

## XVII.—PEARLS AND MOTHER-OF-PEARL AT TAHITI AND THE TUAMOTU ARCHIPELAGO.\*

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[Extracted from report to the Minister of Marine and the Colonies.]

In ancient times pearls came from the Indian Ocean, the Red Sea, and the Persian Gulf. After the discovery of America, the Gulf of Paria, the Isle of Margarita, Peru, the Gulf of Mexico, and the Gulf of California furnished the European market with the most famous pearls. The fisheries of Ceylon, of the Coromandel Coast, of Koudatschy, Manaar, and generally all the fisheries of the Indian Ocean, the Red Sea, and the Persian Gulf, date back to the most remote antiquity.

In modern times these fisheries have been worked by the Portuguese and English, and have always yielded very large profits, furnishing a large share of the trade of the coasts of India. At the present time England derives from these fisheries an annual revenue of several millions of francs; and the total annual yield in pearls and mother-of-pearl of the Asiatic fisheries amounts to 20,000,000 francs † [nearly \$4,000,000].

Next to these fisheries, the most productive pearl fisheries of our times are those of the Sunda Isles, of Panama, of Colombia, all of which have been carried on for a long time. Of more recent date are those of the Tuamotu Islands, the Gambier Islands, and Australia. These last-mentioned stations furnish the beautiful pearls produced by the large pearl-oyster, called in science *Melcagrina margaritifera*, and by another smaller pearl-oyster, the *M. radiata*. We should also mention the fisheries in the fresh and brackish waters of the Hawaiian Islands, Saxony, Bavaria, Bohemia, Jutland, Scotland, Ireland, Norway, Sweden, Russia, and France. But only in exceptional cases are pearls of fine water and great value found. The pearls more commonly found are generally known under the name of "druggists' pearls," because from

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† For abstract of article by Bouchon-Brandely on a like subject, see F. C. Bulletin, 1885, p. 292.

† A franc is valued at 19.3 cents; a pound sterling at \$4.86.

them the powder was obtained which in ancient therapeutics was used in certain astringent medicines, which are now no longer employed.

Formerly the markets of Constantinople, Venice, and Lisbon were celebrated for their sale of pearls; but now the trade in pearls has taken another direction, most of the pearls, which are found to some extent in all parts of the globe, being now sent to England, Germany, North America, and somewhat less to France.

*Quality and value of pearls.*—Pearls have formed the object of numerous classifications, according to their water, luster, transparency, color, form, weight, and dimensions. There are white, gray, black, lilac, rose-colored, blue, and yellow pearls. They are also distinguished as odd-shaped, pear-shaped, button-shaped (flat at one end), virgin or paragon pearls, the last being the most perfect as to form and the most highly esteemed.

Nothing varies so much as the value of pearls. It is entirely a matter of fashion and taste. Sometimes white pearls are most sought after, and sometimes gray ones. At present black pearls are those which are valued most highly. A beautiful pearl, valued, for instance, at 2,000 or 3,000 francs, would be worth 5,000 or 6,000 if a similar pearl could be found to match it; that is, the pair would be worth 10,000 or 12,000 francs to an amateur. Pearls are sold either by the weight or by the piece; by weight when they are of not more than ordinary beauty; by the piece when they are uncommonly beautiful. Even when sold by weight, the price is not fixed, and it may vary from one price to tenfold that sum, according to whether the pearl is round, azure, or black, or whether it weighs six grains or thirty grains. A pearl of ten grains, if shaped like a button, would be worth from 8 to 12 francs per grain; if, on the contrary, it is round, white, or rose-colored, 25 to 35 francs; and if black, 55 to 65 francs. A pearl weighing thirty grains might be bought by a dealer for 100 francs per grain. (There are four grains to a carat and nearly four carats to a gram.) The trade in pearls is counted by millions. It is difficult to make an exact valuation, for after they have been worked, the articles of jewelry and ornaments in which pearls are used are no longer valued at their intrinsic worth, but at their artistic or industrial value. The only information which we possess relative to the trade in pearls in France is found in the customs statistics. In 1883 France imported 94,000 grams of pearls, gross weight. Of these, 84,000 grams came from Germany, 5,000 from Colombia, 4,000 from the United States, and 1,000 from various other countries, representing a total value of 800,000 francs [\$154,400]. But these figures do not represent the total quantity of pearls used in France. French jewelers use a much larger quantity of pearls, and receive them from sources not given in the statistics referred to above. Nor do these statistics mention the pearls which come from England, nor those which come direct from Tahiti. Both these countries furnish us with pearls valued at very large sums.

*Origin of pearls.*—The finest and most valuable pearls owe their origin to a small and very modest little shell-fish, occupying a very low grade in the animal kingdom, the pearl-oyster (*Melagrina margaritifera*, and a smaller variety, *Melagrina radiata*). Beds of pearls, properly speaking, do not exist. There are beds of shell-fish producing pearls, but pearls are not found on the sands of the sea, except in rare and accidental cases.

Fine pearls are not produced exclusively by the pearl-oyster; but they are also found in the shell-fish, commonly called "hog mussel"; in the "*mulette margaritifère*," common in fresh water, the valves of which are used by gilders in preparing their gilding; in the "*bénitiers*," a shell belonging to the conchiferous Acephala, in the *Haliotida*, &c. In the pearl-oyster, however, the finest and most highly valued pearls are generally found.

*Formation of pearls.*—The question as to what is the cause of the formation of pearls has frequently been discussed, and has been studied to some extent, but it has not yet been satisfactorily answered. The best work on the subject is that published by Möbius in 1858. Since then nothing has been said which is not already found in the work of this naturalist. Möbius does not solve the problem of the first origin. He says that the kernel or nucleus around which the pearl forms is formed by bodies foreign to the oyster; such as calcareous crystals, entozoa, anodonta, distoma, sometimes an egg lodged in a corner of the genital gland, organic, amorphous, brown, or yellowish *débris*, &c. But how these bodies found their way into the tissues where the pearl originates no investigation has as yet settled.

The further development of the pearl, and its structure, are better known. The pearl is formed like the mother-of-pearl layer of a scale. It is the product of a secretion of the tissues of the oyster round a nucleus; in other words, it is a shell reversed. In the center is the nucleus around which there is an epidermic layer; over this a layer of prisms (calcareous prisms with six sides, like the prisms of the enamel of the teeth), and finally a third layer, called by Möbius, the mother-of-pearl layer, to which are added several concentric layers secreted by the tissues, and which produce the continuous growth of the mother-of-pearl layer. As in the teeth, the structure of the pearl comprises an organic azotic cover and hard parts, the latter soluble in acids. The coloring and reflection is due to metallic salts.

Pearls may be found in nearly all parts of the oyster—in the genital gland, in and around the adductor muscle, and in the mantle. There may be fixed ones on the shell, or some, covered up by growth but originally external, in the shell itself. The pearls found on the body of the mollusk are considered the finest and purest. Their form approaches that of a perfect sphere. These are the ones which are called "virgin" or "paragon" pearls. They are nearly always found in the periphery of the gland and in the lower portion of the same. Held merely by the

enveloping membrane, which finally breaks, either by too great a tension or from some other cause, they live a life of their own, as they do not seem to adhere at any point to the tissues among which they are found. When freed, the pearl falls in the folds of the mantle or in the cavity of the valves. In this latter case, if the animal does not succeed in ejecting it—which it generally tries to do—the pearl adheres after a few days to the shell, and by constant additions of new layers of mother-of-pearl to the entire inner side of the shell, it finally becomes wholly imbedded in it.

Pearls protruding from the shell are used in articles of jewelry or ornaments where a portion of the pearl can be hid. As regards those which are imbedded in the mother-of-pearl, a Paris jeweler (Mr. Daniel Léoboldti) has found a way to extract them without breaking them; after which, by a special process, they are made so perfect that these pearls, which are otherwise natural pearls, are currently sold under the name of Panama pearls, their primitive value being now restored.

Many pearls, also, are changed by a manual process before they are exposed in the jeweler's window. This is done sometimes with pearls whose luster is only veiled by some peripheric layers, which are removed; some, also, from being pear-shaped, are made round by being delicately worked; others are made black by soaking them in a bath of nitrate of silver. It can hardly be imagined what ingenious devices have been employed to give to pearls of little value the appearance of fine pearls. Means have been found to make them rose-colored, lilac, yellow, gray, &c.; but, on the other hand, ways have been found to discover these deceptions.

There are also pearls which are called fine pearls, but are not such in reality. These are caused by the perforation of the shells by the animals. They are hollow inside, and contain substances having no relation whatever to mother-of-pearl, and all of them have a large and distinctly marked stem. Besides pearls, the pearl-oyster also produces a mother-of-pearl protuberance, of irregular shape, which sometimes reaches the size of a pigeon-egg. These excrescences or swellings are due to the presence of foreign bodies in the oyster. It is not difficult to cause their formation; all that is required is to attach to the inside of the valve a piece of hard substance—stone, glass, or coral—which will soon be covered with glandular secretions, taking from the pearls their transparency and from the mother-of-pearl their iridescence. It is well known that the Chinese manufacture pearls by introducing between the valves of certain shells solid bodies on which secretions are soon deposited.

An experiment that I made at Tahiti in order to obtain internal protuberances of different kinds by artificial means was as follows: By the aid of a gimlet, holes were drilled in different parts of the shell of the pearl-oyster; and through these holes, measuring from one centimeter to a centimeter and a half in diameter [about half an inch], small glass or stone balls were introduced, held by a brass wire. A stopper of cork

or burao wood, pierced by the wire and not protruding inside the valve, closed the opening hermetically. In this way the glass ball was the only foreign body protruding on the inside of the shell. After four weeks a thin layer of mother-of-pearl had formed round the ball, covering it almost entirely. The result was a very fine artificial pearl in course of development. I believe that this process might be developed into an important industry, and I am also convinced that by making the proper selection it will be possible to produce mother-of-pearl of various colors.

*Pearl-oysters.*—The genus *Avicula*, to which the pearl-oysters belong, comprises a great number of varieties, differing but little from each other, and which it would be useless to enumerate in this report.

In commerce two kinds of pearl-oysters are distinguished—the one the *Meleagrina radiata*, which is found in the Indian Ocean, the Persian Gulf, in the Chinese Seas, the Caribbean Sea, the Red Sea, and on the north of Australia inside the Great Reef; the other the *Meleagrina margaritifera*, also comes from the Indian Sea, south of the Comoro Islands, Zanzibar, the Australian coasts, the Sunda Isles, Gilbert Islands, Philippine Islands, New Guinea, and finally from the French Possessions in Oceanica, especially the Gambier Islands, and the Tuamotu Archipelago.

When fully developed, the first of these oysters rarely has a diameter exceeding 10 centimeters [nearly 4 inches]. The weight of both the valves combined rarely reaches 150 grams [about 5½ ounces]. The second kind may reach a diameter of 30 centimeters, and a weight of 9 to 10 kilograms [about 20 to 22 pounds]. The first-mentioned kind furnishes inferior mother-of-pearl, as to quality and commercial value. The second produces the beautiful mother-of-pearl, so much sought for industrial purposes, on account of its solidity, consistence, iridescence, and beautiful whiteness.

*Pearl fisheries.*—The Tuamotu Archipelago contains the largest pearl fisheries in the world. Of the 80 islands composing this archipelago there are only 5 or 6 which do not produce pearls. These immense fisheries, however, are far from yielding the revenue which England derives from her pearl fisheries in India, nor is the manner in which they are managed the same. The English Government has taken possession of these fisheries, works them on its own account, or lets them to different persons at a high rent.

The French Government, on the other hand, leaves the fisheries on the oyster-beds free, derives no revenue from the trade in pearls, and exercises no control. This apparent indifference would be inexplicable if we did not take into consideration the circumstance that we have been absolute masters of the Tuamotu Archipelago only since 1880, and that consequently during this short period we have not been able to work out a system according to which the fisheries should be suitably managed.

It is certain that the Tuamotu Islands are not as rich in pearls as the

India pearl fisheries. But, although there is no basis upon which to make an estimate, it must be supposed that they could every year furnish pearls to the value of several hundred thousand francs.

Whatever the traders may say about it, there are few of the natives who do not possess pearls. I have convinced myself of this by personal observation. Every time we landed at an island, the natives came almost immediately, and, in a shy manner, as if trying to hide them, offered us pearls for sale, drawing them from some fold in their belt in which they had been concealed. The quantity of pearls gathered ought to be in proportion to the quantity of mother-of-pearl fished. If we take, as an example, the fisheries of some parts of Australia which, according to official statistics, produce about 250 tons of mother-of-pearl per annum, and more than 300,000 francs' worth of pearls, the lagoons of Tuamotu, from which 600 tons of mother-of-pearl are drawn every year, should yield at least 600,000 francs' worth of pearls.\* The mother-of-pearl obtained from the Australian waters resembles, except in its coloring, that of Tuamotu and Tahiti. Both in Australia and in the Tuamotu Islands it is furnished by the same pearl-oyster, the *Meleagrina margaritifera*.

It is true that in the French Possessions in Oceania there are no longer found in the same abundance magnificent pearls of such large dimensions that Queen Pomare, of Tahiti, used them as billiard balls. Exhaustive fisheries have been carried on in these lagoons for half a century, and fine specimens of pearl-oysters have become scarce. But, in spite of all this, the Tuamotu Islands cannot be so poor in pearls as people pretend, to judge from the large number of persons who, in Tahiti alone, make a living by trading in pearls. Mention should be made in the first place of the special buyers, nearly all English, Germans, and Americans (with the exception of two Frenchmen sent to Tahiti by two French houses, a thing which had never occurred before); secondly, the captains of vessels plying in these waters, who make a living principally from pearls and mother-of-pearl; and finally the merchants of Papeete, who occasionally add the trade in pearls to that for which they pay a license, as the trade in pearls is exempt from all duties and control, and any one may engage in it.

Nearly all the pearls from Tahiti go to America, Germany, or England, to the great detriment of the French jewelry trade, which uses a very large portion of the beautiful pearls sold in the European markets. It will easily be understood that the French jewelry trade has to

\* In Australia the yield of pearls in 1881 was estimated at \$58,200, and in 1882 at \$84,875. When I passed through Melbourne no data could as yet be furnished for 1883, but it was thought that the quantity of pearls was increasing, to judge from the much greater quantity of mother-of-pearl obtained during that year. In 1875 a pearl was found valued at \$7,275; another, found at Nicol Bay, and weighing 234 grains, sold for \$3,468. At the same place there was found in 1883 an extraordinary pearl, or rather a conglomeration of pearls, there being seven of them, of the size of peas, solidly soldered together, and forming a perfect cross. It was valued at an enormous sum.

obtain its supply of pearls through expensive intermediaries. This is all the more to be regretted, as the Tahiti pearls, of matchless beauty, are at present much sought after and valued very highly.

What measures could be taken to turn the trade in pearls to our profit, and to make French industry (at least as far as the Tahiti pearls are concerned) independent of foreigners? It was proposed to levy a high duty on all pearls destined to be sold to countries other than France, and to exempt from all duty those sent direct to the French markets; but it was recognized that this measure would not answer the purpose, considering the facility with which this precious article can be concealed. A large quantity of mother-of-pearl is smuggled, and the same would be done with pearls.

Mr. Mariot, an old resident of Tuamotu, has proposed a system which deserves to be mentioned. He says: "I think that pearls could be made to find their way to Paris by establishing at Tuamotu a branch of the Agricultural Bank of Tahiti, which would pay the owners of pearls one-fourth their estimated value; the remainder—less a certain small percentage for general expenses—to be paid as soon as their sale at Paris had been reported." I think that Mr. Mariot's plan deserves to be examined and carefully studied. Our large dealers in pearls and our great jewelry houses ought to form a syndicate and establish an office at Tuamotu for buying pearls. It is true that pearls have never been sold in Oceanica to greater advantage than at the present time; and even a medium pearl will fetch a higher price in Tuamotu than in Europe or America.

*Mother-of-pearl.*—The trade in mother-of-pearl is constantly increasing. England imports not less than 5,000 to 6,000 tons a year, and Germany from 1,200 to 1,500. France imports about 2,500 tons, representing a value of \$1,351,000. French industry (fine furniture, inlaid work, fans, buttons, &c.) uses nearly all the mother-of-pearl imported into France, while England retains for industrial purposes only one-twentieth part of the mother-of-pearl she imports, and sells the rest to France, Austria, and North America. In fact, most of the articles into whose composition mother-of-pearl enters are manufactured in France. It is impossible to estimate the value of these articles, but it is certain that it reaches a very considerable sum. For some years Austria has become our rival in this respect, and it is estimated that the number of men employed in Austria in working in mother-of-pearl is 8,000, while their number in France probably does not exceed 4,000.

In 1883 France imported 2,235 tons of mother-of-pearl, as follows:

Whence imported.	Quantity.	Whence imported.	Quantity.
	<i>Tons.</i>		<i>Tons.</i>
Egypt .....	13	Mexico .....	85
Dutch East Indies .....	11	British Indies .....	92
Colombia .....	13	Australia .....	303
Germany .....	18	Various countries .....	37
Japan .....	19	England .....	1,553
Netherlands .....	63	Tahiti .....	28

Two of the above figures are particularly suggestive: the enormous quantity of 1,553 tons of mother-of-pearl which French industry is compelled to buy in England, and the small quantity of 28 tons representing all the mother-of-pearl obtained directly from the French Possessions in Oceanica.\* The Gambier Islands and the Tuamotu Islands each produce about 600 tons of mother-of-pearl per annum; but this goes mostly to England or Germany.

The best mother-of-pearl comes, as we have already stated, from the large pearl-oyster. Other shells, among the rest the nautilus, and even the small pearl-oyster, produce mother-of-pearl of inferior quality, used in the manufacture of less expensive articles. In Australia, the Sunda Isles, Banda Sea, Torres Strait, on the coasts near Panama, and in Tahiti the richest beds of mother-of-pearl are found, and the most extensive fisheries are carried on.

In Australia these fisheries have, during the last few years, developed enormously owing to the discovery of new beds. Queensland alone in 1882 exported 250 tons of mother-of-pearl, representing a value of \$121,250. The entire quantity yielded by the Australian fisheries in 1880 amounted to from 720 to 750 tons. The price of mother-of-pearl in this colony varies from \$26.50 to \$39 per hundredweight. In 1880 forty-four licensed vessels and fifty-five boats were engaged in these fisheries on the northwest coast of Australia.

†The mother-of-pearl from Port Darwin, Thursday Island, is somewhat yellowish on the outside, and when it attains to certain dimensions breaks in small leaves. It is worth from \$630.50 to \$679 per ton brought to London. The consignments comprise shells classed in trade according to their dimensions, as "bold," "chicken," and "medium."

The mother-of-pearl from Freemantle has a greater degree of consistency, is thicker and heavier, not so large, but generally of a whiter color than the preceding kind, and it is worth about \$48.50 or more per ton. Seven or eight years ago its price rose exceptionally to \$1,164 per ton. As there are no laws to regulate the Australian fisheries, shells of greatly varying dimensions are shipped from there.

The Macassar mother-of-pearl is the most expensive, and that which is sought after most. White, like that from Australia, but not so dense and hard, it is used in the manufacture of the most sumptuous furniture. On an average, 120 tons are exported per annum, selling—without regard to dimensions—at about \$970 per ton.

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\* These figures, taken from the French customs statistics, do not agree with those furnished me by the large Paris dealers in mother-of-pearl, nor with those obtained at Papaete. According to the last-mentioned authority, about 70 tons of mother-of-pearl came to France directly from Tahiti.

† I am indebted to the Hon. Emmanuel Sarassin, one of the great Paris dealers in mother-of-pearl, member of the syndicate of manufacturers of fine furniture, for the following information relative to the price and quality of mother-of-pearl of different origin which comes to the French market.



The Auckland mother-of-pearl is grayish and small, hardly ever exceeding 20 centimeters in diameter; it is worth from \$388 to \$485 per ton, according to the demand. The smallest shells exported measure 5 to 6 centimeters [about 2 inches] in diameter.

The Zanzibar mother-of-pearl is one of the smallest and also least expensive kinds. The diameter of the finest shells does not exceed 10 centimeters [nearly 4 inches], and does not sell for more than from \$145 to \$195 per ton. These shells, however, are pleasing to the eye, having azure and copper-colored edges. Only very few are found.

The Panama mother-of-pearl reaches a maximum diameter of 15 centimeters [nearly 6 inches]. The edge is somewhat yellowish, and the center rather white. It resembles the Mexican mother-of-pearl called "Mazatlan," except in the color of the border, which in the latter is bluish green. Panama mother-of-pearl is worth \$242.50 per ton.

The mother-of-pearl called "Banda" is taken in the neighborhood of Manila, and in the Strait of Malacca. It has a deep gray color, is not very transparent, rarely reaches a diameter of 10 centimeters [6 inches], and is worth \$194 per ton. It comes to Europe by way of the Netherlands or Marseilles.

The Sydney mother-of-pearl is gray, and somewhat resembles the Banda, only it is a little thicker, and is worth \$242.50 per ton.

Liverpool, London, and Hamburg are the largest markets in Europe for the sale of mother-of-pearl. In these ports mother-of-pearl and other valuable shells arrive in considerable quantities from nearly all the fisheries in the world.

An English newspaper, bearing date of February 4, 1885, published the following price-list per hundredweight for mother-of-pearl during 1884 and 1885:

Fisheries.	1884.	1885.
Manila, bold .....	\$48 50 to \$40 71	\$44 80 to \$47 28
Bombay:		
Bold .....	23 64 to 26 67	23 02 to 27 87
Medium .....	22 23 to 24 25	19 40 to 21 82
Small .....	15 25 to 22 23	12 73 to 18 10
Egypt:		
Bold .....	21 82 to 25 46	21 82 to 23 04
Small and medium .....	10 97 to 23 04	10 91 to 21 82
Freemantle:		
Bold .....	36 37 to 41 22	38 80 to 41 22
Chilcken .....	46 08 to 48 50	46 08 to 48 50
Sydney:		
Bold .....	38 10 to 45 47	37 50 to 42 34
Chilcken .....	45 47 to 47 89	41 22 to 46 08
Panama .....	11 40 to 11 64	11 64 to 12 01
Tahiti, black-edged .....	18 19 to 33 95	18 19 to 31 52
Auckland .....	16 97 to 23 02	15 70 to 19 40
Banda .....	11 52 to 16 97	10 91 to 12 73

Mother-of-pearl is subject to the caprice of fashion and to the whim of the moment. During the last few years the black-edged Tahiti mother-of-pearl was preferred to the white. At present the latter, although more common, is the more expensive and more highly prized. Very

beautiful in itself, the Tahiti mother-of-pearl is hard, homogeneous, transparent, iridescent, and of darker color along the edges. When held to the light, it shows fiery colors, combining all the colors of the prism; and these astonishing reflections unite in a glittering and delightful harmony. Should fashion take a fancy to prefer brown and azure mother-of-pearl, our oceanic fisheries can satisfy the demands of industry; for no mother-of-pearl can rival that of Tahiti, which, moreover, is a specialty of our possessions in the Pacific Ocean.

*Decrease of mother-of-pearl.*—In all parts of the globe where mother-of-pearl beds exist the fisheries are continually extending at such a rate that, unless proper measures for protection and propagation are taken, the time can be foreseen when the banks will be exhausted. As far as we are concerned, our fisheries in the Gambier and Tuamotu Islands already show unmistakable signs of exhaustion. The “bold” mother-of-pearl has become so rare in these waters that it is found only at a very great depth. And if the yield of the lagoons is not noticeably less than it was fifteen or twenty years ago, the reason is this, that the fishermen go to a greater depth, and that they gather as marketable mother-of-pearl the small shells, which in former times they would have despised when the Tuamotu fisheries were at their height.

Twenty or thirty years ago the trade in mother-of-pearl in the Tuamotu Islands was very profitable to those engaged in it. For a piece of cheap cloth, some handfuls of flour, or a few gallons of rum, the trader could get half a ton of mother-of-pearl, worth 1,000 or 2,000 francs, or beautiful pearls whose value the natives did not know. This archipelago was visited by vessels of different nationalities. Mother-of-pearl was abundant, and pearls were not so scarce as they are now. Since that time the number of vessels has increased; the natives, allured by the advantages of a trade which became more profitable as competition increased, commenced to fish with the most improvident ardor. Now, they find that the lagoons are less productive, that they are gradually being exhausted, and that even some of those which used to be the most productive show signs of approaching exhaustion.

*Mother-of-pearl fisheries.*—The natives of Tuamotu have no other industry but the fisheries. Their aptitude for this difficult and dangerous occupation is truly astonishing; and they all—men, women, and children—follow it for a living. They dive like fish and remain under the water several minutes, sometimes going to the depth of 25 fathoms and staying under the water for three minutes. In doing this they are exposed to the greatest dangers, for in the dark depths of the lagoons there are many sharks which roam about the fishing places in the hope of finding some prey. If, in spite of all possible vigilance and agility the diver does not succeed in avoiding the sharks, he has to meet them in an unequal and terrible combat.

Diving is not only a very dangerous occupation but also one of the most difficult known. In the beginning of the season the fishermen are

obliged to take great precautions, the first and most essential being not to dive in the water too often in one day. To neglect this precaution exposes the fisherman to hemorrhages and congestions. After a while he becomes accustomed to diving; but to continue this practice to a certain age is apt to cause paralysis.

Thus far, very few natives of Tuamotu engage in fishing on their own account. Most of them do not possess the necessary funds or the requisite spirit of enterprise. Some work by the day on a fishing vessel, which is the more profitable way; but only those can do this who permanently reside in the islands near which these fisheries are carried on. Others hire themselves out for the entire season, or for part of it to business houses of Papaete, or to the captain of a fishing vessel. A diver working by the day gets about a dollar a day. The diver who hires himself out for the season makes a contract with the person or persons carrying on the fisheries, by the terms of which he has to give up all the products of the fisheries on conditions determined beforehand, and in return is furnished during the entire period of his engagement with food and other necessaries of life. In carrying out this contract the diver is sometimes badly imposed on.

An ordinary diver earns from about \$23 to \$29 per month, according to the condition of the sea and the productiveness of the oyster-beds. If he is fortunate enough to strike a bed which has not yet been subjected to excessive fishing he can earn very good wages. There are some who in one week have gathered about \$40 worth of mother-of-pearl.

Diving begins in the morning. After the vessel reaches the fishing place the necessary preparations are made, and do not occupy much time. All the clothing of the divers consists in a piece of cloth round the loins, and all their tools in a pair of spectacles. Intended for examining, from the surface, the depths which the diver has to explore, these spectacles resemble those used by calkers. They are composed of four pieces about  $16\frac{1}{2}$  inches long and about 11 inches broad, forming a small chamber, one of whose ends is provided with a glass. The other end is open to admit the head of the diver. The glass side is held to the water so as to remove all blurs. As the waters of the lagoons of Tuamotu are remarkably clear and transparent, a skilled fisherman can, by means of this simple apparatus, discover oysters at a considerable depth. In most cases he will not dive into the depths until he has made this preliminary reconnaissance.

The Tuamotu divers may justly be considered the best in the world. The Hindoos employed in the pearl fisheries in the Gulf of Persia and on the shores of Ceylon, who are very properly considered expert divers, cannot be compared to them. The Hindoo diver descends in the water by means of a weight of 20 to 25 pounds attached to his feet. His belt contains also 7 or 8 pounds of ballast, serving to keep him in the depths after he has rid himself of the first weight. He stops up his nostrils

and ears with cotton soaked in oil, and places a band over his mouth. Thus equipped he goes to a depth of 40 feet, remains 53 to 90 seconds under the water, and ascends by means of the rope which has accompanied him. The Tuamotu diver, on the other hand, does not use any of this apparatus or any of these precautions. All his preparation consists in vigorously exercising his lungs by inhaling and exhaling in an energetic manner a few moments before plunging into the water. After this, he takes a last and copious supply of air, and then, divested of every vestige of clothing, he lets himself drop into the water, feet foremost, without the slightest weight to accelerate his descent. He descends not merely 40 feet, but sometimes 25 to 30 fathoms, and remains under the water not 90 seconds, at most, but from 2 to 3 minutes; and having made his haul rises to the surface, without the aid of a rope, in an incredibly short time.

It has been said that the natives of the lower islands rub their bodies with oil to protect them against the burning rays of the sun and the corrosive action of the sea-water; but in no place was I able to observe anything of the kind. As far as the sun is concerned, the natives have nothing to fear from its rays; for, although the Tuamotu Islands are under the tropics, the heat of the sun is not unbearable because it is greatly moderated by the currents of air which prevail. Cases of sun-stroke are unknown, and the temperature of the water in the lagoons rarely exceeds 25° centigrade [77° Fabr.]. Each plunge into great depths averages from one minute to a minute and a half, rarely two minutes, and only in exceptional cases three minutes.

Some business houses have endeavored, but without success, to introduce swimming-suits among the natives. They refuse to wear them, alleging, and with some apparent reason, that these suits would rapidly produce paralysis of the lower limbs. Three Europeans use swimming-suits, and consequently make rich hauls. They also maintain that these suits keep away the sharks. They rarely rise to the surface without bringing up several pieces of mother-of-pearl at a time; while the native fisherman must be content to detach them rapidly one by one, it being a very rare case that he brings up more than one piece at a time. His first care, when under the water, is to keep the valves of the oyster pressed closely together, for fear that the animal, roughly torn from the object to which it adhered, and feeling a pain caused by the tearing of some of the threads of its byssus, might, by the movement of its organs, eject the pearl which it contains. There are no external characteristic marks indicating the presence of pearls in the oyster. Nevertheless, the fishermen have been observed to dive for certain oysters in preference to others, guided by the looks, shape, and color of the shell. But all these indications are very indefinite; and only in exceptional cases have I seen the selection of the oysters, by the indications given above, realize the expectations of the fishermen.

After the work of the day is over the divers begin to open the oysters, using for this purpose a large knife, which they handle very skilfully. By the first cut the adductor is severed. Each shell and its contents are then examined with the greatest care, so that no pearl may escape. The masters never fail to assist in this operation; for, although divested of all clothing, the native of Tuamotu can quickly swallow a pearl the moment he has discovered it. The shells belonging to independent fishermen are, after they have been emptied, placed in moist sand till the day of sale, so that they may not lose any of their weight by evaporation.

Diving for pearl-oysters is going on from one end of the year to the other, but especially during the months of November, December, January, and February. In June, July, August, and September it takes place only in the afternoon, the water being too cold in the morning.

*Exhaustion of the Tuamotu lagoons.*—After my arrival in the Tuamotu Islands my first care was to make an investigation of the condition of the waters, in order to ascertain if what has been said regarding the gradual exhaustion of the lagoons was exaggerated: in other words, whether the Tuamotu Islands were threatened with approaching ruin. The danger is, I am sorry to say, only too real. The lagoons become poorer in oysters every day, and the time has come for taking energetic measures if their complete exhaustion is to be prevented. This state of affairs is not of recent date. M. de Bovis, in his work on the colony of Tahiti, urged as far back as 1863 that the fisheries in this archipelago should be protected, and expressed the fear that sooner or later the lagoons would become entirely exhausted. Later, Mr. Mariot called attention to the constantly-increasing gravity of the situation, and did not hesitate to predict that if no measures were taken to check the progress of the evil the pearl-oysters would soon become entirely exterminated.

The divers all agree that mother-of-pearl is constantly becoming more scarce; that large oysters are found only in exceptional cases, and that even oysters which are barely salable, namely, those measuring about 7 inches, are found only at a great depth, while formerly they were found even close to the shore. Those times have passed when vessels, carrying seventeen divers, could gather in less than a year, near the island of Tikahau, 120 tons of mother-of-pearl. Mother-of-pearl, as it has become scarcer, has also become dearer. According to Mr. Mariot the kilogram was worth, in 1873, from 30 to 60 centimes,\* but about 1 franc in 1875. At the present time it sells at Tuamotu at 1 franc 75 centimes to 2 francs 25 centimes per kilogram.†

\* 100 centimes=1 franc=\$.193.

† This is the nominal value. By paying part in goods and part in Chilian dollars, these prices, both those of 1873 and 1875, and those of 1884, should be reduced one-third in order to be brought to their exact proportions.

*Causes of exhaustion.*—It will be sufficient to name the following principal causes of this depletion :

1. The abusive fishing which the Tuamotu fishermen have carried on for the last fifteen or twenty years, at the instance of ignorant merchants, and the taking of young oysters.

2. Absence of all supervision.

3. Insufficiency of the administrative measures intended to regulate the fisheries in the archipelago.

4. Absence of efficacious provisions for restocking the lagoons.

There is no supervision in the fishing places, and no officers to superintend the fisheries. Since France took possession of Tahiti the successive governors had their hands full in providing for the first necessities of establishing French rule in these islands. Since then the condition of our mother-of-pearl fisheries has remained the same as it was under the protectorate, and the fisheries have not been subject to any restrictions. At present this question is seriously occupying the minds of all men who have the future of this colony at heart. They know that if the mother-of-pearl was to disappear, the colony would at once lose a great portion of its commercial importance.

A plan for preventing the extermination of these oysters consists in working the lagoons in regular turns, subjecting to prohibitory measures those in which there has been indiscriminate fishing for a number of years. This prohibition is, in the language of the islands, called "rahui." The "rahui" may be ordered by a decree of the governor, for a period varying from two to five years, in any given island of the archipelago; either because, according to the rank it occupies among the islands, its turn has come to have fishing prohibited, or because the condition of the oyster-beds renders such a measure imperative. The decree ordering prohibition at the same time determines in which islands the fisheries shall be free.

The periods of prohibition and of free fishing may be calculated in such a manner, as to have fisheries going on in nearly the same number of islands every year. All this is very well understood, and the principle in itself is good. According to this system most of the fisheries in the Indian Ocean and the Persian Gulf are managed. But with due regard to the character of the Tuamotu lagoons, which really constitute inclosed fisheries, and in which oysters could easily be propagated, and also to the fact that the Tahiti pearl-oyster differs very much from the small pearl-oyster of Ceylon and the Persian Gulf, it may be presumed that the method applied to the open waters of the Indian Ocean will not be the one best suited to our oyster-cultural establishments.

Under the "rahui" system, when an administrative measure prohibits fishing in an island, the divers have left there only those oysters which are at too great a depth, or which have escaped their constant researches. The "rahui" is based on the principle of the hermaphroditism of the pearl-oyster. The persons who inaugurated this system thought that, in view

of the fecundity of mollusks in general, a small number of pearl-oysters would be sufficient to restock in a few years the most exhausted waters. This way of reasoning, however, was based on an erroneous principle. The pearl-oyster is a uni-sexual mollusk, either entirely male or entirely female. In order to accomplish reproduction, it is necessary that within a certain limited space there should be oysters of both sexes, and this was not the case in the fishing grounds which had been ransacked more than once during several consecutive years. The oysters were too scarce and too isolated to let the generative elements meet often. This is the sole reason why the "rahui" has not produced the happy results which were expected from it. Nor should it be forgotten that by reason of the relative tranquillity of the waters of the lagoons, and also from anatomical reasons, the generative elements have very little chance of coming in contact with each other. I have often found that the spawn does not go far from the place where it was produced. Thus the branches of coral near conglomerations of oysters are sometimes so full of small oysters that they literally choke each other. This is a fortunate circumstance, owing to which it becomes easy to get the spawn of the pearl-oyster, and by its means to accomplish their production in the lagoons of Tuamotu.

#### NATURAL HISTORY.

*Reproduction.*—Although of a different kind, the pearl-oyster is not excelled in fecundity by the edible oysters raised in the oyster-pares on the coast of France, and not even by the Portuguese oyster, which every year ejects several millions of eggs. The mode of reproduction of the pearl-oyster resembles that of the Portuguese oyster. The sexual products are, at the period of maturity, ejected from the genital glands, and meet in the water. I have never succeeded in finding spawn in the valves of the pearl-oyster, although I have opened them at every stage of the reproductive period.

Resembling the trees of this climate, which never cease to bear fruit from one end of the year to the other, the pearl-oysters seem capable of performing the generative functions at every season of the year. I have not been able to ascertain the number of times which the pearl-oyster spawned within the period of one year, but they certainly must be very numerous. It is very rare to find the sexual glands completely empty during several consecutive weeks, and it is probable that there are periods during which the emissions are more abundant than at other times. Spawning does not take place at one and the same time in all the islands of the archipelago, nor even in islands of one and the same neighborhood. About the middle of July of last year the oysters of Aratica were not in a fit condition for reproduction, while at this very time the oysters of Fakarava ejected their eggs, and it should be remembered that the islands of Fakarava and Aratica are not very distant from each other. The climatic conditions are the same, and the density and tem-

perature of the water resemble each other. As it appears that the glands accomplish their germinative evolution in a few weeks, the ejection of the elements of reproduction should be accomplished in a comparatively short time. The observations in the next two paragraphs are given in support of this theory:

The spawning oysters gathered and brought by us from Fakarava as far as Papaete, had all, eight days after their arrival in the last-mentioned place, discharged the sexual products. Towards the middle of the month of July we noticed in the island of Aratica, that the oysters of the lagoon did not present any appearance of the near approach of generative activity. Five weeks later the oysters of this same lagoon spawned.

I have made similar observations at Tahiti and Moorea, all proving the constant activity of the organs of reproduction. The fishermen of whom I made inquiries assured me that the oyster propagates its species every year, at least at Tahiti, Moorea, and in the Tuamotu Islands. It is possible that in the Gambier Islands, which at certain periods are much colder, spawning takes place only at certain fixed seasons. The fishermen also think that the oysters become fertile at every full moon. I have not been able to verify the truth of this assertion, as far as the pearl-oysters are concerned, but it appears to be generally admitted that this is a fact as regards the edible oysters, which are very common in the Society Islands (a kind of *Ostrca plicatula*), and as regards some other kinds of shell-fish. The emission of the sexual products generally took place at the waning of the full moon. The mother-of-pearl oyster begins to spawn from the year following that of its birth.

During my stay in the colony of Tahiti I made a certain number of experiments with the reproduction and raising of pearl-oysters, which were accompanied by the best results. I proceeded in the following manner:

At the very outset I found that it would be impossible to create in these waters oyster-pares like those existing on the shores of France for edible oysters. In the first place, the pearl-oyster cannot live an independent life like the edible oyster. Once detached from its original collector, it immediately needs another collector, as without this it cannot exist. It does not matter what may be the nature of this collector (wood, iron, stone, or brick), the oyster will at once adhere to it, provided it is a body which has the power of resistance, and which is brought in close proximity to the threads of the byssus. It would be a grave mistake to scatter pearl-oysters on any kind of sea-bottom, and expect that they would develop there like edible oysters, as the result would most certainly be a failure. If such an oyster falls on the sand, it is irrevocably doomed. Pearl-oysters are not provided with organs of locomotion enabling them to change their place. And how could the oysters be found again among the net-work of coral which covers the



bottom of the sea in this archipelago? How could they be taken care of? An army of divers would not suffice to take care of one parc; moreover the tide at Tahiti is too weak to leave dry any places capable of being converted into oyster-parcs. I therefore at once abandoned the idea of raising oysters in parcs, and I would advise those who intend to engage in oyster culture in Tahiti to do the same if they wish to be spared many disappointments. Some years ago there were seized on the island of Anaa a certain number of small oysters. Under the pretext of planting them again, orders were given to scatter them at a place in the lagoon where the bottom was exclusively composed of sand. Not a single one of these oysters was again found alive, all having been buried under the sediment and thus perished. Similar experiments made in other islands met with the same result.

The system of raising oysters in boxes, which has proved successful at several stations in the ocean, and even in the Mediterranean, seemed to me to be the most appropriate under the circumstance.

Oyster-boxes, containing a certain number of oysters, were submerged in various localities at Tahiti at various depths, varying from 3 to 25 feet. After a month or five weeks the oysters had increased in size, those measuring about 7 inches by about half an inch, and the small ones by almost  $\frac{3}{4}$  of an inch. Only one had died, but then it should be stated that it had been hurt in a particular experiment.

I renewed these operations in the port of Papetoai, in the island of Moorea, and under entirely unfavorable conditions. The oysters, before being placed in the box, had been deprived of the horny part round the edge of the valves by means of sharp pinchers and a scraper. Each oyster was numbered, and the outline of the shell traced on a sheet of paper. In some of them I had bored holes in several parts of the shell, to favor the formation of mother-of-pearl protuberances. After a month or five weeks the mutilated oysters had recovered, the edge of their shell had reformed, and all had increased in size about half an inch. With a few exceptions they had attached themselves to stones or pieces of coral placed in the box, or to the sides of the box. Those whose byssus had not found any object to which to adhere, had not increased in size. The fixing of oysters, taken from their natural collector, to resisting bodies, was therefore an accomplished fact. It had been asserted that once torn from their original collector, they would not adhere to another, and would soon perish. Later I observed that a single thread of the byssus was sufficient to insure fixation. The new fixation took place in from one to three days after the oysters had been placed in the box.

The first oyster-boxes of a model resembling those used in French oyster-cultural establishments, did not altogether suit the pearl-oyster. Accordingly, other boxes were made, which were better adapted to the purpose. These new boxes measured from 4 to 5 feet in length, 27 to 31 inches in breadth, and 10 to 12 inches in depth. They rested on four

feet, making the space between the box and the ground about 10 inches. On the inside there was a row of slats running parallel with the broad sides, and slightly inclined like the slats of a shutter, each slat being provided on the lower side with a bracket with a round hole, each intended to receive one oyster. In this way the oyster was placed almost vertically, its valves were in the air, and its byssus was brought in contact with the wood. Arranged systematically between the slats, the oysters could not become mixed, or become displaced by the action of the current. The bottom and the cover of the apparatus were composed of open slats, and the sides were perforated. In this way the water could enter the boxes and circulate freely.

The submersion of these oyster-boxes presented no difficulties. Four ropes attached to the four feet of the apparatus, were tied in a knot at the height of a yard above it. To this knot a rope was attached, which was lengthened in proportion as the apparatus weighted with stones sunk deeper into the water. A float attached to the upper end of the rope showed the place where the box was submerged. The operation of submerging and hauling up the oyster-box would be very much simplified, and be accomplished in a very short time, if there was a float with a system of winches and pulleys.

On September 3, 1884, a box like those described above, having its full supply of oysters, was deposited in the water of the harbor of Papaete, near the little island of Mutu-Uta. When drawn up three days afterwards all the oysters had become fixed to the wood of the slats, each in its own hole, forming in a certain way one body with the apparatus. It will be seen from this how advantageous the method of raising oysters in boxes might prove at Tahiti. If this method was employed not a single oyster would perish; their exact number would be known, and moreover each one might be numbered. The care which these young oysters need could easily be given them.

At no place on the French coasts is oyster culture carried on under such conditions of convenience and economy as are found at Tahiti. The absence of the tide, leaving the shore dry, is, in my opinion, an advantage to the oyster cultivator, who is thus enabled to carry on his operations at any time. Instead of having to send numerous relays of workmen to the parcs to use the short intervals when the water allows them to work, a small number of laborers will suffice to keep up the establishment, as they can work at any time. And if the trade in mother-of-pearl is languishing and prices are not remunerative, the cultivator can afford to wait for better times. The oysters are simply left in the parcs, where they will continue to grow and increase in value; and when better times come he would be prepared to meet the demands of the merchants, and would obtain good prices.

On nearly all the oyster-boxes containing mother oysters, deposited at Aratica at the entrance to the lagoon, spawn was obtained. Other important results were reached near Papaete. Some of the oysters had

been removed from the box sunk in this place in order to verify their growth. After three weeks the shells of these oysters were covered with spawn, measuring from .06 to .08 inch. On one valve as many as 300 eggs were counted. It is therefore beyond doubt that by placing collectors near the oyster-boxes an abundant supply of spawn could be secured.

*Vitality of the pearl-oyster.*—The pearl-oyster is endowed with a high degree of vitality. Changes of temperature and the density of the water may have some influence on its development, but they are not necessarily injurious to it. Thus, oysters placed, by way of experiment, back of the arsenal of Fare-Ute, although submerged in very brackish water, having a specific weight of  $38\frac{1}{2}$  grains, had hardly increased less in size than those placed at the same time in the harbor of Papaete, where the water weighs 44 grains, and were fully as vigorous as these. This does not mean that there are no places more favorable than others for the cultivation of the pearl-oyster, for in the Tuamotu Archipelago there are islands, especially Takapota, where the oysters always remain small; and the temperature, the density of the water, the nature of the bottom, and the currents, exercise a considerable influence on the growth of the pearl-oyster; but it is not very exacting in its demands, and may easily be preserved.

*Transportation of oysters.*—The transportation of the pearl-oyster is not connected with any serious difficulties. This is a most fortunate circumstance, for it thus becomes possible to furnish young oysters to parcs at a distance from the place where they were produced. Returning from Tuamotu to Papaete on July 13, 1884, we carried on board the Volage several hundred oysters destined for experiments which had been begun at Tahiti. These oysters were kept in cans whose water was renewed every three or four hours; and during this trip lasting forty hours we lost but very few. Some weeks later, employing the same method, I transported from Papaete to Tautira, on board the Aorai, one hundred oysters; and not a single one perished during the three days which this trip lasted. I am convinced that none would have been lost on the trip between Tuamotu and Tahiti, if there had been on board the vessel an apparatus constantly distributing aerated water in cans containing the oysters. Barrels furnished with faucets would fully answer this purpose.

*Enemies of the oyster.*—Like the edible oyster, the pearl-oyster has its enemies and parasites. Among the former there are two fish: the one, called "*Tahereta*" by the natives, is a flat fish bearing a strong resemblance to the fish so much dreaded by our oyster cultivators, on account of the ravages which it makes in the parcs; the other, called "*Oiri*" or "*Kotoke*," is a long fish with powerful jaws. It seems that these fish do much harm; they attack the oysters, break them open, and devour them. Other enemies of the oyster are two shell-fish, namely, a *Murex*, and a *Pholas*. These attack the shell of the oyster. The first pierces it

in several places, compelling the animal by a constant work of secretion to close up the numerous holes which have been bored in the shell; the second confines itself to lodging in the thick part of the shell, just as similar shell-fish on the coast of France lodge in stones or rocks. These animals are aided in their work of perforation by marine worms, one of which (called the "needle-worm," the most injurious of all) bores numerous holes and small galleries between the outer layer of the shell and the mother-of-pearl part, causing it to resemble a piece of wood attacked by xylophagous animals. Mother-of-pearl thus deteriorated loses all commercial value, and is called perforated or worm-eaten mother-of-pearl. A small parasitic sponge works similar injury. Even the malicious crab thinks that it has a special claim on the pearl-oyster, and attacks especially the young ones. I must finally mention the polyps, the ascidians, and the *Serpula*, which are dangerous parasites; also a small crab called "*pinnothère*," similar to the one found in France in non-cultivated mussels, which lodges in side the shell and lives at the expense of the oyster. Oyster culture based on the system of raising the oysters in boxes, provides protection for the young oysters against the many different enemies, of which I have enumerated only a few.

It has been noticed that the edible oysters raised in oyster-boxes were those whose shell was the finest, the healthiest, and the most transparent. The reason of it is this, that the apparatus in which they are inclosed, rests on feet, keeping them 8 to 12 inches above the ground. In this way the oysters are no longer in contact with the sand on the bottom of the sea where those animals live which it is important for them to avoid. Moreover it is one of the rules of oyster culture not to give the parasites contained in the sediments which engender them the time to develop and become fixed.

*Coloring of mother-of-pearl.*—White mother-of-pearl is at present most expensive and most sought after. How does it come that mollusks of the same kind sometimes have a white shell, like the Macassar mother-of-pearl, and sometimes a shell with a black border like the Tahiti mother-of-pearl? Is it a question of breed, or must these differences of color be attributed to more or less local influences, originating from the nature of the water and the bottom? I am inclined to the latter opinion. It has been observed in France that the element in which shell-fish live exercises an influence on their quality and their color. If, for instance, an Arcachon oyster, one year old, is transported to the parcs in the river Bélon in the Department of Finistère, it will be noticed that after a while that part of the shell which has grown in the new place will differ in color, hardness, and transparency from the original part of the same shell. Oyster cultivators have daily occasion to observe facts of this kind. White mother-of-pearl is not entirely unknown in Tahiti. From time to time specimens of this kind are found in the lagoons of the Gambier Islands.

As this question is a very important one from a commercial stand-

point, experiments should be made with a view to ascertain whether by special methods of culture it would be possible to cultivate white mother-of-pearl at Tahiti. These experiments are not the only ones which should be made. There remain a large number of questions whose solution would be profitable, such as, to determine the normal development of the oysters; the influence of waters, currents, temperature, and bottom; the choice of the best collectors for gathering the spawn; the selection of the most suitable places for raising oysters, ascertaining the time when spawn is ejected, &c. A year at least should be devoted to the study of these different questions, with the view to get at some practical data.

From what has been said it follows:

1. That the pearl-oyster is susceptible of being raised just like the edible oyster, and that its spawn can be gathered.
2. That at Tahiti oyster-cultural establishments may be founded with every chance of success.
3. That it is possible not only to check the gradual exhaustion of the Tuamotu lagoons, but to restock them, and make them as flourishing and productive as ever.

*Organization of the fisheries.*—The first thing to be done is to organize a special service of oyster culture analogous to that which the English have established in India, and the Dutch in their possessions in Asia. This service should include a strict supervision of the fishing places; this, in fact, is the most important point. It would cause the regulations to be properly respected, would prevent frauds and smuggling, would cause the contracts between masters and divers to be rigidly observed; it would keep the governor constantly acquainted with the condition of the fisheries, so that he would know which could be worked, and those which should be subjected to prohibitory measures ("rahui"); it would aid in determining the localities where new centers of reproduction should be established, and would assist in properly keeping up these hatcheries. The chief of the service of oyster culture should have at his disposal a steamer of 120 to 150 tons, built so that it could easily enter the lagoons and resist the bad weather which often prevails at Tuamotu. This vessel should be commanded by some experienced naval officer, having under him a crew of seven or eight men, who would act as fisheries police and see to it that the regulations were not violated. The vessel should be a rapid sailer, so that it could promptly and unexpectedly go from one island to the other. Some of the crew might, in certain cases, be detailed to guard the fishing places for a longer or shorter period. From the day when a proper and effective service of supervision has been established, the work of renewing the stock of oysters in the lagoons may be commenced with a well-assured hope of success.

This is, in my opinion, the method which should be pursued. At first only two or three islands should be subjected to the new regulations;

the others might meanwhile merely be subjected to some proper prohibitory measures. We have the choice between the islands of Araticu, Takaroa, Manihi, and Takapota, which can easily be superintended, owing to their small size. The fisheries in these islands should be declared free at all times; but the fishermen should be compelled to deposit in oyster-boxes and in specially selected places all the young oysters which they capture, and which have not yet reached the regulation size. These oysters should remain their property, and as soon as they had reached a marketable size they could dispose of them as they pleased. The centers of reproduction should be kept constantly supplied with oysters and propagate them all the time. Generative elements ejected by oysters placed in these reservations would be found there at all times, and it may be presumed that nearly all the eggs ejected by the mother oysters and susceptible of impregnation would there receive the fecundating fluid which they require. As the pearl oyster is exceptionally productive, numberless young oysters would escape from these reservations, and would by the current be carried into the lagoons, which they would fill with a new generation of oysters; and by placing suitable collectors here and there, a rich harvest of spawn might be gathered.

There would be no serious difficulties in the way of putting this system into operation. The natives of Tuamotu are docile and understand their interests. From what I have stated in my report on the condition of the fisheries in this archipelago, it will appear that the fishermen are entirely disposed to obey the instructions given them, and to become, in short, co-workers in this enterprise, which is undertaken for their own benefit as well as for that of the entire colony.

If we desire to bring to an end a condition of affairs which, as I have said, grows graver from day to day, threatening the natives with absolute ruin; if we desire to save from total destruction our oceanic fisheries; if we wish the Tahiti colony to flourish, it is of the utmost importance that we should make some sacrifices at once, and adopt some measures of immediate practical value.

Our Tuamotu fisheries are peculiar, and combine all the requisite conditions for becoming centers of a most productive and remunerative mother-of-pearl cultivation. If we were to cultivate these fisheries more than we have done, we might have a monopoly which no country could seriously dispute; especially as in a very short time, owing to exhaustive oyster-fisheries, mother-of-pearl is going to become a very rare article. I sincerely believe that if these fisheries were properly managed, the annual yield, which is now about a million of francs, would soon reach eight or ten millions.

However well disposed the natives may be, it will be necessary in the beginning to aid and encourage them. I would, therefore, propose to give premiums to those who, by their labors, had obtained the best results. The expense would not be very great, and the colony would doubtless provide the necessary funds.

I would also propose to send a thousand oyster-boxes from France to the governor of Tahiti, and have them properly distributed among the natives, to whom we shall have to look for establishing the first centers of reproduction. These boxes would also serve as models; and those of the natives of Tuamotu who are skilled in carpentering, could hardly fail to construct similar boxes. The *Miki-miki* wood, common in Tahiti, is very hard and resists the action of the water, and, like the wood of the cocoanut tree, it would be admirably adapted to this purpose.

The introduction of the industry of oyster culture in Tuamotu would be accompanied by very happy results. In the first place it would furnish steady work to the natives, something which they have needed for a long time, and to which they are well adapted; it would relieve them from the cupidity of unscrupulous merchants; it would develop among the natives of Tuamotu a feeling of family, economy, love of property, and of country; it would cause the Tuamotu native to abandon the vagabond life which necessity at present compels him to lead, roaming from one island of the archipelago to the other, in following the precarious trade of a diver, which shortens his life, and would gradually raise him morally and intellectually. And all this would benefit the entire colony, making business of every kind more prosperous.

*Ownership of the lagoons.*—The introduction of oyster culture in our oceanic establishments would bring about the solution of a question which has been pending for a long time, namely, the ownership of the lagoons. As long as this question has not been definitely settled, it will be impossible to do anything. It is very evident that neither the natives nor the French oyster cultivators who might feel inclined to introduce their industry in these remote countries will set to work in earnest until regular grants of these waters have been made to them and they feel that they are secure in their possession.

Some people in Tahiti have, from reasons which I cannot understand, constituted themselves the defenders of ancient and superannuated privileges, which the native population would never dream of claiming, and which are absolutely at variance with the laws in force in all countries of the globe. These officious people seek to convince the natives that these lagoons belong to them, and that they are communal or private property, just like ground. They say that the portion of the sea extending from the edge of the reef to the center of the lagoon is only the natural extension of the ground. Our law, on the other hand, proclaims that the domain of the sea belongs to the state, and is inalienable. Would it, therefore, be proper to make an exception in the case of the Tuamotu Archipelago? If this was the case, navigation in the lagoons would be a matter of sufferance.

In the course of my voyage through the Tuamotu Archipelago I made inquiries of the natives relative to the claims above referred to, which they are said to make, and in all cases I was informed that nothing approaching to such a claim had ever been made. They have

always considered the lagoons as free waters, and belonging to the state. They have all assured me that they have not authorized any one to make such statements. All they desire is, that some preference shall be shown to them, when grants are made, and that no grants should be made to foreigners. The above statements have been entered on the minutes of a meeting held at Takaroa, attended by the district superintendents of the different islands, and by a large number of fishermen.

On the other hand, the Tahiti courts have, on two different occasions, pronounced in favor of the principle contained in the French laws, namely, that the portions of the sea comprised between the reef and the shore are the property of the state. Under the rule of the ancient sovereigns of Tahiti, however, the owner of the shore was also the owner of the corresponding portion of the sea between the reef and the shore; but the fact of these islands having become annexed to France has changed this. And does it not follow, as a matter of course, that the Tuamotu lagoons are subject to the same laws as the Tahiti waters, as the annexation of the archipelago took place at the same time and on the same conditions as that of the Society Islands?

Although the rights of the state to the Tuamotu lagoons, and to the arms of the sea comprised between the reef and the shore are incontestable, it will be necessary to state this authoritatively. This will be the only way to avoid the lawsuits in which the people of these islands are inclined to engage on the slightest pretext.

*Localities for stations.*—Thus far only the Tuamotu Archipelago has come into question; and I have not yet stated whether at Tahiti and at Moorea there are favorable localities for establishing oyster-panels, and under what conditions oyster culture could be carried on there. These two islands would be the very ones in which emigrants would prefer to settle, on account of their greater and more manifold resources. It is impossible for me to furnish any detailed information as regards each one of the localities adapted to oyster culture, and to enumerate all of them. These localities are far too numerous. In the Island of Moorea there are the Cook Bay and the Bay of Oponuhu, well adapted to the purpose by nature, where oyster culture could be conducted on a large scale; likewise the greater portion of the water inside the reef, whose depth is sufficient for submerging oyster-boxes. Pearl-oysters thrive there naturally. Moorea is 12 or 13 miles from Papaete; the climate is healthy, and the means of existence are the same as at Tahiti. It is a most delightful island, one of the most interesting of the oceanic islands; and there is no lack of arable soil of the utmost fertility.

At Tahiti there are also numerous places suitable for the cultivation of pearl-oysters. I will mention among the rest the Papaete Roads, the neighborhood of Faāa, the bays of Matavai, Tautira, Taravao, Port Phaeton, the portions of the sea situated in the districts of Hitiaā, Tiarei, &c. There are enough places to satisfy the whole world, and



large establishments could flourish here. Sheltered from the open sea and the winds, and easy to supervise, these different locations are all inside the reef which at a distance from the coast, varying from about half a mile to  $1\frac{1}{2}$  miles, extends for about 93 miles. Nearly everywhere fine and valuable mother-of-pearl is found. It would be necessary to establish at Tahiti, as at Tuamotu, reservations for the reproduction of oysters and the gathering of young oysters. In case a measure of this kind should meet with difficulties and not be followed by the expected results, spawn could always be obtained from Tuamotu. It is said that mother-of-pearl is not at all scarce in the Tubuai Islands; but no important fisheries are carried on there. It is also stated that there are in these islands places which are exceedingly well adapted to the organization of oyster-parcs. These islands have greater resources than the Tuamotu Islands, and the climate is more favorable. Emigrants would therefore probably prefer them to the former.

*Market in France for mother-of-pearl.*—It remains to be stated briefly by what means the French merchants of Tahiti think Tahiti mother-of-pearl could be brought into our markets. It is well known that we buy from England nearly two-thirds of the mother-of-pearl which our industry consumes. At London a market is held every six weeks. In Liverpool the markets are held according to the arrivals of mother-of-pearl. It is sold by public auction. The business men of Papeete, from whom I obtained information, are of the opinion that if a similar market was created in one of our ports, all, or at least a great portion, of the mother-of-pearl from our oceanic colonies would go there, provided that all the vessels coming directly from Tahiti were exempt from the duty of 40 francs per ton levied on mother-of-pearl by the colony.

PARIS, FRANCE, *May* 28, 1885.