Delve Deep – Pearl Oysters

Oyster pearls and Tahitian black pearls

Oysters may be edible (Genus *Ostreidae*) or pearl producers (Genus *Pinctada*). The black lipped pearl oyster (*Pinctada margaritifera*) is renowned for its ability to produce black and grey shaded pearls and mother of pearl (although other colours such as dark blues, greens and golden orange pearls may be produced). Although they are often called 'Tahitian' pearls, they are not cultured in Tahiti, but are found in a collection of islands and atolls in the middle of the South Pacific Ocean - French Polynesia. Black lipped oysters are normally found in French Polynesian waters (including the Cook Islands, Fiji, Tonga, Samoa, and New Caledonia) and from the Persian Gulf to the Gulf of California and Japan.

Tahitians and pearl oysters

Tahitian pearl divers had to dive down 30 metres to find a pearl. Often the waters harboured sharks and only one oyster out of every fifteen to twenty thousand contained a pearl. This required the divers to have large lung capacities and strong arms to pull themselves down through the water. Some divers tried hyperventilating before their dive, to increase the oxygen and decrease carbon dioxide levels in their blood. Pearls were worn as adornment, while the shells were used to fashion tools such as fishhooks.

European discovery of pearl oysters

Once the Spanish and English discovered the Pacific area in the 1700s, they started exporting mother of pearl shells, turtle-shell, sandalwood, and natural pearls from the islands, greatly depleting supplies. When France gained control in 1880, strict regulations were applied to reduce fishing on the islands. In the mid-20th century, oysters were first nucleated, producing 'Tahitian' cultured pearls. Today, natural black pearls are very rare. 'Cultured' black pearls, produced from farmed oysters supply the market with black pearls today.

Environments for pearl oysters

Pearl oysters prefer protected, temperate (warm), nutrient rich water. They are usually found in lagoons covering dormant volcanoes, which release mineral salts. Coral grows in the upper levels of a lagoon atoll and provides protection from predators. Mineral salts from the volcanic rock provide nutrients and building material for the oyster shell.

Biology of pearl oysters

Oysters belong to the **Mollusca** phylum, which also includes snails, slugs and octopuses. Oysters are known as **bivalves**, because they contain a soft-bodied animal, within two shells. The shells are attached at one end so it can open up slightly to feed. **Bivalve molluscs** have strong muscles, allowing the oyster to shut tightly if any animal (including humans) try to wrench it open. The black lipped pearl oyster (*Pinctada margaritifera*) which produces 'Tahitian' pearls undergoes a sex change during its lifetime. During the female stage, the oyster lays a total of 40 million eggs into the water, so sperm released into the water can reach the eggs to fertilise them and form larvae. Plankton and coral on the reef may eat the larvae and if they survive to develop bivalve shells, (forming 'spats' or embryonic oysters) they can be eaten by giant rays, octopus, crabs, starfish and triggerfish. Adult *Pinctada* oysters can reach 5 kilograms in mass and 30cms in width.

Formation of pearls and cultured pearls
If the oyster gets a foreign body inside (such as a grain of sand, or parasite) it irritates the oyster which produces a pearl by covering the dirt with layers of nacre. Nacre is made up of microscopic crystals of carbonate, which reflect and refract white light to produce the colours. ‘Tahitian’ pearls range from 8 to 18 millimetres in size and take 2 to 3 years to form. Pearls are usually thought of as being white, but they can be found in many shapes and colours. ‘Cultured’ pearls are from farmed pearl oysters, where the ‘farmer’ deliberately places a foreign body inside the oyster to begin pearl formation. Although millions of oysters may be ‘seeded’, only 20% or so survive to produce marketable pearls. Many oysters are lost to parasites, disease, predators and changing conditions (such as algal blooms or freshwater depleting mineral concentration). Less than 5% of seeded pearls produce high quality pearls for the ‘top end’ of the market.

Shells in general

How are shells formed?
The mollusc’s soft body part known as the mantle deposits the crystals of calcium carbonate (as calcite or aragonite) to form the shell. Layers of calcium carbonate are deposited over time and can be seen as ‘growth rings’ on a shell. To keep the layers together, a substance called conchiolin helps to glue and strengthen the layers, like mortar in a brick wall. If the mollusc’s diet is adequate, and the light and temperature levels are suitable, a strong shell will form over time. Generally, warm water shells are more solid and colourful than cold water shells.

What gives shells their colour?
Pigments cause shell colours, while shell iridescence is caused by refraction of light as it passes through layers of calcite and aragonite. Shelled creatures use colour in camouflage, protecting their tissue from harmful light, and to harden the shell structure and eliminate harmful chemicals from their bodies.

True pigments or biochromes – give molluscs red, orange, yellow, green, blue, indigo, violet, brown and black colours. Pigments such as yellow carotenoids, black melanins, green porphyrins and blue and red indigoids cause these colours. Some pigments like beta-carotene and chlorophyll are ingested by molluscs as part of their diet and can also give shells their colour.
Glands embedded in the edge of the shell’s mantle secrete the colour pigment with the fluid calcite during shell formation. The pigment bonds with the conchiolin ‘glue’ of the shell. A segment of shell about 0.1 cm thick can have 450 to 5000 layers of calcium carbonate and conchiolin, which the light passes through and is refracted by.

Structural colours or schemochromes are the iridescent ‘rainbow’ colours often found inside shells such as abalone. These colours are produced by refracted (or deflected) light waves, not by a pigment. White light is actually a mixture of red, orange, yellow, green, blue, indigo and violet coloured light. Each of these colours has a different wavelength, which can be separated out from the ‘mixture’ of white light. Red light has the longest wavelength; violet light has the shortest wavelength. If we see a colour, it is because that wavelength of colour is being reflected back and other colours are being ‘absorbed’. For example, grass appears green because the green wavelength is being reflected (by chlorophyll) while the other colours are being taken up or absorbed by the grass.

In iridescent shells, the light is refracted as it passes through different layers of calcite (a shiny form of calcium carbonate). As white light such as sunlight passes through the layers of the shell, some of the wavelengths of light continue to travel down through the layers, while other wavelengths of light are reflected back as individual colours. These are the rainbow colours we see as we move an iridescent shell around. Iridescent shells tend to produce shades of green, blue and purple, rather than pink red and yellow.