on the culch, and thus prevent the spat from getting fairly attached. Deep-sea oysters, particularly those from the Skelling banks, have frequently larger sized barnacles attached to them, which are apparently of the same nature as acorn barnacles.

ANNELIDS, POCH, POLYPS, BLUBBER, &c.

These are all objectionable on oyster-beds, making the ground foul, and if from any cause they die, decomposition will set in, and the very young oysters will succumb to its poisonous influence. The younger the oyster, the more delicate is its constitution, and the easier it succumbs to bad diet.

Poch is a conglomerate of small semi-globular drops, that forms on the outside of oyster-shells : it is of a brick-red colour, and, if squeezed, emits an odour very similar to that of cucumber.

Blubber, (*b*) called by various other names, such as *squashers*, *jellies*, &c., is a great nuisance on some grounds. It grows and accumulates very rapidly, and if left alone would soon smother the beds. The Blackwater fishermen collect it from every dredgeful, and than stamp it under foot ; the sacs being thus emptied, air takes the place of the liquid, on the pressure being removed ; it is then thrown overboard, and floats away with the tide—if not quite destroyed, at any rate it goes on to some one else's ground. The same objections we have urged against the foregoing organisms apply to polyps, sea anemones, and all other sedentary animals and vegetables ; there is little doubt that you cannot have your ground *too* clean for the reception of oyster spat and the general purposes of oyster culture.

The Blackwater and its tributaries, as well as the Colne and the Mersea grounds, are much troubled with blubber. We saw a great deal on Mr. Harvey's ground, though there was not a single five-finger or dog-whelk there, and Mr. Harvey's grounds are no doubt most excellently cultivated.

(*b*) Poch, in Poole called "*Taddicks*," is very numerous here. When dredging I have frequently seen the dredge almost full of it, quite to the extent of from $\frac{1}{2}$ to 1 cwt. at a time. Fishermen say that they impede dredging so much that they will not take out licenses until the frost sets in, so that they can fish better, for it is the peculiarity of these "*Taddicks*" to disappear after the first frost.

Class B.

INANIMATE ENEMIES.

Sand is the most fatal of inanimate bodies to oysters, and therefore will be treated of first. Where there is a sandy coast, or shifting sand-banks are in the neighbourhood, the accumulation of sand proves destructive to oyster-beds, though all other conditions for their successful establishment may be very favourable. This is more or less the case near the Maplin Sands, Southend, the east coast of Jersey, in the estuaries of the Exe, Solway, Flintshire Dee, and Severn, the mouth of the Aln (Northumberland), Cardigan Bay, and many other places.

In 1868 Mr. Dilnot, who was working with Mr. Buckland at the Reculvers Fishery, near Herne Bay (where, by the way, his oyster culture establishment would have been an entire success had not an accident happened to the embankments) wrote: "It occurred to me to try the experiment of covering some oysters, in the experimental trough, with sand and fine gravel; I put just enough over them to cover the shells. I have just examined them, and find those under the sand all choked; others in the same trough, on which I placed no sand, are all alive. I find when the oyster opens to feed, the sand is drawn in between the valves of the shells, and it is unable to throw it out; consequently it dies." Those who think of cultivating or fattening oysters should try first whether the locality is subject to these marine sand-storms; as Mr. Buckland remarks, the question whether it is favourable or unfavourable will be answered by a few oysters as well as by a thousand pounds' worth.

The following amusing lines appeared in *Punch* in November, 1880, *à propos* of this subject:—

THE MOAN OF THE NATIVE.

'Tis the voice of the oyster—I hear him complain,
“ I *can't* live in this place ; here's a sandstorm again !
I had settled at rest 'mid the rocks and the tiles,
They had made me a home, but this sand, how it riles !
It gets into my shell and the delicate fringe
That I use when I breathe ; and I can't shut my hinge
When the grit lodges there ; so the crabs come at will,
Since my poor mouth is open, they feed and they kill.
I've complained to Frank Buckland, who quite understands,
But he can't undertake to abolish the sands.”
Thus the native made moan, and I took up the brown
Bread-and-butter and lemon, and swallowed him down.

MUD.

Shifting mud is a bad thing for spat or young oysters. If spat happens to fall on mud, it is fatal to its chances of existence. After the oyster grows older it does not appear to mind reposing on a muddy bed, as long as the mud is not too soft, and it does not get buried too deep. Oysters laid on soft ground often sink in the mud ; but if this takes place gradually, the animal contrives, by the flow of water which it takes in and passes out, to keep an air-hole open. When covered over by a mud storm, however, they have not time to establish communications with the sea, and they get “ slubbed ” up and die. There are many places in France, such as at Auray for instance, where the oysters are raised three or four times a year from the mud into which they have sunk, and relaid on the surface. There is a bed of oysters in Cancale Bay where the dredge will come up quite full of mud, but it also brings up living and healthy oysters.

A continuous calm is not considered favourable by the French authorities, especially at spatting time ; this is

almost the only evidence we have collected that interferes with the theory of tranquillity ; the reason is that the mud in a slimy state is deposited or settled on the *appareil collecteur*, and prevents the spat taking a firm hold.

At the Ile de Ré, in 1868, a comparatively small spat of oysters had fallen at La Moulinade, on the west side of the island, whereas at Chanchardon, on the east side, the fall of spat was quite up to the mark. The cause of this was assigned to the power of the wind to shift the mud ; the same wind which brought ill-luck to the west side of the island naturally brought good-luck to the east.

Mr. Buckland, who was at the Ile de Ré at the time, found, upon examining the oyster parcs at La Moulinade, that they were in many localities mudded up, but that on the other side of the island the stones on the foreshore were clean. At Rivedoux, this wind had covered the tiles with mud to the extent of sixty or seventy centimetres (about two feet) deep. A calm coming immediately after heavy waves allowed the mud to drop from the dirty water, and to settle on the young spat and smother them. These mud storms, the same authority continues, “are particularly unfavourable to *foreshore* cultivation, inasmuch as the oysters cannot be dredged and cleaned from the sediment which has fallen on them ; but it does not apply to our English system, because we can gradually clean the mud away with a dredge.” Again, it should be observed that all places are not liable to mud storms ; but a bank of loose mud should always be regarded as a dangerous neighbour by the owner of an oyster-parc or laying.

The flats at Whitstable consist of shelly ground, clay and muddy sand ; the fishermen say that the oyster prefers

the muddy sand during winter, where it can lie close, and get protected from gales and their effects on the rolling gravel.

There appears to be no doubt that in winter the brood are more difficult to dredge up, and the ground becomes very much harder in cold weather, particularly on such parts of the Whitstable Flats where there is only from six to eight feet of water at low tide. It has been stated that oysters bury themselves and hibernate in the winter; the foregoing may partly account for the tradition.

FRESH WATER AND RAIN.

Fresh water does no harm in moderation; when mixed with sea-water quite the reverse, as oysters, when young, appear to fatten and grow more quickly where they are subject to the effects of numerous fresh-water deposits, but with too much fresh water the fish of the oyster increases in size, and becomes fat and flabby eventually; the oyster gapes and dies, or, as an old fisherman said, they "busts theirselves open."

Sea-water fish, with the exception of the salmon and a few others adapted for the change, transferred to fresh water, quickly die. It is therefore dangerous to make oyster-pits or beds where they are liable to being submerged in fresh-water floods, or what are called "freshets," Oysters will live much longer out of the water, if placed on their deep shells and covered with seaweed, than when, as is usually the case in London, they are placed in tubs of fresh water; salt and oatmeal only make the water less suitable for them.

There is a saying among oyster-culturists that a fall of rain is a good thing to settle the spat, and in those years

that spat fell plentifully there was occasionally rainy weather, besides "heat and tranquillity."

Care should be taken that any land drainage should be led clear of the pits and ponds where oysters are laid for protection, or preparatory to being taken to the market.

ICE, FROST, &c.

Ice coming down rivers is frequently left aground by the ebb tide, and takes up a berth on the foreshore. As the volume of ice under the water is much greater than that above, it often grounds below low-water mark, and if any unfortunate oysters happen to be beneath the small floe, it will freeze them on to itself, and with the incoming tide, "walk off" with the oysters attached. When the ice melts, it drops the oysters again, perhaps into water much deeper than they have been accustomed to. In their weakened state they will then succumb, and thus in severe frosts many beds are robbed and their contents killed.

Ice also prevents dredging. During a severe and continuous frost the boats cannot work, and the five-fingers and other enemies have the field to themselves. Some thirty years ago, when a severe frost set in, the river Roach could not be worked, as the ice was over an inch thick on the surface. Thousands of five-fingers then made their appearance, and killed a great quantity of brood.

The effects of the cold in February, 1879, were most disastrous. The loss on the Swale estuary alone was estimated at £20,000. French and Irish (seconds) that were laid down all died. Though up to February 8th natives were not touched, merchants reduced their price 75 per cent. to induce purchasers! The young brood appeared hardier than the parent oysters. This same winter was

very severely felt in the Blackwater and its tributaries and estuary, where the cold killed all the French oysters and a great many natives that were left in exposed places, though the natives laid in pits escaped.

At Wyvenhoe, Messrs. Harvey attribute the fatal effects of cold on the beds to the increased density of the water; but as the greatest density of this brackish water near Mersea is at about 39° Fahr., it is difficult to see why this should be the cause. Frost sometimes freezes the shells together, and the oyster dies from starvation. Oysters have been opened and found to contain the fish enveloped in a lump of ice. In this state, though dead, it is perfectly good to eat, if eaten at once, though when it is thawed the dead animal becomes quickly putrid. In winter, after a thaw, snow-water comes down the rivers and increases the volume of fresh water, and thereby sometimes causes great harm to oysters.

SEWAGE, THE POLLUTION OF RIVERS, &c.

It will not require many words to convince any one who thinks on the subject of the direful effects of sewage on oysters, for, even if they are not killed outright by the withdrawal of oxygen from the water, and the substitution of other noxious gases, it will assuredly render the oysters totally unfit for human food. The rare cases where oysters have acted poisonously are to be attributed to this cause.

Although oysters have very delicate constitutions, we may fairly assume that, if the transition to impure feeding is very gradually reached, they will, like the human being, become accustomed to larger and larger doses of the poison, and will eventually become acclimatised, as it were, to obnoxious aliment.

These cases are, however, exceptional, the usual results of an outlet of sewage being the complete destruction to the oyster-beds it contaminates.

The question of the pollution of rivers is very important to oyster culturists; and these pollutions are such a hindrance to the proper development of other fisheries, that it would be as well to give some of the facts ascertained of late years as to the effects of sewage and other pollutions.

LIVERPOOL.—The Mersey has suffered very considerably in this way; one of the witnesses examined by the Inspectors of Sea Fisheries stated that he recollected when the banks on both sides of the river were clean sand, and the Bay at Waterloo a light-coloured clean sand. He also remembered when a wreck at Rock Lighthouse was covered with small mussels. "There are no mussels there now! The bank of the river consists of dirty sludge. The sewage and chemicals from Liverpool are materially injuring the fisheries, and the smell is obnoxious fourteen miles out." A complaint was also made that the steam dredges are continually depositing a large mass of hard stuff eight miles north-west of the Bar lightship, and are destroying a valuable trawling-ground.

GUERNSEY.—The practice of depositing ballast round the coasts of Guernsey has destroyed a valuable trawling-ground, and rendered the adjacent waters unfit for oysters. This practice has, however, been discontinued (1882).

TYNE.—The hoppers bring down large quantities of dirt from the bed of the river, and refuse from the alkali and other manufactories. The Tyne Commissioners alone dredged up 500,000 tons of rubbish in one year; "this deposit has filled up the crevices in the rocks, and crabs and lobsters have almost entirely disappeared."

TEIGNMOUTH.—A good deal of granite sand comes down from Dartmoor. From Newton comes the drainage and refuse of the gas-works and a tanyard, making the water there sometimes as red as blood. About two years ago Mr. Baxter laid two cargoes of Irish oysters in the river, on a Thursday. On Friday there was heavy rain, and on Saturday they were all nearly dead. The flood brought down a lot of sediment, which choked or buried the oysters.

PLYMOUTH.—A vast amount of mineral sand and clay comes down by the rivers from the counties of Devon and Cornwall. These deposits, coming into contact with the chloride of sodium in the salt-water, fall on the shell-fish banks and spawning-grounds, form an oxide, and destroy the fish! In these cases the whole oyster turns green from copper, reddish-brown from iron, &c.; and whenever an oyster-lover meets such, let him not try experiments *in corpore vili*. If the beard alone is green, as with the Marennes and Roach river oysters, let him eat without fear, for these are vegetable, not mineral results, and such oysters in our opinion are the very best.

If the oysters that have suffered from mineral deposits are relaid down on clean grounds, they will gradually resume their natural colour, and become again quite good to eat.

Evidence has also come from Morecambe Bay, from Leigh, and from many other places, not excepting the mouth of the Thames, to show that where manufactories or sewage works empty their refuse, *fish of all sorts* have been driven further and further out to sea; and many testify to the fact that scarcely any fish will keep alive westward of Gravesend until clear of London. (c)

That an oyster-bed may become tainted through natural causes is quite possible, but I believe such an accident is of very rare occurrence, and beyond that mentioned elsewhere in this work, I am not cognizant of such save in one instance, which, under the head of "Oysters and Typhoid Fever," was accepted by two or three newspapers (November 10th, 1889), as an alarming piece of news awaiting corroboration, and was couched in the following words:—

"The great prevalence of typhoid fever in Dublin is causing considerable alarm. One of the supposed sources to which it is attributed by the medical profession is the use of oysters, which have been taken from beds tainted by sewage. It is said that quantities of foreign oysters have been imported which have been so taken, and many persons, including doctors, have been rendered ill by eating them."

But, in reply to a letter sent by me to the Dublin Medical Officer of Health, that gentleman, admitting the fact of the epidemic, was "rather disposed to think that defective house-drains are the cause."

From the *British Medical Journal* of May 3, 1890, I cull the following statement under the head of "Polluted Oysters at Naples; the supposed cause of Typhoid Fever."

Dr. Godwin Timms writes:—I have just received from Dr. F. W. A. de Fabeek, Brigade Surgeon, Bengal (retired), a very lucid account of the death, at Capri, of a very talented young artist, Mr. Frank James, who was on a visit to his mother and sister, who are residents. He arrived in Italy on February 16th, 1890, began to sicken on March 22nd, and died of Typhoid Fever on April 18th, 1890. Dr. de Fabeek attributes the disease to the eating of polluted oysters, and goes on to say: "I think it right to

take the opportunity of begging you to warn all intending visitors to Naples against the eating of oysters. . . . The locality in which the oysters are kept has always been a very foul one. The oyster beds lie in comparatively stagnant water, close to the embouchure of drains opening into the sea; and now that a retaining wall has been built outside the site of these beds, with the view of ultimately reclaiming the land on which they lie, there is no circulation of water whatever. . . . You will, I trust, in the interest of the travelling public, pardon me for writing to you thus fully."

PROFESSOR HUXLEY ON OVERDREDGING.

It is the opinion of almost all who have studied the subject that any natural bed may be in time destroyed by over-fishing—perhaps not by removing all the oysters, but by breaking up the colonies, and delivering over the territory which they once occupied to other kinds of animals—by barging the breeding oysters, by covering up the projection suitable for the reception of spat, and by breaking down, through the action of heavy dredges, the ridges which are especially fitted to be the seats of colonies.

Even Professor Huxley, the most ardent of all opponents of fishery legislation, while denying that oyster beds are being permanently annihilated by dredging, practically admitted in a lecture delivered in 1883, that a bed may be reduced to such a condition that the oyster will only be able to recover its former state by a long struggle with its enemies and competition—in fact that it must re-establish itself much in the same way as they have acquired possession of new grounds in Zutland, a process which according to his own statement, occupied thirty years.

I have elsewhere stated that the development of the American and the Portuguese oyster is very similar to that of the *ostrea edulis*, except that there is no period of incubation within the mantle cavity of the parent in these two species. Hence it is that so-called artificial fertilisation is possible, that is to say, that fertilisation may be allowed to take place in a tank or aquarium in which the conditions are under control. But if it is possible to procure a supply of spat from the American oyster by the swarms of larvæ in confinement; it ought to be possible in the case of the European oyster. All that would be necessary would be to take a number of mature oysters containing white spat and lay them down in the tanks until the larvæ escape. This would be simply carrying oyster culture a step further back, and instead of collecting the newly-fixed, to obtain the free larvæ in numbers and so insure a fall of spat independently of the uncertainty of natural conditions.

In nature the beds are liable to variations, and though Professor Huxley is rather sceptical on this subject, it seems that they are easily brought into an unproductive condition by overdredging.

Touching upon this point, I am sure that I cannot do better than to lay before the intelligent reader the distinguished Professor's views upon this important matter, in his own words.

There can be no doubt that the great mass of oysters in an oyster bed may be removed by systematic and continuous dredging. But those who are best acquainted practically with the nature of that operation will be least inclined to believe that all the oysters on a bed could be cleared off in this way, even if the attempt were made; and, as it must cease to be profitable to dredge long before the point of entire clearance is reached, it is plain that, in

practice, the attempt will not be made. It may be doubted if ordinary dredging ever fails to leave some thousands of oysters, great and small, on a bed of any extent.

Thus, if we admit, for the sake of argument, than an oyster bed may be exhausted by ordinary dredging, the reason why the oysters vanish is not obvious. For supposing only a thousand oyster left, they ought to suffice to restore the bed by degrees. I am aware that it is said that in the meanwhile, the enemies and competitors of the oyster have got the upper hand, that the ground has been spoiled by accumulation of mud and so on. But this reasoning leaves out of sight the fact that the oysters have not been there from all eternity. There was a time when there were no oysters on the ground, and when the oyster larvæ immigrated, fixed themselves there, increased and multiplied, in spite of all obstacles. Why should they not do so again?

The question is further complicated by the consideration that it is by no means certain whether the population of a given oyster bed is kept up by the progeny of its own oysters or by immigrants. As I have pointed out, it is ascertained that the larvæ, even under very unfavourable circumstances, may swim about for a week; and it has been estimated that they are ordinarily locomotive for two or three times that period. Even if we suppose the average period of freedom to be not more than three days, the chance that an oyster larva will eventually settle within a mile of the spot at which it was hatched, in any estuary or in the open sea, must be very small. For, in an estuary, and almost always in the sea, one of the two alternating currents of water is dominant, and a floating body will drift, on the whole, in that direction, often many miles in the course of a day.

The opportunity of observing the natural formation of a new oyster bed is rare, but the details of the process have been carefully watched in at least one case. Up to the year 1825, the Limfjord in Northern Jutland consisted of a series of brackish water lakes communicating with one another, and opening on the east into the Kattegat. In the last century, unsuccessful attempts were made to plant them with oysters. But, on the 3rd of February, 1825, a great storm broke through the dam which separated the western part of the Limfjord from the North Sea; in consequence of this, the water of the fjord became gradually salter, the brackish water plants and animals disappeared and North Sea animals took their places. Among these, in 1851, oysters were observed, and, year by year, they extended over a larger area. In 1860, only 150,000 were taken; at present, there are ninety-eight beds, and, in 1871-1872, 7,000,000 of full-grown oysters were exported. There could have been very few oysters before 1851, when the first were noticed. But supposing the first entered as early as 1840, then, in thirty years, they spread themselves over an area of about sixty-four English miles, so that every year, on the average, they advanced more than two miles. The oyster beds are, at present, three-fifths of a mile to five miles apart, so that the larvæ must have been able to wander for at least five miles. ¹

During this slow process of immigration, it is obvious that the enemies and the competitors of the oysters had just as good a chance as the oysters themselves; and yet the latter have established themselves with great success. Why should they be unable to do the like elsewhere?

I must confess myself unable to arrive at a conclusion on the question whether what is called "overdredging"—

¹ Mobius. *Die Auster und die Austern-wirthschaft*, p. 52.

that is, dredging to the extreme limit at which it is commercially profitable to dredge—is alone competent permanently to destroy an oyster bed or not. That oyster beds have disappeared after they have been much dredged, I do not doubt. But the commonest of all fallacies is the confusion of *post hoc* with *propter hoc*; and I have yet to meet with a case in which it is proved by satisfactory evidence, that an oyster bed has been permanently annihilated by dredging, when the spatting seasons have been good, and when there has been no reason to suspect an inroad of destructive molluscs or starfishes.

The increasing scarcity and dearness of oysters were subjects of complaint twenty years ago, and the outcry has become louder of late years. Three causes, and only three, so far as I know, have been assigned for this unsatisfactory state of things: first, the increase in the demand for oysters, owing in large measure to modern facilities of transport, consequent upon the vast development of the means of locomotion; second, an unusual succession of bad spatting years; third, over-dredging, that is to say, the removal of so many oysters from the oyster beds that the number left is insufficient to keep up the stock.

That the first and second of these causes have had a great deal to do with the matter is beyond doubt; but, whether any harm has resulted from simple over-dredging is a question respecting which very different opinions are entertained, and I have already stated my reasons for reserving my opinion on the subject. But I shall suppose, for argument's sake, that all three influences are in operation, and proceed to ask what can be done by legislation to mitigate their evil effects.

A sumptuary law restricting the consumption of oysters, per head, is not practicable in these days; and therefore, the first cause of dearness, great demand, must be left to cure itself by the increase of price to which it gives rise.

Nor is the second cause of scarcity within reach of legislation. The seasons cannot be rendered favourable to oyster spatting by Act of Parliament.

But it is very generally believed that the enforcement of what is called a "close time" is an effectual remedy for over-dredging. Oyster "close time" means that oysters shall not be taken during the months of May, June, July, and August, which are supposed, not quite accurately, to cover the breeding season of the shell-fish.

But surely nothing is more obvious than this, that the prohibition of taking the oysters from an oyster bed during four months of the year is not the slightest security against its being stripped clean (if such a thing be possible) during the other eight months. Supposing that, in a country infested by wolves, you have a flock of sheep, keeping the wolves off during the lambing season will not afford much protection if you withdraw shepherd and dogs during the rest of the year.

These considerations are so obvious, that I cannot but think that the cry for close time for oysters must be based on a confused notion that, as close time is good for salmon, so it must be good for oysters. But there is really no analogy between the two things which here pass under the name of "close time." Close time for oysters is merely protection of oysters during the breeding season; close time for salmon is not merely protection of salmon during the breeding season, it means a practical limitation of the capture of salmon all the year round by the weekly

close time, supplemented by the license duties on rods and nets. You might protect the breeding grounds of salmon as strictly as you pleased and as long as you pleased; but, if too many of the ascending fish were captured, the stock would fall off, and if all were captured, it would come to an end.

If the protection afforded to an oyster bed is to be made equivalent to that given to a salmon river, measures must be taken by which the undue diminution of the stock of oysters, at any time, may be prevented. The most effectual way of doing this is to form an estimate of the number of oysters on a bed before the commencement of the open season; and to permit the removal of only such a percentage as will leave a sufficient stock. And regulations of this nature have long been carried out in the Schleswig oyster fisheries and in those of France. A subsidiary regulation, tending towards the same end, is that which enforces the throwing back into the sea of all half-grown oysters. As oysters produce young before they are half-grown, this procedure must contribute to the breeding stock.

When, nearly twenty years ago, my colleagues, Sir James Caird, Mr. Shaw-Lefevre, and I, had to deal with the oyster question, I am not aware that any of us doubted the value of protection of public oyster beds in the open sea, if it could only be made efficient.

What we were quite clear about, however, was:—

(1) That the close time regulation which then existed was always useless, and sometimes mischievous.

(2) That the regulation prohibiting the taking of half-grown oysters interfered with the transfer of oysters from the public beds, where they were exposed to all sorts of dangers, to the private grounds where they were protected.

(3) That it was practically impossible to establish an efficient system of protection on our public oyster beds.

And therefore we came to the conclusion that the best course that could be adopted was to abolish all the delusive and vexatious regulations which were in force, and to see what could be done by giving such rights of property in parts of our shores favourable to oyster culture as would encourage competent persons to invest their money in that undertaking.¹

¹ "We have made diligent inquiry into the condition of the oyster fisheries, and have devoted a large section of our report to the discussion of the evidence which we have obtained. We find :—

"That the supply of oysters has very greatly fallen off during the last three or four years.

"That this decrease has not arisen from over-fishing, nor from any causes over which man has direct control, but from the very general failure of the spat or young of the oyster, which appears, during the years in question, to have been destroyed soon after it was produced. A similar failure of spat has frequently happened before, and probably will often happen again.

"That the best mode of providing against these periodical failures of the spat is to facilitate the proceedings of those individuals or companies, who may desire to acquire so much property in favourably situated portions of the sea-bottom, as may suffice to enable them safely to invest capital in preparing and preserving these portions of the sea-bottom for oyster culture. By which term 'oyster culture' is implied, not the artificial breeding of oysters in the manner in which salmon are bred artificially, but the collection of the brood in years when that brood is plentiful, and its preservation by the application of due skill and care as a source of supply during the years when the spat fails—a process in vogue among British fishermen from time immemorial.

"That no regulations or restrictions upon oyster fishing, beyond such as may be needed for the object just defined, have had or are likely to have any beneficial effect upon the supply of the oysters."—*Report of the Commissioners appointed to inquire into the Sea Fisheries of the United Kingdom, 1866.*

Our recommendations were carried out. But as the complaints about the scarcity of oysters went on increasing, the matter was re-investigated by a Committee of the House of Commons in 1876. This Committee published two reports, a valuable minority report by Mr. Shaw-Lefevre, and a singular majority report drawn up by the chairman.

The latter states that the Committee have "come to the conclusion that the supply of oysters round the British coasts has for some years steadily decreased, and that though, to some extent, cold seasons have contributed to cause this diminution, the principal cause is to be found in the continual and constantly increasing practice of over-dredging for them in open waters, without allowing sufficient close time. Your Committee have also obtained evidence from France, in which country regulations for close seasons, for some years, have been more or less rigidly insisted on ; and it appears to them that, in proportion to the stringency with which these regulations have been enforced, the supply of oysters has increased.

"Your Committee have therefore come to the conclusion that it is desirable to make provision for a general close time for oyster fisheries, and that it should extend from the 1st of May to the 1st of September in each year."

In consequence of this recommendation we have got back the old close time, which, as I hope I have already sufficiently proved, is of not the slightest value for the purpose which the Committee intend it to serve.

It will be observed that the Committee attach much weight to the evidence received from France. It is undoubtedly very weighty ; but I think that if the Committee had given it the attention which it deserves, they would have seen that it tells dead against their recommendation.

In the first place, the Committee do not seem to have noticed that the French regulations involve, not merely a breeding season close time, such as they recommend, but that they restrict the fishing during the open season to a few days, or stop it altogether, at the discretion of the administration. The difference of the two systems is that the French regulations are adequate for the purpose of preventing over-dredging, while the English regulations are not ; and that is a somewhat essential difference.

But there is another point of still greater importance, which is, that a careful study of the French statistics, and of the very excellent reports on the various French oyster fisheries, made to the Committee by Mr. Hall, leaves it very doubtful whether the French system of protection, stringent as it is, has had any appreciable effect on the fisheries.

Let us take the case of the famous oyster fishery of Cancale. Mr. Hall says, in a noteworthy passage of his Report, which, one would think, the majority of the Committee can hardly have considered with due care :—

“The oyster beds of Cancale and Granville extend over that part of the bay of Mont St. Michel which lies beyond extreme low-water mark, and as far out as the Iles Chaussey ; they also stretch for six or eight miles along the coast north of Granville. They are remarkable as presenting instances of beds existing under identical natural conditions, subjected to identical regulations, and offering results of a very varied kind. *They are also interesting as being beds which, notwithstanding the enforcement of preservative regulations for a considerable number of years, have become, on the whole, unproductive.*

“There appears to have been no time since 1853, when the observance of the close season, a limitation of

the fishing during the other months in greater or less degree, and the prohibition of the removal of undersized oysters, except to the *étalages*, or storing beds of the neighbourhood, have not been enforced at Cancale.”¹

The bay is marked out into a series of beds, named from west to east, Bas de l'Eau, Corbières, Vivier-ô-le Mont La Raie, St. George, Beauvais-ô-le Mont; while, beyond the last, is a large area left as a reserve and not allowed to be fished.

From 1862 to 1866, inclusively, hardly any spat was observed in the bay. In 1866, the northern part of the Raie bank, which had already shown some signs of increase in 1865, produced a considerable spat. In 1867, it was fished and yielded 1,007,000 oysters. But, in the following years, so large a number of dogwhelks showed themselves upon it, that it was thought better to fish the bed than to let the oysters be fruitlessly destroyed. The dogwhelks were cleared away and the bank, which though much thinned, still held oysters, was left to rest in 1870. In 1871, however, all the oysters had disappeared, while cockles had taken their place, and remained up to the time of the report.

In 1871, the southern half of the Raie bank, which had produced no oysters since 1862, showed so many, that in 1871-72 it yielded a crop of 2,070,000; and from that time, though fished in alternate years, it became the richest bed in the bay, and in 1876 showed a large quantity of brood over its whole extent. While the southern half of La Raie thus became productive, St. George, which adjoins it, and from which it probably derived the colony which peopled it in 1869, became sterile, without any

¹ *Report of the Select Committee on Oyster Fisheries*, 7th July, 1876, Appendix, pp. 260 and 261.

apparent cause. That it had not been over-fished was evident from the fact that a large number of oysters still existed upon it. No spat, however, had been seen on St. George since 1874.

On the other side of La Raie, the southern half of Vivier-ô-le Mont, which touches the southern part of the former, and on which no fall of spat had taken place since 1862, showed a fair quantity in 1872, before the newly imported oysters in La Raie had had time to spread themselves over it, and up to 1876 it was fairly productive. On that part of Beauvais-ô-le Mont which was productive in 1876, more or less production has always taken place.

No spat has ever been observed on the reserve ground, and in 1876 it was tenanted by only a few old oysters. Culch has always been abundant, and cleaning by trawling has been permitted since 1867.

It will be observed that under the same conditions, and subject to restrictions of a stringency which no one has dreamed of in the public oyster beds of this country—a fertile area (La Raie, N.) has become barren, and a barren area (La Raie, S.) has become fertile; while the others (Viviers and Beauvais), after undergoing great impoverishment, are rather more productive at the end than at the commencement of the period of fifteen years. And, all this time, the oysters have perversely refused to settle upon the ground kindly reserved for their reception by the administration.

TABULAR VIEW OF THE OYSTER FISHERY IN THE BAY OF CANCALE,
BETWEEN 1860 AND 1875.

The numbers in brackets represent the number of tides during which fishing was permitted. In 1873-4 the fishings of Corbières, Viviers, and La Raie (s), and in 1874-5 those of Bas de L'eau, Corbières, and Viviers, and those of St. George and Beauvais, are not given separately.

	BAS DE L'EAU. (s.w.)	CORBIÈRES	VIVIERS.	LA RAIE. (s.)	LA RAIE. (N.)	ST. GEORGE.	BEAUVAIS. (N.E.)
1860-61 ..		1,945,260 (6)	....	....	....	....	....
1861-62 ..	6,200,600 (3)	2,800,400 (2)	3,460,600 (3)	....	....	....	1,220,000, (4)
1862-63 ..	1,020,000 (3)	....	109,300 (1)	....	539,150 (2)	643,300 (2)	111,500 (3)
1863-64 ..		840,000 (3)	1,504,000 (4)	0	....	....	390,000 (3)
1864-65 ..				0	108,000 (1)	109,000 (2)	658,000 (3)
1865-66 ..	200,000 (2)	155,000 (1)	176,000 (2)	0	Spat.	....	....
1866-67 ..			667,000 (2)	0	Dogwhelks { 1,007,000 (2)	....	....
1867-68 ..				0	860,000 (3)	411,000 (2)	....
1868-69 ..		188,000 (1)	215,000 (2)	0	370,000 (1)	220,000 (1)	340,000 (2)
1869-70 ..				Spat.	0	....	1,642,000 (2)
1870-71 ..					Cockles.	1,650,000 (4)	....
1871-72 ..			Spat.	2,070,000 (2)	"	780,000 (1)	1,038,000 (2)
1872-73 ..			3,560,000 (3)	....	"	2,140,000 (2)	1,600,000 (4)
1873-74 ..		5,070,000 (3)		No Spat { 2,140,000 (2) 4,272,000 (4)			
1874-75 ..							

The history of the oyster fisheries of Arcachon is not less instructive.

The Bay of Arcachon may be almost said to be made for oysters. It has the shape of an equilateral triangle nine or ten miles on the side; and it debouches by a channel, thirty fathoms deep at the mouth, situated at its northermost angle, into the Bay of Biscay. The winds and waves of this stormy region have thrown up a range of high sand dunes along the western boundary, and these dunes, covered with pines, shelter the bay from the violence of the westerly gales. The difference of height between high and low water (ordinary tides) is fifteen to sixteen feet. At flood tide the whole surface of the bay, except an island in the middle (Ile des Oiseaux) is covered, but at ebb tide the greater part is dry, except in so far as it is traversed by narrow channels, varying from forty to ten feet in depth, formed by the water as it retires into the deep outer passage at the ebb, and returns at the flood.

The interspaces between the channels thus laid bare at each ebb are called "cressats." The bottom is composed of sand and shells, with more or less mud. The quantity of the latter constituent is said to be gradually increasing, and in many parts old oyster beds are silted up and covered with mud. The salinity varies, being least in the northern angle, where much fresh water flows in. Elsewhere the saline constituents amount to 3 per cent or more, and in hot and dry seasons they may exceed those of the Atlantic water outside.

M. Tolle says, in his report to the German Government on the oyster fisheries of France:—

"The cressats are the old oyster beds of Arcachon, once thought to be inexhaustible, which yearly yielded

seventy to seventy-five million oysters of different kinds and sizes, of the value of 225,000 francs. But in course of time, especially between 1830 and 1840, the demand becoming greater and oysters scarce, they were so exhaustively fished that in the year 1840 the produce was only 1000 francs.”—*Bericht*, p. 9.

According to this, the produce of the beds before 1830 was 75,000,000 yearly, while in 1840 it had sunk to 330,000, or thereabouts, that is less than $\frac{1}{200}$ th of the previous yield.

“It was only after this almost complete exhaustion of the beds that the Government took means to prevent their further destruction. The Prefect of the Arrondissement sent a vessel to watch the beds, and enforce the strict observance of the law. But too late. The attempts of private persons to repopulate the beds also failed. This condition lasted till 1859.”

In 1860, however, at M. Coste's suggestion, two parcs, on the *Crastorbe* and *Grand Cés* cressats (north of the Ile des Oiseaux) were established by the Government, and in the following year numerous concessions were made to private individuals. These were stocked with oysters, so that, between 1859 and 1861, 15,000,000 of oysters were laid down in the parcs.

Such is the account given by Tolle and Möbius. But I am wholly unable to reconcile the assertion that the natural beds had failed before 1860 with the statistics given by Mr. Hall in his already cited report. Mr. Hall states that, in the year 1860-61, no fewer than 19,900,000 oysters were fished on the natural beds. Hence it follows that in 1859-60 there must have been at least 19,900,000 half-grown oysters, and in 1858-59 at least the same number of one-year oysters, and therefore that there must have

been a fall of spat sufficient to produce these in the preceding season. And, in fact, Mr. Hall states that in 1857-8 there was an "abundant" spat, and that the weather during the spatting months was "fine." Mr. Hall further observes that, until 1860-61, "no register was kept of the produce of the natural banks," so that nothing is accurately known of the yield of the beds in 1857-58, or the subsequent years up to 1860-61.

Now it is to be observed that in these years, as in those which preceded them, fishing was "permitted without restriction from the first of November to the first of April," the only condition being that oysters less than five centimetres (about two inches) across must not be taken; and it was only in 1860-61 that the new restrictive regulations came into force, the fishing being limited to not more than fourteen days in the whole season, and less than three hours in each day, on the average.

And what followed upon the adoption of these severe regulations? Simply that for five years the oysters on the natural beds steadily and rapidly diminished.

In 1861-2 19,000,000 were taken.

1862-3 15,097,320 ,,

1863-4 5,154,170 ,,

1864-5 2,697,460 ,,

1865-6 2,012,940 ,,

Then comes a very slight improvement:—

1866-73,266,730

1867-83,711,730

1868-93,648,230

In 1870 a large number of oysters were killed on the beds by the great heat of the summer, and no fishing was permitted.

But instead of any falling-off, the next year shows a manifest increase :—

1870-14,997,540

After this the beds were fished only in alternate years, and yielded—

1872-37,441,720

1874-5 40,360,000

The outcome of all this is that, under one continuous system of extreme restrictive regulation, the returns show :

1st. For five years (1861-66) a rapid decrease, down to a ninth of the produce of 1860-61, which was the end of a long period of slight regulation.

2nd. For five years (1867-71) a slight and slow increase up to about one-fourth of the produce of 1860-61.

3rd. For five years (1870-75) an increase rising in the last year, 1875, to 40,360,000 (that is to say, seeing that 1874 crop was not fished, 20,000,000) ; or, practically, the same yield as that with which the fifteen-year period started.

It is certainly astonishing to have this case held up as an example of the efficiency of regulations, and especially of the enforcement of close time.

Thus, even if the open-sea oyster beds could be watched and protected as efficiently as those of the bays of Cancale and Arcachon, such protection is no guarantee against the greatest fluctuation in the produce of the beds, and the disappearance of the oysters from some of them. But who that knows anything practically of the manner in which the open-sea oyster leads are fished, can imagine that any such protection is practicable ? Is the Government to survey the oyster beds every summer, and then send a gunboat to watch every oyster bed, and limit the quantity of oysters taken ? And if it does not do so, what

is to prevent the clearing of every open-sea bed (so far as it can be cleared) during the open season? Or suppose a law to be passed prohibiting the capture of undersized oysters, is it better to leave these oysters to take their chance of becoming the prey of dogwhelks and starfish, or to remove them to safe and sheltered parcs?

I have not yet been able to obtain answers to these questions in a sense favourable to protective legislation, from any one practically conversant with the facts of the case. People rave about protection, and when you ask them how they propose to give any real protection to open-sea beds they cannot tell you.

I for my part believe that the only hope for the oyster consumer lies first in oyster culture, and secondly, in discovering a means of breeding oysters under such conditions that the spat shall be safely deposited. And I have no doubt that when those who undertake the business are provided with a proper knowledge of the conditions under which they have to work both these objects will be attained. (*d*)

VALUABLE ITEMS CONCERNING OYSTERS AND FISH.

The following interesting and instructive facts, from *Land and Water*, November, 22, 1890, need no apology for their insertion:—

PREMIUMS FOR FISH CURING.

The American Government, to stimulate scientific, improved, and economical fish-curing, inaugurated and continued a series of local fish fairs, for money prizes for

(*d*) *The English Illustrated Magazine* 1890.

the best products. These premiums were hotly contested for by the fishermen and fish-curers.

The Fishmongers' Company, from its surplus funds, should award and contribute similar prizes for our fisher-folk.

PRESERVED CHINESE OYSTERS.

The Chinese remove the oyster-shells. They plunge the separated oysters into boiling water. The oysters are then dried in the sun, and preserved till required for eating.

COOKING OYSTERS.

This Chinese process, like grilling, scalloping, or stewing, coagulates the oyster, making it less soluble and digestible, and less healthy.

POISONOUS OYSTERS.

Of course fresh oysters taken from foul or sewage contaminated waters may produce typhoid fever. All oysters, mussels, etc., taken from stagnant water, may also be poisonous.

PARASITES IN OYSTERS.

The chance of uncooked oysters possibly containing parasites, which, being eaten by man, might there develop a stage further, appears, though a possible danger, to be fortunately a rare one. The same applies to mussels, lobsters, crabs, cockles, and other fish if eaten raw. Cooking would probably kill the parasites.

The dried male organs of the sea lion are popular Chinese aphrodisiacs.

J. LAURENCE HAMILTON, M.R.C.S.

ARTIFICIAL OYSTER CULTURE.

As an item of interest in connection with the above titular subject, I think the two following Letters from *Land and Water* (dated respectively November 8th and 15th, 1890), deserve a wider circulation than that already allotted them, and have much pleasure in their insertion :

Sir,—In the course of conversation, a few days ago, with a well known oyster culturist, he told me that the great obstacle to the successful breeding of oysters artificially was the impossibility of retaining the spat in running water, which it seems is necessary to their well-being. At the early period of their lives the baby bivalves are so minute in size that they will pass through the finest sponge or muslin, and invariably escape. In still water they live for a certain time, but just when they ought to attach themselves to the culch they fog off and die. I suggested to my friend that it might be worth trying a small engine to work an air pump, and thus keep a perpetual current of air instead of water through the tank. I have reason to believe he will try the experiment, and shall be glad to learn the result. Should any one else, interested in oyster culture, experiment also in the same direction, I have no doubt the details will be most welcome to many.

“ SENEX.”

Sir,—I was greatly interested by the notes on “ Oyster Culture ” in your last issue, but there are one or two points raised in it which deserve to be thoroughly investigated before any practical work can be undertaken. I beg to thank your correspondents for the courteous nature of their remarks as to myself, but I am only a private individual, so cannot do all that I could wish single-handed. Still what I can do I will. Reference has been made to Govern-

ment aid ; this, to be of any real efficiency, would, I fear, prove too big a thorn in the side of the Exchequer. We poor commoners shall have to bear the brunt of the experiments, and probably, if successful, there will be plenty of capitalists ready to come forward and give us a cordial pat on the back, but preliminary expenses to pay the piper is quite another thing.

One of your correspondents spoke of the almost insuperable difficulty of keeping the spat in a tank. Now this seems to show a somewhat practical acquaintance with the subject. Our old friend, the late Frank Buckland, always advocated "heat and tranquillity." I quite agree with the suggestion of "Senex," to use an engine for forcing hot air into the tanks, thus obviating the need for constant circulation. I, too, have long been thinking over this, and on the small scale to which any efforts of mine must necessarily be restricted, I think there would be no insurmountable obstacle ; but how about a "Big Business ?"

I know a good deal about air in pipes and its extreme obstinacy. Regulating either air or water in pipes requires a lot of practical knowledge, which cannot be picked up without practice. There are many other matters to be seen to, such as the best form of culch to use, depth of water, and the regular supply of it, besides many other minor matters. All these may seem but trivial affairs, certainly, but they all tell on the result. C. C.

THE OPENING OF OYSTERS.

I have inserted the following Letters, for the simple reason that the instructions they contain may be of service to the uninitiated :—

To the Editor of the Standard.

Sir,—Quite agreeing with “Royal Whitstable” as to the open field for inventive genius in the matter of a safety oyster-opener, may I suggest a means of minimising the danger in the use of the present trade opener, a very dangerous weapon in the hands of inexperienced people?

Let “Royal Whitstable” take an oyster, holding it firmly in the left hand, the flange, or thin part, towards the palm, the thumb across the flat or top shell, and making a bed for the lower shell upon the doubled-up second finger, the first finger encircling the edge, he will thus secure a very firm hold. In the right hand let him take his knife, placing the thumb along the one side to within the third of an inch of the point, resting the lower side on the first finger between the first and second knuckles. An examination will show a division at the point of the bivalve, into which gently insert the point of the knife. This point is very soft, and the knife will readily enter until it is safely embedded; then work with a side-to-side motion until the muscle is divided and the top shell can be lifted off. The mollusc is then discovered lying in its own liquor. Divide it from the lower shell by cutting the muscle, just turn it over, and it is ready for table, without shell or grit.

I am, Sir, your obedient servant,

HENRY WILSON.

September 25.

To the Editor of the Standard.

Sir,—I live some little distance from town, also two miles from the nearest fishmonger's, and have frequently experienced the same difficulty in opening oysters as your correspondent, “Whitstable Royal.”

One day, thinking over the matter, I decided upon trying to open the oyster from the opposite side of the shell, and I found that, by placing the flat part of the oyster downwards, I could readily insert the point of an ordinary oyster knife between the hinge, and thus open it with the greatest ease.

I likewise found no difficulty in instructing my cook to open them in the same manner.

I am, Sir, your obedient servant,

E. A. V.

September 24.

CHEMICAL ANALYSIS OF SEA-WATER.

Although I have given several analytical computations of sea-water, I regret that the following Tables were not at my command for earlier insertion, in order to form an appropriate comparison with those already presented to the reader.

It is also a matter of sincere regret to me that Professor Issel's (*a*) valuable and interesting volume on oyster culture (from which these Tables are taken) did not reach me until almost the final sheets of this book were going to press, else I would have been only too pleased to have made quotations from a practical work which only needs a translator to prove its instructive merit. The paginal excess of my book, however, has precluded the pleasure of quoting thence, which I will certainly avail myself of in a

(*a*) Istruzioni Pratiche per L'Ostricoltura e La Mitilicoltura, dettate da Arturo Issel, per commissione del Ministero D'Agricoltura, Industria e Commercio. (Genova, Tipografia del R. I. Sordo-Muti, 1882.)

second edition, should I be fortunate enough to find such favour with the general public. It is, therefore, on the plea of "Better late than never," that I extract the following as a slight token of esteem for the author, and from a strong desire to introduce him to my readers.

CHEMICAL ANALYSES OF WATER TAKEN FROM THE MEDITERRANEAN SEA.

PARTI D'ACQUA 1000 contengono,	F ^{ra} BARCELLONA e la CORSICA	F ^{ra} la SARDEGNA e NAPOLI.	A MALTA.	1000 PARTI D'ACQUA contengono.	Sulla COSTA DI SPALATO.	Nel PORTO DI LIVORNO.	Nella LAGUNA DI VENEZIA.
Cloruro di sodio ..	29,987	30,292	30,160	Cloruro di sodio ..	25,501	26,191	22,346
Cloruro di potassio ..	0,677	0,779	0,274	Cloruro di potassio ..	0,378	1,111	0,833
Cloruro di magnesio ..	3,661	3,240	2,943	Cloruro di calcio ..	3,354	..	..
Solfato di calcio ..	1,529	1,605	1,541	Cloruro di magnesio..	5,618	3,026	2,591
Solfato di magnesio..	2,361	2,638	2,279	Bromuro di sodio ..	0,495	..	..
Acido silicico, acido fosfo- rico calce e residuo	0,075	0,080	0,080	Solfato di calcio ..	4,462	0,894	0,602
				Solfato di magnesio..	..	3,090	2,750
				Carbonato di calcio ..	..	..	..
				Silice	0,325	..	..
				Allumina e ossido di ferro ..	0,110	..	..
				Ammoniaca ..	0,237	..	..
				Sostanze organiche ..	0,014	..	..
					0,066	..	..

COMPLETE LIST OF THE SPECIES AND VARIETIES
OF OYSTERS.

The following list is obtained from numerous sources, and for its completeness I am gratefully indebted to Mr. G. B. Sowerby, whose name, in all that relates to Conchology, is a sufficient guarantee for its accuracy. In truth, I may add that but for Mr. Sowerby's kind and valuable assistance, I could not have rendered it so thoroughly complete and up to date as it is.

TYPE. MOLLUSCA.

CLASS. LAMELLIBRANCHIATA.

ORDER. ASIPHONIA.

FAMILY. OSTREIDÆ. GENUS. OSTREA.

SPECIES.	AUTHOR.	HABITAT.
<i>Ostrea Adriatica</i>	Lamarck	Adriatic, Black Sea.
— <i>affinis</i>	Sowerby	Diego Garcia.
— <i>Algaensis</i>	Sowerby	S. Africa, Port Elizabeth.
— <i>angulata</i>	Lamarck	Tagus.
— <i>Angasi</i>	Sowerby	Australia.
— <i>æquatorialis</i>	D'Orbigny	Ecuador & Guayaquil.
— <i>attenuata</i>	Sowerby	
— <i>auriculata</i>	Sowerby	Japan.
— <i>Australis</i>	Lamarck	Australia.
<i>vel tuberculata</i>	Lamarck	Australia.
<i>Ostrea Barclayana</i>	Sowerby	Mauritius.
— <i>Belcheri</i>	Sowerby	East Indies.
— <i>Bellovacina</i>	Lamarck	Mediterranean.
<i>vel hippopus</i>	Lamarck	Philippine Islands.

<i>Ostrea bicolor</i>	Hanley	Senegal.
— <i>borealis</i>	Lamarck	North America.
<i>vel rostrata</i>	Chemnitz	
<i>Ostrea Braziliانا</i>	Lamarck	Brazil, W. Indies.
— <i>callichroa</i>	Hanley	China.
— <i>Canadensis</i>	Lamarck	N. America.
<i>vel rostrata</i>	Chemnitz	N. America.
<i>Ostrea carinata</i>	Chemnitz	N. America.
— <i>cerata</i>	Sowerby	Mauritius.
— <i>Chemnitzii</i>	Hanley	China.
— <i>Chiloensis</i>	Sowerby	Chiloe, Philippine Is. New Zealand.
— <i>circumsuta</i>	Sowerby	Fiji Islands.
— <i>cochlear</i>	Poli	Mediterranean Sea.
<i>vel Italica</i>	Deshayes	
<i>Ostrea Columbiensis</i>	Hanley	W. Columbia.
— <i>concentrica</i>	Valencienes	East Indies.
— <i>conchaphila</i>	Carpenter	Mazatlan.
— <i>cornucopia</i>	Lamarck	Indian Ocean.
— <i>crenulifera</i>	Sowerby	Red Sea.
— <i>crista-galli</i>	Chemnitz	Indian Ocean.
— <i>cristata</i>	Born	Mediterranean Sea.
— <i>crocea</i>	Dufo	
— <i>cucullata</i>	Born	Sumatra.
— <i>cucullina</i>	Deshayes	Bourbon.
— <i>cymbæformis</i>	Sowerby	Florida.
— <i>Cyrnusi</i>	Payrandeau	Corsica.
— <i>deformis</i>	Lamarck	Europe.
— <i>densilamellata</i>	Lischke	Japan.
— <i>denticulata</i>	Born	China.
— <i>dentifera</i>	Dufo	
— <i>depressa</i>	Philippi	Mediterranean.
— <i>discoidea</i>	Gould	Fiji Islands.
— <i>doridella</i>	Lamarck	West Indies.
<i>vel frons</i>	Linnæus	West Indies.
<i>Ostrea echinata</i>	Quoy	} Philippines. Amboyna.
<i>vel spinosa</i>	Deshayes	

<i>Ostrea edulis</i>	Linnæus	Europe.
— elliptica	Lamarck	New Holland.
— erucella	Lamarck	Indian Ocean.
vel frons	Linnæus	Indian Ocean.
<i>Ostrea excavata</i>	Lamarck	New Holland.
— florida	Chemnitz ..	.....
— Floridensis	Sowerby	Florida.
— foliosa	Brocchi	Mediterranean.
— folium	Linnæus & Gmelin .	Moluccas.
vel labrella	Lamarck .....	.....
<i>Ostrea frons</i>	Linnæus	West Indies.
var doridella	Lamarck	West Indies.
var erucella	Lamarck	West Indies.
<i>Ostrea fucorum</i>	Lamarck .....	.....
— fusca	Lamarck	China.
vel Sinensis	Dillwyn .....	.....
<i>Ostrea gallina</i>	Lamarck	Atlantic.
vel rhizophora	Guilding	West Indies.
<i>Ostrea gibbosa</i>	Lamarck .....	.....
— glaucina	Lamarck	Mediterranean.
— glomerata	Gould	South Sea, N. Zealand.
— Guineansis	Dunker	Guinea.
— haliotidea	Lamarck	New Holland.
— Hanleyana	Sowerby	Sandwich Islands.
— hippopus	Lamarck	Boulogne.
vel Bellovacina	Lamarck	Mediterranean Sea.
<i>Ostrea hyotis</i>	Chemnitz	Indian Ocean.
— imbricata	Lamarck	China.
— inermis	Sowerby	Corsica.
— iridescens	Gray	Central America and
vel prismatica	Gray	South Africa.
<i>Ostrea Italica</i>	Deshayes	Mediterranean Sea.
vel cochlear	Poli	Mediterranean Sea.
<i>Ostrea labrella</i>	Lamarck	East Indies.
vel folium	Linnæus	Moluccas.
<i>Ostrea lacerans</i>	Hanley	Senegal.
— lactea	Sowerby	Moluccas.
— Lamarckiana	Recluz .....	.....

<i>Ostrea lamellosa</i>	Brocchi	Mediterranean Sea.
— <i>laticorda</i>	Nuttall	
— <i>lentiginosa</i>	Sowerby	
— <i>lima</i>	Sowerby	Sandwich Islands and Mauritius.
— <i>limacella</i>	Lamarck	West Indies.
— <i>Lincolnii</i>		Australia.
— <i>lingua</i>	Lamarck	Timor.
— <i>longirostris</i>	Lamarck	Mediterranean.
— <i>lugubris</i>	Sowerby	
— <i>lurida</i>	Carpenter	Mazatlan.
— <i>margaritacea</i>	Lamarck	South America.
— <i>megodon</i>	Hanley	Peru.
<i>vel undulata</i>	Chemnitz	Peru.
<i>Ostrea Mexicana</i>	Sowerby	Mexico.
— <i>multicostata</i>	Sowerby	Japan.
— <i>multiradiata</i>	Sowerby	Indian Ocean.
— <i>multistriata</i>	Hanley	Africa, on ship's bottoms.
— <i>mordax</i>	Gould	Fiji Islands.
— <i>mytiloides</i>	Lamarck	Philippines, Zebu, Australia.
— <i>nigromarginata</i>	Sowerby	Aracan.
— <i>numisma</i>	Lamarck	Australia.
— <i>ochracea</i>	Sowerby	Mazatlan.
— <i>orbicularis</i>	Gmelin	Africa.
— <i>orientalis</i>	?	East Indies.
— <i>palmipes</i>	Sowerby	Philippines.
— <i>parasitica</i>	Gmelin	W. Indies & W. Africa.
<i>vel arborea</i>	Dillwyn	
<i>Ostrea permollis</i>	Sowerby	
— <i>pestigera</i>	Hanley	Java.
— <i>Prevosti</i>	Sowerby	Mauritius.
— <i>plicata</i>	Chemnitz	
— <i>plicatula</i>	Lamarck	Sicily, Philippine Is.
— <i>prismatica</i>	Gray	{ Central America.
<i>var gasar</i>	Adams	{ Port Elizabeth, S. Africa.
<i>Ostrea pulchella</i>	Deshayes	
— <i>puelchana</i>	D'Orbigny	Patagonia.

<i>Ostrea pyxidata</i>	Adams & Reeve ..	Philippines.
— <i>quercina</i>	Sowerby	
— <i>radix</i>	Sowerby	
— <i>radiata</i>	Lamarck	Indian Ocean.
— <i>raricosta</i>	Deshayes	
— <i>reniformis</i>	Sowerby	
— <i>retusa</i>	Pease	Sandwich Islands.
— <i>rhizophora</i>	Guilding	West Indies.
<i>vel gallina</i>	Lamarck	West Indies.
<i>Ostrea rivularis</i>	Gould	Nagasaki.
— <i>rosacea</i>	Deshayes	Senegal.
— <i>rostralis</i>	Lamarck	Lisbon.
— <i>rostrata</i>	Chemnitz	North America.
<i>var borealis</i>	Lamarck	North America.
<i>var Canadensis</i>	Lamarck	North America.
<i>Ostrea rubella</i>	Lamarck	
— * <i>rufa</i>	Lamarck	America.
— <i>ruscuriana</i>	Lamarck	Algeria.
— <i>Sandwichensis</i>	Sowerby	Sandwich Islands.
— <i>scabra</i>	Lamarck	America.
— <i>semicylindrica</i>	Say	
— <i>Senegalensis</i>	Gmelin	Senegal.
— <i>Sinensis</i>	Gmelin	China.
— <i>sinuata</i>	Lamarck	Australia.
— <i>solida</i>	Sowerby	Panama.
— <i>spathulata</i>	Lamarck	Florida.
— <i>spinosa</i>	Deshayes	Moluccas.
<i>vel echinata</i>	Quoy	Philippines.
<i>Ostrea spreta</i>	D'Orbigny	Rio Janeiro.
— <i>stellata</i>		Guinea.
— <i>stentina</i>	Payrandeau	Mediterranean.
— <i>subtrigona</i>	Sowerby	Australia & N. Zealand.
— <i>Talienwahensis</i>	Crosse	Japan.
— <i>trapezina</i>	Lamarck	New Holland.
— <i>tuberculata</i>	Lamarck	Timor.
<i>var Australis</i>	Lamarck	Australia.

* A young form of *O. denticulata*. (Deshayes.)

<i>Ostrea tubercularis</i>	Lamarck	Timor.
—— <i>tulipa</i>	Lamarck	
—— <i>turbinata</i>	Lamarck	Indian Ocean.
—— <i>uncinata</i>		Smyrna, Greece.
—— <i>undulata</i>	Chemnitz	Peru.
<i>vel megodon</i>	Hanley	Peru.
—— <i>Venetiana</i>		Venice.
—— <i>violacea</i>	Deshayes	Bourbon.
—— <i>virescens</i>	Angas	Australia, New South Wales.
—— <i>Virginica</i>	Lamarck	Virginia and Mexico.
<i>var rostrata</i>	Chemnitz	Virginia and Mexico.
<i>var crassa</i>	Chemnitz	
<i>var Virginiana</i>	Gmelin	Virginia and Mexico.
<i>Ostrea Virginiana</i>	Gmelin	Virginia and Mexico.
<i>vel Virginica</i>	Lamarck	Virginia and Mexico.
<i>vel rostrata</i>	Chemnitz	North America.
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Coralline, a submarine semi-calcareous plant, consisting of many-jointed branches, and often resembling moss.

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Dextrine (from Dexter, Lat. the right hand) the soluble matter into which the interior substance of starch globules is convertible by acids or diastase, so called because when viewed by polarized light it has the property of turning the plane of polarization to the right, 329.

Dialysis, the process of separating the crystalloid or poisonous ingredients in a substance from the colloid or harmless ingredients, 95.

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Diastase, a peculiar substance generated during the germination of grain, one part of which is potent enough to convert 2,000 of starch first into Dextrine and then into sugar, 329.

Diastole, the dilation of the heart, auricles, and ventricles; opposed to systole. or contraction, 160.

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APPENDIX.

COPY OF A FISHERMAN'S APPRENTICE'S INDENTURE.

DATED 1704.

This Indenture witnesseth that JACOB BETHEL, of his own voluntary will, and by, and with the consent of John Strong, of Pagham, in the County of Sussex, Yeoman, Uncle to the said Jacob Bethel, doth put himself Apprentice to JAMES CLARKE, of Emsworth, in the Parish of Warblington, in the County of Southampton, Fisherman. And with him, after the manner of an Apprentice, to serve, from the Feast Day of St. Michael the Archangel, last past before the Date hereof, unto the full End and Term of Seven Years from thence next ensuing, fitly to be compleat and ended. During which Term, the said Apprentice his said Master faithfully shall and will serve, his secrets keep, his lawful Commands everywhere gladly do; he shall do no damage to his said Master, nor see it to be done of others; but to his Power shall let, or forthwith give notice to his said Master of the same. The Goods of his said Master shall not waste, nor the same, without Licence of him, to any person give or lend; hurt to his said Master shall not do, cause, or procure to be done. He shall neither buy nor sell without his Master's licence. Taverns, Inns, or Ale-houses he shall not haunt. At Cards, Dice-tables, or any other unlawful Game he shall not play, whereby his Master may be damaged. With his own Goods, nor the goods of others, nor from the Service of his said Master, day or

night, absent himself, but in all things, as an honest and faithful Apprentice shall and will demean and behave himself towards his said Master and all his during the said Term. And the said Master, his said Apprentice in the Art, Mystery, or Occupation of a Fisherman, which he now useth, shall teach and instruct, or cause to be taught or instructed, the Art and Manner that he can, finding and allowing unto his said Apprentice sufficient wholesome Meat, Drink, Apparel, Washing, Lodging, and all other Necessaries fitting for such an Apprentice; and also will, at the End of the said Term, give unto his said Apprentice two Suits of Apparel as good as the said Apprentice had at the beginning of his Apprenticeship, and for the true performance of all and every the said Covenants and Agreements, either of the said Parties above said, bindeth himself unto the other firmly by these presents. In witness whereof the said Parties to these Indentures interchangeably have set their Hands and Seals the eighteenth day of October, in the third Year of our Sovereign Lady Anne—by the Grace of God—of England, Scotland, France, and Ireland, Queen, Defender of the Faith. Anno Domini, 1704.

Signed, HIS
JAMES X CLARKE.
MARKE.

Endorsed, sealed, and delivered, in the presence of
EDWD. BLACKMOR,
WILL. SOWTON.

Marginal Stamp,
One Shilling.

Jacob Bethel's Indenture,
Dated 18th October, 1704.