Pearls and Organic Gemstones

INTRODUCTION

Pearls were probably the first discovered gems of significance. Because they need no cutting or treatment to enhance their beauty and are rare natural occurrences, they have most likely always been highly esteemed.

Organic gemstones are anything created by living processes. We have looked at amber in the past, but bone, teeth (such as ivory), and shells all have some value and are used today as gemstones.

Pearls in General

A pearl is grown by a mollusk (a bivalve such as a clam, oyster, or mussel or snail [single shell = valve]) in response to an **irritant**. Bivalves (two shelled mollusks) that secrete pearls live in both fresh- and saltwater. The irritant in most cases is a parasite (though it could be a grain of sand or other object). The parasite, a worm or other creature, is walled off by a secretion of calcium carbonate and protein. The **calcium carbonate** is the same as the inorganic material that makes stalactites in caves, and the protein is called **conchiolin**. The combination of these two substances (calcium carbonate and protein) makes the **pearl's nacre** (Nacre is also called **mother of pearl**). The nacre is a lustrous deposit around the irritant and forms concentric layers (overlapping circles).

Many concentric layers of nacre build up over a period of a few years creating a pearl. The internal pattern is much like that seen in a jawbreaker. The layers create a sheen or luster that has iridescence and is described as both pearly luster and if colors of the rainbow are present, the **pearl's orient**. Orient is due to the plates of nacre acting in a way similar to opal or DVD grooves in that the colors are **created by diffraction (Roygbiv)**.

A pearl is valued by its **shape, size, luster, color, and surface perfection.** Natural pearls are rarely spherical and this is the most desirable shape (for the obvious reason of its superior symmetry). The larger the better. The luster is a factor of how many layers of nacre are present and the surface perfection. The color may be related to the species of bivalve, the environment in which the bivalve grew, or how the pearl was treated after harvesting.

Cultured Pearls

Cultured pearls often have a nucleus. The nucleus is a center from where the pearl grows (Figure 1). This nucleus starts growth. The Pearl is started in a way similar to nature, and we can say it like a "synthetic."

a. Nucleated Pearls

Most pearls sold today, perhaps greater than 99%, are not natural, but are artificially induced in a bivalve by surgically implanting an irritant. These induced pearls grown in cultivated bivalves are called cultured pearls. Several countries and notable figures have contributed to pearl cultivation. Carolus Linnaeus (1707-1784), a famous botanist who invented the binomial classification of species, invented a way to culture round freshwater pearls in mussels. As well, induced pearls or nacre-covered objects date back to the 1300s in ancient China.

However, pearl culturing as we know it today, to create round perfect specimens, was perfected in Japan in the early 1900s. The method uses a bead of calcium carbonate that replaces the irritating parasite and acts as a nucleus for nacre secretion that ensures a spherical pearl. The **name Kokichi Mikimoto** is synonymous with fine cultured pearls, but Mikimoto's method of culturing called the whole wrap is not used today. The method used was invented by Tokichi Nishikawa and is called the piece method.

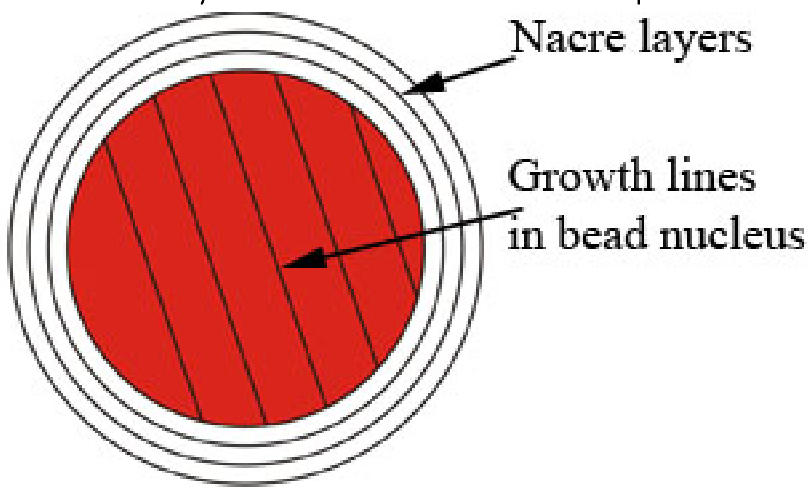

Figure 1. The shaded area is the bead. The bead is made from a shell piece shaped into a sphere. The growth lines are what you see in most clam shells.

The piece method involves a surgical operation on the bivalve that implants a spherical nucleus or bead of calcium carbonate and a piece of tissue cut from the mantle of another oyster. The mantle is the tissue that secretes (makes) the bivalve's shell (which is calcium carbonate) and the pearl. After the operation, the oyster is returned to the water, hung from a special raft, cared for, and grown for a period of time. Harvesting releases the pearl but kills the oyster. The oyster of choice for pearl growth used by the Japanese industry is the Akoya oyster and the pearls from these saltwater oysters are called **Akoya pearls**. These pearls have only a relatively thin coating of nacre around the bead nucleus and yet look as good as natural pearls (Figure 1). The thickness of the nacre layer may vary from 0.1 mm to 1 mm in Japanese pearls and may be several millimeters thick in larger South Seas and Australian Pearls. Clearly a thicker coat of nacre will ensure a longer lasting pearl. Thin layers may be worn away within only a few years of use.

Natural pearls are solid nacre and last as long as the pearl, but having a nucleus almost insures a round shape; not having a nucleus means that the pearl is likely to be uneven in outline and nonspherical. A spherical pearl was so rare before culturing, that a fine quality pearl could be as valuable per carat as a diamond. Figure 2 Shows a schematic diagram of a natural pearl.

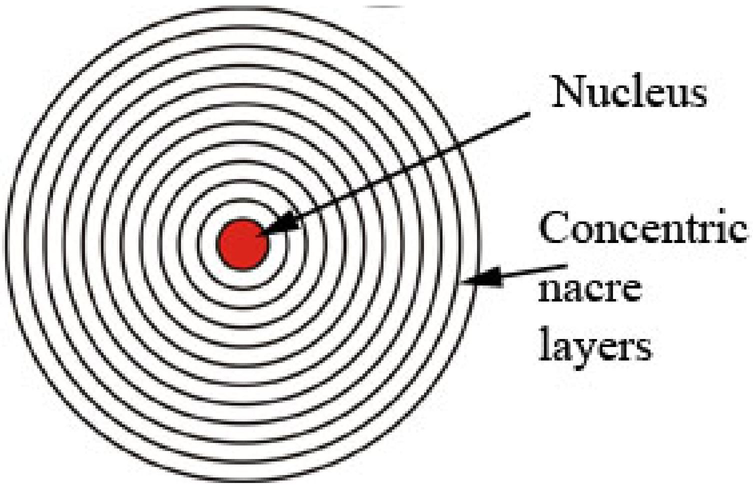

Figure 2. A natural pearl might have a microscopic worm as a nucleus or a bit of sand or shell. Such a pearl would take many years to grow. Today's pearls may start with a rather large nucleus and add only a millimeter of nacre.

b. Nonnucleated Pearls

These pearls origins are not entirely clear, but in the 1970s a type of pearl referred to as a **Biwa pearl**, after Lake Biwa in Japan, was marketed. These pearls are freshwater, not saltwater, and an entirely new method of starting the pearls was created. The traditional saltwater culture pearl, Akoya Pearl, named after the Japanese Oyster, needed a bead cut from Tennessee or Mississippi freshwater mussel shell to be produced. This was not the case with the Biwa or "nonnucleated" pearl. All it needs is the insertion of a piece of tissue, cut from the mantle tissue of a sacrificed mussel of the same species. Mantle tissue forms or "secretes the mineralized shell of mollusks. This "piece of tissue" was inserted into the freshwater mussel (bivalve) of Lake Biwa by a surgical operation, and a pearl grew from the inserted tissue.

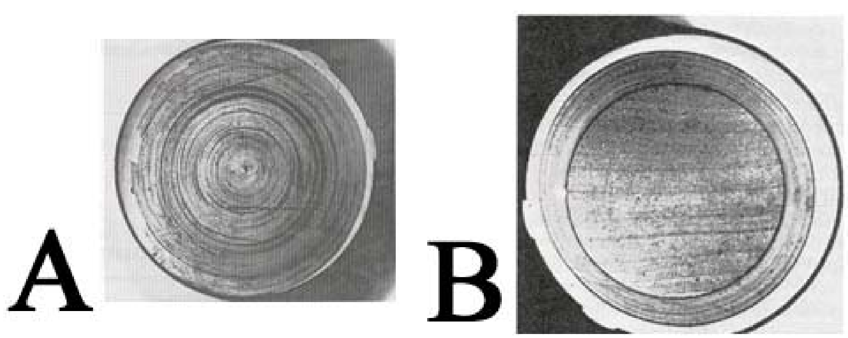

Figure 3. A) A natural pearl, no nucleus. B) A cultured pearl, the bead nucleus has parallel growth of the shell, not the concentric layers of the pearl. It was cut from a freshwater mussel shell (see pages in Read, P. 224 and 226).

The thing is that a pearl that is nucleated with just tissue shows no bead nucleus and is hard to tell from a natural pearl (Figure 3). Thus it became harder to tell natural from cultured pearls. Such a Biwa or any pearl created by a method of “only tissue nucleation” does not necessarily appear to be cultured on an X-ray.

These tissue nucleated pearls may have a small indent in their interior that gives away that there was a piece of tissue there, but the indent is not always obvious (Figure 4).

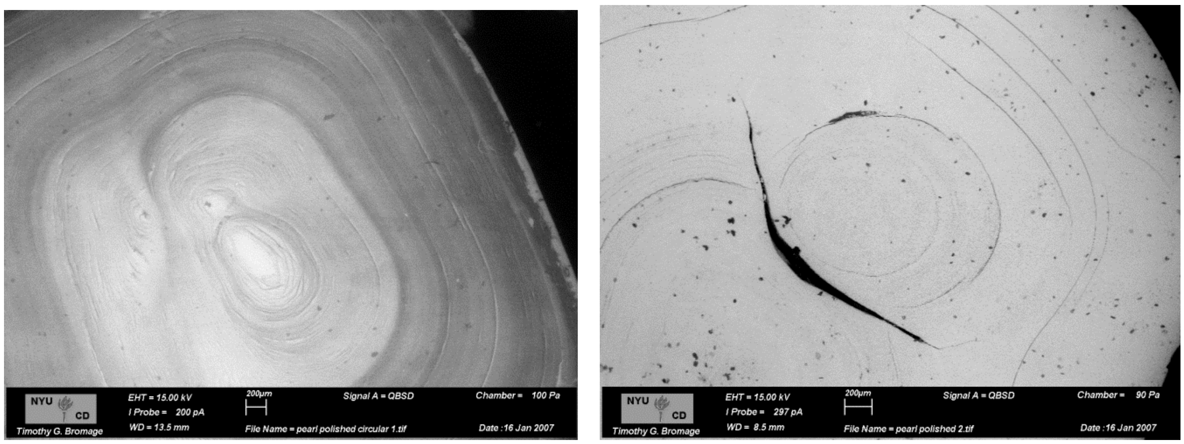

Figure 4. These two halfed pearls give an impression of a tissue nucleated cultured pearl with no bead. The indent on the picture on the right may be where the tissue was inserted to start growth.

The

Outer pearl surface

The outer pearl surface is very important in identification of a nacreous pearl. Individual nacre layers may appear to wrap all around creating the layers of a pearl (Figures 3 & 4), but actually the plates of nacre make even smaller areas within the layers and these may rise to the surface of the pearl (Figure 5). The individual layers terminate on the surface giving a “finger print” like surface that is a series of ridges. One test to see if a pearl is made of nacre (either cultured or natural pearl) is to run the pearl along your teeth. If the person feels a roughness on their teeth, they are feeling nacre layers. If the surface is just smooth, it is not a pearl, but a bead of glass or even plastic. Figure 5 shows the rough surface with the “finger print-like ridges” on a pearl. This can be seen with the gem microscope at around 40X magnification.

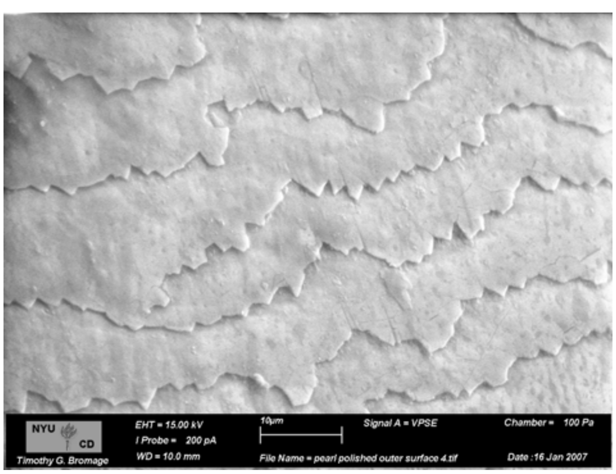

Figure 5. Ridges on the outer surface of a pearl created by nacre layers reaching the pearl surface. These ridges can be felt by your teeth as you turn a pearl against them. Do not do this in class! Not hygienic.

Mabe Pearls

These are not true pearls but are grown by pasting a half-sphere of plastic or mineral matter to the shell of an oyster. They are essentially artificially induced blister pearls. Blister pearls are natural growths from the shell of a mollusk typically induced by a parasite. The Mabe pearl is removed from the oyster shell by cutting and then the hollow portion is filled in and a piece of mother of pearl can be used to cap the pearl, making it Hemispherical. The hemispheres are used in jewelry such as earrings or any place a halfed pearl could be used. They are much easier to make that true “round” pearls. Kokichi Mikimoto first grew these and then moved on to round pearls.

Abalone Pearls

The abalone is not a bivalve, but you may have seen their shells, often used as ashtrays, but also cut into shell beads, etc. They are actually marine snails. Their shells are often very pretty shades of blue, green, red, etc. Their nacre being very colorful, they have strong orient “colors due to diffraction.” Occasionally, abalone make pearls. The pearls can get to be large, but are usually irregular. Cultured abalone mabe pearls are also produced. We may see a half sphere of abalone, and certainly we will look at a shell. Interestingly abalone shells are dangerous to cut and produce an irritating dust that can poison the cutter, so care is needed to work with the shells. Avoid inhaling the dust.

Nonnacreous Pearls

Not all mollusks make nacreous pearls. They may appear porcelaneous, like porcelain or may have a shiny (perhaps waxy luster) but not nacreous (not mother of pearl) finish.

One such type of pearl is made by the giant clam of the Pacific Ocean. These pearls are porcelaneous and look like porcelain without glaze (such as a streak plate). They are collectible, can be quite large, but are not very precious.

Conch pearls are nonnacreous, but have an attractive color, pink, orange, tan, but do not show an nacre. Their color is their important feature. They also may show a strange pattern referred to as “flame structure” on their surface. These pearls are sought after by collectors and used in some jewelry.

Ammolite

We looked at this fossilized mother of pearl or nacre from the marine animals called ammonites, extinct mollusks. Modern nautilus also has a pearly interior. We will look at few more shells. Again the colors are due to overlapping plates made of calcium carbonate that create diffraction.

Non-Pearl Related Organic Materials

Ivory

Most important of these non-pearl gems are probably teeth. **Teeth of elephants, mammoths, mastodons, and some whales** are referred to as ivory. There are also some pig-like animals such as warthogs that have ivory, but are not as desirable as that of the larger mammals. Sadly, elephants are endangered and their extinct relative the mammoths and mastodons are not as fine a material. Mammoth and mastodon ivories are found in northern areas where permafrost (permanently frozen ground) protects the ivory from total decay. These can be carved. Ivory may show a special structure described in the text (P. G. Read, P. 238) as an engine turned structure. A series of lines that curve through the ivory.

Ivory should be avoided, though ancient mammoth and mastodon ivory is not objectionable. The killing of animals for ivory is just not acceptable with limited resources and over pollution and global populations being so large.

Coral

Coral is also endangered and should mostly be avoided, but again fossil and antique materials are available. Most precious is red coral (called precious coral). Red coral tends to form branches. It is made of both calcium carbonate (will react with hydrochloric acid) and protein. A cellular structure can be seen in red coral, but it also takes a very good polish.

Black coral, basically is a protein, horny material (like bull horns and hooves). The coral may show a cellular texture, but is not as dense or hard as red coral.

Golden coral is bleached black coral. Chlorine or hydrogen peroxide provides the bleach. It typically less dense than black coral, because proteins are bleached out of the black coral.

Generally corals being endangered are not a good choice for jewelry, and they are illegal in some countries. Plastic can replace most applications of the corals.

Amber

Amber is a fossilized tree resin, as discussed in prior labs. Amber is generally lighter than most plastics and can float in salty water. Amber may be transparent, translucent, or even opaque. Probably clarity is mostly related to air bubbles and other inclusions.

Because amber melts at a low temperature, it can be pressed from small into larger pieces.

The ways that amber is recognized include: burning it (it has a characteristic scent; plastics smell bad, amber does not); testing with chemicals (amber is more inert to solvents than most plastics), and density.

One of the things most important to amber is its inclusions that may include fossil insects and other once living things that were trapped in the resin while it was sticky. The film "Jurassic Park" produced by Steven Spielberg made amber familiar to most people.

Jet and Coal

Jet and coal are related dark carbonaceous materials that are made of fossilized plant materials. They may be carved or cut in cabochons. Mostly the dark color means that it is for **mourning jewelry** (funerals and such), and it is not of great value. Mostly plastic is substituted for jet and coal and burning it, melting it, and smelling characteristic odors is typically used to recognize imitations.

Lab Projects

Today most of the projects are observational. Look at the specimens, draw something that helps you remember them, and then show your observations to others.

1. Pearls. Look at a cut section of an Akoya pearl. Draw the nacre layer and the bead nucleus.

Larger whole image ________X Microscope view of nacre __________X

2. Pearls. Look at a close up with the microscope of nacre on a pearl's surface to see ridges on surface. At least 40X

Larger whole image ________X Microscope view as needed __________X

3. Pearls. Look at a section through a tissue nucleated pearl (Chinese freshwater or Biwa pearl). Note you can see layers, but no bead nucleus.

Larger whole image _______X Microscope view as needed _________X

4. Pearls. Look at a Mabe pearl. Note the back is not nacre grown of the same grade, but a plug of shell used to seal the as grown half pearl or Mabe.

Larger whole image _______X Microscope view as needed _________X

5. Pearls. Look at a Nonnacreous conch pearl. Draw the flame structure on the pearl's surface.

Larger whole image _______X

Microscope view as needed _________X

6. Look at a shell section of a giant clam. It has no mother of pearl. The holes are bored by sponges. It shows porcelaineous luster.

Larger whole image _______X

Microscope view as needed _________X

7. Look at the nacreous interior of a freshwater mussel. It has orient.

Larger whole image _______X

Microscope view as needed _________X

8. Look at failed pearls and pearls in a dried mussel's tissue. The failed pearls grew together and have high orient. Pearls in tissue are in dried tissue of a Chinese Freshwater Triangle Pearl

Failed pearls _______X

Dried pearl tissue triangle shell _______X

9. Look at an abalone shell and an abalone mabe pearl. Notice the greens, rare in other types or nacre.

Abalone shell ________X

Abalone mabe pearl __________X

10. Look at a Akoya oyster. This is the Japanese saltwater pearl oyster.

Akoya shell ________X

Akoya __________X

11. Look at a piece of red precious coral. Note it's density and cellular structure on some pieces.

Red coral ________X

Another Red coral __________X

12. Look at examples of amber. They are light weight and may contain insects.

Amber piece ________X

Possible insect __________X

13. Look at a piece of ivory. This is may show some structure and lines.

Ivory in shape of tooth ________X Close up (green cap is made of the mineral malachite) ________X

14. Look at Jet and coal. You have seen these before; they are used in mourning jewelry.

Coal ________X Jet________X

15. Ammolite. These two shells are showing a fossilized mother of pearl in a now extinct mollusk related to todays' nautilus.

Shell _______X

Shell _______X