

## Pearl



A black pearl and a shell of the black-lipped pearl oyster



Saltwater pearl oyster farm, Seram, Indonesia

A **pearl** is a hard, rounded object produced within the soft tissue (specifically the mantle) of a living shelled mollusk. Just like the shell of mollusks, a pearl is composed of calcium carbonate in minute crystalline form, which has been deposited in concentric layers. The ideal pearl is perfectly round and smooth, but many other shapes of pearls occur, see baroque pearl.

The finest quality pearls have been highly valued as gemstones and objects of beauty for many centuries, and the word pearl has become a metaphor for something rare, fine, and admirable.

Biologically speaking, under the right set of circumstances, almost any shelled mollusk can produce some kind of "pearl", however, most of these molluscan "pearls" have no luster or iridescence. In fact the great majority of mollusk species produce pearls which are not attractive to look at, and are sometimes not even very durable, such that they usually have no value at all, except perhaps to a scientist, or as a curiosity. These objects would be referred to as "calcareous concretions" by a gemologist, even though a malacologist would still consider them to be pearls.

One unusual example of "calcareous concretions" which nonetheless can sometimes have value, are the "pearls" which very rarely are found growing between the mantle and the shell of the queen conch or pink conch, *Strombus gigas*, a large sea snail or marine gastropod from the Caribbean Sea. These "pearls" are a by-product of the conch fishing industry, and the best of them show some chatoyance.

However, true iridescent pearls, the most desirable pearls, are all produced by two very different groups of molluscan bivalves or clams. One group lives in the sea: the pearl oysters. The other, very different group of bivalves live in freshwater; these are the freshwater or river mussels.

Saltwater pearls can grow in several species of marine pearl oysters in the family Pteriidae. Freshwater pearls grow within certain (but by no means all) species of freshwater mussels in the order Unionida, the families Unionidae and Margaritiferidae. All of these bivalves are able to make true pearls because they have a thick inner shell layer composed of "mother of pearl" or nacre. The mantle of the living bivalve can create a pearl in the same way that it creates the pearly inner layer of the shell.

Fine gem quality saltwater and freshwater pearls can and do sometimes occur completely naturally, but this is a rare occurrence. Many hundreds of pearl oysters or pearl mussels have to be gathered and opened (killed) in order to find even one pearl, and for many centuries that was the only way pearls were obtained. This was the main reason why pearls fetched such extraordinary prices in the past. In modern times however, almost all the pearls for sale were formed with a good deal of expert intervention from human pearl farmers.

A true pearl is made from layers of nacre, by the same living process as is used in the secretion of the mother of pearl which lines the shell. A "natural pearl" is one that formed without any human intervention at all, in the wild, and these are very rare. A "cultured pearl" on the other hand, is one that has been formed on a pearl farm. The great majority of pearls on the market are cultured pearls.

Imitation or fake pearls are also widely sold in inexpensive jewelry, but the quality of the iridescence is usually very poor, and generally speaking, fake pearls are usually quite easy to distinguish from the real thing.

True pearls have long been greatly valued as gemstones. They have been harvested, or more recently cultivated, primarily for use in jewelry but were also historically worn stitched onto lavish clothing as worn, for example, by royalty. Pearls have also been crushed and used in cosmetics, medicines, or in paint formulations.

Pearl is considered to be the birthstone for June.

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## 1. Physical properties



Akoya pearl grafting shed in Xuwen, China.

The unique luster of pearls depends upon the reflection and refraction of light from the translucent layers. The thinner and more numerous the layers in the pearl, the finer the luster. The iridescence that pearls display is caused by the overlapping of successive layers, which breaks up light falling on the surface.

Pearls are often white or cream, but the color can vary quite a lot according to the natural color of the nacre in the various species of mollusk used. Thus pearls can also be black, or various pastel shades. In addition, pearls (especially freshwater pearls) can be dyed yellow, green, blue, brown, pink, purple, or black.

## **2. Freshwater and saltwater pearls**

Freshwater and saltwater pearls may sometimes look quite similar but they come from very different sources.

Freshwater pearls are formed in various species of freshwater mussels (Unionidae), which live in lakes, rivers, ponds and other bodies of fresh water. These freshwater pearl mussels occur not only in hotter climates but also in colder more temperate areas such as Scotland, see freshwater pearl mussel. However, most freshwater cultured pearls sold today come from China.

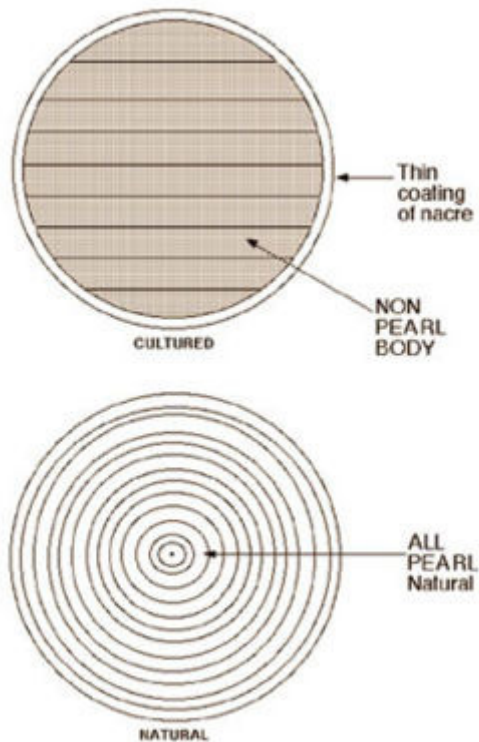
Saltwater pearls grow within pearl oysters (Pteriidae) which live in tropical oceans. Saltwater pearl oysters are usually cultivated in protected lagoons. The three main types of saltwater pearls are Akoya, South Sea and Tahitian.

### **Creation of a pearl**

The difference between natural and cultured pearls focuses on whether the pearl was created spontaneously by nature—without human intervention—or with human aid. Pearls are formed inside the shell of certain bivalve mollusks. As a response to an irritant inside its shell, the mollusk creates a pearl to seal off the irritation.

The mantle of the mollusk deposits layers of calcium carbonate ( $\text{CaCO}_3$ ) in the form of the minerals aragonite or calcite (both crystalline forms of calcium carbonate) held together by an organic horn-like compound called conchiolin. This combination of calcium carbonate and conchiolin is called nacre, or as most know it, mother-of-pearl. The commonly held belief that a grain of sand acts as the irritant is in fact rarely the case. Typical stimuli include organic material, parasites, or even damage that displaces mantle tissue to another part of the animal's body. These small particles or organisms enter the animal when the shell valves are open for feeding or respiration. In cultured pearls, the irritant is typically a cut piece of the mantle epithelium, together with processed shell beads, the combination of which the animal accepts into its body.

## Natural pearls



Cross section illustration showing natural and cultured pearls.

Natural pearls are nearly 100% nacre. It is thought that natural pearls form under a set of accidental conditions when a microscopic intruder or parasite enters a bivalve mollusk, and settles inside the shell. The mollusk, being irritated by the intruder, secretes the calcium carbonate substance called nacre to cover the irritant. This secretion process is repeated many times, thus producing a pearl. Natural pearls come in many shapes, with round ones being comparatively rare.

## Cultured pearls

Cultured pearls (nucleated and non-nucleated or tissue nucleated cultured pearls) and imitation pearls can be distinguished from natural pearls by X-ray examination. Nucleated cultured pearls are often 'pre-formed' as they tend to follow the shape of the implanted shell bead nucleus. Once the pre-formed beads are inserted into the oyster, it secretes a few layers of nacre around the outside surface of the implant before it is removed after six months or more. When a nucleated cultured pearl is X-rayed it will reveal a different structure to that of a natural pearl. It exhibits a solid center with no concentric growth rings, compared to a solid center with growth rings.

### **Gemological identification**

A well equipped gem testing laboratory is able to separate natural pearls from cultured pearls by examining the center of a pearl, and the growth rings separated by conchiolin layers. The differentiation of a natural pearl or tissue-nucleated cultured pearl can be difficult without a gemological X-ray.

All natural and cultured pearls can be distinguished from imitation pearls using a microscope. Another accurate method of testing for imitations is to rub the pearl against the surface of a front tooth. Imitation pearls are completely smooth, but natural and cultured pearls are composed of nacre platelets, which feel slightly gritty.

### **Value of a natural pearl**

Quality natural pearls are very rare jewels. The actual value of a natural pearl is determined in the same way as it would be for other "precious" gems. The valuation factors include size, shape, quality of surface, orientation, and luster.

Single natural pearls are often sold as a collector's item, or set as centerpieces in unique jewelry. Very few matched strands of natural pearls exist, and those that do often sell for hundreds of thousands of dollars. Yachtsman and financier Cartier purchased the landmark Cartier store on Fifth Avenue in New York for \$100 cash and a double strand of matched natural pearls valued at \$1 million.

Keshi pearls, although they often occur by chance, are not considered natural pearls. They are a byproduct of the culturing process, and hence do not happen without human intervention. These pearls are quite small: typically a few millimeters in size. Keshi pearls are produced by many different types of marine mollusks and freshwater mussels in China.<sup>[4]</sup> Today many "keshi" pearls are actually intentional, with post-harvest shells returned to the water to regenerate a pearl in the existing pearl sac.

### **Origin of a natural pearl**

Previously natural pearls were found in many parts of the world. Present day natural pearling is confined mostly to seas off Bahrain. Australia also has one of the world's last remaining fleets of pearl diving ships. Australian pearl divers dive for south sea pearl oysters to be used in the cultured south sea pearl industry. The catch of pearl oysters is similar to the numbers of oysters taken during the natural pearl days. Hence significant numbers of natural pearls are still found in the Australian Indian Ocean waters from wild oysters. X-Ray examination is required to positively verify natural pearls found today.

### Different types of cultured pearls



Nuclei from Toba Pearl Island, Japan

Black pearls, frequently referred to as Black Tahitian Pearls, are highly valued because of their rarity; the culturing process for them dictates a smaller volume output and can never be mass produced. This is due to bad health and/or non-survival of the process, rejection of the nucleus (the small object such as a tiny fish, grain of sand or crab that slips naturally inside an oyster's shell or inserted by a human), and their sensitivity to changing climatic and ocean conditions. Before the days of cultured pearls, black pearls were rare and highly valued for the simple reason that white pearl oysters rarely produced natural black pearls, and black pearl oysters rarely produced any natural pearls at all. Since pearl culture technology, the black pearl oyster found in Tahiti and many other Pacific Island area has been extensively used for producing cultured pearls. The rarity of the black cultured pearl is now a "comparative" issue. The black cultured pearl is rare when compared to Chinese freshwater cultured pearls, and Japanese and Chinese Akoya cultured pearls, and is more valuable than these pearls. However, it is more abundant than the south sea pearl, which is more valuable than the black cultured pearl. This is simply due to the fact that the black pearl oyster *Pinctada margaritifera* is far more abundant than the elusive, rare, and larger south sea pearl oyster - *Pinctada maxima*, which cannot be found in lagoons, but which must be dived for in a rare number of deep ocean habitats. Black cultured pearls from the black pearl oyster — *Pinctada margaritifera* — are NOT south sea pearls, although they are often mistakenly described as black south sea pearls. In the absence of an official definition for the pearl from the black oyster, these pearls are usually referred to as "black Tahitian pearls". The correct definition of a south sea pearl — as described by CIBJO and the GIA — is a pearl produced by the *Pinctada maxima* pearl oyster. South sea pearls are the color of their host *Pinctada maxima* oyster — and can be white, silver, pink, gold, cream, and any combination of these basic colors, including overtones of the various colors of the rainbow displayed in the pearl nacre of the oyster shell itself.



When Spanish conquistadors arrived in the Western Hemisphere, they discovered that around the islands of Cubagua and Margarita, some 200 km north of the Venezuelan coast, was an extensive bed of pearls. One of them, the Peregrina, was offered to the Spanish queens. This pearl later became very famous when Richard Burton purchased it for his wife Elizabeth Taylor. Margarita pearls are extremely difficult to find today and are known for their unique yellowish color. The most famous Margarita necklace that any one can see today is the one that then Venezuelan President Romulo Betancourt gave to Jacqueline Kennedy when she and her husband, President John F. Kennedy paid an official visit to Venezuela.

Before the beginning of the 20th Century, pearl hunting was the most common way of harvesting pearls. Divers manually pulled oysters from ocean floors and river bottoms and checked them individually for pearls. Not all natural oysters produce pearls. In a haul of three tons, only three or four oysters will produce perfect pearls.

However, almost all pearls used for jewelry are cultured by planting a core or *nucleus* into pearl oysters. The pearls are usually harvested after one year for Akoya, and 2-4 years for Tahitian and South Sea, and 2-7 years for freshwater. This mariculture process was first developed by Tatsuhei Mise and Tokichi Nishikawa in Japan. The nucleus is generally a polished bead made from freshwater mussel shell. Along with a small piece of mantle tissue from another mollusk to serve as a catalyst for the pearl sac, it is surgically implanted into the gonad (reproductive organ) of a saltwater mollusk. In freshwater perliculture, only the piece of tissue is used in most cases, and is inserted into the fleshy mantle of the host mussel. South Sea and Tahitian pearl oysters, also known as *Pinctada maxima* and *Pinctada margaritifera*, which survive the subsequent surgery to remove the finished pearl are often implanted with a new, larger nucleus as part of the same procedure and then returned to the water for another 2-3 years of growth. Despite the common misperception, Mikimoto did not patent the process of pearl culture. The accepted process of pearl culture was developed by a team of scientists at Tokyo University between 1907 and 1916. The team was headed by Tokichi Nishikawa and Tatsuhei Mise. Nishikawa was granted the patent in 1916, and married the daughter of Mikimoto. Mikimoto was able to use Nishikawa's technology. After the patent was granted in 1916, the technology was immediately commercially applied to akoya pearl oysters in Japan in 1916. Mise's brother was the first to produce a commercial crop of pearls in the akoya oyster. Mitsubishi's Baron Iwasaki immediately applied the technology to the south sea pearl oyster in 1917 in the Philippines, and later in Buton, and Palau. Mitsubishi was the first to produce a cultured south sea pearl - although it was not until 1928 that the first small commercial crop of pearls was successfully produced.

The original Japanese cultured pearls, known as akoya pearls, are produced by a species of small oysters, *Pinctada fucata martensii*, no bigger than 6 to 7 cm in size, hence akoya pearls larger than 10 mm in diameter are extremely rare and highly prized. Today a hybrid mollusk is used in both Japan and China in the production of akoya pearls. It is a cross between the original Japanese shell, and *Pinctada chemnitzii* of China.

China has recently overtaken Japan in akoya pearl production. Japan has all but ceased its production of akoya pearls smaller than 8mm. Japan maintains its status as a pearl processing center, however, and imports the majority of Chinese akoya pearl production. These pearls are then processed (often simply matched and sorted), relabeled as product of Japan, and exported.

In the past couple of decades, cultured pearls have been produced with larger oysters in the south Pacific and Indian Ocean. The largest pearl oyster is the *Pinctada maxima*, which is roughly the size of a dinner plate. South Sea pearls are characterized by their large size and silvery color. Sizes up to 14 mm in diameter are not uncommon. Australia is one of the most important sources of South Sea pearls. Mitsubishi commenced pearl culture with the south sea pearl oyster in 1916 as soon as the technology patent was commercialized. By 1931 this project was showing signs of success, but was upset by the death of Tatsuhei. Although the project was recommenced after Tatsuhei's death, the project was discontinued at the beginning of WWII before significant productions of pearls were achieved. After WWII, new south sea pearl projects were commenced in the early 1950s in Burma and Kuri Bay and Port Essington in Australia. Japanese companies were involved in all projects using technicians from the original Mitsubishi south sea pre-war projects. Despite often being described as black south sea pearls, Tahitian pearls are not south sea pearls. The correct definition of a south sea pearl is "the pearl produced by the *Pinctada maxima* pearl oyster."

In 1914, pearl farmers began culturing freshwater pearls using the pearl mussels native to Lake Biwa. This lake, the largest and most ancient in Japan, lies near the city of Kyoto. The extensive and successful use of the Biwa Pearl Mussel is reflected in the name *Biwa pearls*, a phrase which was at one time nearly synonymous with freshwater pearls in general. Since the time of peak production in 1971, when Biwa pearl farmers produced six tons of cultured pearls, pollution and overharvesting have caused the virtual extinction of this animal. Japanese pearl farmers recently cultured a hybrid pearl mussel — a cross between the last remaining Biwa Pearl Mussels and a closely related species from China, the *Cristaria plicata* — in lake Kasumigaura. This industry closed in 2006 due to lake pollution.

Led by pearl pioneer John Latendresse and his wife Chessy, the United States began farming freshwater cultured pearls in the mid 1960's. National Geographic Magazine introduced the American cultured pearl as a commercial product in their August 1985 issue. The Tennessee pearl farm has emerged as a tourist destination in recent years.

In the 1990s, Japanese pearl producers also invested in producing cultured pearls with freshwater mussels in the region of Shanghai, China, and in Fiji. Freshwater pearls are characterized by the reflection of rainbow colors in the luster. Cultured pearls are also produced using abalone.

## 5. Jewelry



*Girl with a Pearl Earring*

The value of the pearls in jewelry is determined by a combination of the luster, color, size, lack of surface flaw and symmetry that are appropriate for the type of pearl under consideration. Among those attributes, luster is the most important differentiator of pearl quality according to jewelers. All factors being equal, however, the larger the pearl the more valuable it is. Large, perfectly round pearls are rare and highly valued. Teardrop-shaped pearls are often used in pendants.



Inexpensive, button-shape cultured freshwater pearls used in a necklace and bracelet.

Pearls come in eight basic shapes: round, semi-round, button, drop, pear, oval, baroque, and circled. Perfectly round pearls are the rarest and most valuable shape. Semi-rounds are also used in necklaces or in pieces where the shape of the pearl can be disguised to look like it is a perfectly round pearl. Button pearls are like a slightly flattened round pearl and can also make a necklace, but are more often used in single pendants or earrings where the back half of the pearl is covered, making it look like a larger, round pearl.



*Woman with a Pearl Necklace, by Jan Vermeer van Delft*

Drop and pear shaped pearls are sometimes referred to as teardrop pearls and are most often seen in earrings, pendants, or as a center pearl in a necklace. Baroque pearls have a different appeal to them than more standard shapes because they are often highly irregular and make unique and interesting shapes. They are also commonly seen in necklaces. Circled pearls are characterized by concentric ridges, or rings, around the body of the pearl.

In general, cultured pearls are less valuable than natural pearls, and imitation pearls are less valuable than cultured pearls. One way that jewelers can determine whether a pearl is cultivated or natural is to have a gem lab perform an x-ray of the pearl. If the x-ray reveals a nucleus, the pearl is likely a bead-nucleated saltwater pearl. If no nucleus is present, but irregular and small dark inner spots indicating a cavity are visible, combined with concentric rings of organic substance, the pearl is likely a cultured freshwater. Cultured freshwater pearls can often be confused for natural pearls which present as homogeneous pictures which continuously darken toward the surface of the pearl. Natural pearls will often show larger cavities where organic matter has dried out and decomposed.

Some imitation pearls are simply made of mother-of-pearl, coral or conch, while others are made from glass and are coated with a solution containing fish scales called essence d'Orient. Although imitation pearls look the part, they do not have the same weight or smoothness as real pearls, and their luster will also dim greatly.

There is also a unique way of naming pearl necklaces. While most other necklaces are simply referred to by their physical measurement, strings of pearls have their own set of names that characterize the pearls based on where they hang when worn around the neck. A *collar* will sit directly against the throat and not hang down the neck at all; they are often made up of multiple strands of pearls. *Pearl chokers* nestle just at the base of the neck. The size called a *princess* comes down to or just below the collarbone. A *matinee of pearls* falls just above the breasts. An *opera* will be long enough to reach the breastbone or sternum of the wearer, and longer still, a *pearl rope* is any length that falls down farther than an opera.

Necklaces can also be classified as uniform, or graduated. In a uniform strand of pearls, all pearls are classified as the same size, but actually fall in a range. A uniform strand of akoya pearls, for example, will measure within 0.5 mm. So a strand will never be 7 mm, but will be 6.5-7 mm. Freshwater pearls, Tahitian pearls, and South Sea pearls all measure to a full millimeter when considered uniform. A graduated strand of pearls most often has at least 3 mm of differentiation from the ends to the center of the necklace. Popularized in the 1950s by the GIs bringing strands of cultured akoya pearls home from Japan, the graduated style was much more affordable as most pearls in any given strand were small.

Earrings and necklaces can also be classified on the grade of the color of the pearl. While white and more recently black pearls are by far the most popular colors other tinges of color can be found on pearls. Pink, blue, champagne, green and even purple can be found, but to form a complete string of same size and shade pearls can take years. Some colors like purple can only be found in certain types of clams, while other clams can produce a variety of colors if given the right environment.

## 6. Religious references

According to Rebbenu Bachya, the word *Yahalom* in the verse Exodus 28:18 means "pearl" and was the stone on the Hoshen representing the tribe of Zebulun. This is extremely disputed among scholars, particularly since the word in question in most manuscripts is actually *Yasepheh* - the word from which *jasper* derives; scholars think that refers to green jasper (the rarest and most prized form in early times) rather than red jasper (the most common form). *Yahalom* is usually translated by the Septuagint as an "onyx", but sometimes as "beryl" or as "jasper"; onyx only started being mined after the Septuagint was written, so the Septuagint's term "onyx" probably does not mean onyx - onyx is originally an Assyrian word meaning ring, and so could refer to anything used for making rings. *Yahalom* is similar to a Hebrew word meaning hit hard, so some people think that it means diamond. The variation in possibilities of meaning for this sixth stone in the Hoshen is reflected in different translations of the Bible — the King James Version translates the sixth stone as *diamond*, the New International Version translates it as *emerald*, and the Vulgate translates it as *jaspis* — meaning jasper. There is a wide range of views among traditional sources about which tribe the stone refers to.

In a Christian New Testament parable, Jesus compared the Kingdom of Heaven to a "pearl of great price" in Matthew 13: 45-46. "Again, the kingdom of heaven is like unto a merchant man, seeking goodly pearls: Who, when he had found one pearl of great price, went and sold all that he had, and bought it."

The language of symbolism was in common use around the time of Jesus Christ and most people knew this language. The Circle is a symbol of God, it has no beginning and no end. The circle or pearl was considered to represent Love, Knowledge (the combination of equal amounts of Love and Knowledge is a symbol of Wisdom, the 2 circles intertwined (owl eyes) is symbolic of Wisdom. Some other pearls are Truth, and Faith.

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The Pearl of Great Price is a book of scripture in The Church of Jesus Christ of Latter-day Saints.

The twelve gates of the New Jerusalem are reportedly each made of a single pearl in Revelation 21:21, that is, the Pearly Gates. "And the twelve gates were twelve pearls; every several gate was of one pearl: and the street of the city was pure gold, as it were transparent glass."

Pearls are compared to holy things, in Matthew 7: 6. "Give not that which is holy unto the dogs, neither cast ye your pearls before swine, lest they trample them under their feet, and turn again and rend you."

Pearls are also found in numerous references showing the wickedness and pride of a people, as in Revelations 18: 16. "And saying, Alas, alas, that great city, that was clothed in fine linen, and purple, and scarlet, and decked with gold, and precious stones, and pearls!"

The metaphor of a pearl appears in the longer Hymn of the Pearl, a poem respected for its high literary quality, and use of layered theological metaphor, found within one of the texts of Gnosticism.

### Islamic references

In Islam, the Koran often mentions that dwellers of paradise will be adorned with pearls:

22:23 God will admit those who believe and work righteous deeds, to Gardens beneath which rivers flow: they shall be adorned therein with bracelets of gold and pearls; and their garments there will be of silk.

35:33 Gardens of Eternity will they enter: therein will they be adorned with bracelets of gold and pearls; and their garments there will be of silk.

The Quran describes the wives of the people of Paradise as having eyes that are similar to pearls:

56:22-23 And [there will be] Houris with wide lovely eyes [as wives for the pious], Like unto preserved pearls.

The handsome young boys in paradise are similarly depicted:

52:24 Round about them will serve, [devoted] to them, youths [handsome] as Pearls well-guarded.

**Hindu astrological belief in natural pearls**

The Vedic tradition describes the sacred Nine Pearls which were first documented in the Garuda Purana, one of the books of the Hindu holy text Atharvaveda. Ayurveda contains references to pearl powder as a stimulant of digestion and to treat mental ailments. According to Marco Polo the kings of Malabar (now known as the Coromandel Coast) wore a necklace of 104 rubies and 104 precious pearls which was given from one generation of kings to the next. The reason was that every king had to say 104 prayers to his "idols" every morning and every evening. At least until the beginning of the 20th century it was a Hindu custom to present a completely new, undrilled pearl and pierce it during the ceremony.

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