

XXIX.—REPORT ON THE OYSTER AND MUSSEL INDUSTRIES OF FRANCE AND ITALY.*

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A.—ARTIFICIAL OYSTER BEDS OF LAKE FUSARO.

At the inner end of the Gulf of Baia, between the beach and the ruins of the city of Cumæ, may still be seen, far inland, the remains of two ancient lakes, Lucrin and Averno, communicating in olden times through a narrow canal, one of which, Lucrin, gave access to the waves of the sea through an opening in the embankment over which passed the Herculeanum road; tranquil basins they were, which an eruption of this volcanic soil has almost completely filled up, and where, as the poets said, the sea appeared to repose. A crown of hills, covered with primeval forests casting their shadow upon the waters, had made of it an inaccessible retreat which superstition consecrated to the gods of the infernal regions, and where Virgil conducted *Ænéus*. But about the seventh century, when Agrippa had despoiled them of that gigantic vegetation, and the subterranean route was dug (the grotto of the sibyl), leading from Lake Averno to the city of Cumæ, the unveiled myth disappeared before the works of civilization. A forest of splendid villas, built and

* Extracted from "Voyage d'Exploration sur le littoral de la France et de l'Italie, par M. Coste, membre de l'Institut, professeur au Collège de France. Deuxième édition, suivie de nouveaux documents sur les pêches fluviales et marines. Publiée par ordre de S. M. l'Empereur sous les auspices de S. Exc. le Ministre de l'Agriculture, du Commerce et des travaux publics. Paris, Imprimerie Impériale, MDCCCLXI," pp. 89 to 193.

ornamented with the spoils of the world, took the place of these dark groves. Rome gave herself up to this place of delight, attracted by a soft sky and an azure sea. The warm, sulphurous, aluminous, saline, and nitrous springs which run from the top of these mountains formed the pretext for the emigration of the patricians who were driven from their homes by *ennui*.

Commerce exhausted its resources to accumulate around them all the enjoyments which their indolence sought, and among those who devoted themselves to this enterprise, Sergius Orata, a wealthy man of agreeable manners, and possessed of great credit, conceived the idea of organizing oyster beds, and of bringing this mollusk into popular favor. He had oysters brought from Brindes, and persuaded everybody that those which he raised in Lake Lucrin contracted there a flavor which rendered them better than those of AVerne, and even those of the most celebrated countries. His opinion gained ground so rapidly that, in order to meet the demand, he finally occupied all the circumference of Lake Lucrin with constructions destined to receive oysters, encroaching thus upon the public domain with so little discretion that it was necessary to bring a lawsuit to dispossess him of his usurpations. At the time this misfortune overtook him, to express the degree of perfection to which he had brought this industry, it was said of him in allusion to the suspended receptacles, of which he was also the inventor, that if he was prevented from raising oysters in Lake Lucrin *he would become wealthy by making them spring forth from the roofs*. Sergius, however, was not destined to organize oyster beds. He had created a new industry, of which the methods are still applied some miles distant from the place where he had carried it on. I hope, however, to show this further on.

Between Lake Lucrin, the ruins of Cumes and Cape Misène, there exists another salt pool about one league in circumference, from one to two meters in depth over the greater portion, and with a bottom of blackish volcanic mud. This is the Achéron of Virgil, and bears at the present time the name of Fusaro. At intervals around its entire border one sees spaces, generally circular in outline, occupied by stones brought there from away, but there is no possibility of determining when this industry was begun. These stones resemble a kind of rocks, which have been covered with oysters from Tarente in such a way as to transform each of them into an artificial bed. About forty years ago, the sulphurous emanations from the crater occupied by the waters of Fusaro became so great, that the oysters of all these artificial beds died, and to replace them it was necessary to restock the beds. Around each of these artificial mounds, which are generally 2 or 3 meters in diameter, stakes are driven rather near together, and so as to surround the space, in the center of which are the oysters. These stakes project a little above the surface of the water, so that one may easily seize them with the hands and raise them when it becomes necessary. There are other stakes, also, arranged in long series, and united by a rope from which

are suspended bunches of brushwood intended to increase the growing individuals which are awaiting collection.

In the spawning season, which is ordinarily from June to the end of September, the oysters lay their eggs; but they do not abandon them, as happens with a great number of marine animals. They protect them during incubation in the folds of the mantle, between the gills. There they remain immersed in a mucous substance, necessary to their evolution, and in the midst of which they acquire their embryonic development. The mass of eggs resembles thick cream in color and consistency; and moreover, the oysters at this time, owing to their appearance are called, *milky oysters* (*huîtres laiteuses*). But the whitish tint so characteristic of the eggs when first deposited assumes little by little, as the process of development advances, a shade of clear yellow, then of dark yellow, changing by degeneration into a brownish gray, or a very decided violet gray. The entire mass, which, at the same time, loses its fluidity, probably in consequence of the progressive reabsorption of the mucous substance enveloping the eggs, presents then the appearance of compact mud. This stage indicates that the development has reached its limit, and is a sign of the approaching expulsion of the embryos and of their independent existence; for, already, they thrive very well without the protection furnished by the maternal organs.*

The mother soon ejects the young ones hatched in her mantle. They go forth furnished with a temporary apparatus for swimming, which enables them to seek a fixed body to which they may attach themselves. This apparatus, discovered by Dr. Davaine, and described in the remarkable work which he has undertaken and executed under the auspices of M. Rayer, my associate in the Academy of Sciences, consists of a sort of ciliated cushion, provided with powerful muscles, by the aid of which the animal can at will protrude the cushion from the valves or retract it. When the young oyster has become attached, this cushion, which is henceforth useless, is lost, or, as is more usual, atrophies in position and disappears by degrees.

* It would be interesting, especially in a commercial point of view, to know whether embryos which have arrived at this stage of development, and which have been placed in a pond, or recess of the sea previously prepared, would survive this premature and forced hatching, attach themselves, and continue to grow. An experiment, incomplete it is true, but which I propose to enlarge upon, would seem to show that their organization is sufficiently perfect to permit them to be born prematurely, and, if I may be allowed the expression, outside of the medium in which their evolution is accomplished. Thus, young oysters extracted from the mantle of the mother, and placed in a little vessel filled with sea-water, still preserved all their activity at the end of the fourth day; 24 hours later some were motionless; the sixth day all were dead. In fact, the water of the vessel had not been renewed, and had acquired too great a percentage of salt, and too high a temperature, which very probably hastened their death. I am led to believe that under other circumstances, care being taken to change the liquid of the vessel every day, this experiment would give results which one would be able, perhaps, to apply to the industry.

The number of young thus thrown out from the mantle of a single oyster at each spawning is not less than from 1,000,000 to 2,000,000; so that at the time when all the adult individuals composing a bed set free their offspring, this living mass escapes like a thick cloud, which moves from the center whence it emanates, and which the movements of the water disperse, leaving upon the parent stock but an insignificant portion of that which it has produced. All the remainder wander, and if these animalcules, which wander here and there by myriads at the mercy of the waves, do not meet solid bodies where they can fix themselves, their loss is certain; for those that do not become the prey of lower animals which subsist upon *Infusoria*, end by falling into a place unsuited to their subsequent development, and often by being engulfed in the mud.

One could, therefore, render the industry a great service by furnishing a means of preventing these immense losses, and of securing nearly all the crop. The methods of Lake Fusaro, if we knew how to extend their application, would present this advantage. The stakes and fagots by which the artificial beds are surrounded are precisely for the purpose of preventing the escape of this spreading mass, and of presenting surfaces where they can fix themselves, like a swarm of bees to the shrubs which they encounter on going out from their hives. They attach themselves there, and grow so rapidly that at the end of two or three years each of the original living corpuscles becomes edible.

The facts which the fishermen in charge of the operations at Lake Fusaro brought to my notice confirm what I advance here. The propagating stakes, which have stood around the artificial beds for about thirty years, were drawn out before me covered with oysters which one could assign, notwithstanding the numerous variations of size, to three distinct periods. The largest, resulting from the first spawn which became attached to these stakes, were from 6 to 9 centimeters in diameter, and were, for the most part, marketable; those of the middle size, ranging in diameter from 4 to 5 centimeters, were only sixteen or eighteen months old, and were the products of a second season; some of the smallest were of the size of a 2-franc piece, others that of a 50-centimes piece; the remainder, finally, were of the size of a large lentil, that is to say, from 6 to 8 millimeters in diameter. The age of the first, according to the testimony of the fishermen, was about six months; that of the second, three; while that of the last could not have been more than a month or forty days. Their growth would appear rapid enough if we would consider that at the time of their expulsion they were but the fifth of a millimeter in diameter.*

When the collecting season arrives they withdraw the stakes and the

*According to M. Dureau de la Malle (*Acad. des Sci.*, 19 avril 1852), the young oysters placed in beds established at Cancale grow very rapidly. In a year and a half they reach the size of 9 centimeters, while upon the bank of Diélette they would require five years to attain that size.

fagots, from which all the oysters considered marketable are taken successively, and after having picked the fruits of these artificial clusters, the apparatus is replaced, to remain until a new generation has arrived at maturity. At other times, without touching the stakes, they simply detach the oysters by means of a hook with many prongs. The source from which these generations are derived therefore remains permanent, perpetuating and renewing itself constantly by the annual addition of a small minority which never desert their place of birth.

The products of the collecting, heaped up in wicker baskets of a spherical form and with large meshes, are provisionally deposited, while awaiting sale, in a reserve or park established in the same lake by the side of the royal pavilion, and constructed of piles, which support a platform of open work furnished with hooks to which the baskets are suspended.

I said at the commencement of this work that the industry of Lake Fusaro was known to the ancients, and that probably Sergius Orata was the inventor; there are two historical monuments which prove that it began, probably, in the time of Augustus, or, as Pliny says, at the time of the orator Crassus, before the war of the Marses. These monuments consist of two funereal vases of glass, discovered, the one in Pouille, the other in the environs of Rome. They have the shape of antique bottles, with large bodies and long necks, and are covered on the outside with designs in perspective, in which, notwithstanding their crude representation, we recognize fish ponds adjoining edifices, and communicating with the sea by arcades. However, if we should entertain doubts of their purpose and meaning, the inscription which accompanies them would fully explain their character. We read upon the vase from Apulia, illustrated by Sestina: *STAGNUM PALATIUM (a name sometimes given to a villa upon the banks of Lake Lucrin, owned by Nero), and lower down: OSTREARIA. The other vase, which is preserved in the Borgia Museum at Rome (at the present time that of the Propaganda), and of which M. G. B. de Rossi has given an excellent interpretation,† bears the following words, written under the objects designed: STAGNUM NERONIS, OSTREARIA, STAGNUM, SYLVA, BAIA, which plainly shows that the figures have been drawn from edifices, and from places of the famous shore of Baia and Pozzuolo.

What is most striking in the view of the fish-ponds represented upon these funereal vases is the disposition of the stakes crossing one another in divers directions, and arranged in circles, stakes which were evidently there only to receive and protect the progeny of the oysters.

The industry of Lake Fusaro is simply a practice invented by the ancient Romans, and continued by their descendants, and which for Sergius Orata, *luxuriorum magister*, as Cicero ‡ called him, was the source

* *Illustrazioni di un vaso antico di vetro trovate presso Popolaria, Firenze, 1812.*

† *Topografia delle Spiagge di Baia, graffita sopra due vasi di vetro.* *Bullet. Arch. napoletano, nova serie, anno primo, Napoli, 1853, p. 133, tab. ix.*

‡ *De fin.*, l. ii.

of immense profit; for, according to the statement of Pliny, it was not only for pleasure, but for love of gain that he pursued this business: *Ostrearium vivarium primus omnium Sergius Orata invenit in Bajano, ætate L. Crassi oratorio, ante Marsicum bellum: nec gulæ causa, sed avaritiæ, magna vectigalia tali ex ingenio sus percipiens.**

This curious industry, all the details of which I have been able to study with care, thanks to the obliging co-operation of M. Bonnuci, inspector-general of the royal monuments, who kindly accompanied me during my exploration of the gulf, gives to the civil list, despite its restricted application, a revenue of 32,000 francs; but it would be still more lucrative if, from the disinterested hands of the prince, the proprietorship of the lake should pass into those of speculators. Introduced into the salt ponds of our sea-coast, the trade of Lake Fusaro would then be a real source of wealth to our population. Extended, with modification, to the cultivation of the natural banks which exist in the sea, it would assume the proportions of an enterprise of general utility. I will explain how this may be done.*

In comparing the methods of Lake Fusaro with the methods of cultivating the natural sea banks, it is not difficult to perceive that if the mode of treating the latter is not abolished the source of production will certainly soon be exhausted. Speculation, in fact, without taking any care of new generations, which it would, however, be so lucrative to retain and preserve, only occupies itself in perfecting instruments to be used in securing oysters for the market from the artificial beds where they lodge. This class only exerts itself, therefore, to render the means of destruction more efficacious; for these beds are precisely those where the young ones which, in their infancy, did not abandon their place of birth, increase. Or, since it attacks with equal power of destruction the old and the young, it follows that any bed is surely destined to be destroyed by the hands of the very person who cultivates it. Yet we would be able to produce more abundant crops without ever touching the stock which originates them, or, in other words, that which now forms the sole resource of the industry.

In order to attain so important a result it will be sufficient, in introducing the processes employed with such success in Lake Fusaro, to simply modify them in accordance with the demands of the place where it is desired to operate. We should have the frame-work weighted by stones put in at its base, formed of numerous pieces, covered with stakes solidly attached, secured with props, &c.; then, at the spawning season, this apparatus should be lowered to the bottom of the sea, either above the oyster beds or around them. There they should remain until the young were produced and had covered the different pieces of the frame-work; ropes, indicated at the surface of the water by a buoy, would permit of their being drawn up when it is considered desirable.

These movable beds, so to speak, could be transported to localities

* *Hist. nat.*, l. ix, c. liv.

where experience has shown that oysters grow rapidly, and acquire an agreeable flavor, or they might be carried to some small lagoon, where they would always be easy of access, as in a laboratory.

Already M. Carbonel, struck with the depression of the industry, has endeavored to call the attention of the government to the necessity of creating new beds upon our sea-coast. This useful project certainly deserves to be taken into consideration, but the question of the permanency of this restocking can only be definitely determined by the adoption of a mode of operation analogous to that which has been practiced from time immemorial in the Gulf of Naples, and by making the salt ponds, such as the basin of Arcachon and the lagoons of the Mediterranean, contribute to the production.

But this useful undertaking can only be accomplished by a careful initiative on the part of the government. Upon the government alone devolves the duty of awakening attention to the preservation and development of this source of food; for the domain of the seas is common property.

It is well that the administration of the French marine seems to understand the question, since it takes such great care to prohibit the working of the natural beds during the spawning season, and to compel the fishermen to throw into the sea the young oysters which have not reached the lawful size—a measure full of wisdom, which has already produced the happiest results; but it should not limit itself to this intervention. It is necessary that the hydraulic engineers should prepare a topographic chart of the bottoms to be protected from invasion, and that the vessels laden with the edible mollusk, which it is so desirable to multiply, should distribute the seed on these appropriate grounds.

However, before beginning this work we would have to exterminate the mussels, the presence of which is, perhaps, a difficult obstacle to surmount.

Thus the oysters from the ocean will, when we have chosen beds suitable for them, be transported by degrees from the fresh waters into the waters of the Mediterranean, and from the Mediterranean into salt ponds which line the shores. The administration of the marine has in its hands all the instruments necessary to undertake this great work, and to accomplish it without hinderance, to the advantage of a grateful population. I do not, therefore, hesitate to advise it to enter heartily into this scheme, and I know that in giving this advice I point out an object which is in the minds of intelligent men charged with this part of the service.* It is only to be regretted that the maritime guards appointed by the administration are not numerous enough, nor sufficiently paid, so that one may count upon their efficient watchfulness.

* Since the publication of the first edition of this work, artificial oyster beds have been created, according to my proposition, in the bay of Saint Brieuc, through the efforts of the administration of the marine. (See, in the appendix, two reports on this subject addressed to the Emperor.)

This is a question to which I beg to call the favorable attention of M. the minister of the marine. His active solicitude for the interest of these modest workers, and his desire to utilize their zeal, will inspire him with the thought of bettering their condition.

A question of some importance naturally suggests itself here: it is that of ascertaining whether the process actually in use for breeding fish in fresh water can be applied to oyster culture; in other words, are oysters susceptible of being propagated by artificial fecundation? M. de Quatrefages thought so, and he advises the industry to have recourse to this process, which he has not experimented upon, but which he believes would be efficient from the anatomical researches which he has made upon the structure of the generative organs of these mollusks. I quote *verbatim* the note which this naturalist has published upon this subject, in order that all the elements of the question with which I am occupied may be brought together before the mind of the reader.

"It is generally admitted," said he, "that in oysters the sexes are united. Observations which I made some years ago led me to accept a contrary opinion. More recent researches, due to M. Blanchard, have confirmed these first results, and I believe that we should consider these mollusks as having the sexes distinct. Experience has taught me that, among mollusks which present this condition, artificial fecundation readily succeeds. Thenceforth we would be able to apply this process to the raising of oysters as well as to the raising of fish. Even in cases where the sexes might be united, I believe that the process would be perhaps a little more difficult, though equally applicable, and I am convinced that the industry would find here, in this application of physiology, a new source of profit.

"Several of the oyster banks upon the cultivation of which the fishing population of Mancha depends for its livelihood are so poor that it is necessary to abandon them. Left to themselves, the restocking is always very slow; in a short time a bank is so completely exhausted as to entirely disappear, when, as soon as we know localities favorable to the development of oysters, it would be easy, by resorting to artificial fecundation, to obtain a prompt restocking, for certain facts which I have had the opportunity of observing have taught me that oysters, once fixed, grow rapidly.

"To stock an exhausted bank with oysters it would be necessary to convey the fertilized eggs to the very bottom, in order to avoid the losses which the currents and waves would inevitably cause. To this end, I believe we ought to carry on fecundation in vessels containing a sufficient quantity of water, and then, with the aid of pumps, the pipes of which should be sunk to a sufficient depth, spread the eggs over all the places which were formerly richest. We understand, however, that although artificial fecundation permits of the restocking of these oyster fields at will, it would be useless to plant an entire bank more than a league in length.

"Independently of these natural banks which we would be able to support and cultivate, I believe that the raising of oysters, in ponds and artificial reservoirs, would become easy by means of artificial fecundation. Experiments and researches are here necessary, however, to indicate the best processes to pursue; I will simply recall the fact here, and prove by the document, that oysters do not appear to dread a certain quantity of fresh water. Thus we find these mollusks in considerable quantities in Reance, for instance, at such a distance up that, at dead low tide, they are bathed by nearly pure, fresh water."*

Such are the opinions advanced by M. Quatrefages.

The most careful researches undertaken upon the reproduction of oysters indicate that in all individuals, without exception, the spermatozoa and eggs are met with in the same organ, and develop there together. The cells in which the former are developed are the first to arrive at maturity, and the elements destined to effect fecundation break from their inclosures when the eggs, which they are to fertilize, begin to appear. These mollusks are, therefore, hermaphrodites, since they unite in one and the same organ the attributes of both the male and the female sexes; this is henceforth an incontestable fact.

If oysters are hermaphroditic, fecundation must take place within the body of the animal, that is to say, either in the ovary, which is the more probable way, or in the canals [oviducts] which conduct the eggs from the ovary into the folds of the mantle, where they are to develop. Experience proves, in fact, that it is thus accomplished. When the eggs have arrived at the place of incubation, they present all the indications of development which imply a previous fecundation. Impregnation is then an internal phenomenon accomplished before the spawning, I might say even before the eggs are detached from the ovary.

To prove it, it is sufficient to remember that in the oyster the testicle and the ovary are one and the same organ; that in this organ the fecundating elements arrive at maturity and disappear long before the ovules break from the ovarian capsules which inclose them. But, if these fertilizing molecules disappear before the extrusion of the eggs, their action upon the latter must have been anterior to that extrusion; it is therefore while the eggs are still in the tissue of the ovary that impregnation is accomplished. They remain buried in the tissue of that organ a long time after this influence is exercised, and grow there considerably, only disengaging themselves when they have attained a sufficient size to break the walls of the capsules, which they distend.

Ovarian fecundation so long before the time of the extrusion of the fertilized eggs is a fact that ought not to surprise us. We find striking examples of it among birds in general, and among the gallinaceous species in particular. All physiologists know at the present day that even one copulation fecundates 5, 6, or 7 eggs at a time in the ovary of a hen; that among the eggs fertilized at the same time there are some which have

* *Comptes-rendus de l'Académie des Sciences*, Reance du 26 février 1849.

not yet attained one-fifth the size necessary for them to break their capsule and pass into the oviduct; and that they require fifteen days to attain this size, without this *latent fecundation* showing itself by any appreciable sign.

Under parallel circumstances artificial fecundation, such as is practiced among fish, would be impossible; for, to procure eggs, it would be necessary to forcibly extract them from the midst of the torn ovary, and thus remove them from their normal condition. With oysters, the impossibility is still more evident; the eggs and spermatozoa, originating in the tissues of the same organ, could not be extracted and separated from each other in such a manner as to permit of their being afterward united in one vessel. Besides, even in case this operation should prove successful, it would be necessary to place the artificially-fertilized eggs in a suitable medium; and where could this medium be found except within the mantle of the female?

Thus, in whichever way we consider the question, we must arrive at the conclusion that with oysters the natural processes are the only practicable ones and the only ones we ought to advise for this industry. We shall come to see, in treating of the breeding of oysters at Marenne, what advantage the culturists of that locality would be able to derive from the employment of the processes applied in Lake Fusaro.

B.—GREEN OYSTERS OF MARENNE.

The reservoirs in which the culturists of Marenne deposit oysters in order to give them a green color bear the name of *claires*. They are like so many inundated fields distributed here and there upon the shores of the Bay of Soudre, and spread over several leagues of space, forming an immense domain. Here there is carried on a curious and lucrative trade, the development of which is favored by the State by concessions made to enrolled seamen who wish to devote themselves to this kind of business.

These *claires* differ from the fish ponds and ordinary parks in that they are not submerged at each tide like the latter, but only at the periods of the high tides, which occur with the new and full moon, when the waves reach higher upon the land than at other times; too frequent submersion would be an obstacle to the end proposed. They are, consequently, not established on the immediate borders of the sea-shore, as certain authors have erroneously supposed.

Those which are most favorably situated receive water two or three days before and after the high tides; but that depends upon their relative distance from the shore. In this way the water they contain is never entirely renewed, or, if there is a complete renewal, it takes place only at considerable intervals of time. These intervals cannot, however, exceed the period intervening between the epochs of the spring-tides without serious inconvenience to the industry; for experience

proves that a *claire* which is only renewed on the eve of the day, or the following day, of these dry periods has less value than one which is inundated by the sea for a longer time; but both are endowed, though in different degrees, with the power of improvement and of viridity.

The *claires* have no regularity of plan, nor uniformity in dimensions. Their size varies, however, on the average, from 250 to 300 square meters. They are surrounded by a bank of earth called *chantier*, about a meter in height and thickness, forming a dike where the *amareilleurs* walk about to keep watch or perform the duties pertaining to cultivation; a dike which offers sufficient solidity to resist the pressure of the water when these pools are filled. A flood-gate fitted to an opening in the wall of this dike permits the regulation at will of the flow and ebb of the sea-water, keeping it at the interval of the great tides at a suitable height to accommodate the business, and allowing it to flow off entirely when they wish to empty the reservoir, to cleanse it, and to place the oysters there to become green.

In a well-arranged *claire* is placed, also, at the bottom of the dike and around its inner circumference a ditch intended to receive the slime thrown by the waves on the central plateau which this ditch surrounds, thus preserving the young from this injurious substance. In order to facilitate the end proposed, the plateau itself is slightly inclined from the center to the extremity, so that by means of this inclination hurtful matter may be carried off; but this arrangement is not absolutely necessary, and is frequently dispensed with.

When everything is arranged, they profit by the first high tide to fill the reservoir, in which, when the waves recede, the flood-gate retains the water. The prolonged stay of these waters in this species of hydraulic apparatus fills the earth with a deposit of salt, which gives it qualities analogous to those of the sea bottom, and purges it from all hurtful products which it may have contained before submersion; then, when they think it necessary that these bottoms should be examined, they empty the clear pools, in order, according to the saying of the *amareilleurs*, to prepare the bottom (*parer le sol*).

This preparation, which can be made at all periods of the year, takes place usually in March, April, and June. It consists in drying out the *claire*, in order to level it like a garden walk or a thrashing-floor; all foreign substances, whether dead plants or growing, are carried off with the greatest care, so that upon this surface, hardened by the rays of the sun, there may be no obstacle to the free development and the acclimatization of the edible mollusk which is proposed for cultivation.

In about two or three months the soil is prepared, that is to say, it has taken the consistency necessary for the oysters to be buried therein. It is advisable then, in attempting to stock the surface, to follow the rules established by old experience; rules which are susceptible of considerable improvement, the introduction of which would greatly improve the quality of the oyster, and at the same time lower its price. Let us

see from what source they now procure the shell-fish which are imbedded in these fields of cultivation; we shall afterwards tell how they proceed in the arrangement.

About the month of September in each year, when the spawning season is passed, and the opening of the fishery gives to each one the right to obtain his supply of oysters from the public beds, all the population of Marennes meet there; men, women, and children rival each other in activity to take part in the harvesting. At low tide they are seen running towards the beds which they discover, detaching from them the oysters which the laws permit them to extract, placing them afterwards in store in the spacious live ponds, where they are preserved until the time of sale, or until that of their distribution in the *claires*. At high tide, the deep beds are incessantly raked by the sailing-vessels, which detach from them the oysters by means of a dredge, a kind of iron rake, furnished with a net which collects all that the instrument loosens. But as this mode of operation involves considerable expense, only a few persons are able to practice it.

As they withdraw the oysters from the sea, they place them provisionally, as I have said, in these live-ponds, situated immediately upon the border of the sea-shore, and which differ from the *claires* in being recovered at each tide, which is twice a day. There these oysters live as they do on natural beds; they are kept white, and continue to increase in size. The largest, those which have attained adult age when they are deposited, are ordinarily destined for the use of the surrounding country, where the wives of the fishermen go to sell them. The young ones are preserved for nourishing in the *claires*. But, at present, the natural beds of the neighborhood do not meet the requirements of this trade; about a third of the young which they introduce into these reservoirs come from the coasts of Brittany, Normandy, and Vendée. They are brought by vessels, on which they are loaded in sea-weed, and where they can remain eight or ten days without alteration. But when the voyage is prolonged beyond that time, they are obliged to put them into the water to moisten them (*faire boire*); then they gather them up again, and thus gradually conduct them to their destination.

These foreign oysters never acquire the excellent flavor of those which are taken in this locality. They allow them in vain to stay a long time in the *claires*. The improvement which they undergo in becoming green (*verdissant*) never effaces completely the traces of their primitive nature. They remain tough notwithstanding the new qualities which cultivation gives them, and preserve a certain sharpness which connoisseurs know how to distinguish. It is the same with them as with the adult native oysters. When they attain this period of their existence, their coloration is nothing more, if I may be allowed the expression, than a false stamp, by the aid of which speculation gives to them a higher mercantile value, thus compromising by this fraud, unfortunately too

common, the future advantages of the trade. It is not sufficient that these mollusks acquire a particular distinguishing flavor; it is not sufficient that they contract greenness (*viridité*); it is necessary that these qualities be impressed upon them in their early stages of existence by the continued influence of cultivation in the *claires*. That is, in fact, the sole guarantee of their real value.

Thus the cultivators of oysters in Marennes who desire to satisfy their patrons and to preserve a good reputation for their products never admit any except young oysters in their reservoirs, in order that the action of the improving agents, being exerted upon them as they develop, may become constitutional. They choose among those from the storage-ponds the youngest which the laws permit them to detach from the natural beds of the country, that is to say, those of twelve or eighteen months, which are from 5 to 7 centimeters long. The *amareilleurs* in making a choice give the preference to those having the best shape, separating such as adhere together, freeing them from all foreign substances, and making, so to speak, their toilet, before admitting them to this new regime.

When this sorting is finished, they spread them out with long-handled rakes on the bottom of the *claires*, previously prepared to receive them, taking care afterwards to spread them out with the hand in such a manner that in growing larger they will not crowd each other, and, by their mutual contact, interfere with each other in the free movement of their valves and the preservation of their regular forms. The ostraculturist, in a word, imitates the plan adopted by the agriculturist in resetting his plants. He plants about 5,000 to the *journal* of the *claires*, that is to say, in the space of 33 ares. The young colony, installed in this new home flourishes under a covering of water, which is kept at an average height of from 18 to 30 centimeters, is never renewed except at the great spring-tides, and which rises only at these epochs, descending again to its former level after each periodical submersion. The calm and repose which the new-comers enjoy in these tranquil basins are so maintained that nothing more is needful after installation than to provide against accidental causes which may produce some disturbance, and this then becomes the object of constant solicitude.

When the great spring-tides advance or decline, the workers carefully watch the movement of the waters. They see that they flow in and out freely, repairing the timbers which the waves displace, and neglect nothing to insure the proper working of the hydraulic apparatus which each *claire* represents. If they do not take the greatest care to preserve the integrity of the reservoirs, fissures cause leakages which will diminish the mass of water, so that there will not remain sufficient to preserve the oysters against two influences equally injurious, that of great heat, and of rigorous cold. Their vigilance must, then, be redoubled whenever excesses of temperature are to be expected. To secure the water they completely close the opening of the

flood-gate, at the first great spring-tide in order that the *claire* may remain full; and, thanks to this measure of foresight, the oysters are placed at a depth where the causes of mortality from which they seek to preserve them cannot so easily reach them. The culturists who are not sufficiently vigilant in this respect soon become the victims of their carelessness. In 1820, the precautions of which I speak not having been taken in time, the colds of the first days of January became suddenly so severe that the waters of these *claires* and the oysters themselves, not having sufficient depth of water, were frozen so that it was impossible to remedy the disaster. The entire crop perished in one day.

If the waves of the sea did not bring in upon the bottoms of the *claires* a mass of slime, the deposition of which is favored by the stagnation of the waters, there would be no more to do, as I have already said, but to leave the oysters in repose on this well-provided bottom, where abundant nourishment is secured for them. They would be brought to perfection under the influence of this clear water; quickly becoming fat, large, and green, without receiving any other care; but the slime, progressively accumulating, threatens to destroy them, and will infallibly become a deadly poison to them, if they are not quickly withdrawn from its influence; and the slime is all the more fatal as it attacks every individual at the same time. Industry has succeeded in protecting the oysters from these unhealthy sediments by transporting the whole population from a *claire* in operation to a *claire* at rest, and by renewing the operation whenever necessary, until the maturity of the crop. To provide for all the needs of the experiment, it is necessary to have at their disposal a greater number of reservoirs than is actually necessary to lodge the oysters while they are perfecting. There are in the environs of Marennes speculators who possess 20 or 30 of these reservoirs, of which 8 or 10 are always at rest, in order that they may put them to use as soon as a *claire* becomes slimy and obliges them to transfer the crops to a vacant one. By the aid of this transfer, several times repeated, they preserve their crops and give them, at the end of a certain time, qualities which those do not possess, in the same degree, which have received less prolonged care.

It becomes necessary to repair the *claires* at the period of the equinoctial spring-tides, which are the strongest and the most injurious on account of the great quantity of slimy matter which they bring; but these periods are not the only times when a change must be made. It may happen that the earthy deposits will necessitate a removal at other seasons; generally it is done only once a year. The producers who have not at their disposal a sufficient number of *claires* are content to cleanse their oysters and replace them on the same bottom, thus carrying on their business under very unfavorable conditions, but nevertheless profitably.

It requires a sojourn of two years in the *claires* for oysters twelve or fifteen months old at the time when they are placed there to attain a

suitable size; it takes three or even four years to give them the degree of perfection which characterizes the best products of Marennes. But the greater number of those which are raised in *claires* are, unfortunately for the trade and for consumption, far from having these good qualities. Placed when adult in the reservoirs, they become green in a few days, and speculators, abusing a property which adds to the mercantile value of their products, carry them to market without having taken the trouble to give them the benefit of prolonged cultivation. Thus they avoid all the expenses of manipulation, and can prepare several crops each year upon the same bed. It is this that enriches oyster-culturists.

The oysters of Marennes do not become green in summer, either because during this season the *claires* lose the property of transmitting this color, or because the oysters, having become milky, are then opposed to this influence. Those which had previously experienced the effects blanch by degrees as the time of reproduction approaches, and, when the spawning season has come, lose their color entirely; on the other hand, white oysters deposited at this period of the year remain white. They do not recover from this temporary loss until some time in the month of August, and it is not at all inconvenient for the trade, as the coloration reappears immediately after spawning. This coloring is not general; it shows itself particularly upon the respiratory organs, that is to say, upon the four branchial laminae. The internal surface of the first pair of labial palpi, the external surface of the second pair, and that portion of the intestinal canal which surrounds the exterior of the great attaching muscle also show visible traces of it. No other organ is affected by it. The liver, it is true, presents a more or less intense greenish tint; but this tint is by no means equal to that of the gills and the labial palpi. The green matter which thus invades the parenchyma of the organs which it prefers, invades the contents of the cells which form the tissues of these organs about the same as the substance which colors the yolk of a bird's egg, or the *corpus luteum* of the ovary of a mammal. Chemical analysis leads us to believe that this matter must be distinct from all green substances, animal or vegetable, studied up to the present day, for reagents do not affect it in the same manner.*

* I give here the result of experiments which M. Berthelot has had the kindness to make, at my request, with a view to determine the nature of the matter which colors the branchiae of the oysters of Marennes.

These organs have been treated successively:

First. By water, which has become slimy without being colored or diminishing the color of the gills.

Second. By ether, which likewise had no action upon the coloring matter.

Third. By crystallizable acetic acid, which precipitated traces of a yellowish substance which was neutralized by the yellow prussiate of potash, though it increased considerably the coloring of the gills.

Fourth. By cold potash, which diminished the coloring precipitated by the acetic acid, but without causing it to disappear.

By this series of manipulations the branchiae lose their coloration in part, and are

Authors do not agree upon the origin of this coloring principle. Some suppose that it is the soil itself which contains it; others that it is an animalcule (*Vibrio ostrearius*), or certain algæ which produces it; others, finally, attribute it to a sort of jaundice or to a diseased state of the liver, whose superabundant secretions tinge with green the parenchyma of the respiratory apparatus of the animals influenced by the treatment to which they are subjected in the *claires*.

Of these three opinions, the one which attributes the power of producing a green color to the nature of the soil would seem most nearly correct. Both the comparative analysis of the soil taken from the *claires* which produce the green color and from those which do not, and the experiments of the commission of pisciculture of La Rochelle,† have at least a tendency to establish this. These experiments prove that the bluish-green marls have, like the soil of Marennnes, and to the same degree, the property of coloring oysters; so that, according to the results which this commission has obtained in the artificial basins where they have pursued their experiments, it would be safe to conclude that whenever we can organize clay reservoirs upon our coast, similar to those of which I speak, we will succeed in creating the same industry as upon the shores of the Bay of Sendre.

This industry, extended to districts in which it has not yet been

disintegrated into viscous flakes, in the midst of which the coloring matter is concentrated.

Fifth. The green substance treated by sulphurous acid in solution is not deprived of color; on the contrary, it is deepened in color as by the acetic acid.

Sixth. Treated by chlorine water the color entirely disappears.

Seventh. Heated to a red heat and incinerated, then treated by a drop of diluted muriatic acid, it gave a blue precipitate with prussiate of potash, which indicates the presence of an appreciable proportion of iron in the incinerated tissues.

We may justly regard this iron as one of the essential elements of the coloring matter, although this substance has not been isolated.

In conclusion, the coloring matter of the oysters of Marennnes does not resemble either that of the blood, or the bile, nor is it like most of the vegetable or animal coloring matters. The coloring matter of the blood contains iron, it is true; but the properties of this matter as well as the color are very different.

The earth of the *claires*, which do not make the oysters green, and that of the basins, which do transmit to them this quality, differ notably in the proportions of the elements which enter into their composition. According to the analyses which M. Berthelot has kindly made for me, independently of the ordinary elements of the soil, both are equally colored by the sulphuret of iron, contained in animal and vegetable matter in decomposition, and are impregnated with water containing salt and a little chloride of magnesium; but in the first these elements are much less decided than in the second; the sulphuret of iron is less abundant, and presents less decided tints; the vegetable and animal matters predominate less; the chloride of sodium is found in smaller quantity, and of the salts of magnesia there are only traces. Though these differences, seem of such little importance, may they not be the cause of the differences presented by the products raised in these *claires*? This is a point, which subsequent experiments, made in these places, will doubtless soon clear up.

† *Rapport fait à la Société des sciences naturelles de la Charente-Inférieure, par la Commission de pisciculture, etc.* La Rochelle, 1853.

attempted, simplified and improved by the introduction of the methods of Lake Fusaro, would become the source of a much more considerable and lucrative commerce; but in order that it may make this advance it is necessary to organize the means of cultivation upon a greater scale; to make the reservoirs deeper in order to introduce a greater volume of water when the season requires it; to raise and strengthen the dikes in order that they may resist a greater pressure; to connect the flood-gates in such a manner as to easily regulate the circulation of the waters; to establish reservoirs in which these waters can repose and settle in part before passing into the *claires*, and remain in reserve for the needs of the work. Each establishment, thus transformed into a true workshop, where the action of man creates all the influencing conditions and varies them at his will, will perform at the same time the functions of an artificial bed furnishing seed, and of an apparatus for perfecting the crop; so that the oysters which have become green and marketable will be replaced every year in the *claires* by their progeny, which will be carefully gathered and reared in the place where they were born; giving thus, by this unceasing rotation, constantly renewed products.

The oysters, in fact, which live in the *claires* become milky there as they do upon the natural beds. They deposit spat with the same profusion, but this spat, finding no solid support upon the soft slime which the sea carries there, inevitably perish, unless they attach themselves to the vertical walls of some structure or the boundary stones, by the aid of which, in certain localities, as at Oléron for example, they mark the limits of submarine fish ponds which are not uncovered until the great spring-tides. These live-ponds are not destined for reproduction, for this kind of industry is not practiced upon any part of the coast of France; but small as is the quantity of spat (*naissain*, as the young oysters are called) which remain on the stones placed there for another purpose, it nevertheless indicates the benefit which might be derived from a mode of cultivation rationally organized.

Collecting, in this way, the progeny of the oyster in the *claires*, as they gather that of mussels within the inclosures (*bouhots*) of Esnandes, stocks these artificial reservoirs with thousands of beings, each of which passes its life there held by an artifice, in order that it may be brought to perfection in adult age; such is the ingenious industry which it is attempted to create, and which awaits its Walton to utilize these immense riches. The products of this new mode of cultivation, obtained by economy, will acquire qualities far superior to those which the present method gives them; for, born in the *claires*, from parents raised therein, they will add to the advantages of education those of inheritance.

The deposit of mud in the waters being the only obstacle to the preservation of the progeny of oysters in the *claires*, a simple means may be found to remedy this evil and save the offspring. This will be to place for the spat at a certain height above the bottom, and in such a position

that the molecules of mud cannot encroach upon them nor cover them, solid bodies upon which they may fix themselves. If in supplying these points of support we should follow the example of what is done in Lake Fusaro, and use stakes, it will be necessary to plant them vertically, either at the bottom of the *claire*, or to fasten them to floating rafts, which would hold them suspended without the necessity of occupying a portion of the soil upon which the reproducing animals repose. These rafts would have another advantage: they could carry movable planks, placed obliquely side by side like the slats of blinds, in such a manner as to have one side always preserved from contact with, and from the deposit of, the mud. These movable pieces, when covered with seed, could be disconnected and suspended vertically from the frame of the raft; we would thus imitate the process long since adopted in one of the basins of the arsenal of Venice, by the keeper, who raised mussels there artificially. But there are details of operation which experience will teach us how to vary in practice. The following extract leaves no doubt as to the success of the enterprise.

In 1820 a salt-maker of Marenne, having parked 6,000 oysters in one of the *claires*, an intense cold killed them all with the exception of a dozen, which survived this disaster. But when the reservoir was emptied in order to cleanse it, instead of finding the soil nearly deserted, it was an agreeable surprise to discover upon the shells of all the dead oysters young of considerable size, which restocked the whole reservoir.* The presence of these shells was sufficient to enable the new generation to fix themselves, and prosper there. Art must then only imitate the example which nature offered in this curious circumstance, and it will not be necessary to borrow from more or less distant countries the material for restocking (*renouvelain*), which is now obtained at great expense.

When we have adopted this mode of cultivation, it will be important to find out if, instead of maintaining the dikes in reproductive *claires* low enough for the great spring-tides to submerge them, it would not be better to raise them above the level of the highest sea, in order to prevent the receding waves from washing away a part of the seed. At the eve of each great spring-tide the water of these reservoirs, emptied almost entirely by careful workmen, who leave only a necessary quantity to protect the oysters from injury, will be replaced the next day, so that all the conditions favorable to development will be found combined in the same degree as in the ordinary *claires*. These would be true nurseries from whence could be drawn all the elements of a new prosperity, since they would furnish the live-ponds with abundant seed easy to obtain.

With the help and consent of the administration of marine, an abund-

* Essay upon the green oysters of Marennes, M. G. de la B., president of the Tribunal of Marennes; Rochefort, 1821. ("Dissertation sur les huîtres vertes de Marennes, par M. G. de la B., président du tribunal de Marennes; Rochefort, 1821.")

ance of the seed might be gathered, by very simple and cheap means, on the natural beds themselves without ever exhausting them. It would be sufficient to fix upon the beds, some time before the spawning period, by means of anchors or weights, a quantity of bushes tied with ropes, to one or more buoys; these bundles might be taken out five or six months after their submersion, either to be carried to the *claires*, where the sorting of the oysters which may be clinging to them could easily be done, or for the purpose of detaching the oysters of suitable size to be placed in the perfecting basins. The young ones which have not attained sufficient size may be left on the branches, which should again be placed in the reserved part of the pools, or on the beds themselves; here they will grow rapidly, and from them a second and third crop may be taken. I recommend, with all confidence, the adoption of this process, as I have proof of its success. M. Ackermann, commissary of marine at Marennes, having caused some pieces of wood to be drawn out from an oyster-bed, where he had driven in the pickets at my request to receive new generations, found them covered with seed. The young attached to these fragments had collected in sufficiently large numbers to justify the supposition that a few stakes or fagots would be sufficient to stock a *claire*. The commissary at Marennes thus announces the sending of the specimens in question:

"I am happy, sir, to be able to announce to you to-day the shipping of a box containing embryonic oysters adhering to pieces of wood. I have indicated their approximate age estimated by the Oysterman Babeau. The specimens which you will receive come from on the rock called *Bouchot*, which M. Gabion formerly owned, where we had placed stakes; there is no doubt in my mind that oysters can, like mussels, be raised from *bouchots*."

The *claires* of Marennes now furnish annually for consumption 50,000,000 oysters, the price of which varies from one franc and a half to six francs per hundred, which, at an average of three francs, represent the enormous sum of 2,000,000 francs. They are shipped to all the southern villages of France, from Bordeaux to Marseilles, and from the latter city to Italy and Algeria. Those which are intended for the latter countries are deposited in the Marseilles ponds, where they are left at rest some days before being reshipped. Paris consumes very few; they prefer there generally, as in other more northern cities, the white oysters of Normandy, which are furnished in great quantities.

The oyster, therefore, is important as an article of food and of commerce. Many localities along our seaboard owe to it their prosperity, and among those which are most noted, the banks of the bay of Seudre are best esteemed. On the left bank especially, the inhabitants are almost entirely occupied in this culture and enjoy a great reputation on account of the superior quality which the soil gives to the oysters raised there.

To give an idea of the prosperity which this business produces in the

country, and to give a vivid description of the habits of the people who follow it, I could not do better than quote from a manuscript work, by M. Robert, a merchant of Marennes, the details which he confided to me with liberty to publish them :

"A stranger, going from Tremblade to Royan, is struck with surprise at the number of buildings which abound along the whole route as in the vicinity of large cities. New houses, tastefully built and luxuriously furnished, rise from the center of rich vineyards; and the progress in building is such that ere long Tremblade and Étante will be nothing more than extremities of a street several kilometers in length. These fine houses, it may be added, are of little use to their owners, who, ill at ease in their splendid apartments, generally spend their time in the least habitable portions, thus condemning themselves to be less comfortably lodged than when they had dwellings suitable to their means.

"At first thought it would seem that the culture of oysters requires but little care; but quite the contrary is true. The men so employed work very hard at certain times. They are, however, not prevented from engaging in other industries, from being salt-makers and farmers; their work is disagreeable, as it is done in the water and mud, when necessary to repair and cleanse the *claires*. The same difficulty occurs in depositing and collecting the oysters.

"The women take no part in this kind of work, except to assort the oysters before putting them in the ponds. Their principal work consists in selling the shell-fish. Towards the end of August, or early in September, as the heat decreases, great numbers of women and young girls can be seen going in all directions to live until April in the villages which they have selected. Many women sell for their husbands; others buy from the oyster-growers and sell again on their own account. There are also many who are hired, and who receive a certain sum for the season. When they go to their destination, they carry the oysters in wicker baskets carefully closed. Each one has some particular selling place. Some pass the day in the open air, at the doors of restaurants and hotels; others, more favored, have a little stall or corridor to shelter them. They remain there from morning until near night, and it is astonishing to see them enjoy such good health, exposed, as they are, to the cold and to the inclemency of winter. This kind of life gives the young girls much assurance; the stay in the city develops, also, a taste for dress and a certain skill in making it up. Tremblade also, on Sunday, offers quite pleasing scenes. The workers of the week-day, dressed in their holiday clothes, are not recognizable, and these oyster women, with willowy forms, coquettish air, and easy bearing, agreeably enliven the scene.

"The men are vigorous, active, and enterprising, and as the *claires* are their fortunes, they are reproached, with reason, with not respecting sufficiently, in forming them, the interests of the public and of the bordering proprietors. Thus cultivators are often seen contract-

ing the bed of the Bay of Seudre, and obstructing the channels of the saline marshes, in order to make oyster beds. The means they employ to accomplish this end is both simple and ingenious. They cut bundles of grass and transport them in boats to the localities selected; then, at low tide, they arrange them in such a manner as to form small dams. Now it is known that the water of the Bay of Seudre contains mud, and in such great quantity that each tide deposits many millimeters of it on the ground which it covers. Ordinarily this mud, stirred up continually by the water, would be carried out again by the receding tide, but being prevented by the dams, it settles, remains where it falls, and the bottom soon becomes sufficiently raised to receive the oysters. In this way dry land will often be seen where a short time previously there was several feet of water.

"Thanks to the watchfulness of the authorities, these culpable encroachments are to-day exceedingly rare, and will no doubt cease entirely. Then it will only be necessary to encourage and protect an industrious population, who have learned oyster culture in general, and they will find profit in the marshes which are otherwise in great part useless."

These details I have thought of sufficient importance to mention, in order to give an idea of the methods of the industry of Marennes and of the means which might contribute to its perfection. The manuscript of M. Robert, and the good offices of M. Ackermann, commissioner of marine of that locality, were of great assistance to me, and I am happy to express my gratitude to the author and the officer. I also owe to M. Chabot, manager of the establishment for fish culture at Huningue, many thanks for information furnished while accompanying me in this investigation.

C.—MUSSEL WEIRS (BOUCHOTS*) OF THE BAY OF AIGUILLON.

The majority of persons who partake of the fine mussels which are daily served upon their tables suppose that they, like the oysters, come from natural beds. They do not know by what skill human industry gives to this mollusk, raised by its care, the size and the flavor which render it so far preferable to the poor, little, acrid mussel, frequently unwholesome and infested by a repulsive crustacean, with which the rocks and mud of our coasts are inhabited. Few authors having treated upon this subject,† it will be useful to describe here the processes and

* A word formed by contraction from *boulchoat*, an expression derived from a mixture of Celtic and Irish, and signifying a wooden inclosure: *bout*, inclosure, and *choat* or *ohot*, of wood.

† The work containing the best details of the origin and processes of this curious industry bears the date of the year 1598, and has for its title, *Théâtre des merveilles de l'industrie humaine*, par D. T. V. T., gentilhomme ordinaire de la chambre du Roi, Rouen,

to illustrate the apparatus which the genius of a victim of shipwreck and the experience of several centuries have applied to this important enterprise.

In the Bay of Aiguillon, a few kilometers from Rochelle, upon the immense and sterile marsh which forms the extremity of this muddy bay, where up to that time the inhabitants of the coast had been unable to obtain any sustenance whatever, a poor Irishman, thrown thither by storm and shipwreck some eight centuries ago, created a business which now supports at ease over 3,000 inhabitants of the communes of Esnandes, Marsilly, and Charron, to whom he left this legacy, as if Providence wished that he should be able to repay the generous hospitality which had been extended to him in his misfortune. It was towards the close of the year 1235 that this event occurred, which was destined to open up to the country an era of prosperity and produce an abundance where before only want and misery existed.

A bark laden with sheep and manned by three sailors was driven by a terrible northwest gale from the coast of Ireland and thrown upon the rocks at the point of Escale, half a league distant from the port of Esnandes. The crew and the freight would all have been inevitably swallowed up in the sea but for the timely help of the fishermen along the bleak coast. But with all of their efforts they succeeded in saving the life of only one of the sailors; he was Walton, the owner of the cargo, and became the founder of the first *bouchot*, a marvelous invention, the fruits of which have long since enriched one province, and the application of which to other shores will some day cause the once obscure name of its author to be inscribed among those of the greatest benefactors of the human race.

Exiled on this barren coast, with all his fortune gone, save a few sheep rescued from the wreck, which afterwards, crossed with the local breed, produced that splendid variety known in Vendée as *marsh sheep* (*mouton de marais*), Walton applied his inventive genius to the problem of obtaining a livelihood and of making himself useful in his new home. He therefore determined to explore throughout its length and breadth the immense lake of mud which lay before his eyes, and ascertain if it could not be turned to some profit. But to do this he was compelled to walk at low tide through this liquid mud, which slipped from under his feet and formed an obstacle to the realization of his purpose.

1598, chez J. Caillove, Cour du Palais (très-rare). In 1752, Mercier Dupaty, treasurer of France, inserted in the reports of the Royal Academy of Rochelle a *Memoir on the bouchots for mussels*, which he had previously read two years before at one of the meetings of this academy. In 1835, M. C. d'Orbigny, sr., wrote a memoir in favor of the *bouchot* fishermen, containing documents and statistical reports proving the importance of this business. This work has been republished, partially, but with additions giving it greater importance, in the *Annales de la Société d'agriculture de la Rochelle*, for the year 1846, under the title of *Mémoire sur les bouchots à moules des communes d'Esnandes et de Charron*.

In the presence of this first and very serious difficulty, the idea struck him of building a canoe of the most ingenious simplicity, by the aid of which, without other impulse than that of the foot, he could glide over the mud with the rapidity of a trotting horse, visiting remote localities, and being able, thanks to this new instrument, to devote himself from this time to all enterprises which he thought useful. He noticed that the sea birds and land birds, which skim along the surface of the water during the twilight, collected in sufficiently large numbers to form an object of lucrative trade, if suitable snares could be devised for their capture. He used for this purpose a particular kind of net invented by him, and called *filet d'allouret*,* or night net.

This immense net, of two unequal meshes, was 300 to 400 meters in length, by 3 meters in height, fastened upon long stakes driven in the mud to the depth of a meter; it was stretched carefully above high-water level like a curtain, in the meshes of which all the birds flying in that direction would be caught. Walton was not engaged in bird-catching very long before he discovered that young mussels attached themselves in great numbers to the submerged stakes which upheld his net, and he perceived that if they were suspended a certain distance above the mud, they would not only grow larger, but be of much finer flavor than those beneath the mud. This discovery was to him a veritable revelation. He increased the number of stakes, and, like the first, these became covered with young mussels, which increased in proportion to the number of stakes provided for these growing colonies. After the success of such an experiment, he became convinced that the progeny of the native mussels could be gathered and bred in artificial reservoirs, and that this culture might be made a great industry. To this important work he consecrated henceforth all his efforts.

The methods which he applied were so happily adapted to the permanent necessities of the new industry, that after the lapse of eight centuries they are still employed by the people who were so greatly enriched by them. In putting up his structures he seems to have desired that they should serve the most useful purpose to his contemporaries, and at the same time remind their descendants of him, since he gave them the form of the letter V, the first letter of his name, as if he wished that his monogram should be inscribed on all the points of this swamp, fertilized by his genius, hoping, no doubt, that in time a suitable monument would be erected by a grateful public to the memory of the founder. According to the plan described below he constructed his first establishment, upon the model of which the 490 *bouchots* now in operation along the Bay of Aiguillon were built.†

Referring to a document published towards the close of the sixteenth century, we find that it was in the year 1246, ten years after his ship-

* *Allawrat*, or *allawrat*, from which comes *allouret*, is a word compounded of Celtic and old Irish, which signifies a dark-night net: *d'allaou*, obscurity, and *rat orvet*, net.

† See plan of the Bay of Aiguillon, on page .

wreck, that Walton began this construction. The scattered stakes which he had used up to that time, but which were often torn up by wind and sea, or broken down by vessels and blocks of floating ice, from which causes he frequently lost in one day the fruit of months of labor, led him to have recourse to appliances more complex, stronger, and less apt to be affected by the action of the tides, and which would offer a large surface to the young mussels. He therefore drew at low-water mark, following an imaginary line running from the Castle of Esnandes to that of Charron, where now are to be seen extensive meadows, a V, the apex of which, partially opened, was turned towards the sea, and the sides of which, extending along the coast about 200 meters, were turned towards the shore, forming an angle of about 45°. On both sides of this angle he imbedded half their length in the mud strong stakes, 10 to 12 feet high and 2 to 3 feet apart, which were joined at intervals by bands of twisted branches so interlaced that they formed solid palisades and resisted the waves of the sea. At the vertex of the angle formed by the two wings he left openings of from 3 to 4 feet, where receptacles were to be placed to hold the fish, which, as the tide flowed out, would follow the way bordered by this double hedge; thus his invention served a double purpose, being at the same time an artificial mussel-bed and a fish-trap. And so even at this day we see the *bouchot* fishermen, faithful to all the details taught them by Walton, going in their canoes (*acones*) before the sea recedes, to station themselves behind the entrance of each trap, in their hands a net called *avenau*, to devote themselves to fishing until the tide leaves their boats, and they can then fill them with mussels, and bring them back to port by gliding over the mud.

It is quite a curious spectacle to witness the return of this singular fleet, composed of hundreds of canoes, gliding here and there through all the openings in the palisades, where they disappear during their work, slipping along the surface of the mud like a flock of birds driven by the tide. It is impossible to describe the grotesque maneuvers of this strange looking fleet. These *acones* or foot-canoes (*pousse-pieds*) are nothing more than plain wooden boxes, about nine feet long by about 18 inches deep, the front of which is shaped into a kind of prow. The fisherman places himself in the stern, supporting his right knee on the bottom, leaning forward, seizes the two sides with his hands, leaving his left leg, clad with a long boot, hang over the side to serve as a propellor. When he has thus balanced himself, he plunges his free leg into the mud, which serves him as a point of support, withdraws it, then pushes again, and, by repeating this maneuver, he propels his boat easily and guides it wherever his presence is required. By long habit these fishermen have learned to distinguish, even in the darkest night, their own *bouchots* from those of their neighbors, notwithstanding all the mazes of the immense labyrinth which is formed on the marsh by the 6,000 palisades which cover it.

This was the ingenious though simple device which Walton invented,

to explore, at low water, the Bay of Aiguillon, and which enabled him to carry out plans and perform work which, without its aid, he could never have undertaken with such a muddy and mobile surface to contend against. Besides, this apparatus is to this day of prime necessity in the business. The inhabitants of Esnandes, Charron, and Marsilly not only use them to bring in their mussels, or to keep up their colonies, but they also transport in them all the wood with which they build their inclosures and palisades. In such a case a single canoe is not enough; they join three together abreast, tying them in front and behind with cords, which they pass through holes prepared for the purpose, then, loading the stakes and the branches on the middle canoe, they take positions on those at the sides, and push, one with his right leg the other with his left, by their united efforts directing the cargo toward the place of its destination. The alder and the snow-ball (*obier*), one employed for the thatching, the other for the stakes, are the only kinds of wood used in constructing the *bouchots*.

There is one season of the year when it would be very difficult to propel these canoes but for the timely assistance of a small crustacean, the *Corophium longicornis*, which, in following marine worms upon which he feeds, smooths the irregularities and rough places in the mud, which, hardened by the rays of the sun, would otherwise offer great obstacles to the movements of the fishermen.

"What a thousand men," says M. d'Orbigny, sr., "could not effect in the whole summer, is performed in a few weeks by the hordes of these little animals, scarcely 4 lines in length and a line and a half in diameter; they fill up the fissures, and smooth the surface; they loosen the mud which is carried out of the *bouchots* and even out of the bay by the sea at each tide; and, but a short time after their arrival, the marshes present as smooth a surface as at the close of the preceding autumn.

"The *Corophies* first appear towards the end of April; about this time also the burrows of which I have spoken are inhabited by innumerable annelids of many species. All these marine worms, which appear in the month of March, as soon as the tide begins to cover them, hold themselves in readiness at the openings of their retreats to seize the animalculæ which are floating by, secreting themselves and sinking in the mud; but as soon as their enemies come they are seen no more. The *Corophies*, which are very fond of them, wage upon them a war of extermination; they pursue them incessantly, even in their retreats in the depths. Nothing is more interesting for the observer than to see these little crustaceans at the rising tide moving about in all directions, striking the mud with their long antennæ, beating it to discover their prey. Should they meet a *Nereis*, an *Amphitrite*, an *Arenicola*, frequently a hundred times their own size, they unite and seem to act in concert in attacking, killing, and devouring it, continuing the carnage until they have searched everywhere and nothing remains to satisfy their voracity.

"These animals, which seem to multiply during the whole of the warm season, generally quit our marshes towards the end of October; they go all at once, in one night, and spread over the high seas, and not one can be found where a few days before they were innumerable."

Walton realized from his first structure all the success which his experience with the isolated pickets in the first instance had led him to hope for, but still he did not entirely give up for this the use of the isolated stakes. He drove a considerable number on the sea-shore, using them afterwards to fill up the gaps in the wattle fence which the young of the year did not fill up, and in the succeeding spring the fine mussels which he raised in these artificial beds were preferred to all others. His neighbors, struck with the advantages he had obtained through his industry, followed his example with such eagerness that soon the whole marsh was covered with *bouchots*, and at the time these lines are being written a forest of about 230,000 stakes is permanently in use to support 125,000 fascines bending every year under the weight of a crop which a whole fleet of vessels of the line could not carry. These stakes are trunks of trees, measuring 12 feet in height and 6 inches in thickness, which are driven down into the mud half their length, thus leaving 6 feet above the surface; planted about 40 or 50 centimeters apart, they are arranged in double rows, according to Walton's plan, and extend some 200 to 250 meters, each pair forming a V, with the point towards the sea. The upper ends of the stakes, that is, the ends out of the mud, are interlaced with wicker-work formed from the branches of the *obier*, which are not less than 25 to 30 feet long, and by twisting them the long colonnades which support them are converted into solid stockades, covered like basket-work. But the wicker-work does not extend entirely to the bottom, stopping a few centimeters above its level, so that the water may flow freely between, both at the rising and ebbing of the tide. Its lower side does not touch the mud, and the whole weight rests on the poles; they, of course, must be placed sufficiently near each other to offer a great number of points of contact, for without this precaution the wicker-work, weighted by the mussels, would bend in the long spaces between the supports so as to touch the bottom and promote the accumulation of soil by opposing an obstacle to the mud which the tide carries, or, being broken by it, the expenses of cultivation would be so increased as to ruin the business. A distance of two feet is sufficient; a distance of a meter would be disastrous. The question, therefore, is whether narrower intervals will not cause a more rapid filling of the Bay of Aiguillon, and whether, in favoring the culture of mollusks, the interests of navigation, of which the minister of marine ought to be the vigilant protector, may not be put in jeopardy.

A careful exploration of the Bay of Aiguillon during an ebbing spring-tide completely reassured me on this point; I discovered that the ebbing sea encountered just as much opposition from the stakes which hold up the wings of the *bouchots*. Striking against them, the waves

were separated, only to fall with greater force on the next ones. If the wind is northwest (which is usually the case in this locality) the struggle between the waves and stakes is plainly visible. A depression of the mud in the direction of these wings proves that the erosions could only be caused by the rushing of the waves against the obstacles in the way; therefore there is no doubt that if the stakes be driven 2 or 3 feet apart they would not cause any deposit of alluvium. If their presence could produce so unfortunate a result, the portion of the Bay of Aiguillon, near Charente, where there have been for centuries more than 150,000 stakes, should now be much more filled up than that of Vendée, where there has never been one driven; the fact, however, is quite the contrary. The minister of marine need, therefore, have no scruples in permitting this great industry to be developed to its utmost extent. The pursuit of this industry is not incompatible with the interests of navigation. I therefore join my wishes to those of this industrious people, and call the attention and sollicitude of the government to their work, that the watchful protection heretofore given them may be continued.

The palisades which the stakes support are not less than 200 to 250 meters in length each, by 6 feet in height. They are, as I have said, grouped in the form of V's, to constitute weirs or *bouchots*, and these *bouchots* are so arranged as to always present their vertices toward the sea, and prevent the waves from attacking their flanks. These palisades, to the number of thousands, form 500 weirs, and each weir is at least 450 meters long; so that the whole forms a vast wicker-work of 225,000 meters in length and 6 feet high. This immense apparatus extends over a surface of 8 kilometers in the Bay of Aiguillon, occupying all the space between the points of St. Clement and the mouth of the river Marans, in the communes of Esnandes, Charron, and Marsilly.

The majority of the fishermen own several *bouchots*, as some farmers own several farms. The poorest of them have for their whole patrimony only the half, third, fourth, or even the fifth part of one of these structures, which they work in common with their partners, dividing the profits and losses proportionally.

All these structures are arranged in four series, each of which has its different use, according as it is near to or distant from the shore. They are called by the names of *bouchots du bas ou d'aval*, *bouchots bâtarde*, *bouchots milloin*, and *bouchots d'amont*, names which refer to the zone which each series occupies in the topographic plan of the bay.

The *bouchots du bas* are the most distant from the shore, and are left dry only at the lowest tides. Instead of being built in palisades, as the others, they are composed simply of stakes driven about a third of a meter apart. These solitary stakes, if I may so express myself, are in the zone most favorable to the preservation of the embryo mussels which attach themselves to them. In other places this spat, composed

of exceedingly delicate animals, would too often be left exposed, and could not well resist the prolonged action of the sun or of extreme cold. It is therefore here that all the seed is allowed to grow and accumulate which is intended afterwards, by means of transplanting and rearranging, to replenish the palisades which are empty or too scantily furnished, and the series which the sea uncovers very often; for the inhabitants of the country use agricultural expressions to designate the different operations of their industry they say sowing, planting, transplanting, weeding, pruning, and harvesting the mussels.

Towards the month of April, this seed, fixed in February and March to the solitary lower *bouchots* (*bouchots d'aval*), hardly equals in size a grain of flax, and is then known under the name of *naissain*; by the month of May it has grown as large as a pea, and by July attained the size of a bean, and is then called *renouvelain*; at this time the transplanting occurs.

When the month of July has arrived, and the spat has acquired, in its cradle, the size of the seed-mussel, it is considered sufficiently developed to undergo the change and to acclimate itself to a spot somewhat less favorable, where, before this period of its age, it would have suffered. The fishermen push their boats out to the points in the marsh where the spiles are filled with this seed.

They detach by scraping, with the aid of a hook fastened in a handle, as many shells as they will be able to transplant at low water, heaping up these shells in baskets, and directing their canoes towards the nearest palisades, the bastard weirs (*bouchots bâtards*), which are uncovered after ordinary high tides, and there begin the work of stocking (*la bâtisse*).

Then, taking each parcel separately, they inclose it in a bag of old netting; then they place all these colonies among the branches, one cluster after the other, the individuals of which, bound together by their byssus, form distinct families; filling all the interstices with this stock (*bâtisse*), as a mason would do who inserts plaster to convert open stone-work into a wall; with this difference, however, that here one must always place the families so far apart that the increase of one community shall not obstruct that of its neighbors. The bag in which they were wrapped soon decays, and nothing prevents these isolated colonies from extending their limits by the development of individual members. They grow up in this new abode and finally touch one another; so that these immense palisades, when these clusters completely cover them, resemble the sides of a wall blackened by a fire.

When this state of things has arrived, and the mussels are so large as to touch each other, their resistance to the action of external conditions is much stronger than when in their young state. They may be thinned out, when too thick, to make room for younger generations, and to transfer those which are detached from the bastard *bouchots*, which, as I have already said, are not uncovered during ordinary tides, to the

empty fascines in the middle *bouchots*, which are uncovered at low water during all tides. Here the same operation of placing the mussels in bags, which has already been mentioned, is repeated, before assigning them to a new dwelling place, where they may continue to grow and expand without hindrance. They are not, however, so carefully wrapped as when younger and taken from the first series, because their size is now such that they can be put in position more easily and securely without the help of this fastening.

Thus the work of distribution goes on as long as there remain on the solitary stakes of the deep water *bouchots* any young which can be transferred to the wicker-work, taking advantage at all seasons, at all hours of the day and night, of the low tides, the only times when they are able to prosecute this laborious culture. If the scaffoldings, upon which they have so carefully placed their crop, give way or break, they repair the damages, replace the stakes which can no longer be used, change the position of the mussels that are not lying properly, and take precautions for the preservation of the whole establishment.

Ordinarily, after ten months' or a year's residence upon these artificial beds, the mussels become marketable. Then, before offering them to the consumer, and to make room on the intermediate palisades, these colonies are subjected to a third and last transplanting. Those which have attained the desired size pass accordingly into the *bouchots* of the inner series, which are more accessible from the shore, as a sort of depot where they are more easily handled. They live here, though left dry twice a day by the sea, and, thanks to this continuous changing, there is no fear that the crop will suffer or the culture be interrupted.

The mussels thus raised, although developed side by side on the same wicker-work, have not all the same qualities. Those which occupy the higher rows are better than those in the middle rows, and so the latter are preferred to those in the lower rows, which, being nearer the mud, are defiled by it whenever it is disturbed by the action of the waves. Only enough of it arises, on the contrary, into the upper series to furnish the mussels with the nutritious molecules, the infusoria which abound in this diluted mud, and this is really the cause of the difference. However, notwithstanding this difference, the poorest of the cultivated mussels are sufficiently improved by the care bestowed upon them to be far preferable to the best mussels grown in the sea.

This mollusk, on account of its abundance and cheapness, has become the daily food of the indigent classes, and is sold at all seasons of the year. But there is one period during which its flesh is more tender, more savory, and fatter than at any other season. This period begins in July and extends into January. From the close of February to the end of April the mussels are milky (*laitieuses*). They lose, like the oyster during the spawning season and during the period of incubation, the qualities which they previously possessed. Poor and tough, they are at such times less sought after. From July to January, therefore,

the business is most important, and the greater portion of the crop is sold.

When it is desirable to supply the neighboring villages or cities not far distant, the fishermen draw their canoes to the shore filled with mussels. The women then take charge of them, transport them first into caves dug in the foot of the cliff, where they keep their implements and building materials. They first wash them and then arrange them in baskets and hampers, which are either loaded on horses or in carts, and then as soon as night sets in, no matter what the state of the weather, they start with their cargoes towards the point of destination, arriving sufficiently early to be present at the opening of the market. Thus they travel to Rochelle, to Rochefort, Surgères, Saint-Jean-d'Angély, Angoulême, Niort, Poitiers, Tours, Mauzé, Angers, Saumur, &c. About 140 horses and 90 carts, making altogether to these different cities more than 33,000 trips, are employed annually in this service.

If, on the contrary, they wish to export to greater distances, and on a larger scale, 40 or 50 barks coming from Bordeaux, the isles of Ré and Oléron, and Sables-d'Olonne, and making altogether 750 voyages annually, distribute the crop in countries which the horses and carts do not reach.

A *bouchot*, well stocked, furnishes generally, according to the length of its wings, from 400 to 500 loads of mussels, that is to say, about one load per meter. The load is 150 kilograms, and sells for 5 francs. One *bouchot*, therefore, produces a crop weighing from 60,000 to 75,000 kilograms, and valued at 2,000 to 2,500 francs; from which it follows that the crop of all the *bouchots* united would weigh about 30,000,000 to 37,000,000 kilograms, which at the figures already given would be worth about 1,000,000 to 1,200,000 francs. These figures and the abundant crops from which they result, give an idea of the food supplies and of the great benefits that may be derived from a similar industry, if, instead of being confined to only one portion of the Bay of Aiguillon, it should be extended to the whole of it, and carried from the locality where it originated to all the coasts and salt-water lakes where it could be successfully carried on. In the mean time the prosperity which it secured in the three communes of which it has become the patrimony will remain as an end worthy of effort; for, thanks to the precious invention of Walton, wealth has succeeded to poverty, and since the industry has been developed here no healthy man is poor. Those whose infirmities condemn them to idleness are cared for in a most generous and delicate manner by the others.

"Twice a week," says M. d'Orbigny, the elder, "the housekeepers of each family carry their bread to be baked at the baker's; the poor people or their agents, often persons in easy circumstances, who take upon themselves the honorable mission when the unfortunate themselves are not able to go to the place, present themselves there with a basket. Each

housewife, before putting her bread in the oven, breaks off a piece of dough from each loaf; the baker charges himself with the duty of making all these bits of dough into loaves of bread, gratuitously. Nothing is more interesting, for a sensible and observing man, than to be present on the arrival of the weir-men and fishermen, at the unloading of the fish; a course of lectures on morals would not be worth as much as this lesson of fraternal humanity. Whether by day or night, the same indigents, ranged in rows and furnished with baskets, and stationed near the place of unloading, receive from each of them, according to what he brings, the first fruits of his fishing, one a handful of mussels, another a few fish; this gift is bestowed with politeness, with questions which show the interest each one takes in the unfortunates whom he knows, who, perhaps, are his parents; the fisherman fears that he will bring upon himself trouble by refusing them or treating them rudely; often he even has the gift carried to them on a horse or cart which his wife has brought to the landing place to receive the results of the fishery. Bread furnishes them subsistence; the surplus of fish and of mussels is sold, and the revenue therefrom serves to buy for them fire-wood, candles, in fact everything that they may need.

"This population, entirely Catholic, fairly represents those large establishments in North America and Germany of the Moravian Brothers. Everywhere are found plenty of work, good morals, cheerfulness, contentment; the households are happily managed, quarrels seldom occur; hospitality is here looked upon as a religious duty; honesty is the foundation of all education; and the traveler, astonished at all he sees, almost dreams that he has found a better world."*

We present here according to a statistical report made in 1846, by M. d'Orbigny the elder, the estimated cost at that time of conducting one of these establishments, and the annual expenses and profits of the 340 *bouchots* which were being operated by the three communes of Esnandes, Charron, and Marsilly.

Cost of equipment of 340 bouchots.

	Francs.
159, 400 stakes driven, at 300 francs per hundred	478, 200
90, 000 bundles of twigs intertwined, at 150 francs per hundred	135, 000
160 canoes with apparatus, at 40 francs each	6, 400
160 pairs of boots for fishermen, at 33 francs per pair	5, 280
166 <i>aveneau</i> nets, rigged, at 15 francs each	2, 490
400 <i>alkouret</i> nets, at 15 francs each	6, 000
200 boundary stones (<i>bournes</i>), at 20 francs each	4, 000
2, 000 <i>bourolles</i> , at 1 franc each	2, 000
600 pairs hampers, at 3 francs a pair	1, 800

* *Les habitants des communes littorales de l'anse de l'Aiguillon, etc., au Gouvernement, etc. La Rochelle, 1835, p. 25.*

1,000 fish-baskets, at 75 centimes each	750
110 pack-horses, at 350 francs each	38,500
28 cart-horses, at 380 francs each	10,540
28 carts, equipped, at 800 francs each	5,600
	<hr/>
Total	696,660

Making the cost of each *bouchot* 2,049 francs.

Annual expenses of keeping up 340 bouchots.

	Francs.
Annual interest on 696,660 francs	34,833
Cost and transportation of stakes and brush	64,000
For the repairing of canoes, boots, nets, utensils, &c	11,000
102,000 days' labor of men, at 1½ francs	153,000
42,000 days' labor of women, at 1¼ francs	52,500
Feed for 138 horses, and repairs of harness, carts, &c	41,400
1,800 days of detention in Rochelle, at 50 centimes	900
Hire for lodgings for 140 families, at 60 francs each	8,400
Cost of gathering seed	1,400
Old nets for wrapping, and time spent in placing them	18,807
	<hr/>
Total	386,240

Annual expenses of each *bouchot*, 1,136 francs.

Annual revenue in mussels, fish, and game from 340 bouchots.

	Francs.
To Rochelle, 60 horses make 18,000 trips annually, at 5 francs	90,000
To Rochelle, 28 carts make 7,000 trips, at 20 francs	140,000
To Rochefort, 12 carts make 840 trips, at 40 francs	33,600
To Surgères, 16 carts make 1,120 trips, at 20 francs	22,400
To Saint-Jean-d'Angély, 28 carts make 1,120 trips, at 20 francs	22,400
To Angoulême, 40 horses make 1,600 trips, at 5 francs	8,000
To Angoulême, 8 carts make 320 trips, at 20 francs	6,400
To Niort, 28 carts make 1,960 trips, at 40 francs	78,400
To Poitiers, 8 carts make 160 trips, at 40 francs	6,400
To Mauzé, 8 carts make 320 trips, at 25 francs	8,000
To Tours, 12 carts make 240 trips, at 30 francs	7,200
To Angers, 4 carts make 80 trips, at 40 francs	3,400
To Saumur, 8 carts make 160 trips, at 40 francs	6,400
To Bordeaux, 32 barks make 128 trips, at 300 francs	38,400
To isles of Ré and Oléron, 4 barks make 480 trips, at 30 francs	7,200
To Sables-d'Olonne, 6 barks make 150 trips, at 30 francs	4,500
Fish caught in the <i>bouchots</i> and birds caught in nets	27,500
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Total	510,000

	Franca.
Each <i>bouchot</i> produces annually	1,500.00
Deducting annual expenses.....	1,136.00
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Net profit	364.00
To which should be added the interest on capital of 2,049 francs.....	102.45
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Total	466.45

The labor of both men and women is included above in the annual expenses.

If this statistical report made by M. d'Orbigny gives a correct estimate of the condition of things, the business must have developed considerably since that time (1846). Instead of the 340 *bouchots* then in the Bay of Aiguillon, there are at present nearly 500; and I do not think I make any mistake in these figures, for, after having taken them on the spot, a letter which I received from the mayor of Esnandes confirmed all my estimates.

M. Belenfant, commissary of marine at Rochelle, by the information he was so kind as to give me, and by the interest he manifested in accompanying me in my exploration, has also contributed a great deal toward the investigation of all the details of this industry.

[APPENDIX TO THE FIRST EDITION.]

D.—DOCUMENTS RELATING TO THE MARINE FISHERIES

I.—REPORT TO HIS MAJESTY THE EMPEROR ON THE CONDITION OF THE OYSTER BEDS ALONG THE COASTS OF FRANCE AND ON THE NECESSITY OF RESTOCKING THEM.

PARIS, February 5, 1858.

SIRE: The domain of the sea, like the earth, may be cultivated; but this domain being public property, to the government belongs the duty of applying such methods as science has demonstrated to be the most suitable for the execution of so grand a scheme, and then leave to its grateful citizens the harvests which have been prepared by its care.

I have, therefore, the honor to submit to Your Majesty, according to command, the various plans which promise to promote the success of this useful innovation. I will commence with those which relate to the multiplication of oysters on the shores of France.

The oyster trade has already fallen into such a state of decadence, that, unless a prompt remedy be at once applied, the source of production will soon be utterly exhausted.

At La Rochelle, Marennes, Rochefort, and in the isles of Ré and Oléron, out of the 23 beds lately forming one source of wealth of that portion of our shores, 18 are completely destroyed, while the others, still

furnishing a small supply, are seriously injured by the growing invasion of mussels. The cultivators also in these regions, not being able to find sufficient oysters to stock their ponds and *claires* for greening or perfecting, are obliged to seek them at great expense as far off as the shores of Brittany without being able to supply the demand.

The bay of Saint-Brieuc, so admirably and so naturally adapted to the reproduction of the oyster, and which on its clean, hard bottom formerly contained no less than 15 beds which were continuously dredged, has to day but 3, from which 20 boats could in a few days carry off the last shell, while in the period of its prosperity more than 200 barks, manned by 1,400 men, were annually employed in the business from the 1st of October to the 1st of April, and realized from it between 300,000 and 400,000 francs.

In the harbor of Brest and at the mouths of the rivers of Brittany the decadence has not been so great, because these fertile spots have not been subjected to such constant dredging. But inasmuch as our own fishermen are now compelled to resort to these beds, they, like our own, will soon become exhausted.

At Cancale and at Granville, which are historic grounds for the multiplication of oysters, it is only by good management that they succeed, not in increasing the supply, but in preventing its decline. While this important trade is steadily declining, or remaining stationary, the increased facilities of communication between the sea-board and the interior as steadily augment the demand for these marine articles of food. These products, made costly by scarcity, now bring in our markets fabulous prices, and the inhabitants of the coast, consulting only their immediate wants, and looking only to the present hour, commit deprecations which, in the near future, will aggravate their distress.

Now, Your Majesty, there is for this deplorable state of things a remedy, easy of application, certain to succeed, and which will furnish an incalculable wealth of food for the public. This remedy consists in undertaking at the expense of the government, under the direction of the administration of the marine and by means of its vessels, the stocking of the shores of France so as to restore the ruined beds, to revive those which are declining, to protect those which are prosperous, and to create new ones wherever the nature of the bottom is suitable. And when by this generous policy these marine fields shall once more become productive, the dredging may be placed under such restrictions that while certain fields are being operated others may lie in repose; a plan which, for a century, has kept the bays of Cancale and Granville from the destruction which injurious dredging has caused everywhere else.

To give a striking example of the method in which these operations of restocking and of creating new beds ought to be conducted, and of the immense results which may be obtained, I have the honor to recommend to Your Majesty's government that the bay of Saint-Brieuc be set

apart for this purpose. There the experiment may be undertaken in a restricted space, supervision will be easy, and in less than six months a fair estimate could be made of the expected results, as from a tree in blossom, provided the artificial beds are planted in March or April, that is, before the spawning season.

The sum of 6,000 or 8,000 francs, placed at the disposal of the commissary of the marine, in that quarter, would suffice for the purchase of the oysters required for stocking the bay. These oysters should be caught in the open sea, and, if possible, carried immediately by a government steamer to the grounds naturally fitted for them. But, when they are unable to collect enough in one day to complete a cargo, they may store them temporarily near Plévenon, a dependency of Saint-Brieuc, in charge of two custom-houses found there, so as not to start them from this provisional storage to the places where they are to remain before they have a full load.

With the aid of this simple means, and at a relatively insignificant cost, it will be possible in a few years, if proper precautions be adopted, to realize a considerable revenue in the bay of Saint-Brieuc alone.

Among these precautions, I put first, that the oysters ought not to be out of the water for a moment longer than is required for their transportation from the place where they are caught to their destination. It is owing to a neglect of this precaution that the failures in the past are due; for, whenever it has been observed, success has crowned the experiments, as is proven by the attempts of M. de Bon in the Rance.

A second and not less important condition is that an intelligent and watchful care be given to these submarine fields, made fertile by science and cultivation; and to the commissary of the region naturally belongs the duty of exercising this care. But in order that the equipment of this officer may correspond with his responsibility, he should have at his command a pinnace, or better still a launch of 8 to 10 tons, furnished with a captain, four sailors, and a cabin-boy, a sufficient crew for all the needs of the enterprise; the launch may serve at the same time to guard and cultivate the tract which is assigned to its care.

The oyster beds created or supported in this way by the government will always be easy of exploration and investigation. Nothing connected with them can occur without the administration being instantly informed of it and in condition to act. If the mud accumulate on the producer's grounds, or if the mussels and the *maërle* invade them, the drag will detach the oysters' enemies or remove the parasites as the plow removes weeds from the ground. - If in the vicinity of the established beds they discover other bottoms adapted to the multiplication of oysters, the exploring launch may always be occupied in superintending its domains, will seek everywhere on the natural beds the adult oysters required for stocking these new fields, or will sow there the young oysters, which in the fishing season are rejected in selecting the marketable oysters. So that whether we consider this craft from a

supervisory point of view or as a means of cultivation, it will render services which cannot be obtained by any other means.

I am willing, then, considering all things, to follow the example of the chief of the service of Saint-Servan.

These launches would, in the navy, form a sort of agricultural marine, the employment of which would not exclude the use of vessels concerned in the general police of the fishing vessels which are employed in a greater development of the coast. They should be so constructed as to contain a well in which experiments could be made, or in which specimens could be transported alive from one point to another.

Without doubt, when it is necessary to restore the prosperity of the affected beds by delivering them from a general invasion of mussels (*moules*), such as exists now at Marennes, or from the encroachment of the no less injurious *maërle*, as at certain points in the harbor of Brest, the fleet devoted to the ordinary service of the region will not suffice for the emergency; but, on such an occasion, the boats of the fishermen, for whose benefit the enterprise was established, could be pressed into service for the treatment of these beds, by the same rights which the proprietors of communes exercise when they undertake the repair of a public road.

The young oysters and those taken in the open sea form two sources from which the government vessels may secure supplies for stocking the coast; but notwithstanding their abundant reproduction they would never be sufficient to accomplish this vast project unless means are employed to prevent the loss of the myriads of embryo oysters, which, in the spawning season, leave the maternal valves as bees leave their hives; embryos which are nearly all lost in the natural state for the want of something to which they may attach themselves.

To the care of this precious spat the attention of the agents of the government should be henceforth directed.

Each oyster produces not less than 2,000,000 of young. But, if out of this immense number a dozen succeed in attaching themselves to the parent shell it is all that can be hoped for, even in years of the greatest abundance. Those, then, that succeed in attaching themselves are as nothing in comparison with the immense numbers that are swept off by the waves or which are lost in the mud, or which become the prey of polyps, which feed upon the animalcules suspended in the waters of the ocean. The problem to be solved, then, is how shall this inexhaustible seed supply be secured and carried to the grounds which are to be stocked?

In doing this, no notice need be paid to the natural beds formed from the young obtained at each spawning season, although even from them incalculable riches might be obtained. The only thing necessary is to fasten around the beds a species of wicker-work made with twigs and branches of trees with the bark on, imbedded in such a manner as not to interfere with navigation, and held to the bottom by heavy

weights. The progeny of the oysters deposited will rise like a living cloud of dust through the branches, and the embryos will incrust every available point of this structure, which will thus be made the recipient of seed.

These receptacles, filled with this microscopic population, should be left on the beds not only during the whole spawning season, but also until the young oysters shall have attained a sufficient size to be used for restocking other localities. The government vessels will then carry the whole structure to the point which may be selected for organizing new beds. After they have been fixed for a short time, the young oysters will detach themselves naturally and sink to the bottom, previously cleaned by the dredge, just like the wheat from a drill on ground prepared by the plow.

This transportation should be effected in February or March, because at that season of the year the spat deposited in the branches, during either the months of September or May, are easily discovered, the first having already attained the size of a 20-sous piece and the latter that of a 2-franc piece. It is then easy to ascertain whether the seed is scarce or plentiful, and in what measure it will contribute to the object in view. Besides, the force of vital resistance with which it is endowed at this age enables it to endure without inconvenience the changed conditions of its new abode.

The possibility of gathering the progeny of the oysters by means of this wooden wicker-work is a fact established not only by the results obtained from time immemorial on the artificial beds of Lake Fusaro, an industry of which I described the methods in my *Voyage sur le littoral de la France et de l'Italie*, but also from experiments made in the ocean itself. Branches suken on the beds of Brittany by M. Mallet, commanding the Moustique, and on those of Marennes by M. Ackerman, ex-commissary of marine, were taken out a few months subsequently, filled with seed. I preserved them in my collection as a proof of the efficacy of the methods which I recommend. In order to derive from these methods incalculable benefits, it is only necessary to employ them on a large scale.

I make bold to affirm, sire, that if the administration of the marine will draw upon the various sources I have designated, and employ all the means tending to the development of the object which I have had the honor to recommend to Your Majesty, they will very soon convert the whole coast of France, except in such places as are filled with mud, into one long chain of oyster beds. It will be necessary for the realization of this scheme that the agents be encouraged to devote themselves zealously to the service, and that they shall have placed at their disposal all the means requisite for the furtherance of the object in view. As if by enchantment the harbor of Brest, the bays of Brittany, and the mouths of the rivers will extend their isolated beds and unite them, by the creation of new ones, into one vast productive field. The depleted

beds of Cancale and Granville will be renewed and extended to a great many neighboring localities whose suitable bottoms will readily respond to the attempts which are made to enrich them. The basin of Arcachon, all that portion of the shores of the British Channel which extends from Dieppe to Havre, from Havre to Cherbourg, from Cherbourg to Granville, will be covered with oysters, and the extinct beds in the neighborhood of La Rochelle, Oléron, Rochefort, Marennes, &c., will be restored to their former prosperity. But here, more than elsewhere, it will be necessary for the government to continue the work of restocking and division, which it fortunately has already begun: that of cleansing, by repeated dredgings, these productive bottoms from the mussels and mud which completely cover them.

This work accomplished, there is no reason why these ruined localities may not witness a return of their early prosperity and an increase of their wealth. The exploration which has enabled me to ascertain the state of suffering, of poverty, and of complete ruin in which most of the beds along the coast are now to be found, also demonstrated to me the fact that the depopulated depths had lost none of their fitness for reproduction. The abuses by excessive fishing, aggravated by the want of care, have alone completed the destruction. Careful culture will soon repair the harm done in the past, and properly taken in charge, fields hitherto sterile will create, by a kind of submarine cultivation, new sources of abundance. But to create new sources of wealth is not sufficient; it is necessary, in order to perpetuate them, to define also the method of their cultivation, and to fix the time of year when it will be best to gather the crop.

The experience of more than a century has already, in the bays of Cancale and Granville, given a solution of the first part of this important problem; regular periods of harvesting are the only means of obtaining from the beds the greatest yield without destroying their fertility. The same general methods should be henceforth applied to the cultivation of oyster beds; they should be divided into zones, so as not to return to any one of them for two or three years, according as the bottoms are more or less suitable for the rapid maturing of the crop; but always taking care to leave a sufficiently large number of adults, so that the spat which they spread during the periods of repose may create new and sufficient harvests. By the general application of this method, the supply of our markets and the fertility of the beds will be assured.

There is, however, no rule so general, especially when applied to the reproduction of living creatures, subject to all the vicissitudes of the external world, that it may not have exceptions. There may exist unknown causes which will delay for a longer or shorter time the generative function of the oysters of one locality or destroy their spat, and, in this case, the beds found to be affected ought to be kept in reserve until it is certain that they have resumed the regular exercise of their func-

tions. This moment having arrived, they should be included anew in the alternation of regular harvesting.

In the present state of things, the regulations of the police which supervise our fishing coasts, prescribe the first half of the month of August for the purpose of visiting the oyster beds and designating those which are to be dredged at the opening of the month of September, which is the legal period for commencing operations; but the commissioners charged with this duty cannot at that time form any exact idea of the actual condition of things; for a large number of oysters have not at this period spawned, and the spat of those which spawned in the month of July is scarcely visible to the naked eye. In order to fully recognize them recourse must be had to a magnifying glass, by which they can be distinguished only after drying, and by one accustomed to researches of this kind. To obtain the most satisfactory results, therefore, it is necessary to defer the inspection of the beds until later in the season, that is to say, until the month of January. By the adoption of this measure the government will find that February or March, and not September, is the proper season for the opening of the fisheries, and by this means alone the yield will be increased at least tenfold.

In fixing upon the first of September as the time for the opening of the fishing season, the government has undoubtedly (in a measure) acted wisely, as the majority of the oysters have already spawned, and there is not much danger of taking from the water the parent oysters still containing the spat in their interior. But this progeny, which, before the spawning, forms in the interior of each milky (*laitéuse*) oyster an innumerable family, after parturition spreads itself over the exterior of the valves, incrusts them, and creates a new population on the surface of the old. Now, if at this time dredging be permitted, the harm resulting therefrom will be almost as extensive as though it had occurred at the period of gestation; for, in taking out the adult oyster, the younger generation will also be removed, at least all that have not deserted their birth-place. The dredge would devastate the fields in full germination like a rake drawn through the branches of a fruit tree while covered with blossoms. This is not one of the least causes of the impoverishment of our coasts. To remedy this evil it will only be necessary to change the opening of the dredging season and make it February or March instead of September. By that time the young oysters of the year will have attained the size of seed-oysters (*huîtres de rejet*), and those that still adhere to the parent-shell can be easily detached, and either returned to the beds, as prescribed by law, or preserved in the *étalages*, as is done at Cancale.

It may be said, probably, that in appointing February as the opening of the season there will be only three months for dredging, as in May the oysters become milky, and dredging is then prohibited. But this objection is not well taken, for six weeks of daily dredging would be suffi-

cient to depopulate the whole coast of France. Besides, the question has already been settled by experience: At Cancale, one of the most fertile districts, the season extends only from March to May. The fishermen of Marennes, from what I learned during my exploration of the bay of Seudre, will hail with gratitude such a measure. It will cause their exhausted beds to be once more restocked, will prevent the complete ruin of those which are still dredged, and, as a consequence, will relieve them from the heavy taxes which they pay to other countries from which they are obliged to obtain their supplies.

It will probably be also said that the interval of three months between the opening and closing of the fishing season will not suffice for the consumption of the crop. But the oysters which are eaten at this season are not then taken from the sea. On the contrary, to be admitted to our markets, it is first necessary that they be kept several months in the *parcs, claires, and viviers*, where they are prepared for their destination. Now, the owners of these *parcs, claires, and viviers*, in which the oysters are brought to perfection, being always able to accommodate more than can be supplied, it follows that the fishermen will always find a ready market for the stock on hand.

While, by the generous intervention of the government, this industry may be extended to all suitable points along the whole coast, the navy department will be enabled easily to follow its progress, if the agents charged with this work be compelled to keep a register not only of the seed beds, but also of the establishments where the oysters are perfected, such as *parcs, claires, viviers, étalages, and bouchots*; if it instructs them each year to give, in this register, a complete description of the beds and to state which are affected and which are thriving; if, finally, it compels them to keep as exact an account as possible of the yield, not only of each bed in particular, but of all the beds contained in their jurisdiction, whether the yield be obtained by dredging or by hand.

This statistical work, which I propose to extend to all the marine products, will form, in the archives of the central administration, a collection of documents from which to ascertain in what proportion these products enter each year into the public food supply, and to determine whether they are increasing or declining: important questions upon which up to this time our knowledge is very incomplete, as I have reason to know from my experience in exploring the sea-coasts.

The methods which I recommend for the creation of artificial oyster beds along the ocean shores are equally applicable to the Mediterranean. While waiting for the special plans which I shall propose for the latter scheme, I think it would be well, sire, to authorize, as a preliminary experiment, the commissaries of the districts in which the ponds of Berre and of Thau lie, to begin at once gathering, from the natural beds of the Gulf of Lyons, in the neighborhood of Cette, a sufficient quantity of seed oysters, to be transported to these ponds, and deposited alongside of each other, on sandy and rocky bottoms, rather than muddy,

which will there form experimental beds. These beds, protected from depredation by a rigid surveillance, will constitute the first step toward the further experiments which your majesty wishes to make in the salt lakes of Southern France.

I am, with profound respect, sire, Your Majesty's humble and very faithful servant,

COSTE,
Member of the Institute.

2.—REPORT TO HIS MAJESTY THE EMPEROR ON THE ARTIFICIAL
OYSTER BEDS CREATED IN THE BAY OF SAINT-BRIEUC.

PARIS, *January 12, 1859.*

SIRE: Subsequent to the report in which, in February last,* I had the honor to submit conclusions for your acceptance, Your Majesty, desirous of testing the conclusions I had arrived at, and of ascertaining decisively whether the promises held out by science in regard to the cultivation of marine products could be realized, ordered that the Gulf of Saint-Brieuc be made the theater of the first experiment at oyster culture by the government, executed by means of its vessels, confided to the keeping of its navy, and destined, in case of success, to serve as a model for the creation along the coasts of France of a vast submarine industry, alike profitable in developing the navy and enhancing the prosperity of the coast inhabitants.

The harbor selected for the accomplishment of this undertaking has a solid bottom, naturally clean, composed of shells or coral, thinly covered with marl or mud, with scattered eel grass (*pailleul*), covering an area of 12,000 hectares everywhere adapted to the sojourn of the parent oysters. The current, which at each tide sets from northwest to southwest and from southwest to northwest, at the rate of one league per hour, brings in fresh waters continually, carries off all unhealthy deposits, and gains by rushing upon the rock-bound coast all the vivifying properties which such constant aeration communicates to it.

The excellent bottom, the active nature of the limpid waters which cover it, unite, then, over this immense submarine domain all the conditions favorable to the multiplication and development of this article of food, which I propose to introduce there, and the products of which we are endeavoring to transform into an inexhaustible annual harvest.

But while in its work of intervention and conquest science recommended this as an enterprise of great public benefit, empiricism and old fogysm condemned it in advance as rash and visionary. It is only necessary, sire, to recall the various obstacles which had to be overcome, and the amount of perseverance required for the realization of a scheme, the marvelous results of which I already have the honor to make known

* See preceding report.

to Your Majesty; a scheme which aimed to retain on the spawning beds, by means of a simple device, the seed which in a state of nature is dispersed by the currents, and to create sources of wealth wherever the bottoms are not subject to the invasion of mud.

No region along our coast offered at the same time so vast and so appropriate a theater for drawing public attention to the solution of this double problem; for the bottoms are undisturbed, though the currents rush over them at times with such violence that superficial thinkers judged this to be an inevitable cause of failure. Everything there depended on a triumph of art over nature, for it was necessary not only that material from various provinces should be transplanted to a foreign land, but also that the progeny of this exiled population be protected from the perturbation of the waters.

It will not be out of place, sire, for the honor of science, to state here in detail how the dominion of the sea is made accessible to industry, for, in providing new methods applicable to the business, it creates, for its abstract studies, instruments of investigation which extend its range to regions yet unexplored.

The planting of the reproductive oysters, opened in the month of March, closed under my own supervision towards the end of April. In this brief period 3,000,000 of individuals, some taken in the high seas, others at Cancale, and others from Tréquier, were distributed over ten long beds, situated in different parts of the gulf, and together representing an area of 1,000 hectares; beds previously traced on a marine map, indicating the productive fields, and provided with signals intended to facilitate the movements of the vessels engaged in the stocking. But in order that the planting should be done with the regularity of a practical farmer, and that the mother oysters should be sufficiently separated so as not to interfere with each other, a government steam-vessel, first the *Ariel*, and then the *Antelope*, towing the launches, and a *basquine* filled with oysters, would make alternate trips to either extremity of the line, where a small boat, placed crosswise, designated the spot upon which operations should begin. Then, steaming to the other end, designated by another boat, it would go around this in following the long axis of the rectangular space designated by the flag signals, and return to the starting point, like a plow which makes two parallel furrows in a field.

While our tow-boat was thus engaged, the sailors belonging to it were placed on board the accompanying launches and employed in emptying the hampers, filled with oysters, which they had previously arranged in rows along the decks, and as they were gradually thrown overboard they sank to the bottom and spread themselves over the surface intended to become stocked by their seed. To insure the success of the work, it was not only necessary that the oysters should be planted under the conditions most favorable to their propagation, but also to build around and above them efficient means of securing the progeny and of compell-

ing it to fix itself on the beds where it had commenced to spread; for the planting took place at the time of the first spawning.

This second end, which transforms the gulf planted into a species of submarine farm, undergoing the various processes of rational cultivation, has been accomplished, by means of two contrivances, the simultaneous employment of which has already furnished immense results, and which in the near future will permit the increase of the supply to any extent that may be desired, provided propagation keeps pace with the demand.

One of the contrivances consists in covering the productive bottom with oyster or other kinds of shells, so that every single embryo that sinks shall find a solid body to which it may cling. The shells which we used for this purpose were gathered on the beach at Cancale, by order of M. de Bon, chief of the maritime service at Saint-Servan, who was kind enough to lend us his assistance, and were brought to the gulf by a special convoy of fishing smacks, and scattered over the artificial beds in my presence. These shells, otherwise useless, which must be cleared away from the beach at great expense every year, so that they may not encumber it, if carefully preserved hereafter, will become, after drying, valuable instruments of culture.

The second appliance, which is designed to secure the embryos carried away by the currents, and to receive them on solid bodies placed under the tide-whirls, which do not extend to their depths, consists of long lines of small bundles, placed crosswise like intersecting bars, from one end to the other of each bed. These bundles, perfect collectors of seed, formed of branches from 2 to 3 meters in length, tied in the center by means of a rope to a stone, which holds them 30 or 40 centimeters above the bottom, were put in position by men wearing cork jackets, who were instructed to place around each stone a few oysters about to spawn. The rope, which the haste of the first experiment made it necessary to use for anchoring this apparatus, will, of course, soon rot, and it may be necessary to replace it in future by chains made of galvanized iron, which can be constructed in our arsenal shops, and which will form a part of the permanent outfit of this new culture.

Bearings, carefully taken, form, on special charts well plotted, the means of identifying the points where each line is sunken, so that there will be no difficulty in finding each one in succession, of raising the bundles and removing the crop of oysters, as easily as the farmer gathers the fruits from his trees.

Two government vessels, the *Pluvier* and the *Éveil*, stationed at opposite points in the gulf, one at Portrieux, the other at Dahotet, visit each day the artificial beds, while a small cutter, which was constructed by Your Majesty's orders, at my request, steams up the gulf and helps to complete the surveillance, besides rendering other necessary assistance in carrying on the work. This little cutter, which is almost indispensable in the enterprise, should be placed under the im-

mediate orders of M. the commissary of the marine at Saint-Brieuc, so that my daily instructions can be promptly executed by a force selected by that agent of the administration. I think, sire, that it is my duty to insist that this essential part of the programme be not forgotten.

These, sire, are the initiative means which have been adopted for the fertilization of the gulf. Hardly six months have elapsed since they were put into execution, and already the promises which were held out by science have become startling realities. The treasures accumulated by the persevering application of these methods in these fully developed fields exceed the most sanguine expectations. The mother oysters, the shells which were scattered over the bottom, in fact everything brought to the surface by the dredge, is covered with spat; the beach itself is thick with them. Never at Cancale or Granville, in the eras of their greatest prosperity, was such a spectacle of immense reproduction witnessed.

The bundles bear in their branches and on their smallest twigs bouquets of oysters in such profusion that they resemble the limbs of our fruit trees, which, in spring, are hidden by the profusion of their blossoms. They look like veritable petrifications. To believe such wonders it is necessary to be an eye-witness of them.

In order that Your Majesty may judge with your own eyes of the extent of these treasures, I caused to be transported to Paris one of these appliances for collecting the spat, together with specimens taken from the several beds; these will testify eloquently in behalf of our successful efforts. The young oysters which cover them are already from 2 to 3 centimeters in length. They are simply the seed which, in eighteen months, will ripen and yield an immense harvest. On one bundle alone, occupying no more space in the waters than a sheaf of wheat in a field, as many as 20,000 were found. Now 20,000 oysters, when they are of edible size, represent in value 400 francs, the current price being 20 francs per thousand on the spot. The revenue from this industry will therefore be immense, since one may put down as many spat collectors as he wishes, and since each adult individual forming part of the bed will furnish not less than 2,000,000 to 3,000,000 embryos. The bay of Saint-Brieuc will become in this way a perfect storehouse if, by the junction of beds already formed, we convert the whole area into a vast productive field.

All the arrangements necessary for the accomplishment of this great scheme can be promptly executed, sire, if the prosecution of it be entrusted to those from whose intelligent zeal I have received so much aid up to this time. The experience which they have acquired in these first operations is a guarantee that what remains to be done will be brought to a successful issue.

I therefore hope that, in order that I may retain the indispensable assistance of two fellow-workmen, Your Majesty will deign to reward

their zeal, and appoint from the list of officers M. Levicaire, chevalier of the Legion of Honor, and wearing the medal of Saint Hélène, who, unites with the best record thirty-nine years of excellent service, and ought to be raised to the rank of commissary of marine at Saint-Brieuc; and that M. Bidaut, lieutenant in the navy, a chevalier of the Legion of Honor, with nineteen years of excellent service to his credit, will be kept in command of the *Pluvier*, with all his crew, beyond the ordinary period, that is to say, until the scheme that we are now engaged in be entirely accomplished.

With the assistance of these two distinguished officers and the aid of an inspector of fisheries, whose appointment should be immediate, so that the bay of Saint-Brieuc may be placed on the same footing with Cancale, Granville, and Marenes, we hope in less than three years to unite all the beds, and have the whole surface of 12,000 hectares under full cultivation. An annual appropriation of 10,000 francs will suffice to carry on the work of clearing out the bottoms, buying supplies of seed oysters, gathering shells, repairing the structures for holding the embryos, organizing other beds of acclimatization like the one already established at Plevénon, and for the creation of perfecting-*claires*, where the fattened oysters are improved by becoming green. When this project is accomplished, the inhabitants of the sea-board will find in the gulf, as in a very productive field, an inexhaustible supply provided by generous foresight, and will witness on the shores an example of the different methods and practices connected with this oyster industry. It will prove at the same time a lesson and a great benefit.

If Your Majesty consent to this proposition, I shall immediately transmit to the commissary of the marine at Saint-Brieuc, and to the commander of the *Pluvier*, all the instructions necessary in executing these delicate operations. But to preserve our artificial beds one more measure must be brought into requisition; to order the dredgers to obtain their supplies at greater distances from the beds, where they may rake the bottom without injuring an enterprise commenced under such happy auspices.

To sum up, sire, the experiment made in the bay of Saint-Brieuc has been attended with such decisive success that the lessons it teaches cannot be ignored. It proves, by a splendid result, that whenever the bottoms are free from mud and slime, industry, guided by science, may reap from the depths of the sea, fertilized by its care, more abundant harvests than can be obtained from the earth. I deem it, therefore, my duty to recommend that Your Majesty order the immediate restocking of all our sea-coasts, that of the Mediterranean as well as of the ocean itself; that of Algeria and of Corsica, not excepting all the salt lakes found in southern France, the fruits of which, by multiplying, will become a source of wealth to the poor people who inhabit the shores. But, in order that these operations may be successful, it is necessary that a swift propeller of light draught should be built and devoted exclusively to this

service; which vessel, during the spawning season, should be subject to my orders, so that I may visit all the centers of these great phenomena of natural reproduction, where science promises to industry precious revelations.

Captain Isidore Le Roy, known to the government by his studies upon the fisheries, a pilot experienced in the waters which are to be the scene of our work, well qualified in mechanical arts, and officially recommended for the surveillance of the first and second naval districts, could render me much aid if he were invested with the command of this vessel, heretofore mentioned as necessary to the execution of our plans; and in case Your Majesty sees fit to appoint him my coadjutor, he should at once report at the College of France, there to be instructed, under my direction, in all that pertains to the cultivation of marine products.

Among the measures to be taken for the accomplishment of this object, there are, sire, some which experience has already demonstrated to be efficacious, and which, by their immediate application, will produce certain results. But, besides these known facts, there are mysteries which persevering study alone can reveal, and which should be made the object of serious investigation. It will then be necessary to open along our shores vast laboratories, where scientific experiments may be performed, which will furnish new means for the extension of empire of industry. The saline lakes of Southern France, the bays of the ocean, those of Algeria, of Corsica, &c., offer the best opportunities for organizing great districts to be gradually transformed at Your Majesty's desire into supply centers for the seeding and cultivation of the sea.

The different edible species admitted by turns into those zoological gardens, so to speak, would be, like the animals in our stalls or in our parks, under the observant eye of those charged with the duty of studying their laws of propagation and of development, investigators placed there, as a branch of my laboratory of the College of France. It will then be necessary to enlarge the study rooms and increase the *personnel* and endowment. A skilled artist with his brushes will give a representation of each curious discovery which shall be made in this living museum, and thus prepare plates for one of the most important publications with which the annals of natural history will ever be enriched.

The unexpected phenomena which I witnessed at Concarneau, in the small ponds of Pilot Guillou, left no doubt in my mind as to the great serviceability of an establishment which will place in the hands of the government the necessary means for executing a work of public utility.

In the age when, by a sovereign application of the laws of physics, an invisible flame carries thought through conducting wires with which the genius of man has encircled the earth, physiology will exercise its empire over organic nature by an application of the laws of life.

I cannot conclude this report, sire, without expressing my thanks to Admiral La Place, *prefet maritime* at Brest, for the energetic assistance which he gave to our enterprise, by confiding its rapid execution to the

combined care of the commandant of the station at Granville and to the chief of the maritime service at Saint-Servan.

I am, sire, with profound respect, Your Majesty's very humble and very faithful servant,

COSTE,
Member of the Institute.

After the above report was made, M. Levicaire was promoted to the grade of officer of the Legion of Honor, and M. Le Roy was appointed to the command of the Chamois, a steam-vessel which was placed at the orders of those superintending the restocking operations. M. Bidaut, lieutenant of the Pluvier, was retained in command of that vessel.

3.—REPORT TO HIS EXCELLENCY THE MINISTER OF MARINE, ON THE RESTOCKING OF THE BASIN OF ARCACHON.

PARIS, *November 9, 1859.*

SIR: In the first edition of a work which is now being republished by order of the Emperor, I demonstrated five years ago, by the help of numerous facts observed at Marennes, at Tremblade, and at the isle of Oléron, that oysters reproduced themselves in as great profusion in the *claires*, *viviers*, and *étalages* as in the open sea.

At the sight of these revealed sources of wealth, I announced that, by means of appliances for collecting the seed, all the establishments organized along the coasts would soon be transformed into productive areas, where, without quitting the land, the coast inhabitants would have in their hands the inexhaustible treasure which science offers to labor; and I described the instruments which were to be used in securing the possession.

I hope, sir, in the presence of the wonders accomplished under the eyes of the astonished inhabitants, henceforth anxious to take part in the prosecution of a work in which they, at first, had no confidence whatever, that your excellency will permit me to restate here the means employed, so that it may again be shown that the most abstract knowledge is everywhere the lever employed in attaining most wonderful results, in the great workshop where the genius of man extends its empire over the world. As I said before: "Each establishment, being thus transformed into a veritable manufactory where all the conditions are created by the genius of man, and varied at his pleasure, would at the same time answer the purpose of artificial beds and of appliances for perfecting the yield, giving in this manner constantly renewed products. The deposit of mud being the only obstacle to the preservation of the progeny of the oysters in the *claires*, there is a simple method of saving the spat, which is to place at a certain distance above the bottom, within their reach, and in such a position that the mud cannot interfere with them, solid bodies upon whose surface the oysters may cling. If

in building these resting places preference be given to stakes, they should be planted in a vertical position, either driven in the bottom or fastened to floating rafts. These rafts would have another advantage: they could carry movable planks, placed obliquely one by the side of the other, like the slats of a window-blind, so that one side would always be free from contact with the mud. These movable planks, when once filled with seed, could be taken apart and suspended vertically to the frame-work of the raft. These, however, are initiatory details, the application of which may be varied according to the dictates of experience."

The first models of these plank collectors, whose efficiency as a means of collecting the seed has been tested along our whole sea-coast, had certain disadvantages which rendered them insufficient for practical purposes. One objection is, that they offer but a limited surface to adhere to; and another is, the difficulty in gathering the crop, as the young oysters attach themselves to the surface in such a manner that in removing them one part of the valve is frequently left adhering to the wood.

The problem, then, is not whether the spat may be cultivated in new grounds, for that fact has long since been demonstrated by science, and is known to all oystermen, but to discover some economical means of gathering large numbers of embryos in a limited space, and of easily removing them from these temporary repositories. It is necessary, in short, to organize hive-like structures where the mother oyster can deposit her young, like the queen bee, in myriads of cells so arranged that the swarm may be removed and renewed. This apparatus of precision places the work of nature under complete shelter, and carries the business even to man's habitation, where the saline waters, invigorated by a communication with the sea, are retained by artifice. By such means every point will be occupied by the spat, and they may be easily removed and multiplied.

The idea of applying these hive-like structures to the cultivation of the oyster, whether in bottoms sometimes exposed or always covered, has already made a decisive advance in the bay of Arcachon by the combined efforts of Drs. Lalesque and Lalanne, who bring their physiological knowledge to bear upon the new methods. The first named of these park-owners has converted my plank collectors into inclosed spaces, or submerged boxes, where the spawning is as effectual as when the oyster enjoys complete freedom, and so arranged that the young are entirely protected from the currents. The second is applying himself to the problem of *multiplication of surfaces* by doubling the height of the propagating cells by means of *artificial stalactites* made from a mixture of three parts rosin (*brai*) to one of tar (*goudron*). This mixture, poured while hot on the prepared plank surface, gathers up the pieces of shell with which it is sprinkled, and, in cooling, substitutes for a hard, smooth platform, a rough, jagged, and friable surface, from which the spat can be easily removed and attached to other parts of the seed-plots on the *étalages*.

The collecting appliance thus modified is of a much more practical character, as the artificial stalactites form an inclosure where the oyster can be reproduced, and from whose surface the young can be easily removed. But even with this improvement it will be insufficient for the necessities of an industry which has so suddenly assumed colossal proportions, unless the interior of the structure be filled with fagots and branches, among which the embryos find unlimited space for spreading themselves. Thus sheltered, the branches, kept from contact with the mud, will, as I have already frequently demonstrated, be more abundantly filled with the embryos than if exposed in the open sea. But whether the industry be prosecuted upon the naked planks or in artificial stalactites, whether upon inclosed or open wicker-work, whether upon surfaces sometimes exposed or always submerged, it is still the same industry, furnishing everywhere proofs of incomparable success, and organizing effective appliances for fertilizing all the coasts where its development may be attempted.

Thanks to the rapid progress already made in this industry, it is now possible to retain in a space of a cubic meter in extent more than 100,000 embryos. So that with a simple outfit of twelve or fifteen hives of the dimensions given a million individuals may be obtained, which can be raised in a space of one hectare.

Now these oysters, representing in the pond when they have attained marketable size a value of at least 25,000 francs, it follows that, from the 800 hectares of surface in the bay of Arcachon suitable for this oyster culture, an annual revenue of 12,000,000 to 15,000,000 francs may be derived. What wealth for France, and what a lesson for the people!

A simple arrangement of the productive bottoms, a watchful care, and the necessary appliance for collecting the seed, will give this wealth and this salutary lesson.

Although the entire bay of Arcachon may be transformed into one vast oyster-bed, there are two localities, the point of Germanan and the space comprised between Estey de Crastarbe and the port of the island of Oiseaux (bird island), which are best adapted to the purpose of reproduction. The muddy, pebbly, and uneven bottoms will afford every opportunity for the various methods.

I have, therefore, the honor of proposing to your excellency that the government agents be ordered to proceed at once to the organization of two kinds of model farms, which will be at the same time public storages for seed and great areas for the concentration of the harvests.

The superabundance of seed which the collecting apparatus cannot hold will spread far and wide over the shells and artificial repositories with which the bottom of different parts of the bay will be covered, and will furnish, both to the hand fishery and the boat fishery, a continually renewed source of food. This portion of the harvest will be common property.

Those which develop in the reserved cantonments will be distributed in lots to the most zealous seamen, to whom this loan or generous gift will be a means of cultivating, on their own account, beds, ceded by the government, and thus creating for themselves a first capital, by which they will pass from a mercenary or laboring condition to that of cultivators. *This will be part of the recompense.*

But in order that nothing shall be left undone that is calculated to expand the business, it will be well to admit, to a certain extent, private enterprise to the benefits of the concessions, obliging it to be associated with the fishermen, whose rights will be protected by contracts made before the proper authority. So that, without making over anything, the government can aid the development of the industry and attract those who, witnessing its prosperity, feel disposed to engage in the pursuit.

If your excellency consent to this plan of organization, the commissary of maritime inscription at Teste will have ship-loads of shells taken from the Matoc bank, situated at the entrance of the bay, and carried either by the fishery-police boat or other vessels and deposited in the places designated to receive the spat. But before spreading them over the bay, they should be exposed to the sun a sufficient time to destroy any deleterious animals that may live in or cling to them, so that they will not be deposited in the oyster beds to increase and multiply.

In carrying out the details of this general arrangement, about 1,000,000 breeding oysters, procured either in the channels where fishing is prohibited or in the markets, should be carried during the following months of March or April to the places I have designated for the creation of the two model establishments. These oysters should be submerged, as in the ordinary *étalages*, in parallel rows, between each of which a path must be left for the laboring men, who, during the highest tides, will be occupied in the restocking operations. But in order to avoid the injury incurred by leaving the oysters exposed too long to extremes of heat or cold, such places as are less frequently left dry should be selected for depositing them.

Above each of these level rows boxes 3 meters long, 2 meters wide, and 60 centimeters in depth, built of fir planks, are to be placed in line, end to end, and held at a certain distance above the bottom by means of stakes, to which they must be securely attached. These boxes, divided into two compartments by wooden partitions, something after the manner of a traveling valise, will receive in the upper story as many fagots as can be placed under the cover, which is provided with artificial stalactites; the covers should be arranged on hinges, so that the operations of nature may be watched without interfering with them, and any causes that might prove an obstacle to them be easily removed. By the side of these appliances, placed like bells, receiving in their open lower part the spat which escapes from the *étalages*, a few completely closed should be built, the sides of which should be pierced with holes to allow the free

flow of water; and in these pens, filled with branches, a few oysters about to spawn should be placed, in order to ascertain whether these collectors will retain more or less seed than the first.

In other places, the work will consist simply in placing wicker-work beneath planks, fastened by cross-pieces to stakes. The ceiling of this plank structure, being roughened by adhering chips, will furnish to the spat points of support which will replace the artificial stalactites.

I have had constructed by the crew of the Chamois models of these different instruments of cultivation, and will place them at the disposal of the government when it is desired to introduce them.

In the center of each of these school-farms a pontoon surmounted by two rooms will serve as a lodging place for the persons in charge of the apparatus, who will act in concert with the maritime guards of Dauris, Séveillard, and Daillon. These guards are all devoted to the work, and the first named have excited special remark by their ardent zeal. In order, however, that these agents may derive from their employment a livelihood, I hope that their salary may be raised to at least 800 francs, whether in the form of a temporary grant, or as a permanent salary. The watchmen of the two pontoons, two men to a pontoon, will be taken in turn from the crew of the police-boat; for the personnel of the fleet, being under a rigid discipline, offers a guarantee of faithfulness.

In the present condition of things the general surveillance of the bay is insufficient. There are in a circumference of 18 leagues containing 10,000 hectares of surface, three maritime guards, the inspector of fisheries, and a small cutter commanded by a skipper. So limited a force is evidently insufficient to meet the exigencies of the service. I therefore recommend that the maritime guard be increased to six, their pay doubled, and that the inspector of fisheries be promoted to the first class, so that increased responsibility may be rewarded by increased pay. I also recommend that the actual guard be stationed at the far end of the bay towards Gujan, and the employment in addition, of a screw-launch of 25 or 30 tons burden, of light draught, constructed upon the model of those used in the light-house service, and commanded by an ensign or lieutenant.

With these means of action, and the aid of private enterprise, an appropriation of 20,000 francs would be sufficient to transform, in two years, with profit to all and honor to the government which extended its help to the enterprise, the bay of Arcachon into a veritable field of abundance. This bay then would produce upon its stocked depths, by means of appliances prepared beforehand, immense harvests, the extent of which may be calculated in advance by the result which the permanent depots have already begun to accumulate.

But shell-fish will not constitute the only harvest taken from this fertile tract. The government can easily create along the coast a no less precious source of production, by building reservoirs connected by trenches with the sea, through which the excess of fish spawn can be

carried into the interior; this question has been controverted, and to its discussion I will in a future report call your excellency's attention.

While awaiting your decision, sir, I beg you to accept a renewed assurance of my respectful consideration.

COSTE,
Member of the Institute.

In accordance with the conclusions arrived at in the above report, two establishments, to be used as models, are already in operation at the designated places in the bay of Arcachon. A second police-boat, the brig *Léger*, commanded by Lieutenant Blandin, is charged with the surveillance of the bay, and co-operates with M. Filleau, commissary of maritime inscription of that region, in the cultivation of the two beds created by the government. One hundred and twelve grantees (*concessionnaires*), associated with registered seamen, now follow this new industry over an extent of 400 hectares which the government has ceded to them.

4.—APPLIANCES SUITABLE FOR THE RECEPTION OF OYSTER SPAT.

Young oysters, after leaving the parent shell, move about in the waters, here and there, seemingly in search of the most favorable conditions for their adherence and their subsequent development, preferring solid bodies, with a slightly roughened surface, protected from the mud. It is for the purpose of creating similar conditions that the appliances, of which a compendious description is herewith given, were invented.

These various appliances, when used in the *parcs, claires, viviers, étalages*, natural beds, &c., which are left dry at each tide, or only during equinoctial tides, should not be put in place more than a week or two previous to the most active period of the spawning season, that is to say, during the first fifteen days of June, or towards the end of that month, if the hot season be early.

THE PLATFORM COLLECTOR.

The platform collector will cover only a limited space, if but one compartment be used, but may be extended over a vast surface if its compartments be multiplied. Its construction is such that the labor of one person is sufficient to manage its different operations. Wherever the oyster is cultivated it may always be used, if it be so arranged that at any time after the young oysters have attached themselves it may be taken apart and transported to such places as may be desirable. It has an additional advantage, in that it protects the embryos from the mud, which would smother them at their birth, and also shields them from most of the animals that feed upon them.

The platform collector, with multiplied compartments (Fig. 1), consists of several series of double stakes (A) separated by a space of 12 to 15 centimeters only; arranged in squares like a chess-board, at a distance of about 2 meters from each other, and divided by passages for convenience of cultivation (E) about 60 or 70 centimeters in width. Two corresponding holes, the first at 50 centimeters from the bottom of the bay, and the other 25 or 30 centimeters above the first, pierce the coupled stakes. A pin (I), either of wood or iron, passed through the lower hole, converts the stakes into a kind of trestle, and serves as a resting-place for cross-pieces made of a single piece of timber (B), at least 2 meters and 20 centimeters in length, and from 10 to 12 centimeters in diameter. These cross-pieces should be solid, because they are to bear the weight of the flooring, consisting of planks (D) supported horizontally at their extremities by the lower cross-pieces, and placed as close together as possible. Other cross-pieces (C), of the same length as those already mentioned, placed above the planks, and held together by pins (J) passed through the upper holes, keep all the planks in place. If it should happen that there be too much play between the upper pins and the cross-pieces they hold in position, a wedge (Q) placed between the two will prevent this inconvenience. Wooden wedges (Q') serve also to fasten such planks as are too movable. Whenever it is desirable to take the planks apart, either to carry them to some other supports, or to turn them and isolate the young oysters, which are large enough to resist the deleterious action of the mud, or to inquire into the state of the crop, or examine the surrounding bottoms, all that is necessary is simply to pull out the upper pin (J') and remove the cross-pieces (C') that hold the planks down. The wood best adapted for making these planks is that of pine or spruce; the planks should be from 2 meters and 10 centimeters to 2 meters and 15 centimeters in length, and about 20 to 25 centimeters in width; one side of which is made rough with an adze, the chips to be left adhering to the plank. These chips which project 2 to 3 centimeters, offer a larger and better surface to the embryos, and also make it easier to gather the oysters which adhere to them. The chips may be replaced by a bed of shells of cockles, clams, scallops, mussels, or of pebbles as large as a nut, which can be fastened to the planks with a cement made of tar and rosin. Finally, to increase as much as possible the points to which the spat may fasten themselves, small branches of chestnut, oak, vine cuttings, &c., are tied on to the planks (DD), holes being bored through them for the purpose.

In *parcs, viviers, &c.*, where the bottom is rocky or hard, and piles therefore cannot be used, stones should be used as a substitute; these (G) should be about 70 centimeters high and 25 centimeters thick, pierced at certain points with holes sufficiently large to receive the cross-pieces (B C), and also a wedge (H) to hold the latter in place, and held in position by masonry or by means of iron clamps.

ROOF COLLECTOR.

The *roof collector* (Fig. 2) may be used advantageously instead of the stones, which serve at some points, for the purpose of keeping the spat in the *parcs*, or it may supplant the wooden collectors where these are subject to the invasion of teredos and of other wood-eating mollusca.

The *roof collector* is supported on trestles made of cross-pieces nailed to stakes, which rise above the bottom from 15 to 20 centimeters.

The number of trestles is increased or diminished according to the area which is to be covered.

The tiles, which are the chief elements of the roof, being susceptible of different combinations, allow the form to be varied at will.

These tiles may be arranged in parallel and contiguous rows, and thus form a simple complete roof.

In all the *parcs* where the action of the water is very strong the different rows of tiles should be secured to one another by means of a galvanized iron wire, or with stones placed here and there over their surface.

A double roof may be formed (Fig. 3), consisting of an open work of tiles covered by a series placed close together.

The tiles may be placed between wooden supports (Fig. 4) in rows, covering, without touching each other, and forming, with the bottom upon which they rest, an angle of from 30 to 35 degrees.

They may also be arranged in the shape of a tent, with both ends open and more or less extended, as in Fig. 5.

In this last combination, the tiles touching the bottom will act as a mutual support to one another, and can be strengthened by placing stones along the line of contact with the bottom; thus the use of wood becomes unnecessary; the apparatus is consequently protected from destructive animals. The embryos can be gathered from this kind of collector more easily and with less loss than from those made of stones.

HIVE-COLLECTOR WITH MOVABLE TRAYS.

The hive-collector with movable trays, although of limited dimensions, offers, nevertheless, to the spat multiplied points upon which to fasten themselves, and the independent collectors, which form the essential elements, offer the most favorable conditions for the complete development of the young oysters.

This apparatus (Fig. 6) is composed of an enveloping part, consisting of a chest made of light wood, rectangular in shape; measuring 2 meters in length, 1 meter in width, and 1 meter in height; without a bottom; with a cover made of several pieces (D), held in position by a cross-piece (T) passed through cleats at the handle (A). The chest is bored at the extremities with a double series of holes, either square or round, corresponding to each other, and large enough to admit beams of 6 to 7 centimeters in diameter (S); it is held together on the sides by

battens of wood (R), which correspond to traverses of the same size placed across the bottom (Q). In order that the water may circulate freely in all parts of the structure, the vertical bands (R) should extend some 10 centimeters below the bottom of the chest; the planks that form the partitions ought also to be placed 2 or 3 centimeters apart, or be pierced with a great many holes (O).

In this chest wooden trays of about 4 centimeters in thickness are placed, having two handles opposite each other (Figs. 7 and 8), and furnished on the opposite side with a screen of brass wire with meshes 2 centimeters in size; the bottom is held in place by means of cords, nails, or galvanized iron wire. A median cross-piece (Fig. 7), consisting of two copper rods placed at right angles to each other, fastened at the ends, either to the angles of the frame (Fig. 8) or to the middle of its arms, increases the strength and helps to support the wire gauze.

To make the work all the more easy, the trays ought to be square, of only one-half the size of the interior surface of the chest, so that it will be possible to place two of them on the same supports, as shown in Fig. 9, and there should also be sufficient space between them so that they may be removed or put in place without difficulty.

Finally, shells of different mollusca, of medium size, such as the ordinary mussel, the edible cockle, commonly called *coque* or *sourdon*, of our various species of *Venus*, &c., form an indispensable part of this apparatus.

The method of putting the various parts together is very simple (see Figs. 6 and 9). After having placed the chest on the strips of timber which extend beyond its bottom, and having placed under these a flat stone which prevents them from sinking too far into the earth, some sixty odd selected parent oysters are spread in the vicinity; then, in the lower openings of the ends of the chest the first two supports (SS) are placed, on which two trays are laid, which are previously covered with a bed of mussel or cockle shells, above which other spawning oysters are spread. This first tier being arranged, the second is proceeded with, and then the third, in the same manner except that in the third no mother oysters are admitted.

The whole is then covered with notched planks (D), which are held in place by means of a cross-piece passed through iron handles and tightened with wooden wedges (C). These handles being fastened in two posts solidly attached to the ends of the chest (P), it follows that in holding down the planking the cross-piece also keeps the whole structure together; additional strength can be given to it by nailing to the sides two other independent posts (P'), shorter than the first, but as deeply imbedded in the earth.

Five or six months after the spawning, the young oysters having attained sufficient growth, the apparatus is taken apart piece by piece by an inverse operation, that is, proceeding from top to bottom, and the contents of each frame are carefully placed in some *parc, étalage*, or *vivier*, in places least affected by currents and mud.

PAVING-STONE COLLECTORS.

Oyster spat is also gathered upon blocks of stone, such as are sometimes used in parks; this practice obtains in the neighborhood of La Rochelle, and notably at Laleu and the isle of Ré.

These stones, irregularly and obliquely arranged one against the other, serving for mutual support, should form numerous winding caverns, whose arches are protected from mud, and afford numerous large spaces where the young oysters may fasten themselves.

The paving-stone collectors can be constructed at small cost, and each one of them offers, also, the advantage of accommodating two crops; all that is necessary to accomplish this is simply to return the blocks to the same places from which they were taken, and arrange them as nearly as possible in the same position as they originally occupied.

By this operation the oysters fastened to the lower surfaces are placed in a full light, which is a most favorable condition for their growth; while the upper surface of the stones, when reversed, furnishes to succeeding generations shelter and an excellent surface for their adherence.

But while these paving-stone collectors offer incontestable advantages, they are also open to grave objections, made evident by experience. The oysters are apt to fasten one whole side of the valve to the stones, and hence cannot be removed except with great loss; and then again, those that are not attached in this manner are liable to contract defective shapes.

It is not only necessary that large quantities be produced, but also that the product may be easily gathered, and that the oysters have a desirable form.

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