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THE FISHERY RESOURCES OF THE PHILIPPINE ISLANDS.
PART III, PEARLS AND PEARL FISHERIES.¹

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P. I.)

INTRODUCTION.

During the past ten years the writer has been engaged, as time would permit, in making a study of pearls and pearl fisheries. In 1900, a year was spent in the fisheries of Paumotu and Gambier Islands and in 1902 the fisheries of Australia and the Solomon Islands were visited; during the past year considerable time was given to a study of the pearling grounds of the Philippine Islands.

So far as possible, a careful study has been made of the development, life history and habits of the pearl oyster, chiefly with the view of increasing its value as a commercial asset. Experiments relating to pearl growth, development and culture have been inaugurated; and a large number of both hard and soft sections through pearls from various localities have been made in order to throw additional light on the direct cause of their origin and growth.

The object of the present paper is to give the results of these observations and a general review of our present knowledge of the subject, with the hope that such results may lead to increased interest in the Philippine pearl fisheries and to their greater development.

¹Part I of this series appeared in *This Journal* Ser. A (1908), 3, 513; Part II, *Ibid.* (1909), 4, 57.

PHILIPPINE PEARL OYSTERS.

There are two varieties of pearl oysters in the Philippines which are of considerable commercial importance: One, called the gold lip pearl shell, Doctor Pilsbury kindly informs me is doubtless *Margaritifera maxima* Jamson² (see Plate III, figs. 1 and 2); the other, the black lip pearl shell, is *Margaritifera margaritifera* (Linnaeus). (See Plate IV, figs. 1 and 2.) The gold lip shell is by far the most important, it being the variety chiefly sought in commercial ventures, its market value being from 30 to 80 pesos³ per picul of 63.3 kilos (139.5 pounds). This shell, when mature, is usually from 180 to 230 millimeters (7 to 9 inches) in diameter and weighs from 1.82 to 2.3 kilograms (4 to 5 pounds); shells weighing more than 5 kilograms (11 pounds) have been found. This species occurs in waters of from 5 to 20 fathoms throughout the Sulu Archipelago, and is probably more or less abundant throughout the entire Philippine group.

The black lip shell is a much smaller variety, rarely exceeding 150 or 180 millimeters (6 or 7 inches), with a weight of from 1 to 1.5 kilograms (2 to 3 pounds), although usually it is much smaller. It is common along the shores of almost all the islands of the Philippine Archipelago, and is of much less value commercially than the gold lip shell, being in but little demand and selling for about 13 pesos per picul. This form usually gives a large yield of pearls which are of comparatively little value, as they generally are small, irregular in shape and of a gray or dusky color.

In the year 1886 a paper was published in Bergen, Norway, which contained the following interesting statement regarding the Philippine pearl fisheries:

The Philippine Islands produce great quantities of pearl shell. In 1877, 165 tons were exported. In 1878, 162 tons, valued at 164,720 pesos were exported. In 1879 the value of exported pearl shell was 155,802 pesos. The entire region from Tawi-Tawi to Basilan is a continuous pearl oyster bed; the Sulu fisheries are the largest and most productive of any in the East Asiatic waters. The pearls are famous, and the shell has a fine luster. Labuan is the chief market. The yield is decreasing.

It will be of interest to compare the above account of the fisheries of thirty years ago with those of the present time. During the year 1907 there were exported from the port of Jolo 154,918 kilos (340,820 pounds) of pearl shell, valued at 119,045 pesos; and during the same period the product exported from Zamboanga was valued at 45,254 pesos, making a total of 164,399 pesos from the Moro Province alone, which shows a substantial increase rather than a decline in the fisheries. The above value

² Revised Nomenclature of Pearl Oysters. *Proc. Zool. Soc. London*, (1901), 1, 392.

³ One peso equals fifty cents U. S. currency.

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is of the shell alone; that of the pearls secured during this time is unknown, but doubtless it amounted to several thousand pesos.

No export duty is charged on shell, but wharfage to the amount of 1.50 pesos per ton is collected.

The price of shell at the present time is from 60 to 100 pesos per picul for those of the first class of the gold lip variety, and about 20 pesos per picul for the black lip variety. The picul is counted at 63.3 kilograms (139.5 pounds, 16 piculs to the ton). Almost all the shell is sent either to Singapore or to Europe. There is one button factory located in Manila which has a capacity, when running constantly, of about 6,000 gross per month, requiring about 300 tons of shell per year; otherwise, all the shell is exported.

During the past year about 56 tons of shell were taken from the Davao pearl bed. These were of very large size and first class in every respect. They gave a very small yield of pearls, the value of which was probably not more than 6,000 pesos. Some very beautiful pearls are to be found in the Sulu fisheries, and it was my pleasure to examine two of these, each valued at 5,000 pesos, secured from this region during the past year.

Almost all the fishing for pearl oysters is carried on by the use of diving armor, in water of from 15 to 20 fathoms. Shells are occasionally found in shallower water, but in such cases naked Moros usually dive for them, or they are secured by a primitive rake-dredge worked by a rattan line from a native canoe and which can be used only in smooth water. The natives frequently soak dry shell in water for several days before it is sold, in order to increase the weight; and I have seen Chinese and other middlemen doing the same thing. The shells are usually opened on the boats and all the pearls extracted soon after the oysters are brought up.

THE PEARLING FLEET.*

At present about 30 vessels are engaged in pearling in the Sulu Archipelago. These boats range from 5 to 15 tons, and usually carry a crew of seven men, including the diver. All boats with armored divers

*The following boats constituted the Zamboanga pearling fleet for the year 1908: *Siroco* and *Nantiles*, owned by J. F. Maddy; *Cleopatra*, *Gaitea*, and *Maritima*, owned by J. Wilson; *Isenis* and *Pascido Reyes*, owned by the Cebu Pearling Company; *Mina*, *Burtandy*, *Ida*, and *Manay*, owned by Capt. Chas. Linberg; *Paragus*, *Zamboanga*, and *Sagit*, owned by G. W. Langford; *Aliso* Holmes, *Rosario*, and *Olings*, owned by Mr. Holmes; *Mindanao*, owned by Mr. Teck; *Pruno*, owned by V. Sisilon. All of these boats carried on more or less active operations during the past year.

The Jolo pearling fleet is composed of the following boats: *Victoria*, *Helena*, *Santa Maria*, and *Elizabeth*, owned by Ong Tiam Teng; *Almosouth*, owned by Hadji Abubakal; *King of Spades*, owned by Richard H. Gibbs; *Ramon*, owned by Hernandez & Co.; and *Alfonso* and *Nena*, owned by Asing.

are required to take out a license, for which the charges are 300 pesos a year for a first-class license, or a three months' license may be secured for one-fourth of this amount. These are obtained from the provincial treasurer at Jolo, Zamboanga, or Davao. The divers are usually natives or Japanese. Each boat is equipped with one complete diving outfit, consisting of armor, pump, tubes, weights, etc. The diver receives a wage of from 20 to 80 pesos per month, in addition to a percentage of the shell, but the terms upon which both men and divers are hired vary with almost every pearler.

The treasurer of Davao reports that nine first-class licenses have been taken out at that place since January, 1908, chiefly by local firms, and for the purpose of working the newly opened Davao pearl bed.

It costs about 55 pesos a month, aside from wages, to navigate a pearling boat. The diving armor used is nearly all of a modern type, and of English manufacture. The air pumps used are worked by hand, two men being stationed constantly at the pump when diving is in progress. The diver has from 18 to 20.4 kilos (40 to 50 pounds) of weight attached to him in order to reach the bottom. Divers usually remain under water until they fill the net basket which they carry, this requiring from ten minutes to an hour. The diver of a boat on which I was a guest for some time, usually made about three descents in one hour; this was on the Davao bank in a depth of 20 fathoms and where the man experienced great difficulty in working because of strong currents. The length of time during which an armored diver can remain under water is very indefinite, depending on the depth of water, strength of current, strength of the diver, and other factors. In calm water, but a few feet in depth and of an even temperature, a man should be able to remain for almost an indefinite period. The naked diver scarcely ever stays down for more than one minute. Fishing is carried on at all seasons of the year.

THE PHILIPPINE PEARLING BANKS.

Practically the entire region from Sibutu Passage to Basilan Straits and around the southern shore of Mindanao Island is a continuous potential pearling bank. However, the greater number of the known localities have so constantly been fished that they have had small chance to recover, and, as a result, much of the pearlers' time is lost in prospecting for new beds in various parts of this wide area; but the ground never seems to become completely exhausted, for we found pearling boats operating successfully directly in front of the town of Jolo, within half a mile of the beach. Fishing for shell had doubtless been carried on at this point for over a hundred years.

Occasionally, a pearler will locate a bank on which the oysters are

very abundant. Such a bank was found just south of Basilan Island; another near the Tapu Islands, and another in Tatanan Pass of Tawi-Tawi Island. A large yield of shell has been secured near the Samuales group. Shell has been reported from Illana Bay, and during the past year an extremely valuable bank was located in the Gulf of Davao in Pakiputan Strait between Samal Island and the mainland. The most prolific portion of the bank was in the narrow part of the passage directly between Point Lanang and Point Linao. The depth of water is from 20 to 25 fathoms. The bank is well protected above by the large reef known as Arholes Island. Usually, there is a very strong current pouring through this strait, but at the point where the pearl bank occurs the tides and currents form a strong eddy which has doubtless contributed to the formation of the bank by giving an opportunity for the spat to settle and attach. The bottom is of coral, sand, and gravel, and is comparatively smooth. The width of the strait at this place is less than 1.6 kilometer (1 mile); the beach on one side slopes steeply down, and on the other drops abruptly into several fathoms of water from a live coral reef. The water is quite clear, its temperature about 24° C., and its specific gravity 1.022. At the time of my visit (May, 1908), there were only four pearling boats operating on this bank; two others were prospecting in adjacent waters.

The currents were so swift that diving could be carried on only between the hours of 6 and 7 o'clock in the morning. The diver, a Filipino, during this hour made three trips to the bottom; on the first he secured three shells; on the second, eight; and on the third, two. These were all large, first-class shells, each weighing about 3.2 kilos (7 pounds). One contained a small pearl.

The diver brought up some young shells for our inspection, and reported that they were abundant on the bed. All the large oysters were in a breeding condition, so probably this bank will be able to keep up a moderate yield, unless overfished at the beginning. So far, the Davao pearl bank has yielded about 56 tons of first-class shell.

Pearl shells in considerable numbers are found in Tañon Strait, between Cebu and Negros Islands; in the vicinity of Guimaras; and also along the west and the north coast of Samar. Shell has also been reported from Palawan and Cagayan Sulu. It is more probable that as the Islands become better known, many new pearling banks will be found, and those now known will be mapped and better defined.

The most desirable bottom for a pearl bank is coarse sand, with dead coral and rock to which the young may attach. They can not grow on live coral, and they are very apt to be covered up and smothered on fine sand.

LIFE HISTORY OF THE PEARL OYSTER.

The oysters are of separate sex, male and female. The eggs of the female, when ripe, are extruded into the sea water, where they are fertilized by the spermatozoa of the male, if by chance the currents bring the two elements together. Doctor Hornell² observed in regard to the Ceylon pearl oyster, "that a ripe female, in close proximity to a mature male, was sufficient cause to excite the male to throw off spermatozoa." The meeting of the spermatozoa and ova is left entirely to chance.

The eggs of the Philippine pearl oyster (*M. maxima* Jamson) are at first pyriform (see fig. 1) and float on the water; as soon as they are



FIG. 1.—Spermatozoa and ova of Philippine pearl oyster.

- (a) Micropyle through which the spermatozoa enters the ova.
- (b) Nucleus.
- (c) Nucleolus.
- (d) Spermatozoa of male.

fertilized, they become round; and when from three to six hours old, they move about by means of small, hair-like cilia. Segmentation is complete, but unequal. The shell begins to form at the end of the second day, and in from four to eight days the young oysters settle and become attached to the bottom, or to any object they chance to fall upon. At this stage they are known as spat and

are about 1 millimeter (0.04 inch) in length. They attach by means of a small tuft of coarse, hair-like bristles, known as the byssus.

Each mature female contains several thousand eggs, but no doubt the destruction of eggs and young is very great, many being swept into great depths by strong currents, where they either perish or settle on the bottom so thickly as to smother each other; or else they become covered with sand, or attach to some floating object and are washed ashore. Apparently, there is no fixed time in the Philippines for the maturing of the ova, as sexually ripe individuals are found at all seasons of the year.

The shells are supposed to reach a maximum size and are most valuable commercially in from four to five years, although they doubtless continue to grow for several years longer. I have examined specimens weighing 5 kilos (11 pounds) which I believe were ten to twelve years old. However, shells older than five or six years are apt to be worm-eaten or full of holes caused by boring sponges, and so are of less value. More

²Report on the operations of the Ceylon pearl banks during the fishery of 1905. Rep. Ceylon Marine Biol. Lab. (1906), 55.

accurate information regarding the age and growth of shells obtained from direct observations and measurements is very desirable.

Mr. Seville Kent states in regard to the rate of growth of the pearl oyster:

Under favorable conditions a period not exceeding three years suffices for the shell to attain to the marketable size of 200 to 230 millimeters (8 or 9 inches) in diameter, and heavy shells of 2.3 kilos (5 pounds) weight per pair may be the product of five years growth.

The food of the pearl oyster consists of minute marine infusoria, *Diatomaceæ*, etc. We discovered that in fully 75 per cent of the specimens examined, the food consisted of *Diatomaceæ* with a small amount of vegetable matter.

The pearl oyster does not travel to any great distance; in fact, after the spat stage, it remains in one spot for the greater part of its life, although it can, and does at times, cast off the byssus attachment and reattach to some more desirable place, moving very slowly by means of its small foot. The very old shells of *M. maxima* Jamson were, with but few exceptions, without attachment, probably the weight of the shell being sufficient to keep them in place.

ENEMIES OF THE PEARL OYSTER.

The pearl oyster, especially in its younger stages, is exposed, to constant danger. Numerous fishes consider it a great delicacy, and such fish are found in large numbers about the pearl banks. The various species of sharks, rays, sparoides, and balistes feed largely upon shell fish, including the pearl oyster. However, these are not wholly an evil, as they are probably the intermediate host for the cestode which is the cause of the growth of pearls; the fish becoming infested with this cestode by eating the oyster. Doubtless, star fishes also cause much destruction to the banks, and, in old specimens, the boring sponges, boring worms, and gastropods, do great damage.

In addition to these enemies which affect the oyster directly, there are an enormous number of marine animals and plants that, by using up the available space and food which otherwise would fall to the lot of the pearl oyster, affect the life of the oyster indirectly.

One pearl diver reported the finding of a very large pearl bank south of Basilan Island, where the shells were abundant and of very large size, but of no value, as they were dead and had lost their luster. In cases of this kind, it is almost impossible to state the cause of the destruction. It may have been brought about by some epidemic due to the crowded condition of the shells, or possibly by some volcanic disturbance, or a dozen other causes might be assigned, but without facts it is useless to theorize on the subject.

TRANSPLANTING AND CULTIVATING THE PEARL OYSTER.

Pearl oysters may with but little difficulty be transported for several days, if they are kept in running salt water, or if the water is changed frequently; thus the question of transplanting them from one bed to another in a more convenient locality, or in water of less depth, becomes a comparatively simple one and will doubtless play an important part in the pearl oyster industry of the future.

As a matter of fact, the Ceylon government is, or was at a recent date, engaged extensively in the transplanting of young oysters and the distributing of "clutch," i. e., rock of small size which is scattered over the bottom of the oyster beds, and to which the young oysters become attached. The young pearl oysters are removed from beds which are overcrowded to others which are less productive.

It would be an easy matter for men engaged in pearling to keep suspended over the side of their vessels bamboo crates or cars in which they could place the young oysters which are frequently brought up, and so transport them to a favorable place for development, as is the case in the sponge fisheries.¹ In this way they might, with but little effort, accumulate a valuable pearl farm where a number of oysters could be harvested each year and the bed looked after just as in the case of the edible oyster. The yield of pearls and shell would doubtless pay a good dividend. This process would especially be easy to carry out in the Davao fisheries which are near shore and where local people are engaged in the fishing. Such farms should simulate the natural beds so far as practicable, but improvements over natural conditions could be effected by supplying an abundance of small, broken rock as "clutch," upon which the young could attach; the keeping of the beds free from undesirable tenants, such as star fish, holothurians, etc., could be accomplished by dredging.

LAWS RELATING TO PEARL FISHING.

I have abstracted the laws,² or at least such portions of them not repealed by amendments, as are now in force in the Islands.³ They are of undoubted benefit in protecting the young shells, and, for the greater part, relate to the waters of the Moro Province. In other portions of the Archipelago, various local acts and provincial legislation greatly handicap the pearling industry.

¹ *This Journal*, Sec. A (1909), 4, 62, 63.

² These laws were enacted by the legislative council of the Moro Province. A copy of them may be secured from the provincial treasurer of either Jolo or Zamboanga.

³ Sec. 23, Act No. 51, of the Philippine Commission should read: "The words 'pearl shell and shell of the pearl oyster' as used in Act No. 43 of the Legislative Council and in this Act shall be construed to mean the shell of the marine bivalve mollusk *Margaritifera marina* Janson, commonly known as the Philippine gold lip pearl oyster."

The laws should be extended to include the entire Archipelago, and all local regulations should be repealed. In this way only can the young shell properly be protected. Additional legislation protecting the black lip pearl shell, *Margaritifera margaritifera* (Linnaeus), should be enacted.

Act No. 43 provides for the protection of pearl fisheries within the jurisdiction of the Moro Province, and was passed February 29, 1904. It forbids the taking of pearl oysters less than 100 millimeters (4 inches) in diameter.

Act No. 51 regulates the fishing for shells of marine mollusks and was enacted June 7, 1907, at the urgent request of the pearl fishers. It prohibits from engaging in pearl fishing all vessels not built in the Philippine Islands or in the United States, or not wholly owned by citizens of the United States or by people having the political rights of the natives of the Philippine Islands. It prescribes the places at which licenses to engage in pearl fishing may be secured, the price for such licenses, and the length of time for which they are granted. It states that the master of every vessel operating under a first-class license shall record the date of every operation and the number of shells taken each day. Before any shell can be landed, these records must be verified under oath in the presence of the collector of customs of Jolo or Zamboanga. This Act also amends Act No. 43 and requires the size of the shell to be 180 millimeters (7 inches) in diameter from the outer margin to the middle of the hinge, measured at a right angle to the hinge. A fine of not less than 50 pesos is provided for the violation of any provisions of this Act.

Act No. 131 amends Act No. 51 by reducing the price of first-class shell licenses to 300 pesos per annum, and provides for the issuance of such licenses for periods of three months. The enforcement of Act No. 51 resulted in such a decrease of revenues, owing to the excessive cost of licenses, that this amendment was made necessary, and it was enacted August 22, 1905.

Act No. 176 amends section 2 of Act No. 51 and was enacted October 12, 1906. It provides for the issuance of licenses only to those vessels wholly owned by citizens of the United States, to honorably discharged soldiers or sailors of the United States Army and Navy, to natives of the Philippine Islands, or to those having the political rights of natives.

Act No. 200 repeals Act No. 176 and was enacted September 10, 1907, and approved by the Philippine Commission October 7, 1907.

PEARLS.

The Philippine fisheries give a fair yield of pearls; in fact, some of the most beautiful specimens ever discovered have come from the Sulu fishery. The yield is fully as large as that in either the Gambier Islands or the Pearl Islands. The number of pearls secured in Ceylon is much greater. In that country the commercial pearl oyster is of a different species (*Margaritifera vulgaris* Schum.), a very small oyster prolific in pearls, but with shells of practically no value.

The composition of a pure pearl as given by Harley and Harley* is as follows:

Carbonate of lime	91.72
Organic matter	5.94
Water	2.23
Loss	0.11

*The Chemical Composition of Pearls. *Proc. Roy. Soc. London* (1888), 43, 401.

and that of the Ceylon mother-of-pearl, as given by Herdman and Hornell²² is—

Calcium carbonate	88.79
Calcium sulphate	4.93
Organic matter	2.32
Water	2.28
Loss (no magnesium, no phosphates, faint trace of iron)	1.68

It is well known that the organic basis of the shell, conchiolin, is a cuticular product excreted by the underlying epidermis of the mantle.

Passing without comment the many fanciful theories regarding the formation of pearls which have been held from historic times up to a comparatively recent date, we will consider only such facts as have been revealed by modern scientific investigation.

I have in my work dissected a large number of pearls from our large gold lip pearl oyster (*M. mazima* Jamson). Of this number, forty were prepared as "hard sections," each side being ground down so that a small transparent section through the center of the nucleus was obtained for microscopic examination. (See Plate V, figs. 1 to 3.) Ten were prepared as microtomic sections, and the remainder, and by far the greatest number, were dissolved in acids of various kinds and dissected.



FIG. 2.—Cestode from center of a Philippine pearl.

The results show that the round orient Philippine pearl may have various objects in the center forming the so-called nuclei, which, because of stimulation or irritation, have become incased in naure, thus forming pearls. Fully 50 per cent of the pearls examined contained larval cestodes, two only contained sand, one a bit of seaweed, one a spicule of calcareous sponge, two, forms which with but little doubt were larval Distomids. One rather interesting form (see fig. 3) obtained from a perfectly round pearl appears very closely to resemble the free-swimming larval cestodes secured by Mr. Hornell in Ceylon,²³ and is doubtless a related form. Several pearls contained

material that had become calcified and could not be identified with any degree of certainty. Three had what I believe to be the ova of the small

²² Report of the government of Ceylon on the pearl fisheries of the Gulf of Mannar. Roy. Soc. London (1906), Part V, 6.

²³ Hornell & Shipley. Reports on Parasites of the Pearl Oyster. Rep. Ceylon Pearl Fishery (1903-1906), Part II, 77; Part III, 49; Part V, 43.

crab (*Alpheus asarus* Fabricius) which is almost without exception found living in pearl oysters as a commensal.

Pearls may be found in any part of the oyster, or in the shell. The free pearls and those attached to the shell result from some injury, while those in the muscles are formed around small, calcareous bodies called calcospherules. The so-called "blisters" on the inside of the pearl shell are usually produced by boring worms or by some external injury. How-

ever, in one case at least, a very fine blister now in my possession was caused by a small black pebble which was completely embedded in the shell. Blisters frequently contain pearls of value, and specimens of good shape and luster may become fully embedded in the shell. I now have a shell before me which, when found, exhibited no sign of a pearl, but when broken, showed two fine pearls, embedded and completely hidden in the shell. (For similar examples see figs. 3 and 4.)



FIG. 3.



FIG. 4.

A bit of shell in which a pearl valued at 500 pesos was hidden. The x, fig. 3, shows where the pearl was located. Fig. 4 is the same shell cracked open, showing the pearl.

Cyst pearls are found in the mantle or soft parts of the oyster. These are formed by a larva, usually a cestode, which enters some portion of the connective tissue where, as stated by Doctor Jamson,¹² it at first occupies a space lined with connective tissue fiber; but the oyster soon gives rise to a pearl-secreting, epithelial layer which lines this space and becomes the pearl sac. I am of the opinion held by Mr. Herdman and Mr. Hornell¹³ that this pearl-secreting epithelium is of ectodermal origin.

ARTIFICIAL PRODUCTION OF PEARLS.

From the time of Linnæus, who claimed to have discovered a method whereby the oyster could be made to produce pearls, up to the present date, the attempt to force the passive oyster into producing culture pearls has never ceased, so that almost each year some one announces in the press of the country that he has at last reached the true solution of the problem and can produce pearls at will. There is no question but that,

¹²The Formation of Pearls in European Mussels by Action of Trematodes. *Proc. Zool. Soc. London* (1902), 140.

¹³Notes on Pearl Formation in the Ceylon Pearl Oyster. *Rep. Brit. Assoc.* (1903), 995.

in some cases at least, cultural pearls have been produced; but when the methods have been brought to the crucial test there is always some small point or flaw which has prevented their application with profitable results. This is at least true concerning the forming of the free, round, cyst pearls of fine luster, but in so far as the production of half-pearls and blisters is concerned, the Mikimoto pearl farm in the Bay of Ago, Japan, need only be visited to carry conviction that the artificial production of pearls is both practicable and profitable, for at this place several hundred people are employed in the work, and the cultural pearls harvested find a ready market at a good price. In fact some of the "antique" jewelry sold in Manila was found to be set with these. (See photograph of some of these culture pearls, natural size, Plate VI, fig. 1.)

From 200,000 to 300,000 oysters are treated each year at this pearl farm. The method employed is similar in most respects to that used by the Chinese hundreds of years ago, when small, rough images of Buddha were placed between the mantle and shell of the live river clam, which was then returned to the water until the images were coated over with nacre, after which they were taken out and sold as charms. The Japanese use a small canula to insert a minute mother-of-pearl bead which is flat on the side and which fits against the shell. The oyster is then again placed in the water and allowed to grow for six or seven years, when the pearls are harvested. The undertaking is profitable, owing to the large number of oysters treated.

However, the chief object to be desired is to grow round, perfect, cultural pearls of fine luster; in other words, to produce a cyst pearl, or one so closely resembling it as to be indistinguishable from it. Our efforts have been directed to this end, but the results so far obtained do not warrant publication. As an illustration of some of the difficulties encountered by those engaged in experimenting in pearl growing, a gentleman from Australia, who some time ago purchased the experimental pearl farm inaugurated at Tuesday Island by Seville Kent, and who had spent several thousand pounds in attempting to grow cultural pearls, remarked to me, "I have succeeded in growing the perfectly round pearls, but my great difficulty is to prevent their discoloration."

It may be predicted that within the next few years perfectly round cultural pearls of fine luster will be produced commercially and that the undertaking will prove to be the most profitable achievement of modern zoölogy.

Pearls of value sometimes are found in other mollusks of the Philippines, as, for instance, in the Taclobo (*Tridacna gigas* Linn.) which occasionally contains pearls of great beauty. (See Plate VI, fig. 2.) However, these usually are without luster and hence valueless.

DETERMINATION AND VALUATION OF PEARLS.

Pearls have a hardness of 4; they are so compact that they do not break when stepped upon; their specific gravity is 2.65 to 2.68. To be of much value they must be round or drop-shaped and either pure white, or dark, or of a golden color, with a peculiar luster and slight translucency. They must be free from spot, speck, or blemish. As they are formed, layer upon layer, around a central point, like the layers of an onion, they are sometimes peeled or "doctored" to remove spots or flaws, in the hope that the new layer will be of better luster. Such pearls are obviously of much less value than those found perfect, in their natural condition. However, any such tampering with a pearl can usually be detected by the use of a good glass, which shows any minute band-like stripes or slight scratches. It is also a very easy matter to detect whether a trifle more than one layer of a pearl has been taken off, and equally as easy to tell the difference between a pearl that has been ground into a round shape and one naturally round; such specimens are of but little greater value than marbles. The following is a table of the actual size of pearls of from 0.1296 to 1.944 grams (2 to 30 grains).





















Grains.		Grains.		Carats.
2		3		$\frac{1}{4}$
4		5		$\frac{3}{8}$
6		7		1
8		9		$\frac{1}{2}$
10		11		$\frac{5}{8}$
13		14		2
15		16		$2\frac{1}{4}$
17		18		$2\frac{1}{2}$
20		22		3
25		30		4

FIG. 5.—Exact sizes of pearls from 2 to 30 grains in weight.

No one but an experienced buyer can properly estimate the value of a pearl, as many conditions, such as size, shape, luster, flaws, etc., must be taken into consideration. In 1896 a very interesting publication was issued by the United States Government,²⁴ giving the value of pearls all over the world, together with an estimate of the yield. In Manila, a perfect pearl of 0.0643 gram (1 grain) with good luster and shape retails for about 5 pesos. The price increases more rapidly than the size of the pearl, as from 70 to 100 pesos per 0.205 gram (1 carat) is asked for perfect pearls over 0.41 gram (2 carats) in weight.

²⁴ Pearl Fisheries and Pearl Supply. *U. S. Consular Report*. (1896), 51, 622.

ILLUSTRATIONS.

PLATE I.

Landing pearl shell at Jolo.

PLATE II.

- FIG. 1. Jolo pearling float.
2. Pearl diver in the water.
3. Pearl diver coming out of the water.

PLATE III.

Philippine gold lip pearl shell (*Margaritifera saxatilis* Jamson).

- FIG. 1. Inside view.
2. Outside view.

PLATE IV.

Philippine black lip pearl shell (*Margaritifera margaritifera* Linnaeus).

- FIG. 1. Inside view.
2. Outside view.

PLATE V.

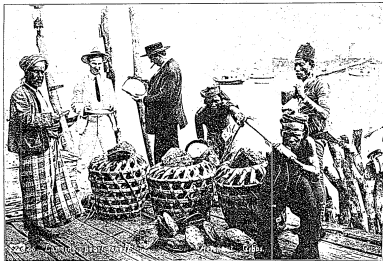
- FIG. 1. Section through center of Philippine pearl, showing an encysted cestode.
2. Section through a Philippine pearl, showing a calcified cestode in the center.
3. Section through a Philippine pearl which had a grain of sand in the center. It is also shown how a perfectly round pearl may become irregular and how it may be peoled to form a perfectly round pearl.

PLATE VI.

- FIG. 1. Culture pearls from the pearl farm in the Bay of Ago, Japan.
2. Pearls, found at Sinsu Island in Tacleban shells.

TEXT FIGURES.

- FIG. 1. Spermatozoa and ova of Philippine pearl oyster.
(a) Micropyle, through which the spermatozoa enters the ova.
(b) Nucleus.
(c) Nucleolus.
(d) Spermatozoa of male.
2. Cestode from center of a Philippine pearl.
3. A bit of shell in which a pearl valued at 500 pesos was hidden. The *x* indicates the spot where the pearl was hidden.
4. The same shell as in fig. 3, but cracked open showing the pearl.
5. Exact sizes of pearls from 0.1200 to 1.944 grams (2 to 30 grains) in weight.



LANDING PEARL SHELL AT JOLO.

PLATE I.



FIG. 1.



FIG. 2.



FIG. 3.

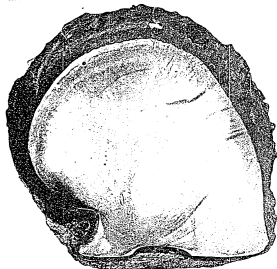


FIG. 1.

PHILIPPINE GOLD LIP PEARL SHELL (*MARGARITIFERA MAXIMA* JENSON).

PLATE III.

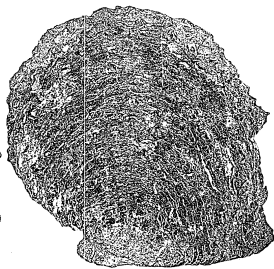


FIG. 2.

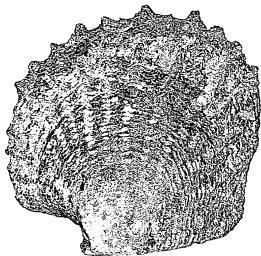


FIG. 1.
PHILIPPINE BLACK LIP PEARL SHELL (*MARGARITIFERA MARGARITIFERA* LINNAEUS).

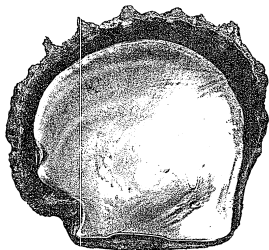


FIG. 2.

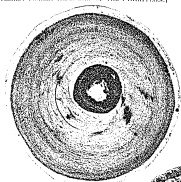


FIG. 1.

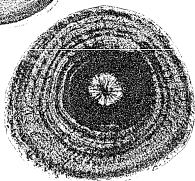


FIG. 2.

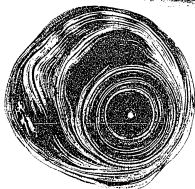


FIG. 3.

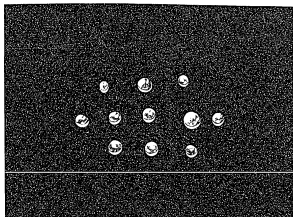


FIG. 1

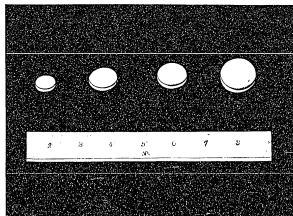


FIG. 2