IV. THE PHILIPPINE WINDOW-SHELL.

DESCRIPTION.

In the majority of windows in the city of Manila, the pane is of shell instead of glass. The shell used for this purpose is called *kapas* or window-shell (*Placuma placenta* Linn.).

This shell (Plate VII, fig. 2) is thin and flat with a rounded outline, and somewhat resembles a very large wafer. The entire shell including the animal is about 1 centimeter in thickness (Plate VII, fig. 1) by 14 centimeters in diameter. The left side (valve) of the shell is slightly convex, the right side is flat. The right side is easily transformed into a windowpane simply by squaring off the edges with a big pair of scissors or a crude machine such as is used for cutting plug tobacco. The shells are then framed and are ready for use. The size of shell most in demand will square 7.5 centimeters, although those that square 6.5 centimeters are also much used. The opinion prevailing among the general public regarding window-shell is that it is a slab of shell split off from some larger shell. This, needless to say, is entirely erroneous, as the window-shell is used in its natural condition, the two halves being torn apart and the edges merely trimmed. The left side of the shell is convex and hence is in but small demand. Windows made of these shells are translucent, admitting a soft light, very grateful to the eyes in a tropical country.

The windows present a most attractive appearance (see Plate IX, fig. 1) and consequently are used in some of the handsomest structures in Manila, such as the American Cathedral, the new General Hospital, and the new Young Men's Christian Association building; and while they increase considerably the beauty of this type of architecture, they are also peculiarly adapted to, and make a most attractive appearance in, buildings of the bungalow style.

DURABILITY AND STRENGTH OF THE WINDOW-SHELL.

These windows of shell last for generations. Some of the old churches of Manila have shell windows which have been exposed to the weather for over a hundred years and which are still serviceable. Shell windows are easily repaired, as a new shell is readily sprung into place when one becomes broken or worn.

The strength of these thin, wafer-like shells is something astonishing. Below is given a table showing the relative strength of window-shell as compared with plate glass 2 to 3 millimeters in thickness by actual test in the Bureau of Science.[9] It is shown by this table that window-shell is much stronger than plate glass 3 millimeters in thickness. The

[9] The tests were made by W. C. Reibling of the laboratory of inorganic and physical chemistry, Bureau of Science.

relatively poor showing of the Capiz shells probably is due to the fact that they were old and very dry; they also were somewhat smaller than those from Cavite.

Table showing the strength of window-shell compared with plate glass.

Material tested.	Average thickness.	Average weight per square cm.	Number of falls of a steel ball weighing 3.55 grams, necessary to produce failure on samples 2.54 cm. wide and supported at both ends 5 cm. apart.			Number of blows necessary to produce failure with 1 kg. weight with a rounded striking end falling 1 cm. high on specimen 7 by 7 cm. and supported at both ends 6 cm. apart.
			Height of fall.			
			50 cm.	100 cm.	150 cm.	
	mm.	*gms.*				
Capiz shells	0.8	0.162	50, not broken	6 to 61	Two	6 to 73.
Cavite shells	1.1	0.227	do	50, not broken	50, not broken	390 to 1,500.
Glass	2		do	One		1.
Glass	3		do	do		2.

GENERAL ANATOMY OF THE WINDOW-SHELL.[20] See Plate VIII (a-l).

These shells when alive are more or less transparent and in younger specimens the functions of the animal may readily be observed through them. Old specimens are thickened and opaque.

The largest and most striking object that attracts attention upon opening a window-shell is the mantle, or pallial lobe (Plate VIII, fig. a), which lines the interior of the shell, the margin of which has numerous, fine, finger-like projections forming the pallial fringe (fig. b); the mantle usually is much pigmented. When the left valve is removed and the left pallial lobe cut away, the 4 scimitar-shaped gills or branchiæ are exposed (fig. c). Near the center of the shell is the round, hard adductor muscle (fig. d) which has been cut in order to open the shell. Directly above the muscle, surrounding the stomach, is the large, yellowish-green liver (fig. e); directly to the right of this is the large, yellow, genital lobe (fig. f); originating just above the highest point of the gills is the foot (fig. g), a long tube-like organ extending to or beyond the edge of the mouth and ending in a disk which is usually full of mud. On the opposite side of the shell is seen a structure slightly similar but much smaller and ending in a disk; this is the anal funnel (fig. h). The intestine extends up to the stomach. Near the base of the foot, between two, thin, flap-like membranes, the labial palps (fig. i), is found the small, slit-like mouth. Between the lower genital lobe and the muscle will be seen a delicate, thin-walled organ, the heart (figs. j and k), consisting of 2 auricles and 1 ventricle. The aorta, with some of its large branches, is on the top of the liver. To the left and near the muscle are the kidneys, or nephridia (fig. l); dark colored, elongate organs. By dissecting between these and the muscle, a long, curved, cartilage-like rod is exposed. This is the crystalline style; it is inclosed in a sac, the pyloric cæcum.

[20] For a detailed and accurate account of the anatomy and histology of *Placuma placenta* L. we refer the reader to the excellent work of James Hornell, F. L. S., of the Madras Fishery Bureau, in a Report to the Government of Baroda on the Marine Zoölogy of Okhamandale in Kittrawar, Part I (1909), 43-99, 5 pl.

The nervous system is similar to that of other members of this order, being composed of the following three ganglia: (1) The cerebral ganglion may be seen by folding back the labial palps; it is a large, pale, orange-colored mass halfway between the base of the palps and base of the foot. (2) The pedal ganglion is on the base of the foot in the middle on the dorsal side. (3) The parieto-splanchnic ganglion will be found on the lower front curvature of the muscle close to the extremity of the kidneys. The byssus and byssus gland are absent.

DISTRIBUTION OF THE PHILIPPINE WINDOW-SHELL.

The window-shell is widely distributed throughout the Islands in certain definite areas. A large bed exists in Manila Bay, especially in the shallow arm of the bay east of Cavite known as Bacoor Bay. It is also found at Parañaque; in fact, the entire east end of the bay from Parañaque to Cavite is a potential bed for the window-shell. Kawit is the center of activity for window-shell fishing for the Manila Bay beds. Important beds also occur at Pangolao and Talibon in Bohol, at Valladolid in Oriental Negros; in Capiz, Masbate, and Iloilo; in the Province of Pangasinan, Luzon, and in numerous localities in Mindanao. Doubtless, there are a number of other places in the Islands where this shell is found which have not been reported. Iloilo supplies large quantities of shell for the Manila market. Shells from the Province of Pangasinan seem to be uniformly thicker and more opaque than Iloilo shells, but average slightly less in size, being 112 and 107 millimeters in diameter.

In no place in the Philippines are these shells fished for the pearls which they sometimes contain, but always for the shell alone.

HABITS, CULTIVATION, AND FOOD OF THE WINDOW-SHELL MOLLUSK.

The window-shell mollusk is usually found in shallow water, but has been known to exist in a depth up to 20 fathoms. It requires a bottom of grayish or bluish mud where more or less fresh water is carried in by streams.

There is a large variety of marine life found in the Manila beds, such as large quantities of clams and edible oysters; in fact, the cultivation of the oyster and the window-shell is carried on simultaneously by a number of fishermen. The oyster beds are staked off by their respective owners, and when fishing for window-shell or oysters outside of their claims, all the small and half-grown window-shell oysters are collected and planted on their oyster farms and kept there until they are mature. The young shells can not be sold as they are not large enough for windows. The adults keep the claim well supplied with spat.

The owners of these claims club together and hire a watchman, who is stationed in a house built over the water near the claims.

The yield of the Cavite beds is estimated at 14,000 adult shells for a good week's fishing. However, the fishing is intermittent, depending upon the demand and also upon the owner's need of ready cash. The shells are fished entirely at low tide in water of 1 meter or less in depth; the fishermen feel for them

either with their toes or their hands, just as the fancy strikes them. Adult shells are rather scarce on the public fishing grounds of these beds. I secured but 35 in one hour of fishing, but in ten minutes an owner of one of the planted beds secured 100 adult shells for me. These measured 118 to 135 millimeters in their greatest diameter.

The shell matures in three years. At the end of the first year it is 62 to 83 centimeters in its largest diameter. The sexes are separate, the eggs being fertilized in the water. The mature ova have a decided resemblance to the form (in outline) of the mature shell, while the spermatozoa have globular-shaped heads and extremely long tails, fully 10 to 15 times the length of the head. It is a comparatively easy matter to fertilize the ripe ova under artificial conditions by taking the ripe spermatozoa of the male in sea-water or normal salt solution.

The artificial fertilization and cultivation of this important commercial mollusk is well worth our careful consideration, and it is to be hoped that with the opening of the salt-water aquarium and fish hatcheries having running salt water, that the study of the life and cultivation of this shell will be made with great care and detail.

The food of the window-shell mollusk consists of small marine organisms, chiefly diatoms, which it collects from the water. The window-shell mollusk apparently does not move about, but lies flat on the mud on its convex, left side. The foot, instead of being a means of locomotion, is used to keep the mud from the gills and other organs.

QUANTITY OF SHELL AVAILABLE AND PRICES DEMANDED.

The supply of this shell in the Philippines is so large that at no place has it been found necessary to resort to diving for it, as is done in India, as plenty of shell is secured by wading in water less than 1 meter in depth and feeling about with the toes.

There are no laws regulating the gathering of window-shells, and so far as we have been able to ascertain there are no municipal ordinances relating to them.

It is estimated that there are 5,000,000 of these window-shells used each year in the City of Manila alone. A single lumber company of this city in 1910 used 1,500,000. The demand is increasing.

The price depends upon the size. Shells that will square 63 millimeters (2.5 inches) sell for 3 to 7 pesos (1.50 to 3.50 dollars) per thousand; while the large ones which square 7.5 centimeters (3 inches) sell for 8 to 10 pesos (4 to 5 dollars) per thousand. One window-shell fisherman explained to me that he had three prices for the first-grade shells. These were valued at 8 pesos per thousand to the Filipino, 10 pesos per thousand to the Spaniard, and 12 pesos per thousand to the American.

The Chinese traders do not hesitate to ask the amateur buyer 15 pesos per thousand. The shells usually are sold in large baskets, each holding 10,000 pieces.

The window-shell is not exported to any extent, the only shipment for last year being 1,458 kilograms sent from Iloilo to New York. However, it is expected that when the builders of bungalows in the United States, especially in California, recognize how much stronger, cheaper, and more attractive these shell windows are than the same thickness of glass, there will be a brisk demand for them in that country.[11]

HOW WINDOW-SHELL IS USED.

Shell windows are made of narrow strips of wood usually 13 to 18 millimeters wide and 13 millimeters thick, or they may be any size desired. These strips are grooved on two sides and notched every 6.0 or 7.5 centimeters as the case may be, to receive the cross stick which also is notched; thus a solid square frame is formed for each shell. After these are put together the entire square is set in a solid frame to fit the window or door. (Plate IX.)

The following uses are also suggested for the shell:

Screens.—(Plate IX, fig. 2.) These shells make a most attractive and useful screen, made up either in three divisions in the usual form of the Japanese screen, or else in a single division like the Spanish screen.

Lights for verandas.—(Plate I, figs. 1, 2, and 3.) These shells make a most durable and desirable light for open verandas, as they lend themselves to a great diversity of forms, the shell being easily trimmed to fit into any form of opening. The old-fashioned lantern shape is a popular form for these lights.

Old mission shade lights (Plate X, fig. 3) are most attractive and serviceable; they are usually made up with hard-wood frames and large window-shells.

Conservatory windows.—These shells would be found most desirable by the owners of hot-houses or conservatories in countries where hail is prevalent or where the direct rays of the sun are too strong; they admit a soft light with a fair amount of heat, and the expense as compared to that resulting from breakage and painting or frosting of glass would be almost nothing.

Fronts to kitchen cabinets.—These window-shells would make up into most attractive fronts for kitchen cabinets, being easily kept clean and not liable to breakage.

A dozen other uses might be suggested for window-shells. We can most highly recommend them for almost any purpose to which opaque glass would ordinarily be applied, and I feel confident that, when their cheapness and utility are recognized in the United States, they will be exported in larger quantities.