Dean (B.)

[ARTICLE 14.—EXTRACTED FROM THE BULLETIN OF THE U. S. FISH COMMISSION FOR 1890. Pages 363 to 388. Plates LXVIII to LXXVIII.]

REPORT

ON THE

Present Methods of Oyster-Culture in France.

BY

BASHFORD DEAN.

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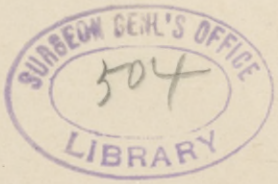

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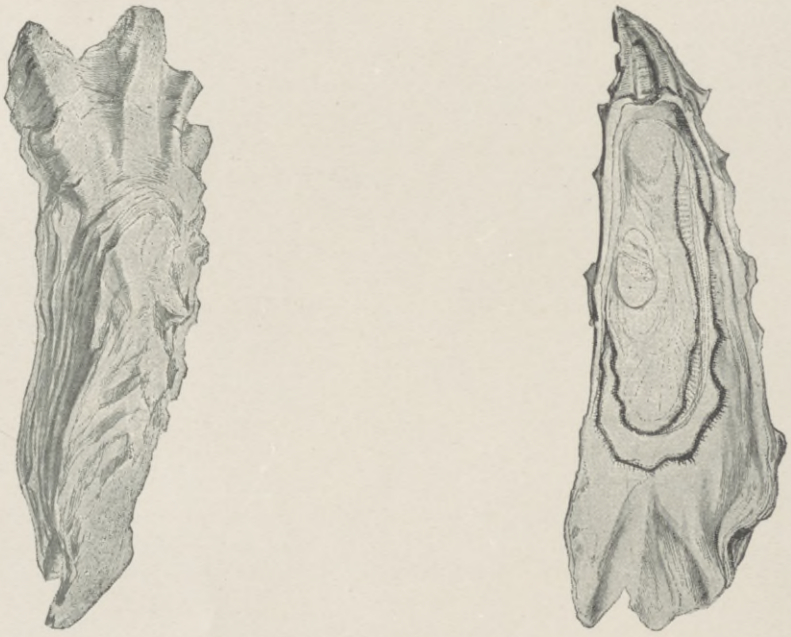
FIGS. 1, 2. FLAT OYSTER, OSTREA EDULIS. SPECIMEN FROM BELON, TWO AND A HALF YEARS OLD. Natural size. Limit of size of *edulis* is about 4" × 4". These old individuals were formerly regarded as a distinct species, *pied de cheval*, *O. hippopus*.



FIGS. 3, 4. PORTUGUESE OYSTER, OSTREA ANGULATA. SPECIMEN FROM THE TAGUS, ×½. (Page 365.)

(Figures from drawings by the author.)

14.—THE PRESENT METHODS OF OYSTER-CULTURE IN FRANCE.

BY BASHFORD DEAN.

I.—INTRODUCTION.

The studies upon which the present report are based were conducted by the writer during the summer and autumn of 1891, under instructions from the United States Commissioner of Fish and Fisheries. The discussion of the results of his observations has been made as pertinent as possible to the conditions of the American waters.

When one has carefully examined oyster-culture in France, it appears more than ever manifest why the industry at home has been a profitable one. It has certainly required the exercise of but little labor, and all costly methods of cultivation could have proven of little practical value. So great has been our natural supply of oysters that we have always thought far distant the need of replenishment.

If, however, the present condition of our industry must be improved, there are fortunately but few natural obstacles to overcome, and we may well be hopeful. Our oysters are of a hardy and prolific species, our coast is a natural collecting-place for seed, and the conditions of our oyster-bearing grounds are practically as good as ever. We have in no degree the adverse conditions that the French have so successfully encountered. Their coast regions, in the first place, favorable to a natural growth of oysters, are both few and small. Their waters, even in some of the best-known localities, are often turbid, accumulate sediment, and give rise to shiftings of muddy bottoms. Culture has had to bring into use the softest flats and mud banks, crusting them over with gravel and sand; it has had to devise every possible way of protecting its oysters from sediment, mud burial, and enemies. Finally, there are but two points along their entire coast where seed oysters occur in any natural abundance. Skill in culture, however, has enabled Arcachon and Auray to supply readily the great home demand for seed, and even to furnish in large part the parks of the Low Countries and England, a success the more remarkable when we consider how recently was the French coast so depleted that for the first experiments in cultivation the oysters were actually purchased from other countries.

Natural difficulties have caused the French to study division of labor in the industry; to make, for example, one locality furnish the seed, another to raise the oyster to maturity, a third to flavor or color it, and sometimes even a fourth to prepare it for transport.

Under these conditions the growth of the industry has been especially and almost entirely dependent upon the wise action of the Government. The reservation of the

natural grounds as state property and the forbidding of general public dredging is generally regarded as the keystone of French oyster-culture. These grounds, once exhausted, now flourishing, are regarded as the permanent capital of surrounding areas, whose profits in the form of seed oysters are shared by all alike.

The state exercises the additional right of surveillance in the interest of culturists through the local commissaires of marine, and of regulating and changing the terms of state rentals.

The industry is a profitable one to the culturist. To the state it returns in rentals a greater revenue yearly than the total sum expended in the failures of Coste. Competition, moreover, on the side of the culturists is operating more and more favorably for the people, insuring a product for general consumption.

Throughout my visits of inquiry every courtesy was extended to me by oyster-culturists. The inspector-general of fisheries, M. Bouchon-Brandely, gave me most important aid and counsel, while the minister of marine, M. Barbey, instructed the commissioners of marine at the different oyster stations to facilitate my observations in every way possible. The following localities were visited, designated mainly by M. Bouchon-Brandely as typifying the branches of the oyster industry: Cancale, Roscoff, Belon, L'Orient, Auray, Breneguy and Trehennarvour, Trinité, Vannes, Sables d'Olonne, Marennes, La Tremblade, Rocher de Der, Arcachon, La Teste, and Ossegor.

Oyster-culture in France is decidedly of recent origin. It is but little over a half century ago that the natural oyster banks of the coast were, like those of the Chesapeake, deemed inexhaustible, and were still allowed to be dredged even by foreign vessels. The French government at length realized how necessary was state intervention to save the entire industry, and laws were passed regulating stringently how and when the few remaining oysters might be dredged. More important still, the agitation of these measures led to the question of replenishment as the important problem. In 1853, M. de Bon, commissaire of marine at St. Servan, made his historic experiments upon the fixation of young oysters upon bits of wood and stone, and found that by suitable arrangement the oyster growth might be rendered far more rapid. The importance of practical use of "collectors," as the sticks and stones were termed, was at once taken up most enthusiastically by M. Coste, professor of embryology in the College of France. For additional light upon the subject, Coste made his visit to Italy, searching the processes there retained of the famous Roman oyster-culture. His report, supported by a successful experiment, made what was virtually a proposition to replenish the banks of the entire coast. Though the proposition was looked upon at the time as at the best impracticable, it was too tempting a one to be put aside. Napoleon III. became discreetly interested, and secured an appropriation for the carrying on of extensive experiments. Coste firmly believed that his work was to be of the greatest importance to his country, and that his success was to be immediate. He entered ardently into his rôle of oyster-culturist. Unfortunately he was ill advised in his choice of experimental stations, seasons were unfavorable, and he failed in his entire undertaking. His failure he recognized more keenly than did his enemies. "He died, blind, in disgrace, looked upon as almost a charlatan." What Coste did for the cultural industry is now well recognized. He certainly centered upon it public attention and pointed out clearly what should be done. It was he who furnished the ideas for others to profit by.

Since the time of Coste numberless improvements, great and small, have been added and have made the industry practicable and profitable.

II.—THE OYSTER IN FRANCE.

ITS SPECIES AND CHARACTERISTICS.

In the French markets oysters are first distinguished as either "flat" or "Portuguese" (Plate LXVIII). The former is the oyster of Northern Europe, *Ostrea edulis*, esteemed for its flavor and commanding a higher price; it is the species that is especially cultivated. The latter, *O. angulata*, is a modern importation, lacking in flavor, introduced as a substitute for the more delicate *edulis*.

The *flat oyster*, as the name implies, is readily recognized by the shape of the shell. This is round in outline, flattened, large in proportion to the size of the animal. The shells are often quite smooth outwardly; the lower valve, spoon-like in our American species, is scarcely as concave as a shallow saucer.

The Portuguese oyster is typically long and irregular. One valve is deeply trench-like and contains the entire animal. The opposing valve is smaller, thinner, and recurved. The shell is heavy, rough and angular without, and coarse of texture within. When the shell is opened, the oyster appears slaty or bluish in color, outlined with the broad, jet-black margin of its mantle. Its taste is salty, bland, peculiar to itself, and somewhat sweetish. The flat oyster shrinks vastly on its opened shell, is faint in color, with a brown or pinkish margin. It possesses that piquant taste, perhaps slightly metallic or "coppery," so highly prized by the connoisseur. The contrast between the species in point of taste is considered more striking than the outward differences in shell.

As regards natural conditions of living, the flat oyster occurs rarely in clusters and is found in deeper and salter water (sp. gr. about 1.026*). It may, moreover, slightly change its position and thus tend to keep itself above the mud. The Portuguese oyster occurs naturally along shore and in clusters, in water of a less density (about 1.023) and of a somewhat higher normal temperature.

It may be of interest to continue the question of differences in order to understand more clearly the position occupied by our American oyster.

The long-discussed bisexuality of the flat oyster is in Europe generally conceded; the American and Portuguese species are regarded as monosexual. If the flat oyster possesses this anomalous sex character, its genealogical relationship to other species will be difficult indeed to determine. The Portuguese oyster, still looked upon popularly as a *Gryphæa*, must take precedence from geological antiquity. It certainly is the least prone to form varieties. The American oyster appears to be intermediate. The flat oyster is in many ways most specialized, and presents over thirty recognized varieties, several of which were formerly regarded as distinct species.

* The extreme saltness of the waters of the French grounds shows quite clearly why the introduction of the American oyster has always been unsuccessful. Our oyster is comparatively a brackish-water form, occurring naturally in river mouths and sounds liberally supplied with fresh water (sp. gr. 1.017). At Arcachon, where the density of the water is low (1.022 to 1.024), American oysters have been known to live for years, but without reproducing.

Continuing the contrast between flat and Portuguese oysters the following differences are noteworthy:

FLAT OYSTER.

Shell grows laterally at the expense of thickness; is usually light, friable, very large in comparison to size of animal; its margin is undulated by a dozen or more flattened projecting ridges. The lateral method of growth is marked by a circling fringe of straw-colored cuticle, *dentelle*. The saucer-like valve is the more robust at the free margin and indicates outwardly, by slight asperities, the concentric rings of growth. These are sometimes outlined by a slight violet tint. The upper valve is usually quite flat, showing from within a broad band of translucent cuticle often an inch in width. Outwardly this valve is shingled with irregular overlapping bands of horn-colored cuticle. The nacre is frequently pearly, of a pinkish cast. The hinge is slight, allowing the oyster to be opened hingewise. The breadth of ligament is suggestive of *Pecten*, a likeness often made still more striking by the flat, angular processes thrown out by the shell on either side of the hinge. The shell moreover is circular and ridged, like *Pecten;* its muscular impression, too, is central and usually colorless. A degree of movement might therefore be suspected, though the adductor muscle does not appear relatively large.

The mantle is delicate and broad-margined, contracts vastly, forming irregular plaits; its sensory margin is wide, generally pale pinkish or brownish in color; papillæ abundant, small, and needle-like; posterior flaps of mantle wide and prominent. The transparency of the mantle permits the viscera, liver, intestine, and rectum to be generally outlined. The crystalline style is dense and prominent.

In habits, the *edulis*, as before noted, gradually separates from the object to which it had attached. In muddy localities it is enabled to survive by opening and shutting its flattened scallop-like valves, to retain a horizontal position. When out of water the quick snapping of valves and forcible ejection of water are noteworthy. With gradual shifting of bottom the oysters are enabled to alter their position considerably, tending, it is said, to congregate in banks. In all of the oyster ponds examined during the summer the density of the water was found to be extreme, practically that of the sea, of a mean sp. gr. of about 1.026, and in range from 1.020 to 1.028. In relation to the question of spawning it is remarkable that at the two centers of seed production, Auray and Arcachon, the water densities have been found lower (1.022 to 1.024) than at other localities examined. It would naturally appear therefore that, aside from the question of silt deposit, probability for spat-catching seems to decrease as the water increases in saltness.

PORTUGUESE OYSTER.

Shell shaped roughly like a human foot, but distinctly pointed at the heel. The external ridges become at the margin deeply accented, forming notches grotesquely toe-like. The valves thicken rapidly, their plane of growth becomes tilted and undulate, and their limy growth extends to the free margin of the shells, with cuticle lacking. The deep valve is trench-like, with usually a recess under the hinge, and with free edges appearing to arch over. Its depth measured externally is often five times that of the opposing valve. Its outward asperities are prominent and irregular. The upper or right valve is depressed, but resembles outwardly the lower one. The nacre is limy and irregular, often greenish in color, and often darkened in patches where invading mud masses have been cemented in. Hinge ends of shell heavy and pointed, that of lower valve produced backward, spur-like. Hinge ligament, located in deep notch, is stout and defends the oyster from being opened hingewise. The muscular impression, usually purple, is small, oblong antero-posteriorly, its muscle attaching the shell near the median of the posterior margin. The oyster is therefore opened by a knife thrust at the side.

The oyster is sunken in its deep shell. Its mantle is narrow and opaque, outlined with a broad, jet-black, sensory band. The sense papillæ are finger-like in shape, large and long. Posterior flaps of mantle not marked.

The Portuguese oyster is naturally a clustered form, occurring in shallow water of a mean normal temperature of 65 to 70° F. The weight of its cluster keeps it firmly rooted in its native muddy sand. All of its conditions of living appear to be those of the *O. virginiana* in South Carolina (*vide* U. S. F. C. Bull., 1890, p. 336). The clusters are often of great size, composed of a hundred or more individuals. The oyster separated from its cluster and grown on a sandy bottom improves materially in flesh and shell. It is a littoral form, though not occurring in waters notably freshened, the densities over the oyster beds at the mouth of the Tagus (middle of September) ranging from 1.023 to 1.0255.

NATURAL OYSTER BANKS AND DREDGING.

On the French side of the British Channel the natural oyster beds, or "banks," as they have been termed from their original mound-like form, have been struggling to regain their prosperity, aided by the stringent regulations governing the dredging. At favorable points, as at Granville, Cancale, and St. Malo, they have again become valuable. As supplying the general market, however, their importance is little to be compared with that of artificial culture. Where the natural banks become of the utmost importance is in the regions of productive oysters, as giving the seed oysters for surrounding areas. Here their reservation is made most absolute, their limits are determined and guarded, and their condition from time to time examined by careful dredging. In general, government assumes the management of the natural beds, prescribes how, when, and by whom dredging may be carried on, and enforces the law that oysters under the standard size shall be sorted out from the dredge and be at once returned to the water.

As to the banks and the dredging, the natural banks have originally clustered around a series of half-buried rocks and have spread out by the acre as the oysters have become detached. The bank depends naturally for its shape upon the character of the bottom and upon currents; in general, however, it lengthens out irregularly coastwise. Some of the most important banks exist far out from shore, located upon reefs or flats in water of 20 or 30 feet, or even deeper. Others exist in clusters but a few rods from shore and are uncovered at low tide.

Dredging within prescribed limits is, as at Cancale, granted so seldom that such occasions have become like holidays.* The *chaloupes* (3 to 10 tons) are drawn up ready for work and the beach is filled with spectators. At a cannon shot the little vessels start as in a regatta (see Plate LXIX, Fig. 1), each striving to be first on the ground. The dredges, four or five to a boat, are operated by half a dozen fishers. A cannon shot closes the dredging and the little fleet returns shoreward, usually well laden. The vessels are now beached, and the cargo is thrown out upon the sand as the tide descends. The mass of oysters is at once attacked by women and children, who sort the oysters out in regard to size and place them in oblong wicker baskets (Plate LXIX, Fig. 2). The oysters may now be sold for *élevage* in the slightly freshened waters of the neighboring parks.

Here, as elsewhere, the dredged oyster must be fattened to gain for it a favorable market price, since it is poor in flesh, dark in color, and as yet little able to bear the fatigues of transport.

The operation of dredging would be regarded by our Connecticut culturists as of a most primitive character. Hand labor is economical and prevails, and the entire dredge net is often of hempen cord. The dredge iron is curiously light in construction, braced all about with soft iron rods; the mouth is nearly 6 feet in width; its broad lower brim is bent abruptly downward to scrape the bottom at an angle of 45°.

*The time allowed for the dredging of the natural banks during the past year has, I have been told, averaged between two and three hours.

III.—OYSTER-CULTURE AND ITS BRANCHES.

French oyster-culturists are engaged either in collecting the young oysters (*production*) or in raising the seed for market (*élevage*). The *éleveur* buys his seed directly from the producer and is little interested in the question of dredged oysters. In our discussion, therefore, it will be most convenient to take up the processes in their regular order. We shall thus see, for example, how the swimming fry of the oyster becomes attached to the cement-coated collector, and how afterward, when the size of a finger-nail, the young oysters are separated and sold. Here begin the duties of the *éleveur*. He arranges the seed in wire-gauze growing cases till they are large enough to be little injured by enemies. He may then economize case room and transfer the oysters to inclosures fed daily by tidal water (parks). Or still further, the oysters may be specially fattened or given a desirable color by a sojourn in a shallow, long-stagnant pond (*claire*). These may finally secure a higher market price by processes of cleansing or of education for transport.

PRODUCTION, OR THE RAISING OF SEED OYSTERS, AND KINDS OF COLLECTORS.

Now that the supply of seed oysters along the Atlantic coast is becoming depleted by the increasing demand, the question of how the French have developed their industry practically without seed beds is of serious importance. If we have now to undertake artificial production on a large scale, we have evidently no need of repeating experiments already found fruitless.

In France, ever since the time that de Bon showed how swimming oyster fry might be collected upon sticks and stones, every trial has been made of ways and means to produce the greatest number of seed oysters at the least expense. As collectors they have anchored bundles of brush, built platforms of wood, suspended strings of shells. The serious difficulty was always that the collectors would become speedily coated with slime or sediment, which would either stifle the young oyster or, at the best, prevent it from attaching. For this reason our method of simply scattering broadcast over oyster-grounds shells or pebbles as collectors would in French localities prove of little value. It became evident, therefore, that a collector must be of a shape to render it least liable to become coated with sediment. This requisite was found in the roofing tile.

A tile may be to us somewhat of a curiosity. One must imagine a shingle of brick so arched as to appear like the side of a tall flower pot, hollowed, therefore, on its under side. Its length is about 14 inches, its width 6 inches at one end and 5 at the other. Its arch is a slight one; the curve of one-fifth of a circle is found best adapted for purposes of collecting. It is this slight curve, however, that gives the tile its principal value in oyster-culture. Its under or hollow side becomes a recess almost free from sediment and may be crusted with spat, while the upper side is slime-coated and unproductive.

Experiments as to the best way in which the tiles should be arranged showed, first, that tiles should be banked up in tiers, rather than spread out horizontally, in order to place the collectors above the reach of the bottom sediment. A second deduction was that the collectors should be placed along beach strips near the line of low water, thus to evade sediment, because of surface waters, yet at the same time to allow the collectors to be rarely exposed.

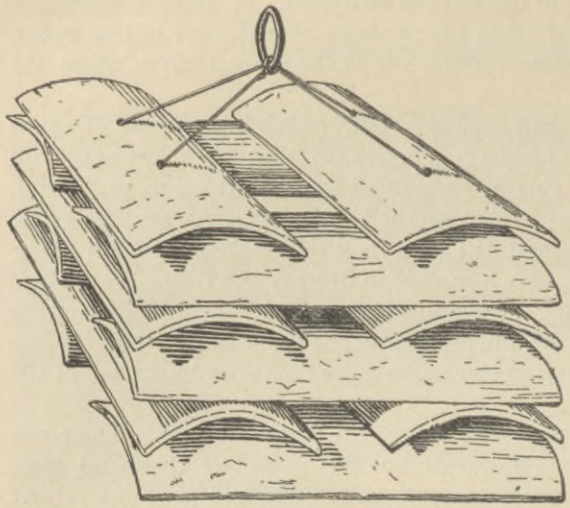
Formerly, when the young oysters had become about an inch in diameter, the tiles were skillfully broken or cut by means of heavy pincers, so that each oyster should have attached to it a fragment of tile; this was regarded as of great value, protecting the delicate mollusk against its enemies. This method of separating the oyster is, however, now obsolete, except under a modified form in several establishments along the Trinité River. It became too expensive a matter to destroy the tiles—the oysters must be separated and the tiles saved for the coming season. At length a thin coating of lime cement was found to answer the purpose, proving even better than the tile itself for "set," while allowing the young oyster to be flaked off even by a push of the finger-nail.

This innovation brought the tile more and more into general favor. Their use was now found economical; costing at the outset but $5 or $6 per thousand, they became fairly permanent, for even the percentage annually broken in handling (about 5 per cent) could be made of use in special forms of collectors. Moreover, besides giving the greatest surface for attachment of spat, they might by their arrangement in tiers economize available space; they might readily be handled and stored, yet be sufficiently heavy to withstand the wear and tear of the water. It is stated that at Arcachon and in the regions of Auray the yearly average of each tile is at least 200 seed oysters.

With this brief introduction we may examine the three typical forms of spat-collectors in present use and their method of employment. Varieties in tile collectors are naturally dependent upon the place to which they are destined, upon the softness of bottom, upon tides, and sweep of currents.

(1) Where the bottom is suitably firm, with but little water at low tide, the *gabarét* (*ruche*) is perhaps the most popular collector (Pl. LXXI, Fig. 2). It may be described as a crate of tiles. The accompanying figure represents the form used by M. Dasté, of Arcachon, undoubtedly the most convenient of those I have examined. The crate is made of strips of wood, $2\frac{1}{4}$ by $1\frac{1}{4}$ inches, with the ends pivoted, so as to allow the frame to be folded for transport and storage. The wood is tarred once a year by immersing the entire frame in a tar vat. The measurements permit ten tiers of tiles and allow nine tiles to a tier. For solidity the tiles in the different tiers alternate lengthwise and crosswise, their wedge-like shape dovetailing the mass firmly together, the lighter upright strips preventing their displacement. In actual use the uppermost tiles are usually roofed over with seaweed, as a protection against the heat of the sun, should the collector be exposed. The collector described is arranged for the largest size of tiles, preferred by M. Dasté as more economical in handling. *Gabaréts* are often employed holding a greater number of smaller tiles, 120 to 200, gaining thereby a greater exposed surface for fry attachment. A modified *gabarét* arranges the outer tiles and fills in the central portion with the tile fragments broken in *détroquage*.

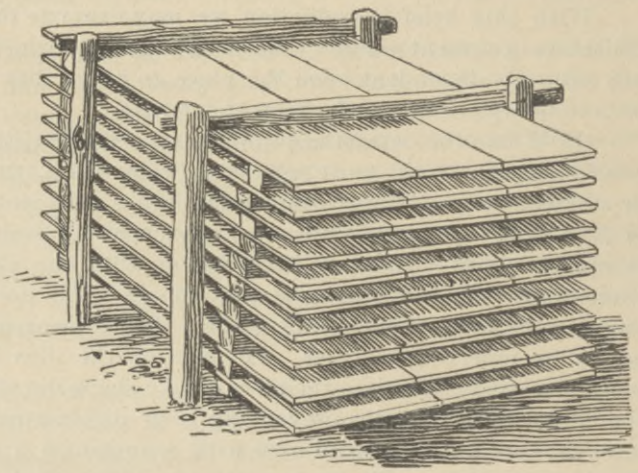
(2) Another type of collector is the *bouquet*,* employed when the bottom is suitably firm, but where from depth of water the *gabarét* is inconvenient. This collector is simply a bunch of a dozen tiles strung together in different ways by galvanized wire. Its wire loop is readily seized by a boat hook, and its compactness makes it convenient in handling.



The *mushroom* is the form almost exclusively used where the banks are soft, or in deeper water where there is a heavy bottom sediment to be avoided. Without this collector many localities would be rendered absolutely worthless. It is simply a *bouquet* raised a foot or two above the bottom, hung by its wire ring to the top of a firmly driven stake. All the attendant care is readily given from flat-bottomed skiffs as the tide is falling.

Another modification of the *bouquet* is the *camion* (Plate LXX, Fig. 2), a collector used in place of the *gabarét* in localities where the current is not too strong. It is a *gabarét* lacking the wooden frame, formed by banking together *bouquets*, one above the other. It is therefore readily taken apart and handled. To aid its stability it is sometimes weighted by stones.

(3) In place of the *gabarét*, equally exposed by the receding tide, there is often employed a *planche collecteur*, or a bank of a dozen horizontal wooden trays (Plate LXXI, Fig. 1). This collector is kept in position by rough uprights driven into the ground, which serve from year to year. The wooden trays are easily removed and transported for *détroquage* or reliming.



We must now examine (1) the way in which the tiles are coated with cement, (2) how the collectors are put in place, and (3) how the young oysters are afterward separated.

* The *bouquet* is shown in the upper figure; the second figure represents the *planche collecteur*.

COATING WITH CEMENT (CHAULAGE).

Early in the spring each proprietor causes his collectors to be thoroughly sun-dried. The cement vat is then prepared with a mixture of lime and sea water, often with a proportion of sand or mud stirred to the consistency of thick cream. The collectors are rapidly dipped in this limy fluid, allowed to drain off, arranged on rough trays, and set aside for several days to thoroughly dry. The cement crust should then be about a millimeter in thickness, somewhat brittle, separating from the tile in flakes. The dipping of the tiles in cement is sometimes performed by hand, sometimes by means of a well-sweep. The operation is a rapid one, the attendant women on one side of the vat passing up the tiles separate or in bunches, as in *bouquets*, for immersion; another detachment promptly removes the moist collectors and spreads them to dry. A new tile is first saturated with a watery mixture of quicklime and water, to fill the pores in its spongy substance. It is then dried and subjected to the regular process.

Of the properties and ingredients for *chaulage* each proprietor has his own recipe. At Arcachon the formula is in general that of M. Dasté: one part quicklime, three parts fine sand, with coloring matter sometimes added. In the region of Auray, M. Martin gives his tiles a double liming, first with a light coating of quicklime, and second, after the tiles have dried, with one of hydraulic cement. In the Trinité River region, M. Leroux prepares a mixture of one part quicklime and one part of fine gray mud, as best suited to his locality.

PLACING AND MANAGEMENT OF COLLECTORS.

In localities where spat collection is naturally favorable, as at Arcachon and in the region of Auray, the tide limits along the beaches will be seen covered with collectors (Plate LXX, Fig. 1). These are most numerous near the low-water mark, usually arranged in close regular order, but with alleyways between leading shoreward, wide enough for the passage of a cart or boat. In placing collectors it is usually arranged so as to allow the current to run counter to the length of the tile, in order thereby to gain nodes of still water under each tile as places of refuge for the young oysters. It is claimed, however, that this precaution is a needless one. The matter of the greatest importance, universally conceded, is *when* the collectors should be put in place. Experiments have shown that in localities of French production the placement should be arranged during the low tides of the last week in June and of the first fortnight in July, and that the bulk of the collectors should be in position by the commencement of July. The question of time is carefully studied by the culturist. He examines the oysters from time to time, looking for the *gray* spawn, the nurslings which the oyster is about to eject. As long as the spawn is white or creamy in color the culturist defers the placing of collectors. As the collectors so speedily become slime-covered, the question of a few days is regarded as of the greatest importance for the success of the set, since the major portion of spawning is found to take place quite suddenly. The anxiety of the culturist in regard to exactness of time seems one that should be carefully considered at home, for the habits of the fry appear to be very similar to those of our own, especially as it is now conceded that the swimming stage of the European species lasts for several days, or even a week.

The set once obtained, there is nothing to do but wait till growth has rendered the young large enough to be safely separated from the tile. They have attained by

October at least the size of a finger nail, and *détroquage* commences, this operation being often finished before the coldest weather. Some proprietors allow the oysters to remain unseparated until spring—Trinité River, for example—but in shallow waters there is danger of losing the entire set from freezing.

DÉTROQUAGE AND TRANSPORTATION.

Détroquage begins with the carrying of all the collectors to the neighboring shops (Plate LXXII, Fig. 1). Everything is made ready; the *camions* and *gabaréts* are carefully taken apart and the tiles placed on lighters; as the tide rises these are gradually floated ashore and promptly unloaded. Each cargo is precious to the proprietor, for he can at once sell the tiles for immediate transport at an average price of $10 per 100. The tiles are arranged in small heaps, and the operation of separating the seed oysters commences. The plaster coating of the tile, softened by water, is readily flaked off with the oysters adherent, by short pushes of a chisel-like knife. The women who perform the task become extremely skillful, each separating perhaps 20,000 seed during the day. The loss is but trifling, estimated in general from 2 to 5 per cent.

The young oysters are at once placed in baskets to be transferred to neighboring growing ponds, or are packed directly for transport. Their price is a variable one, dependent upon size, locality, and scarcity, but usually ranges from 50 cents to $2.50 per 1,000.* Each proprietor has his *clientèle* of *éleveurs* and finds but little difficulty in disposing of his product. Curiously enough, transportation at this stage does not appear to be dangerous. The proportion of seed lost during a journey of three or four days is but trifling. I am told that even after a stormy transport from Auray to the Irish coast, taking in all nine days, more than two-thirds of the cargo was found in good condition.

Before concluding the discussion of seed oysters, a few words must be said (*a*) in regard to production in closed ponds, and (*b*) of the importance of the reservation by Government of oyster-bearing tracts.

Production in closed ponds.—All production thus far considered has been that of open bays or rivers. Here, however, everything is at the mercy of season and weather, and profits every culturist alike. The French, however, recognize that the ideal production can only be carried on in closed ponds provided with spawning oysters, where by favorable conditions a great percentage of the myriads of young might be successfully collected. During the present season a most remarkable success in this production has been made by Mme. Veuve de Saint-Sauveur, in her lake at Breneguy, adjacent to the mouth of the river Auray. Experiments in this line have usually failed the second year; but in this case the principles seem far more likely to promise continued success. They are at least worthy of discussion.

The lake is, in the first place, a large one, covering a rounded basin of about a hundred acres (Plate LXXVII, Fig. 1.) It had originally been a salt marsh, of a bottom naturally clayey. It was converted into a pond by constructing a high bank on the one side and finishing the inclosure by a massive sea-wall on the other. Here, as the tide is favorable, two great flood-gates prevent the escape of the water, allowing an average depth to be maintained of about 4 feet. The management of the lake has been an extremely rational one. During the past winter the pond had been well dried,

* A letter from Arcachon tells me that the set of the present year has been so great that the price has fallen to 10 cents.

allowing the basin to thoroughly purify, and during this time the muddy tracts had been roughly macadamized with clay and gravel. About the middle of April the water was gradually admitted. A week later oysters were introduced to furnish the spawn. These were scattered in the deeper parts of the lake at about forty to a square yard. The water was now daily changed at the flood-gates till the first appearance of spawn (May 15). This was the sign that the collectors should be put in place and that the flood-gates should be closed. Since that time, up to September 1, no water and consequently no oyster fry had been allowed to escape. Loss from evaporation was several times made good by allowing the entrance of tide water, a precaution hardly necessary because evaporation had in a measure been counterbalanced by several small springs occurring in the bottom of the lake. These, moreover, exercised a very salutary effect in keeping the gravity of the water slightly lower (1.021 to 1.023) than in the open harbor. The temperature of the confined water became gradually higher (5° to 8° F.) than that without, while the water volume was yet sufficient to guard against sudden changes of air or weather. Obviously, absence of strong currents tended to a minimum of sediment accumulation. It was soon evident that the success of the experiment was a pronounced one. A dense set was apparent throughout the entire bottom. The spat had even attached to the stouter sea-weeds. Owing to a minimum of sediment both sides of the tiles in the collectors were usually well covered, each tile showing on an average 400 spat. The set was sometimes as dense as 3,000 per tile.

The principles to which Mme. de Saint-Sauveur has attributed her success are as follows:

(1) The necessity of inclosing a large area in order to present a great water surface for the absorption of air.

(2) The necessity of thoroughly drying out the basin for at least two months, doing away entirely with animal and plant life and allowing the clayey bottom to become purified for the following season.

(3) In the management of the pond the necessity (1) of introducing a small but continued supply of fresh water to compensate for evaporation; (2) of a uniform and low density (1.022); (3) of a depth of water sufficient to guard against sudden changes in temperature or density.

The success in the management of this closed pond has been so remarkable that if continued during following seasons it will insure the establishment of permanent stations of this character. It is noteworthy that from the time that water was allowed to fill the dried basin a healthful condition prevailed and was apparent throughout. Sea-weeds became sufficiently abundant to aid materially in oxygenating the waters, and to provide the richest of feeding for the contai oysters. In former experiments the difficulty has been malaëration, causing the death of animal life and the subsequent empoisoning of the water. Breneguy has refuted most clearly the doctrine of Chaumel, Gressy, and de Wolbock, that "current is indispensable to the life and transport of oyster fry."* The question seems rather one of perfect aëration and of lack of sediment.

In relation to our present need of seed-culture the success at Breneguy should be seriously considered. The ease with which our species of oyster may be artificially fertilized would allow us to introduce in a pond of this kind myriads of active fry, could we be but sure that natural conditions would be favorable for their set. We

* *Vide* Hausser, ref. 47, 22.

might thus, it is evident, determine absolutely the time to place collectors and to close and open the tide gates. At home all experiments have failed owing to imperfect aëration. Efforts to renew the water by supply and drainage currents have led to the escape of the embryos; while, if the basin has been entirely closed, its smallness, together with accumulations of sediment, has usually resulted in leaving the collectors far less covered with spat than if they had been placed in the open water without. In Europe artificial fertilization of the flat oyster is impracticable, since the fry are retained and incubated by the maternal shell; hence, in pond culture, there will be necessary the troublesome task of introducing, examining, and guarding the spawning oysters.

Experiments by Bouchon-Brandely in 1881 with fertilized eggs of the Portuguese oyster are clearly set forth in his report.* The embryos were successfully reared in small ponds, but the success was not sufficient to warrant profitable culture.

Reservation by Government of oyster-bearing tracts.—To the Government as well as to the culturist the oyster industry is a profitable one. It is, therefore, state policy to foster its development. This it has done most judiciously in the regions of seed production. Oyster-bearing tracts centrally located have been staked out and rigorously guarded to furnish spat for the entire neighborhood. These tracts are intended to include all depths of water and all conditions suitable for production. The importance of these measures can not be overestimated. Without it seed production would become impracticable. Everybody's business would otherwise become nobody's business, for the culturists would have a jealous dread of retaining oysters to furnish fry for the entire neighborhood. The condition of these reserved grounds becomes a matter of great importance. A committee is appointed to represent the different estates and to control their management. This committee causes the grounds to be regularly examined, and experiments and reports upon questions relating to dredging, cleaning, or replenishing the banks.

ÉLEVAGE, OR THE GROWING OF OYSTERS FOR MARKET.

The question of obtaining seed oysters is regarded in France as a certain and not a costly affair. The time and expense devoted to the oyster are during its *élevage* or process of cultivation. The *éleveur* receives seed oysters which, perhaps, are but the size of a finger-nail. He must place them under their most favorable conditions for growth and fattening, must care for them, and must in the end send them to a critical market as cultivated oysters, perfect in shell, well-fattened, and delicate in flavor. He must, therefore, make a study of his locality, to find what conditions are most favorable for rapidity of growth or flavoring. His work begins when he receives the freight of millions of seed from Arcachon or Auray. These are unpacked, carried down to the low-water line, and arranged in the flat wire-gauze rearing cases (Plate LXXII, Fig. 2). These he regards as important to the industry as the tile itself, for in the first place the cage lifts from the bottom and prevents the young from being stifled by the shiftings of mud; it renders the growth regular and rapid, and above all it protects the oysters from their enemies—crabs, boring snails, and starfish. The mortality of oysters during the three years of their *élevage* may by case culture be reduced as low as 10 per cent.

* V. ref. 9, *e*.

The case is not a costly affair; it is merely a large flattened box, whose top and bottom are of stout wire gauze; it is about 6 inches in thickness, 6 feet long, and 4 feet wide. This shallow wire-gauze box or tray is held a few inches above the bottom by four corner posts; its lid when in use is held in place by four nails at the corners. Where rough usage is expected, as at Cancale (Plate LXXII, Fig. 2), the supporting stakes are increased in number, the wooden frames of the lid and bottom are made wider, rendering the gauze window-like, and the lid is hinged, held in place by weights or a lever. In the Trinité River, M. Benjamin Leroux outlines the gauze of the top and bottom with iron, instead of wood, thus allowing both to be readily lifted from the frame convenient for storage and tarring. This device, however, is generally regarded as a matter of needless expense. At Arcachon a modification occurs as adopted by M. Dasté. The tray, formerly single, is now formed of three smaller ones side by side. By this change the separated trays become convenient for partial transportation. A single lid, as before, covers this compound case. All cases are furnished with gauze of galvanized wire, with a mesh varying from one to three to the inch. If tarred regularly once a year the cases last from ten to twenty years.

The cases are arranged near the line of low water with a view of keeping them submerged as long as possible. They are placed side by side in lines, with alleyways between passing shoreward. The corner pickets may thus be made to serve on either side. This double service is most successfully attained by means of the cast-iron pickets of M. Martin. These are T-shaped, with ledges on either side at convenient heights to support the case frames; they are readily put in place and are obviously permanent. The first task of the *éleveur* consists, as we have noted, in placing the seed in the cases. These are strewn thickly, sometimes for economy of space even packed edgewise, enabling each case to contain at first as many as 25,000 seed. During the first few months rapid growth renders it necessary to pick out each fortnight and transfer to other cases the largest oysters. This task is carried on at low tide by a squad of women, who at the same time sort out the dead shells and pick from the ground stray oysters. Along muddy river banks their bare feet are shod with great square mud shoes.

As a practical question the culturist is often seriously puzzled to obtain space to plant his cases. He must often make use of the softest river banks, which Americans would look upon as absolutely worthless. He has found that if the surface mud is macadamized with sand and gravel a crust may be formed that will serve admirably for his cultural purposes. The crust is hard to the foot, but jars curiously as one walks heavily upon it. By this costly means miles of bay and river banks are constantly being brought into cultivation. (Plate LXXI, Fig. 1.)

How long the oysters must be allowed to remain before marketing is a question that depends largely upon locality and the length of time they have remained in sub merged cases. Deep parks (Plate LXXIV, Fig. 2) are looked upon with great favor, though they are at times, especially in cold weather, very difficult to properly care for. The lake of Ossegor, seen in the figure, is remarkable for giving its oysters a maximum rapidity of growth, *cf.* p. 377. Case culture should in general prepare the oyster for market during the second season. Winter is the time of the great mortality, and, though ice rarely occurs to any thickness, the oysters are usually kept well below the surface. This end is attained by inclosing the area and retaining, by flood-gates, the

necessary depth of water. Many proprietors, at the approach of cold, remove the cases for storage and repairs, leaving the oysters scattered on the bottom of the inclosures or parks.

An oyster park, accordingly, is an inclosed tract intended to retain tidal water for purposes of culture (Plates LXXIII and LXXIV). It is looked upon as an indispensable aid to the industry. To scatter oysters broadcast in deep beds, as with us, would be especially impracticable in French waters; the oysters would be in constant danger either of *envasement* or the attacks of enemies. It accordingly becomes a matter of economy to construct inclosures that permit the oysters to be guarded and tended, and that give them at the same time the thrifty conditions of warmer water and of littoral feeding. A park may be simply a tract of tide land inclosed by the simplest barriers of planks or of interlaced boughs that serve simply to retain the water for a few hours (Plate LXXIII, Fig. 1). With this view the simple tidal parks are rarely large, perhaps 50 or 100 feet square, to thus give more barriers to hold back the escaping water. In outlining the inclosure, account is taken of expense and of resistance to currents. For the first reason the barrier need be but a foot or two high; for the second, it often requires ballasting with stones. If the current is not a strong one the barrier is constructed in a double line of little fascines. These are of pine or gorse twigs, 10 inches high and 5 inches thick (Plate LXXIII, Fig. 2, and Plate LXXIV, Fig. 1). These stand upright and are firmly implanted, the space between the parallel lines packed with sand and clay, and they form ultimately a wide, low, park margin both water-tight and durable. This inclosure, by keeping the rearing cases continually under the surface, also serves an additional use, considered of great importance in the French localities, that of giving more space for culture, since it brings into use a higher zone of the beach. Should the bottom of the park be not too soft,* it may be thickly strewn with half-grown oysters; the cases then vacant are at once refilled with seed. The *élevage* of the dredged oysters, as we have noted, is of this character; they are simply scattered regularly over the park bottom and allowed to fatten under the thrifty conditions of littoral feeding in warmer water. As a rule, accumulation of sediment does not interfere with culture in these parks. Should the barriers prove not water-tight, a marginal draining trench is naturally formed and the escaping current bears away a great part of the sediment with it.

The more costly oyster parks differ from these primitive inclosures only in the character of their walls. Stone walls, massively masoned, render the structure permanent, while mechanical gates regulate with nicety the depth and renewal of water. An especial use of this kind of park is that of *vivier* for the storage of marketable oysters, especially during the winter season (Plate LXXVI, Fig. 1).

The simplest kind of barrier park is well seen at Cancale (Plate LXXIII, Fig. 1). Here the entire sweep of muddy or sandy shoals may at low tide be seen checkered off in rough inclosures. The barriers that outline them noted in the figure are formed of rough planks well covered with seaweed, held in position by firmly implanted stakes. The center of the park is seen to be drained and the thickly spread oysters are exposed. These parks may be drained at the side by withdrawing a small wooden vane; the collecting sediment is then carried seaward down the intervening alleyway. The

* Mud a foot thick is not regarded as detrimental. The oysters keep readily upon the surface.

oyster's feeding conditions along the flats at Cancale are certainly noteworthy. During my visit the lower sands were streaked and mottled with a golden-brown crust of diatoms.

The second kind of barrier park prevails at Arcachon, by far the most important seat of oyster-culture (Plate LXXIII, Fig. 2, and Plate LXXIV, Fig. 1). The first figure shows one of M. Dasté's parks. The fascines of twigs seen banking the inclosure have been implanted in the hard sand of a little emerging island, a *crassat*. The park bottom is hard, and for that reason draining trenches are not formed. About 10 inches of water is retained to cover the oysters. The other figure represents the employés at work and shows the way in which the small parks are grouped. One of the curious features of Arcachon is a boundary fence, formed of waving saplings, a device intended either to frighten away injurious fishes or to retain them as the tide falls. An illustration (Plate LXXV, Fig. 2) shows the sapling fence on either side of an alleyway, imposed by law, separating adjacent parks, to serve for transport. The oyster boat of Arcachon (Plate LXXV, Fig. 1) is the ancient *pirogue* of the Basque region, often provided with lateen sails—half dory, half gondola—a capacious affair, heavy in build, but curiously light to handle. At the boundary of each park is located a guard boat or *ponton*, one end of which contains the guard and his dogs; the other end serves as a workshop.

An illustration (Plate LXXVI, Fig. 1) shows the character of the most costly type of oyster park, a lake surrounded by well-slanted stone walls. It is the *bassin des chasses* at Sables d'Olonne, half of whose area of 160 acres is devoted to oyster-culture. As a park it illustrates several novel points well worthy of discussion. It is, in the first place, a compound or coöperative park; that is, it includes a myriad of smaller parks and has an organized management. Its central government, supervised by the ministry of marine, regulates the important matter of water supply and rents out tracts to the culturist. This annual rent, about 2 cents per square foot, is understood to include the general expenses of water supply, guards, and necessary repairs. The parks are for *élevage*, the greater part of the seed coming from the region of Auray. The planted beds remind one curiously of those of a market garden, well banked and separated by trenches. These serve to collect the depositing sediment conveniently for removal. The bottom, however, is naturally level and hard, a firm mixture of sand, mud, and clay. This large park again illustrates the principle spoken of in regard to Breneguy, that a large surface allows the water to aërate without constant renewal. The management permits change of water during only three days consecutively per week. The great gates are first opened to allow the water to pass out until only about a foot of water remains above the oysters; the rising tide is then admitted to the depth of 4 to 6 feet and the gates are closed. The water is comparatively shallow and becomes warmer; germination and growth of plant life speedily ensue and furnish the best of feeding to the inclosed oysters. This is attested by the rate of growth and fattening that the oysters are here remarkable for, a *pousse* sometimes as great as half an inch per month. The culturists themselves note that if the water is shallow and warm the growth of the oysters may be forced as that of the plants in a hotbed. There is danger, however, that the water, if shallow, might become too salt by reason of evaporation, or too freshened by reason of continued rains, and therefore a depth of 4 feet is normally maintained. Aëration and living conditions become then so per-

fect that the water of the basin has been left a month without endangering its inmates. For rapid growth, it is found best not to place the oysters too thickly, a maximum of fifty per square yard. The water (sp. gr. 1.026+) is practically that of the sea, the bottom containing no springs and there being no ingress of little streams. Hence, to avoid too great a density from evaporation it is deemed advisable to renew the water more frequently than otherwise required. It is probably on account of the extreme saltness that production can not be attempted. I have personally no doubt that, if it were practicable to temper the density of the lake by a careful introduction of freshened water, and to maintain it at the specific gravity of Breneguy, production might be both possible and profitable.

CLAIRES: SPECIAL PROCESSES, SUCH AS "GREENING" OR PREPARING FOR TRANSPORTATION.

On either side of the great lake at the Sables extend meadow and marsh lands, suited for salt-making. Here have been formed, by means of turf-covered banks, rectangular pond-basins (50 by 150), arranged to be occasionally filled from the lake without (Plate LXXVI, Fig. 2). Our oystermen would be surprised that oysters could be kept alive, much less grown or fattened, in such small and muddy salt ponds. They are nevertheless the *claires*, famous for fattening the oyster or for giving it a color or special flavor. The bottom of the pond is like a plowed field, perhaps slightly more clayey; the sloping sides are turfed to the water's edge. The water, maintained at the depth of but a few feet, is naturally muddy and continually causes sediment, which would be of extreme detriment if the pond basin had not been arranged with a marginal ditch into which all sediment shifts, convenient for removal. It will be seen that the *claire* will be advantageous, yet at the same time dangerous to the oysters. They become continually coated with mud; the water, renewed but once a week or fortnight, is malaërated, and the mortality is of course great. On the other hand, everything conspires to give the conditions for the richest feeding; the minute plant-life that enters the *claire* is forced into luxuriant growth by warm and food-bearing waters, that are slightly freshened by surface drainage. At the Sables differences in temperature between *claires* and outside lake are from 5 to 8° F.; in specific gravity the differences are from .001 to .002. There may naturally be all degrees of *claires*, small and large, some renewing their water every few days, others but a few days each month. It is the exuberant growth of the oyster that makes *claire* culture profitable. In special localities entire *élevage* would not be practicable on account of the rate of mortality. The oysters when grown are simply introduced in the *claires* for several weeks to give them an esteemed taste or color.

Claires must be studied at Marennes, a locality long known to produce oysters green or bluish-green in color and deemed exquisite in taste. Green oysters have become synonymous with Marennes, their reputation, if not their flavor, commanding a high price in the market. Nowhere else along the French coast are found conditions as favorable for *élevage* as well as for "greening." The low-lying tide lands, clayey, but rich in peaty mud, produce the richest of oyster food, clouding the slow waters with minute plant life. Of these low organisms, by far the greater number are diatoms, a race of minute, single-celled plants that often possess a curious power of navigating about apparently at will. They are transparent, incased in a delicately fretted

shell of glass, and contain a number of pellets of golden-brown coloring matter. An exceptional diatom, *Amphipleura ostrearea* (Gr.), contains a green pigment and is nowhere as abundant as at Marennes. The oyster feeding upon it, stores away, first in gills and then in mantle, the vegetable coloring. The green color is said by the connoisseur to give the oyster an inimitable and exquisite flavor, as if savored with mushroom or truffle, an idea which the culturist, however skeptical, is not apt to refute. With a view to higher market price, he has even studied astutely how to give his products the maximum degree of color in the least time. He early attributed the cause of coloration to the myriads of green diatoms, which he termed "moss," and discovered that this moss developed most readily in muddy basins where the water was seldom renewed. The low regions of swamp and salt meadow, often for a mile on either side of the Soudre, has now been built into *claires*, drawing water from intersecting canals (Plate LXXVII, Fig. 2). The *claires* nearer the river may readily renew their waters every few days, offering the better conditions for *élevage*. The *claires* situated upon the uplands, where rapid greening takes place, can only be refilled a few days monthly, in accordance with the lunar tides, and their shallow stagnant waters are therefore most dangerous to the oysters. I am told that here the mortality may average 50 per cent, even though under favorable conditions the oysters will green in a fortnight.

The *claires* at Marennes are established as follows: They are crowded together, separated only by low earthbanks, are small in size, the largest perhaps 75 by 100 feet (Plate LXXVIII, Fig. 1). The bottom is of soft, light-brown mud, banked up in the middle; the marginal trenches are deepest at side, draining into the canal. The drain-pipe piercing the low earthbank is usually a bored pine log, a foot in diameter. The drain-stoppers are like a mallet, removed conveniently from above by means of the handle. In the best development of the green moss the *éleveurs* believe that the *claire* bottom should, like a cultivated field, be annually broken and "freshened up." Early each spring, when the green moss is beginning to disappear, the ponds are emptied. After several weeks the bottom becomes seamed and cracked by the heat of the sun; the trenches are now deepened, the upturned soil so disposed as to give the bottom a mound-like appearance; the basin may even be spaded up as if for a flower bed. In August the water is again permitted to enter, at first but little at a time, allowing the crust to slowly deliquesce, a stage that often produces a froth-like appearance. A week later the *claires* are filled so as to allow about a foot of water to cover the oysters. Late in August the green begins to appear, first in the low *claires*, then in the higher ones; in November it is at its height, the entire basin becoming literally moss-covered. Warmth is naturally essential to rapid greening, the shallow waters varying from 3° to 12° F. higher than margin of the Soudre (August 26 to 28). The slight freshening of water caused by the rains in September and October is also considered of advantage. Springs are absent. The differences in saltness of water of river, canal, low, and high *claires*, are certainly not marked—(73°) 1.023, (75°) 1.0235, (76°) 1.0235, (80°) 1.021 to 1.0225. In value, adjacent *claires*, under apparently the same conditions, sometimes differ most unaccountably in the quantity of green moss that is produced, one *claire* often enabling the oysters to green thrice as rapidly as the adjoining one. For rapid greening it is found best to place the oysters not too thickly, a normal of fifty to the square yard. The oyster's color may entirely disappear if the oyster is allowed to remain for a month or more in other waters, but is not

lost during transport. The green oysters are said, moreover, not only to retain their color, but to bear the fatigue of journeying as well as those raised in tidal parks. Fortunately for the *claire* culture the winter at Marennes is not a severe one, and the only precaution to be taken is to slightly increase the depth of water. More than 2 inches of ice rarely occur.

Before shipment to market two processes may be employed, giving the oyster an additional value to the connoisseur. The first, termed *dégorgement*, frees the oyster from any traces of sand or mud that may have been ingested with its normal food. The second would with us be called *education;* it trains the oyster to bear the fatigues of transport.

Of *dégorgement* but few words need be said. Oysters, especially those that have fattened upon a soft, marly bottom, usually show outward traces of black indigested matter contained in the intestine. The oyster loses these traces of coloring naturally when allowed to remain tranquilly upon a hard bottom in clear water. Cemented or stone-masoned basins or tanks are conveniently employed; the oysters are scattered over the bottom, the water is admitted, and the oysters allowed to remain for a week or a fortnight. (Plate LXXVIII, Fig. 2.) As a rule the basins of *dégorgement* are divided by brick walls into smaller areas of perhaps 25 feet square, enabling one compartment to be emptied without inconvenience to others. A typical basin, seen in Plate LXXVIII, Fig. 2, is at the margin of the Soudre, at La Tremblade, Marennes. The small tramway is one of the features of a French oyster park; the wide platform cars, passing from the shops along the embankment, are found most convenient in transportation.

These basins may sometimes be used for the second process, that of accustoming the oysters to an out-of-the-water existence. The basins may for several days be allowed to fill or empty, according to the tide. It is found, even in this brief time, that the margins of the shells will fit more tightly together and retain the fluids of the oyster for a longer time during transportation. If concreted basins are lacking, the oysters are simply strewn on the shore between tide limits for the same length of time. The shells are finally cleaned, first by a jet of water from a portable hand pump, then by brush or broom. Shells incrusted by *Serpula* or *Membranipora* are scoured with a metal brush.

Oysters are often purchased directly from the *éleveur*, whose duty it is to keep his customers informed of current prices of the different grades and sizes. The oysters are carefully packed in bracken fern by the two, four, or eight dozen, and the box forwarded, express paid, to the residence. A consumer is thus apt to receive the oysters in a perfectly fresh condition. An order, for example, may be left with the agent in Paris at 8 o'clock Friday night; this is received at Marennes the afternoon of the following day; and the fresh oysters will be delivered in Paris in time for the Sunday dinner. If thus ordered the prices can certainly not be regarded as exorbitant. The green oysters of the best grade will cost at the home of the purchaser from 1 to 4 cents, while for half of this price may be bought the largest and finest Portuguese.

IV.—THE PORTUGUESE OYSTER.

The Portuguese oyster has taken an important place in French oyster-culture on account of its cheapness. It requires but little care—for that reason is profitable—and there is a growing tendency on the part of the culturists to raise this less-prized species in their poorer parks. Its introduction from Lisbon into France was certainly economical. A cargo of oysters, supposed entirely lost, was thrown overboard in the Garonne near its mouth. In course of time the surviving oysters gave rise to a remarkable bank, similar in every way to those at the mouth of the Tagus.

The habits of this oyster have already been discussed. We have seen, for example, that it differs from the flat oyster in the general angularities of its shell, coarseness in flesh, sex characters, and in its littoral conditions of living. Outwardly it sometimes resembles the coarsest varieties of the American oyster, a likeness which the sailors recognize, misnaming our product the Portuguese oyster of America!

Since its introduction, in 1866, the oyster has been the subject of careful discussion. The culturists first feared that its hardiness and rate of increase would dislodge its weaker neighbor. It was rumored that the species were producing hybrids, that danger was imminent of loss of the valued qualities of the *edulis*, a notion promptly refuted by scientists. The most important discussions were those tending to legally restrict the introduction of the inferior species in regions of production on the ground that the tiles would become covered with its spat.*

Common consent, however, rather than legal measures, has kept reduced the proportion of Portuguese oysters and has diminished the chances of the less profitable production. Artificial production is as yet crudely developed, since attention is naturally directed in the line of greater profit.*

As with the American species, the fry is hardy and attaches readily. In favored localities the annual production is remarkable, especially near the line of low water, the spat covering pebbles, rocks, sandy beaches, even seaweeds. Collection is often a general one, and is sometimes the principal industry of the poorer class of fisher people. One of the regions naturally favored is Rocher de Der, where it is only at the lowest tides of the month that the great flat rocks are exposed. It is then a curious sight to see as many as a thousand people, men, women, and children, engaged in detaching the oysters. The recult is placed for *élevage* at a slightly higher level in small parks given by the state. The loose stones of each inclosing wall, though thickly covered with seaweeds, are found profitable collectors and are annually overhauled.

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* *Vide* List of Works, 51, 55, and 9, *c*, *d*, *e*, *f*.

V.—GENERAL CONCLUSIONS.

In France all attempts to introduce the American oyster have naturally failed, owing, as before noted, to the greater saltness of water. This condition not merely prevents the process of spawning, but changes entirely the character of the animal. The French have a general and very depreciatory idea of the American oyster, just as our compatriots, when traveling, are wont to look upon all French oysters as "coppery and colored with verdigris." Our oyster is classed as a Portuguese, larger in size and inferior in quality on account of lack of parkage.* They can not believe that we have varieties of oysters, small, white, and smooth of shell, whose flavor we would prefer to that of the most exquisite of Belon or Marennes.

The methods of oyster-culture employed in France must be carefully considered in regard to how we ourselves may profit by them. A number of their ideas appear undoubtedly quite pertinent to the needs of our culture. Others must require careful experiments to demonstrate how far they will succeed if transplanted.

In regard to seed production, the principles will prove true with us, but unfortunately there is a stumbling-block on the practical side. With the high price of labor, will production pay? This is a question which I am yet inclined to answer affirmatively. The French pay in general 50 cents per day for their labor. But it seems possible that workers, better paid and of a higher degree of activity and intelligence, might in the end be not far more expensive. The French have many expenses which we would not have to encounter, yet their production is profitable. I have even heard proprietors talk of supplying seed for the American market, a business affair which they regard as practicable, even with the great expenses and losses of transportation.

It is certain that if we can, in favored localities of production, obtain as a steady average two hundred oysters per tile, the seed-oyster industry might readily be profitable in spite of everything. As a collector it will be doubtless difficult, for the reasons above given, to find better than the tile. The Portuguese oyster, however, is said to affix more readily to rocks than tiles, a suggestion to be carefully weighed, on account of the kindred habits of the American oyster; but I am strongly inclined to take the opposite view, after a careful examination at Rocher de Der of the rock and tile fragments that had taken the set side by side. With us the common tiles can be manufactured almost as cheaply as in France; and as the annual breakage is but 5 per cent the loss can not be regarded as great, especially as tile fragments may again be utilized. *Détroquage*, moreover, which appears toilsome and expensive, is in reality a simple affair, the oysters peeling from the tile, even with a thrust of the finger-nail. It would be a most important point in the development of our industry to consider, as the French have done, the raising of seed in regions naturally favored, with a view to thus supplying the entire coast. This would not be impracticable. The two centers of production, Auray and Arcachon, supply the coast of France, and often the foreign market; while with us it would not be difficult to select a number of localities noted for seed oysters in almost every Atlantic State. If production will pay sufficiently to

* *Vide* List of Works, 9 *e*, 49, and 9 *a*, 117.

warrant a dozen collectors, the same locality would certainly be far more profitable if collectors were established by myriads. A plan, neither costly nor difficult, would be to experiment with a few collectors and determine expenses of production. We may then compare the rate of cost with the market price of seed as now obtained. First expenditures would naturally be at the maximum; that is, for collectors and labor yet unskilled. At the outset, for example, a collector of 150 tiles might cost $3; but, should collectors be subsequently manufactured in number, the price might readily be reduced one-half. We should not forget that these collectors are said to last a generation, if one-tenth of their first cost is expended in annual tarring and repairs. Each collector should with us produce 15,000 seed; there remains but to find what will be the total cost of production.

The rearing case should be most strongly recommended at home. Without it the French industry would be impracticable; it is as important a factor to their cultural methods as the tile itself; it protects the delicate seed against its many enemies; it keeps the oyster just high enough from the ground to protect it against shiftings of mud or sand, and gives it at the same time the best conditions for rapid fattening and growth. Our oysterman at present purchases his bushels of seed and strews them over his ground below 2 fathoms of water; in the course of time he rakes them up and finds their mortality a very great one, due to many causes, ravages of crab, drill, and starfish, shiftings of sand or mud. Occasionally he loses his entire harvest. If by cases he can succeed in raising for market 80 per cent of the seed, he will in many localities find it to his interest to invest labor and capital in this kind of culture. Each case costs in annual repairs less than 50 cents and should rear at least 500 grown oysters. Its price, which in France is about $3, should be, if anything, less with us on account of cheapness of wire gauze and wood. In quantity, by machine manufacture, the total might be reduced to $1.50, including tarring and labor of putting in position. Case culture will, moreover, render of value many tracts which are now useless solely on account of softness of bottom. The labor required in overlooking the cases should not prove a matter of great expense.

The French have great changes in the height of tides during the month, sometimes a difference of several fathoms. These changes either keep their cases too long under water to allow the proper care to be given them, or, worse still, place them too long out of water to suit the oyster's living conditions. It is but natural to infer that the more regular degree of rise and fall of tides should be more favorable to the establishment of both cases and collectors.

In view of our present needs, what is the most important lesson we are to draw from the studies of the French oyster-culture? The most practical certainly seems the action of the Government in reserving oyster-bearing tracts for the purpose of furnishing seed. This prudent restriction has been the safeguard of the entire French industry. Our oyster-grounds are becoming exhausted solely by the enormous drain upon their resources. In general their conditions for culture are as rich as ever. The oysterman has sent to market practically all of his oysters and expects the beds on his neighbor's ground to furnish him with seed. Too often, however, the neighbor has been equally thrifty and has marketed all of his product. The following year both are astonished at the poorness of the set, attributing it to coldness and rain, but they

never think that the deficiency might have been caused by the want of a quantity of neighboring oysters sufficient to furnish the spat. Nor is one to blame for not preserving his oysters to furnish seed for everybody. French political economy has assigned to government the duty of reserving oyster-bearing tracts for the common good, and the Government has studied where these might most judiciously be located so as to profit all alike. The tracts need not be large and would not be of great expense to the State, at any rate as an experiment in a single locality. The grounds would practically take care of themselves; their only expense would be that of a guardian.

If an experimental oyster tract in one locality should prove eminently successful to neighboring seed-culture, a more general legislative action in different States might reasonably follow. The matter would certainly be most heartily seconded by the oystermen themselves.

We should not expect seed to be abundant where oysters are lacking. And our industry may, for many years to come, demand nothing more pertinent to its welfare than State spawning-grounds near centers of oyster-culture.

The waters of the oyster-grounds of the French coast.—A table of densities for comparison.

	Locality.	Date.	Specific gravity.	Temp.	Specific gravity reduced to 15° C. standard.	Remarks.
				°F.		
1	Cancale	Aug. 6	1.025 -1.0258	74	1.0263–1.0271	
2	Roscoff	11	1.0252	73	1.0263	At marine laboratory.
3	Belon	13	1.0235–1.0252	75	1.0249–1.0266	Margins and middle of river.
4	Lorient	15	1.022 -1.0225	74	1.0233–1.0238	In rearing parks (M. Charles), 1.024(75°)—1.0245(75°).
5	Auray	16	1.0225–1.023	67	1.0227–1.0232	Margins and middle of river.
6	Breneguy	17	1.021	71	1.0218	In basin of production.
7	Trinité	18	1.023	66	1.0230	
8	Sables d'Olonne	23	1.024	68	1.0243	*Claires* about 1.023—1.0235(74°).
9	Marennes	26	1.023	73	1.0241	Cf. p. 379.
10	La Tremblade	27	1.023 -1.024	76	1.0246	Do.
11	Arcachon	Aug. 29 to Sept. 5	1.0185–1.0245	69–78	1.0189	During my visit I had opportunities of taking densities in many parts of the basin. Lowness in specific gravity is surprising, since the idea is very general that its saltness is greater than that of the Mediterranean. As my densimeter was made and tested especially for this work, I feel confident of my results. The same instrument served for all localities and the densities are relatively just. The greatest density is naturally found in the inlet and main channel. The saltness in the regions where production is most favorable was 1.019—1.021 (about 72°). The least densities were found in the N. and E. parts of the basin, due to influx of a number of draining streams.
12	Ossegor	Oct. 7	1.0245–1.0255	64–66	1.0242–1.0255	

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[The most important for practical study are indicated by bold-faced type.]

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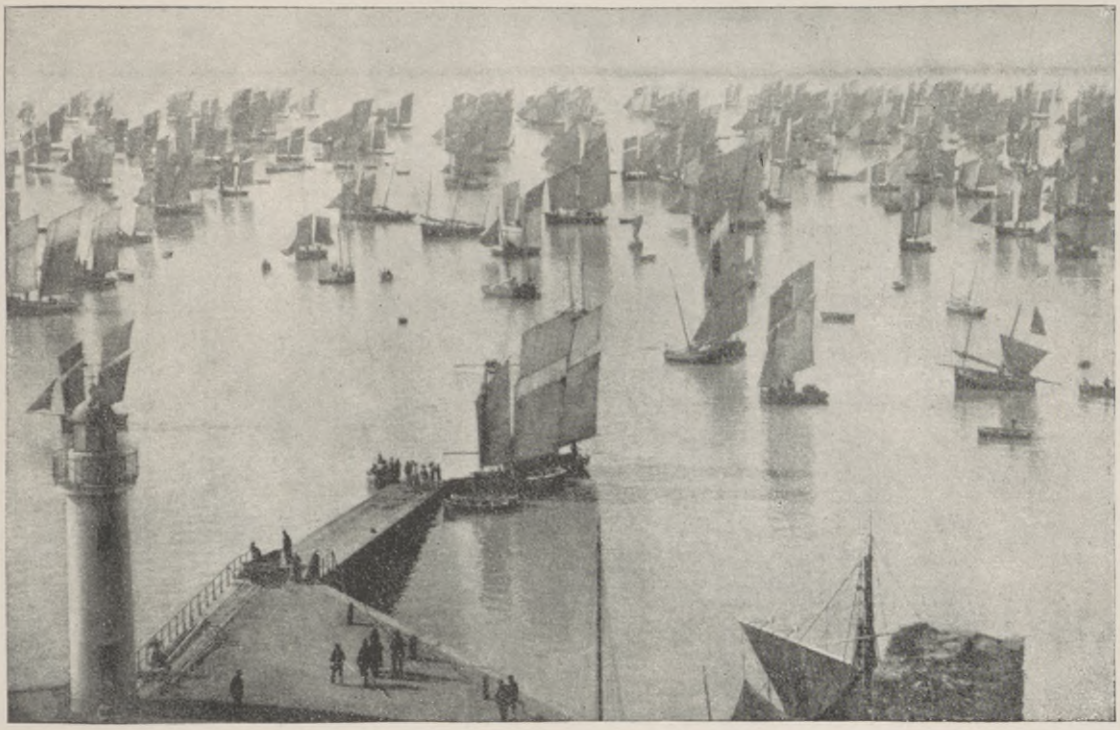

FIG. 1. CANCALE. OYSTER-DREDGING. (Page 367.)

FIG. 2. CANCALE. LOW TIDE AFTER THE DREDGING. THE SORTING OF THE OYSTERS. (Page 367.)

FIG. 1. AURAY. THE RIVER AT LOW TIDE, WITH MUD FLATS EXPOSED, SHOWING THE COLLECTORS IN PLACE. (Page 371.)
View from property of MM. les Frères Jardin.

FIG. 2. AURAY. THE CAMION COLLECTORS IN PLACE. A CASE OF ÉLEVAGE FOR TEMPORARY USE SEEN IN THE FOREGROUND. (Page 370.)

FIG. 1. TREHENNARVOUR, NEAR AURAY. THE COLLECTORS OF WOODEN TRAYS (PLATEAUX).

The entire region seen in the figure was originally a shifting mud flat; it is now entirely reclaimed for purposes of culture by being macadamized. The dark line in the left background is a breakwater. (Page 370.)

FIG. 2. ARCACHON. THE GABARÉT COLLECTOR (RUCHE) IN POSITION.

A tile is being held so as to show the young oysters attached to the under side The collectors are roofed over with seaweed, keeping the tiles moist when exposed, and protecting them against heat and light. (Page 369.) Park of M. Dasté.

FIG. 1. AURAY. DÉTROQUAGE. WORKERS ENGAGED IN SEPARATING THE SEED OYSTERS FROM A TRAY COLLECTOR.

At the left will be seen the side of the lighter used in floating ashore the collectors. (Page 372.) Park of M. Jardin.

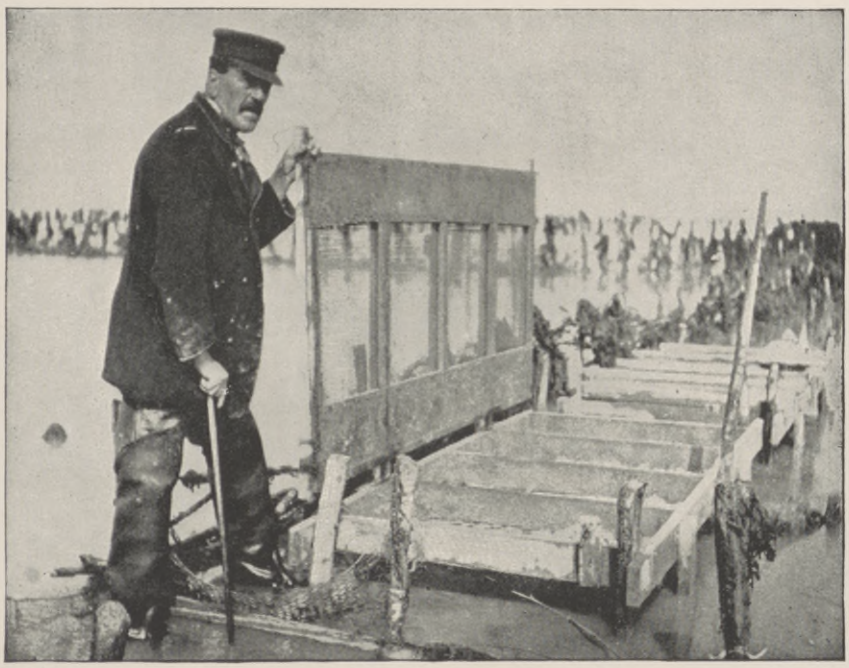

FIG. 2. CANCALE. GUARDIAN OF PARK, AND CASE FOR REARING SEED OYSTERS. (Page 374.)

FIG. 1. CANCALE. THE BARRIER OYSTER PARK.

The water is seen slowly draining seaward, allowing the oysters in the higher parts to become exposed. The sides of the park are simple plank barriers. To the left are cases of élevage, well raised from the ground as a protection against shiftings of sand. (Page 376.)

FIG. 2. ARCACHON. AN OYSTER PARK WITH LOW BANKS OF FASCINE AND CLAY.

Cases of élevage are inclosed. The case covers are seen held open by propping sticks while the oysters are being sorted. The embankment separating the ponds are here composed of brush bundles, clay, and plank. The sand flat in the background is covered with Portuguese oysters (Page 376.) Park of M. Dasté.

FIG. 1. ARCACHON. PARKS OF THE SAME KIND AS IN THE PRECEDING FIGURE. A GENERAL VIEW SHOWING THEIR SIZE AND ARRANGEMENT.

Those at the left have been emptied for annual repairs; the shallowness may be noted. (Page 377.)

FIG. 2. OSSEGOR, NEAR BAYONNE. A NATURAL TIDAL LAKE FED AND DRAINED BY A SHALLOW, SWIFT-RUNNING CREEK.

The water is sufficiently deep to allow the cases to be rarely exposed. Oyster growth is extremely rapid; an instance of half an inch shell growth in a month is recorded. Cases are naturally covered with filamentous sea salad, ulva, which protects the oyster against light and heat, and gives attachment and shelter to the rapidly growing oyster food. (Page 375.) Park of MM. du Puy, St. Martin, and Dasté.

FIG. 1. ARCACHON. THE OYSTER BOAT.
The fringe of waving saplings in the background are seen in detail in the second figure. (Page 377.)

FIG. 2. ARCACHON. AN ALLEYWAY FOR TRANSPORT, PASSING BETWEEN NEIGHBORING PARKS. IT IS MARGINED WITH SAPLING FISH-DEFENDERS. (Page 377.)

FIG. 1. SABLES D'OLONNE. VIEW OF GREAT BASIN OF ÉLEVAGE TAKEN FROM NEAR THE SLUICE GATE.

The claires, Fig. 2, are situated on the low meadows alongside. The end of the lake in the distance furnishes the water for salt evaporation. The white points seen in the figure are large heaps of salt. (Page 377.)

FIG. 2. SABLES D'OLONNE. A VIEW OF THE CLAIRES TAKEN FROM THE MARGIN OF THE GREAT BASIN, SHOWING THE HEIGHT, WIDTH, AND CHARACTER OF THE EARTHEN BANKS THAT FORM THEIR OUTLINES. (Page 378.)

FIG. 1. BRENEGUY. THE PARK FOR SEED CULTURE IN A LARGE CLOSED BASIN.

Picture taken from the great dyke on the seaward side. The building screens from view the stone wall and the sluice gates. The bed of the wide draining creek may be seen at the right. (Page 372.) Park of Mme. de Saint Sauveur.

FIG. 2. MARENNES (LA TREMBLADE). VIEW OF THE MOUTH OF THE LARGE CANAL WHICH PASSES INLAND AND FEEDS SYSTEMS OF CLAIRES ON EITHER SIDE.

The picture gives an idea of the degree of the fall of the tide and, in the background, of the width of the Soudre. The village of Marennes is directly opposite. (Page 379.)

FIG. 1. MARENNES (LA TREMBLADE). VIEW OF THE CLAIRES FOR GREENING THE OYSTERS.

The draining and feeding canal, communicating with the large one of the preceding figure, is seen margined with planks. The picture shows clearly the flat character of the country, the size of the claires and of embankments, and the way in which the establishments are crowded together. Each shop in the figure represents a collection of adjoining claires. (Page 379.)

FIG. 2. MARENNES (LA TREMBLADE). A BASIN OF DÉGORGEMENT, CONCRETED, DRAINED BY COMPARTMENTS.

An oyster tramway is seen; the Soudre in the background; at the left the margin of a low claire. (Page 380.)