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A shell garniture from Gujarat, India in the British Museum

Barbara Wills, Susan La Niece, Bet McLeod and Caroline Cartwright

Summary This garniture – or set of paired and single display items – from the collections at the British Museum comprises a pair of candlesticks, a pair of ewers, a large basin and a bottle. It is made from shaped plaques of the marine gastropod *Turbo marmoratus* L. (green turban shell) with small inserts of two other marine shells, the gastropod *Trochus (Tectus) niloticus* L. (button shell) and the bivalve *Pinctada margaritifera* L. (pearl oyster). Garnitures and individual items of this type were made from the late sixteenth century in Gujarat, western India, to Portuguese order for export to Europe and possibly also for the Jesuit missionary market throughout Asia.

The available literature describes the expected method of construction as being, for the larger items, either shell plaques pinned to a wooden substrate, or a double-walled technique of shell plaques alone. The initial simple visual examination had shown transmitted light visible through the walls of the ewers, candlesticks and all but the very centre of the basin. Thin plaques of mother of pearl shell may be translucent, but a wooden core does not permit light to pass through. To identify the method of construction, X-radiography and X-ray fluorescence analysis were employed. A skeleton of brass bands was found between the inner and outer walls of the vessels. A dense material, possibly a metal plate, was seen at the domed centre of the basin. Other than the body of the bottle, it became evident that all pieces are made of a mosaic of precisely shaped and closely associated small mother of pearl shell plaques held together with pins and an adhesive over a sub-structure of metal bands.

Various phases of repair and intervention were observed and noted. Conservation treatment for display was straightforward; a simple method was developed to reveal the particular qualities of the iridescent shell. Recommendations for care of objects made from shell materials on display and in storage are given.

INTRODUCTION

In October 2005 a garniture of items made from green turban shell was placed on public exhibition at the British Museum. It forms part of a display that addresses issues relating to European trade and discoveries in the seventeenth and eighteenth centuries, as illustrated by the Museum's collection. The garniture, first published and illustrated in 2006, comprises a bottle (OA+ 2642), a basin (OA+ 2644), a pair of candlesticks (OA+ 2643,1–2) and a pair of ewers (OA+ 2645,1–2), Figure 1 [1].

At 15 cm, the green turban shell (*Turbo marmoratus* L.) is the largest of the turban shells belonging to the Turbinidae family. *Turbo marmoratus* occurs in warm waters, particularly around coral reefs in the Indo-Pacific region, in conjunction with other *Turbo* species such as *T. argyrostromus* (silver mouth turban) and *T. petholatus* (tapestry turban). It has long been exploited commercially to provide mother of pearl for making buttons, beads, jewellery and decorative inlay on wooden or lacquered furniture. It has been reported that large quantities of these materials were traded, for example the 100–150 tons of *T. marmoratus* and 400–500 tons of *Trochus niloticus* fished annually from around the Andaman and Nicobar Islands [2]. The spire of *T. marmoratus* is small in relation to its widely expanded body whorl that is dull green with brown blotches. The periostracum (a hard outer covering layer) can be rubbed away to reveal the pearly inner layer. It is significant to note that this modification has obviously been carried out on the green turban shell used in the garniture. It is not the only *Turbo* species which can be modified in this way – the South African turban (*Turbo sarmaticus*) is covered with a thick red periostracum which, when rubbed down, also reveals a nacreous inner layer. Most *Turbo* species show a thick

FIGURE 1. The shell garniture with the basin centre back and the bottle centre front, flanked by the pair of candlesticks and the two ewers

pearly aperture; that of *T. marmoratus* often has a golden appearance, although the iridescent qualities of mother of pearl on any shell result in the presence of very variable colours.

Mother of pearl or nacre is the smooth, shiny, iridescent inner layer of the shell present in some marine and freshwater bivalves and gastropods including oysters, mussels, abalone, topshells and nautilus. Around 95% of the material is composed of thin platelets of aragonite – calcium carbonate ($CaCO_3$) crystals – arranged in parallel lamina (see Figure 4 on page 46 of this *Bulletin*), separated by sheets of an organic matrix composed mainly of proteins and polysaccharides that make up the remaining 5% [3]. Nacre exhibits an interlocked layered 'brick-and-mortar' structure where the bricks are the aragonitic calcium carbonate and the mortar is the organic phase [4, 5]. Nacre is secreted by the epithelial cells of the mantle tissue of these molluscs not only to create a smooth surface to the shell but also as a defence against parasites and detrital particles, hence the process of pearl formation.

The history of the manufacture and collecting of such items as this garniture has been well researched in recent years, thanks to three major international exhibitions and their accompanying catalogues, which have dealt with European contact with Asia and European collecting of the exotic [6–9]. The provenance of the Museum's garniture remains unknown, as are the precise details of its acquisition by the Museum: the registration number has as its prefix 'OA+' for 'Oriental Acquisitions' rather than the standard year of registration. Each piece is inscribed on the underside in ink 'FB', possibly for 'Franks Bequest'. If so, it may suggest that the garniture was acquired by Sir Augustus Wollaston Franks (1826–1897), the influential Keeper of British and Medieval Antiquities (1851–1897), a great collector of the exotic and a renowned benefactor of the Museum.

In summary, the establishment of the Portuguese trading empire throughout Asia from the early sixteenth century brought an unprecedented flow of exotic goods to Europe. Transhipped via Lisbon, such rare materials as tortoiseshell, marine shell, seeds and nuts were highly valued, both in their raw state and as manufactured items made expressly for the European market. Exotic and costly garnitures were commissioned by the Portuguese as magnificent display pieces and were dispatched to Europe as well as being used throughout the Portuguese Empire. Jesuit missionaries also played a significant political and artistic role in the Portuguese settlements throughout India and Asia, and the Church commissioned liturgical furnishings from local craftsmen. There is some conjecture that garnitures such as these may have served as altar sets, but it has not been possible to verify this.

The archaic English term 'the great green turban snail' probably refers to the attributes of this species – its large size, its marbled green outer surface and its resemblance to the eastern headdress [6–10]. Gujarat in western India had a long craft tradition in the use of shell as a decorative inlay and in the construction of smaller items such as bowls, cups and boxes. The form and scale of items commissioned by the Portuguese generally followed European metal prototypes, as in the ewers, but the influence of Chinese porcelain forms and Mamluk metalwork of the 'Veneto-Saracenic' type was also significant, and can be seen in the basin and candlesticks respectively.

EXAMINATION AND CONSTRUCTION

Although there are a number of similar garnitures and numerous individual pieces in European public and private collections, the exact method of construction of these pieces remains uncertain. Smaller items, such as containers in the form of boxes, cups and bowls are usually described as being constructed in a double-walled technique whereby an inner and an outer wall of shell plaques are secured together by pins. Larger items such as basins, ewers and candlesticks are generally described as being made of a thin wooden substrate to which shell plaques are attached on both sides by pins [7; Nos 24–32 pp.118–131, 10; pp. 36–43]. One of the catalogues for the 2000 *Exotica* exhibition [7] illustrates a pair of candlesticks (No. 24) a ewer (No. 26) and a basin (No. 30) similar to those examined in this paper. A number of other large pieces have, however, been described as of double-walled construction [8; Nos 68–69 pp. 162–164].

The initial visual examination had shown transmitted light visible through the walls of the ewers, candlesticks and all but the very centre of the basin. Thin plaques of mother of pearl shell may be translucent, but a wooden core would not permit light to pass through. This raised the questions of how these large items were made and to what they owe their robustness if a void exists between the shell walls. To elucidate the construction of the Museum's set, X-radiography and X-ray fluorescence (XRF) analysis were carried out.

To examine the interior structures, X-radiography was carried out at 75 kV, 5 mA for three minutes. The film used was Kodak Industrex AA/MX in cassettes with lead filters back and front, Figures 2 to 8. The X-radiographs were scanned using an Agfa RadView digitizer with a 50 μm pixel size and a 12-bit resolution, to allow digital enhancement of the images. To emphasize edges and discontinuities, the images were subject to greyscale manipulation and enhanced using an 'unsharp mask' filter. The results show real features that are faintly detectable in the images prior to enhancement. Some of the images are presented as positives – that is where dense areas appear pale, as on the original X-radiographic film – and others are presented as negatives, where the dense areas appear dark; it was found that more features could be clarified by using both modes.

X-radiography revealed an unexpected skeleton of metal bands, approximately one centimetre in width and three to six centimetres apart, between the inner and outer walls. The X-radiographs indicate that each of the metal bands has a soldered join, the density of which suggests it to be a soft solder of tin and/or lead. The bands are perforated by small holes into which some of the pins are secured, but the majority of the pins fix the inner and outer walls directly together.

The metal components were analysed qualitatively by non-destructive XRF spectrometry. The majority of the pins are silver (alloyed with a little copper), as are the collars around the top of the candlestick sockets. The liner to the rim of the bottle is brass (an alloy of copper with zinc). The metal bands providing hidden support inside the shell facings were, by definition, inaccessible for analysis, but a small portion of the edge of one band supporting the footring of one of the ewers protrudes far enough for qualitative analysis. The metal of this band was identified as brass, and because its X-radiographic opacity is comparable to the other structural bands, it is reasonable to suppose that they are also made of brass.

Other than the bottle, it became evident that all the pieces are made of a mosaic of precisely shaped and closely associated small mother of pearl shell plaques held together with pins and an adhesive over a sub-structure of metal bands. It did not prove possible to identify the original adhesive as the only easily sampled areas appear to be repairs. The side of each item intended for view is made up of a delicate pattern of shaped shell pieces, whereas the less visible side, for example the underside of the basin, is mainly composed of larger, rectangular plates. Close inspection of all the X-radiographs shows the two sides superimposed. Fine detail can be observed, but nothing that might be interpreted as a wooden sub-structure.

THE COMPONENTS OF THE GARNITURE

Basin

The basin (OA+ 2644; Figures 2 and 3) has a diameter of 440 mm. The central dome is decorated with geometric and lappet-shaped plaques, while the interior of the basin is composed of shaped plaques forming a radiating petal motif. This radiating pattern of shaped plaques continues to the edge of the basin where it curves upward to meet the outer rim. The curved sides and flared outer rim are made up of rectangular plaques, as is the underneath of the basin. The underneath of the basin is composed of rectangular plaques of *T. marmoratus* shell. Around the outer edge of the rim and similarly at the outer surface of the basin where it curves to meet the rim are inserts of *P. margaritifera* (L.) (pearl oyster) and *Trochus (Tectus) niloticus* L. (button shell). It is possible that these are reused plaques or offcuts, employed to edge the rim and in less visible areas.

X-radiography shows five concentric metal bands inside the walls of the basin, Figure 2. The bowl of the basin appears denser than the rim; where the plaques are thinner, light can be seen through both areas. Although of the same overall thickness as the rest of the bowl, the centre of the domed area is noticeably denser (Figure 3) and does not transmit light. The internal textural pattern of the dome, revealed by X-radiography, cannot easily be identified as wood grain, and its density suggests it may be metal. There is a small hole in the centre of the dome, which may suggest that a device such as a compass might have been used to set out the design, or that the basin was assembled on a lathe. This hole may once have been filled with a small circular shell plaque, known from other basins and the interior of the bases of the ewers studied here.

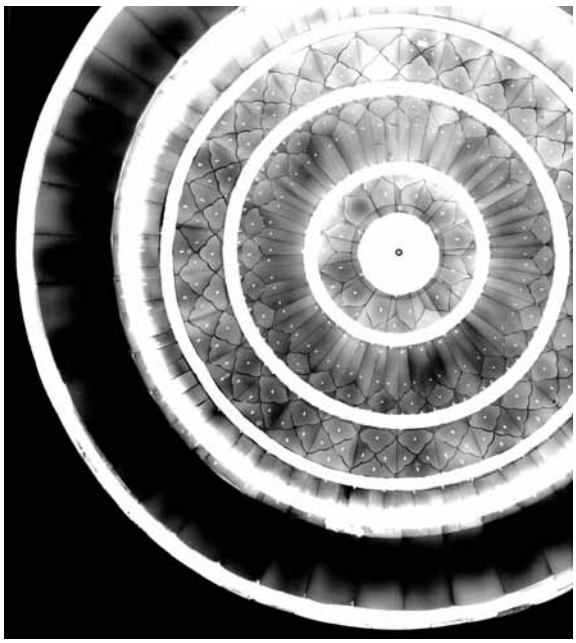

FIGURE 2. X-radiograph (positive image) of the basin, OA+ 2644. The lightest areas are the densest: the concentric rings are metal reinforcing bands and the white spots are silver pins. The shell plaques forming the rim appear darker because they are thinner. The edges of the finely shaped plaques on the front can be seen overlaid on the larger, rectangular plaques on the underside of the bowl

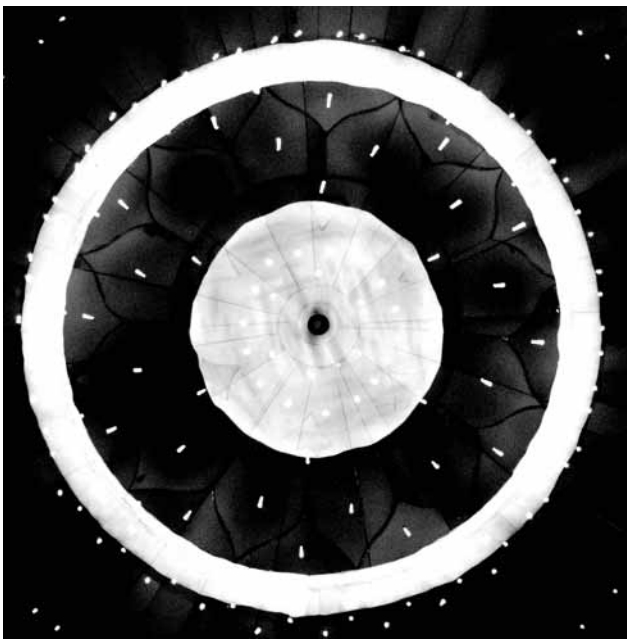

FIGURE 3. Detail of Figure 2, showing the centre of the dome in the middle of the basin framed by the innermost metal band. This dense feature is approximately 4.5 cm in diameter. In this zone, the edges of the plaques appear as grey lines, centreing on the hole (black), and the pins appear as diffuse white dots. There is a smeared texture (light grey) to this area, which gives it a slightly different appearance to the metal band but does not resemble wood grain

FIGURE 4. X-radiograph (negative image) of a ewer. The darkest areas are the densest: note the reinforcing bands. The concave shape just above the rim of the foot is a valve of a *P. margaritifera* shell

There is no evidence of wear on the interior of the basin, although some of the plaques around the outer rim show signs of damage and subsequent repair. There are small rectangular patches to some plaques, perhaps concealing imperfections in the shell. These are very neatly executed and it seems likely they were made before the plaques were built into the basin.

A number of basins were fitted with European mounts of the seventeenth century onwards. These mounts, which are more or less elaborate depending on the patron, tend to be around the rims [7; No. 25 pp. 120–122, 10; No. 13 p. 42]. In the set under examination, an internal brass band is fitted at the junction of the bowl and the rim. This feature would allow the outer rim to be removed from the brass band without compromising or damaging the remainder of the basin. It may perhaps explain how European goldsmiths could remove the outer rim and substitute gold or silver-gilt mounts to the remainder of the basin, or attach mounts over the rim itself.

Ewers

The two ewers (OA+ 2645.1–2; Figure 4) are *c.* 250 mm high; each rises from a pedestal foot and has a curved spout and scrolled handle. The exterior plaques of the body are shaped and arranged in a lozenge pattern above lappets. All the remaining plaques on each ewer are rectangular. One ewer has two parallel lines incised around the bottom rim of the body. The interior plaques of each body are also rectangular, but the plaques forming the bottom of the body are of geometric shape and are arranged in a petal motif around a central disc. The scrolled handles were probably originally fitted with a ball finial, known from other examples. One handle is now fitted with a small replacement piece of shell where a finial may have been, while the other handle has been extensively remodelled with replacement plaques. The body of each ewer has been cut away where the spout has been fitted. Although the ewers are fully functioning pouring vessels, there is no evidence of wear or staining caused by liquid. Underneath the foot of each ewer, a valve of a *P. margaritifera* shell is fitted, which may act as a strengthening device. Each ewer has five metal bands to reinforce the vessel and three further bands inside the foot, Figure 4. The band at the edge of the foot protrudes sufficiently to allow its identification as brass by XRF analysis. Holes in the bands, which are not filled with pins, are noticeable at the rim and base, suggesting later repairs to these vulnerable extremities.

Candlesticks

Each candlestick (OA+ 2643.1–2; Figures 5 and 6) rises to a height of 215 mm from a spreading foot and drum base. The plaques on each drum base are shaped and arranged in a lozenge pattern above lappets, while the remaining plaques are rectangular in form. The bulb-shaped socket is fitted with a silver rim. One particularly fine detail of the candlesticks, which appears original, is the infilling of tiny holes (presumably the result of infestation in the original marine environment) with shell inserts.

FIGURE 5. X-radiograph (negative image) of candlestick OA+ 2643. Note the patchy areas on the base (bottom left) and on the neck just below the candle socket. These appear to be a denser adhesive, perhaps indicative of a repair

FIGURE 6. X-radiograph (negative image) of candlestick OA+ 2644 taken from above showing an area of patchy adhesive on the flared base, similar to that on the other candlestick. The dark circle in the centre is the candle socket, and the dark ring around this is the wall of the base seen from above. Note that the candlestick has been constructed slightly off-centre

The X-radiograph shows the internal brass bands and also reveals a slightly denser uneven feature, perhaps an adhesive layer, in one part of the base of both candlesticks, Figure 5. A similar patchy layer can be seen in Figure 6, just below the candle socket. These patches may indicate repairs.

FIGURE 7. X-radiograph (negative image) of the bottle, OA+ 2642. The pins are very long and the construction appears comparatively crude

FIGURE 8. Detail of the neck from Figure 7, enlarged and enhanced using an 'unsharp mask' filter. The strainer is the not-quite parallel feature across the centre of the neck. There is a decorative brass collar inside the rim of the neck and an internal metal band joining the body of the bottle to the neck concealed beneath a band of shell at the base of the neck

Bottle

The bottle (OA+ 2642; Figures 7 and 8) is 280 mm high and is of a different type of construction to the other elements of the garniture. It is composed of two complete shells of *T. marmoratus* with a funnel-shaped neck and a circular spreading foot of double-walled construction attached by pins, Figure 7. The neck is formed of two sections; the upper, which has a rim of rectangular plaques, fits into the lower, Figure 8. Where the lower section joins the body is a collar comprising bands of petal-shaped plaques, while a strip of rectangular plaques masks the junction between the two shells. The rectangular plaques at the foot rim and where the foot meets the body are incised with two parallel lines. A pierced disc with a foliate pattern, which may act as a strainer, is fixed part way down the neck. This disc blocks any view into the interior of the bottle, but the X-radiograph shows long pins protruding into the cavity. There is an internal metal band at the base of the foot and another where the foot joins the bottle. The same arrangement is seen at the neck, but otherwise the body of the bottle owes its rigidity to the complete shells.

The bottle shows much marine infestation with clusters of bored holes in both the large shells that make up the body of the vessel; mother of pearl plaques shaped in the form of trees, fish or flowers cover some of the worst damage. The bottle is constructed much more crudely than the other pieces of the garniture. The foot and neck elements and the plain joining strips are made from *P. margaritifera* and have relatively few pins.

CONDITION AND TREATMENT

Structurally, all the pieces of the garniture were stable and sound. A layer of dust on the upper surfaces rendered these dull. There were a number of small solid droplets and 'fingerprints' of adhesive/filler on some surfaces, which appeared to result from handling with glue-laden fingers, presumably during an earlier repair campaign. The visible areas of metal were stable, but had tarnished in places to black, grey or brown.

It became clear on examination that the set had undergone at least two phases of repair. This was evident from the different colours of adhesive/cement used; the absence of pins, or unusual pins that do not conform to the general pattern in size and position; and in the use of the bivalve *P. margaritifera*.

It was also apparent that the paired objects did not fully match. For example, the height of the ewers differs slightly and one candlestick shows carved banding that is absent on its pair. Some differences appear original and may be attributed to different hands or practice in a workshop, while other differences probably result from later repair.

The excess 'fingerprint' adhesive was removed using a 50/50 (v/v) mixture of de-ionized water and industrial

methylated spirit, applied to the surface using moistened cotton wool swabs wound on a bamboo stick. Gentle polishing removed the most superficial of the fingerprints. Careful paring down with a small scalpel under magnification reduced the thicker, more resistant, droplets of glue/filler until these too could be polished away.

All the mother of pearl surfaces were cleaned using cotton wool swabs moistened with de-ionized water, polishing lightly to dry with a soft cotton cloth, a process that enhanced the spectacular iridescent colours. The metal mounts and pins were left as found.

FUTURE STORAGE AND DISPLAY

The routine assessment of materials used inside showcases at the British Museum, including fabrics, mounting boards, adhesives, sealants and paints, has been carried out since 1973 [11]. Organic acids have long been known to cause the corrosion of lead, but they can also have an adverse effect on other metals and react with materials such as calcium carbonate. In their presence, shell-based materials may be subject to a damaging efflorescence comprising calcium ethanoate hemihydrate ($Ca(CH_3CO_2)_2 \cdot ½H_2O$), and calcium methanoate ($Ca(HCO_2)_2$), more commonly known as Byne's disease [12]. No evidence of Byne's disease was found on the garniture, and the cleaning method would have reduced any incipient salts. Given the possibility of the objects developing Byne's disease in the future, it is important to avoid storage or display of shell material in conjunction with wood or other materials that may emit volatile acids. Decay is exacerbated by high relative humidity (RH) and elevated temperatures. Conditions that favour the preservation of the shell material would also generally benefit the metal components.

The ambient RH and temperature in the gallery in which the garniture was to be displayed showed some fluctuation in 2006, but the range of conditions noted (30–50% RH and 15–20°C) is adequate, if not ideal, for all the material on display. The nature of the display, focusing on the impact of trade and travel in seventeenth-century Europe, necessitates organic material being shown in the same case as metal and ceramic material; the case will be monitored for any negative interactions.

Recommendations for storage of shell material

Shell material should be stored in archival quality materials that do not emit organic acid vapours. The RH should be kept stable and low, ideally at less than 50% with a daily variation of no more than ±5%, and the temperature reasonably low (16–20°C). It would be advantageous if the gaseous pollutants were removed from the environment, or alternatively scavenger materials placed in the storage boxes. There has been little research undertaken on the effects of light, although it would seem reasonable that high light levels and ultraviolet radiation might eventually constitute a danger to the organic components of the shell.

CONCLUSIONS

This study has discovered that there is a skeleton of brass bands between the inner and outer layers of shell mosaic, providing structural support. There is no evidence for a wooden substrate to the shell mosaic on the ewers, candlesticks and bottle. The central domed part of the basin is dense but is unlikely to be made of wood; the X-radiographic density and the shaped form more closely resemble the metal bands. The vessels were constructed of two layers of shell plaques, joined by silver pins and adhesive, with the hidden metal bands providing strength and stability. It might be envisaged that this structure was built up in stages, with the interior and exterior shell plaques being applied in overlapping rather than in parallel units.

Without further examination of other garnitures, it is impossible to determine whether the Museum's set is unique in its manufacture. Other sets have been described as having brass pins: it may be that the Museum's set is indeed unusual in having silver pins. Individual items and garnitures would have been subject to alteration over the course of time, for example by the addition of mounts for the European market, or by restoration and repair following damage or losses. It seems highly probable, though, that the specialist Gujarati workshops producing these goods had by the late sixteenth century developed the most efficient and stable methods of construction for large-scale production and that at least some of the features seen here, in particular the internal skeleton of metal bands, are characteristic of other sets.

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AUTHORS

Barbara Wills (bwills@thebritishmuseum.ac.uk) is a conservator, Susan La Niece (slaniece@thebritishmuseum.ac.uk) and Caroline Cartwright (ccartwright@thebritishmuseum.ac.uk) are scientists and Bet McLeod (bmcleod@thebritishmuseum.ac.uk) a curator at the British Museum.

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