

Analysis of Myanmar golden-lipped cultured pearls using X-ray radiography, EDXRF, UV-Vis-NIR and Raman spectroscopy

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Introduction

Myanmar golden-lipped pearl oysters (*Pinctada maxima*) are well-known to be found at the Myeik Archipelago - formerly also known as Mergui Archipelago - in the Andaman Sea in southern Myanmar (Tint Tun 1998; Strack 2006). One of the authors (TTS) visited there a pearl farm on February 2020 just before COVID-19 hit the world. The pearl farm is a joint venture between Myanmar Pearl Fishing & Culture Syndicate (government owned) and the South Sea Pearl Co. The farm is situated at Pa Lel Kyun (formerly known as Sir J. Malcolm island) about 70 nautical miles south-west of the city of Myeik (Tay et al, 2021). According to Myanmar Pearl Enterprise, about 1.3 million cultured pearls were produced that weighed 764,151 momme (about 2.8 t) in the two years period from 2019 to 2020 (Sze Man, 2018, 2019; Sto. Domingo, 2020).

The mollusc used for pearl cultivation is *Pinctada maxima*. From growing the spats either in the sea or the modern hatchery station, to eventually allowing the spat to grow to a size suitable for culturing (at sea) takes about 18 months. When the mollusc is about 12 cm in size, it is then implanted with a spherical bead nucleus of 4.5-7.0 mm size. It takes then another two years before the cultured pearl is harvested from the mollusc.

Figure 1: (a) Myanmar golden-lipped cultured pearls with *Pinctada maxima* shell (photo by Tay Thye Sun). (b) the colour of seven selected Myanmar cultured pearls ranges from yellow to light yellow and slightly cream, with their shape ranging from round to off rounded. In size these selected pearls range from 9 mm to 14 mm (photo by Michael S. Krzemnicki).



The author (TTS) bought seven cultured pearls from the pearl supplier at Myeik for further research. Their size ranges from 9 to 14 mm, and colour from yellow, light yellow to slightly cream. Besides basic gemmological methods such as binocular microscope, further analysis using x-ray radiography, UV-Vis-NIR reflectometry and EDXRF were applied to characterise these cultured pearls.

Gemmological investigation:

X-ray radiography of these seven samples confirms that they all are bead nucleated. Interestingly, the nacre overgrowth in these samples varies considerably in thickness from about 0.5 mm to about 3 mm with an average of about 2 mm (Fig.2). This may indicate that harvesting was done after different growth time in the mollusc (e.g. 1 to 3 years) apart from individual differences in nacre accumulation rates in individual molluscs. Chemical analyses with

EDXRF revealed a chemical composition typical for saltwater (cultured) pearls, consisting nearly entirely of CaCO₃ with only traces of Mn and Sr. All seven cultured pearl samples were examined in reflectivity mode using a UV-vis-NIR spectrophotometer. The reflectance spectra show an increasing reflectivity in the 330-450nm range (Fig.3), thus indicating that the yellow colour of these cultured pearls from *Pinctada maxima* is natural (Elen, 2001, Karampelas 2012). This was further confirmed using Raman spectroscopy (using a 514 nm argon laser) where small broad natural pigment-related Raman bands were commonly observed in *Pinctada maxima* apart from distinct peaks related to aragonite (nacre). In addition, X-ray micro-tomography was applied on all seven bead cultured pearls to further characterise their internal structure, specifically also to confirm that the spherical beads were cut from a (freshwater) shell showing parallel nacre layering.

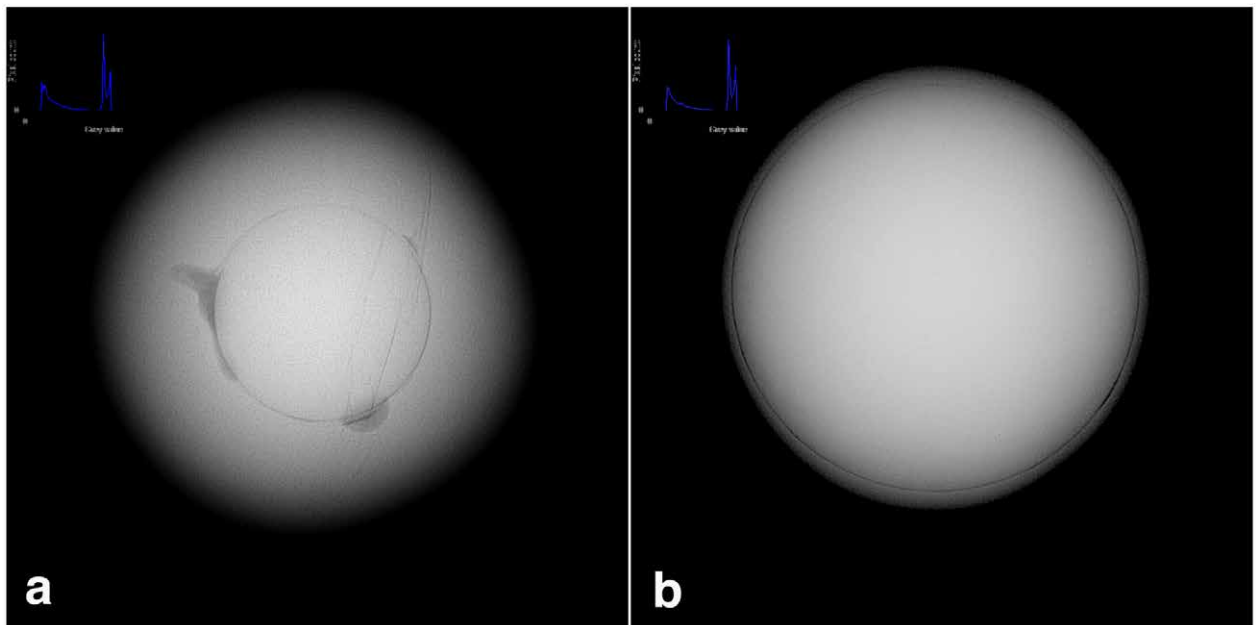


Fig.2. Radiographies of Myanmar golden lipped cultured pearls: (a) 3 mm thick nacreous layer, (b) 0.5 mm thick nacreous layer. (Radiography by Gina Brombach, SSEF).

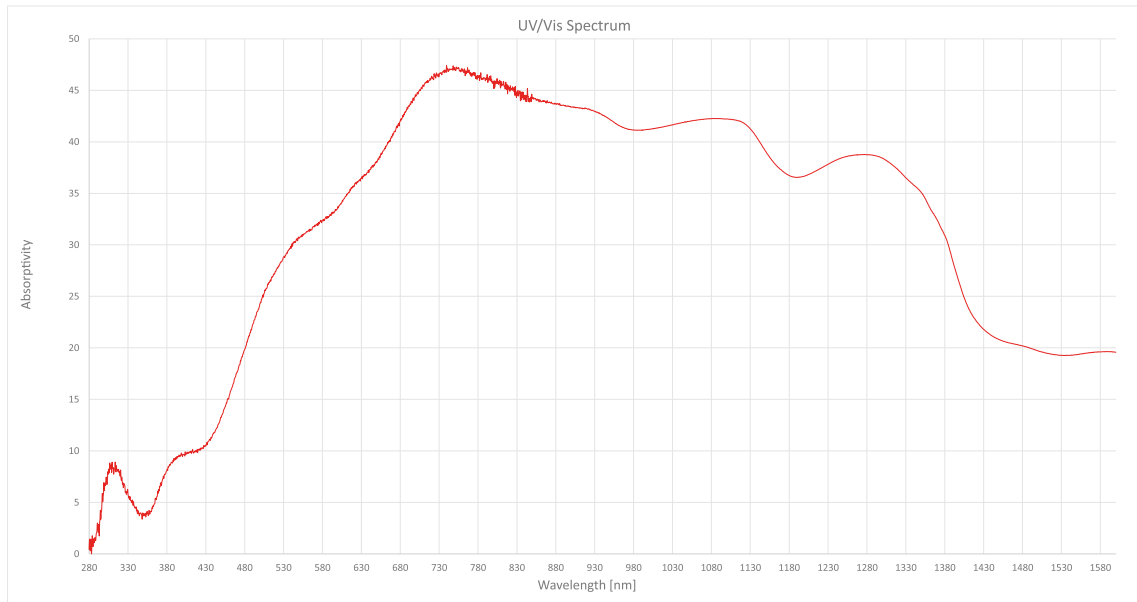


Fig.3. Reflectance spectrum of a Myanmar golden-lipped cultured pearl (*Pinctada maxima*) shows an increased absorption in the 330-450 nm range, an indication of natural colour (Spectrum by Gina Brombach, SSEF).

Conclusions

The Pa Lel Kyun (or “Pearl island”) in Myanmar has been producing golden-lipped cultured pearls since 1954. Seven cultured pearls were analysed and our findings using advanced instruments on a selection of this production confirm that these pearls are indeed “classic” bead-nucleated, saltwater cultured pearls, with a natural yellow colour.

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