A Short Synopsis of Pearls: Natural, Cultured, Imitation

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Introduction

We may sometimes remark with some disappointment that the worldwide recognised CIBJO nomenclature rules are barely respected even in countries whose trade bodies are CIBJO members. It is the aim of this short paper to give an introductory scope on important terms and backgrounds regarding the field of these organic gems and similar materials. This paper is not complete either in its contents or in the references cited, but the author attempts to give reliable outlines and structures where further details can be classified properly.

Some of the growth peculiarities observed in shell material and natural and cultured pearls cannot be explained on the basis of growth theories currently accepted in gemmology. A new model for the formation of shell and pearl had to be developed in order to better understand some of the features observed in natural and cultured pearls

The following basic divisions regarding the above mentioned materials should be observed when the term "pearl" is applied:

Natural Pearls

Accidental products from wild oysters without any human interference. Includes seawater natural pearls and freshwater natural pearls.

Trade names such as "orient pearls", "South Sea pearls" etc. are used to indicate the origin or quality. The terms "drop, baroque, half pearl or blister pearl" describe the shape and should be used in connection with the term "natural pearl" in order to indicate the true nature of the pearl.

Cultured Pearls

Voluntarily provoked reactions of domestic shells on a human operative intervention. Includes tissue-nucleated cultured pearls without beads, tissue-nucleated cultured pearls with beads and cultured pearl doublets or assembled cultured pearls (mabe cultured pearls).

Trade names such as "Akoya, Biwa, Keshi, and South Sea" must only be used in connection with the term "cultured pearl" in order to indicate the true nature of the pearls.

The terms "drop, baroque, half pearl or blister pearl" describe the shape and must be used in connection with the term "cultured pearl" in order to indicate the true nature of the pearl. Any artificial colouring must be indicated.

Pearl Imitations

Only the visual aspect of pearls is reproduced by the imitations which have not been either fully or party produced by shells.

Various bead materials are used and different substances, lacquers or "essence d'orient" are applied to cover the beads.

Trade names such as "Majorica" must only be used in connection with the term "pearl imitation" in order to indicate clearly the nature of the beads.

Natural Pearls:

Formed accidentally by wild shells without any intervention by man, natural pearls are extremely rare compared to cultured or imitated pearls. Natural pearls may grow in seawater oysters or freshwater shells. Approximately 10 different species of seawater oysters and approximately five species of freshwater shells were found to produce nacreous concretions, i.e. pearls. The pearls consist mainly of calcium carbonate ($CaCO_3$) and a small amount of organic material (conchiolin).

The pearly sheen or orient is due to light scattering and interference on an array of microscopic tablets of aragonite ($CaCO_3$). The aragonite tablets are disposed like tiles in concentric layers and have thicknesses of about 500 nm (figure 1). A daily deposition rate of 15 to 30 tablets seems a reasonable figure for most of the pearl-producing shells. The nacreous aragonite is also called mother-of-pearl and, in a round pearl, is deposited in a concentric array. This substance is secreted by a thin skin or mantle epithelium that lines the interior of the shell. This epithelium also produces the whole nacreous part of the shell. Its specialty and only capability is the secretion of substances that reinforce the shell.

Except for nacreous pearls produced by shells (bivalves), we rarely see porcellaneous concretions produced by a seawater snail (univalve) which lack a pearly sheen. The most well-known porcellaneous pearls are Caribbean conch pearls or pink pearls.

Natural pearls are quite rare today and highly priced when in good shape, colour and with appealing lustre and orient. Their identification is safely done by X-ray testing methods, using mainly the direct radiography method. Natural pearls are still encountered in estate jewellery and regularly appear in auctions. There is also new production of natural pearls every year.

Cultured Pearls:

These are formed by human intervention by using living shell organisms to (1) fully produce a (mostly baroque or button-shaped) cultured pearl or (2) to obtain a round bead overgrown with nacre. Therefore, we differentiate between basically two types of cultured pearls:

(1) tissue-nucleated cultured pearls without beads

(2) tissue-nucleated cultured pearls with beads

In both cases the production of nacre is started by inserting a small portion of foreign mantle tissue into a shell or mussel. This mantle tissue is taken from an oyster sacrificed for this purpose.

Freshwater Cultured Pearls

Tissue-nucleated cultured pearls without beads are usually produced by freshwater shells. As a rule, more than 10 foreign pieces of mantle tissue are inserted into slits cut into the mantle areas on both shell halves. The result is 20 to 30 cultured pearls per mussel after a period of a couple of months (figure 2). For some years, tests have been performed using freshwater cultured pearls to overgrow round beads; the process was started by implanting a small piece of mantle tissue.

Seawater Cultured Pearls:

Tissue-nucleated cultured pearls with beads are usually produced by saltwater shells. The foreign piece of mantle tissue is inserted together with a round nucleus or bead into a slit cut into the gonads. Usually only one bead is brought into an oyster for getting a nacreous overgrowth. With small beads it is possible to insert more than one nucleus at a time. The production of beaded, cultured pearls usually takes more than a year.

Cultured pearls are produced in industrial quantities and are therefore much less rare than natural pearls. Therefore, differentiation from each other is important and can safely be done by X-ray methods. A quality estimation regarding the thickness of the nacreous layer of beaded, cultured pearls is also possible when the X-ray radiographs are evaluated. Larger cultured pearls with good colour, shape, lustre and orient are quite rare and therefore costly.

Pearl Imitations:

Industrial products which imitate pearls by their visual aspect and use beads (e.g. glass or plastic) which are covered with a lustery, iridescent material. They are sold as cheap fancy jewellery and might be regarded as fakes as long as their identity is not clearly indicated. Such products should be named properly as imitations and consumers should not confuse them with natural or cultured pearls. It is not sufficient to give the trade name, since the consumer might not be aware of its signification and might take it for a trade term used by specialists. In the case of Majorica imitation pearls, this name may recall the island Mallorca in the Mediterranean Sea, where pearls could be expected. Pearl imitations possess a very limited durability compared to cultured pearls even with a thin overgrowth.

The Formation of Shell and Pearl

Natural pearls are the result of a pathological reaction on an irritation. The animal reacts by secretion of calcium carbonate and forms a concretion. The sand grain theory must be relegated to rare occurrences since it usually does not stand to examination (Farn, 1990). As explained in Gutmannsbauer & Hanni (1994), the growth process for shell material and pearls is essentially the same. The construction of a pearl may best be studied in comparison with a cross section of shell material (figure 3). The epithelium cells of the mantle tissue are responsible for the protection of the soft body of the bivalve mollusc.

For the spat, this important epithelium produces a horny skin (periostracum) as a first protection. Later these cells secrete calcium carbonate in the form of columnar calcite. The formation of inorganic calcite columns is influenced by an organic matrix (framework protein). After secreting prismatic calcite for a time, the same spot of epithelium changes and starts to produce calcium carbonate in the form of tabular aragonite. The aragonite platelets are controlled by the organic matrix. The epithelium thus runs through three stages: periostracum, columnar calcite, tabular aragonite. The last stage (aragonite) lasts the longest, as can be seen in a shell cross-section. Observing this we can register the subsequent productions (from outside to inside) of one and the same portion of epithelium (mantle tissue).

We can now better understand the structures seen in natural pearls. Typically, the build up of a natural pearl consists of a brown central zone formed by columnar calcite and a yellowish to white outer zone consisting of nacre (tabular aragonite). In a pearl cross-section, such as in figure 4, these two different materials can be seen. It depends on the age of the epithelium at the moment pearl formation begins whether the later pearl will contain a more or less large core of columnar calcite. When the tumorous effect touches the very young mantle epithelium cells, it then forms calcite. Its reaction to the pathological deviation is the secretion of calcite. With time, it will change to producing tabular aragonite. When the irritation affects older tissue, e.g. the aragonite-forming stage, the pearl will consist of aragonite layers only.

It was very interesting to see this theory backed by the observation of columnar calcite as a first deposition on the bead of a cultured pearl. In this case, the epithelium used to start the overgrowth reaction was cut out of the outer mantle edge, i.e. from juvenile epithelium.

Gutmannsbauer (1992) has demonstrated that the thickness of the aragonite platelets in nacre increases with the age of the creating tissue. In many shells the quality of lustre and orient are better the closer we come to the edge of the shell. Younger, epithelium forms thinner aragonite platelets, and these are better for producing diffraction and scattering of light. Therefore, for good quality cultured pearls, the tissue portion used for nucleation should be selected from the farthest edge of the mantle. These cells will, after a period of calcite secretion, cover the beads with thin aragonite platelets, producing a marvelous orient on the surface of the cultured pearls.

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Figure 1. Scanning electron microscopical picture of aragonite platelets on a broken surface in the nacreous layer of a pearl oyster (Pinctada maxima). SEM picture courtesy of REM Labor, University of Basel. Length of bar is 10 µm.

Figure 2. An opened mussle (anadonta plicata) with mumerous tissue nucleated freshwater cultured pearls, in Cheng Guan, Hubei province, China.

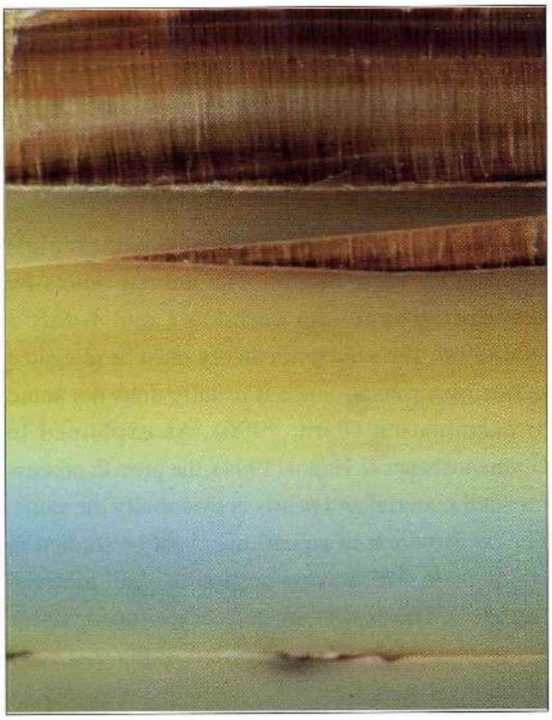

Figure 3. Cross section through a shell of Pinctada maxima (Philippines) with a typical brown calcite prism layer and a yellow to white aragonite platelet layer. Thickness of the shell is here 8 mm.

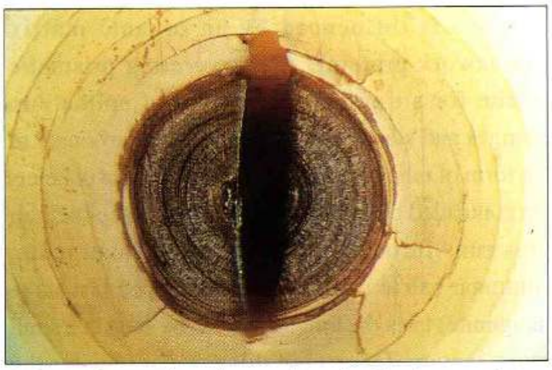

Figure 4. Cross section of a natural pearl with a brown columnar calcite centre, overgrown by a thick layer of yellowish aragonite. The centre of the pearl is pierced and the initial material unfortunately lost. Diameter of the pearl is 5mm.