The Mombasa Wreck Excavation
A 17th-Century 
Portuguese East Indiaman: 
the *Santo António de Tanna*

During field seasons held between 1976 and 1981, the Institute of Nautical Archaeology and the National Museums of Kenya jointly excavated a shipwreck in the Old Harbor of Mombasa, Kenya. The wreck has been identified as that of a Portuguese East Indiaman, the *Santo António de Tanna*, which sank in 1697.

Archival research has shown that this vessel was built at Bassein, near Goa on the west coast of India, and commissioned in 1681. In 1696 she was sent out to the relief of the Portuguese stronghold, Fort Jesus, in Mombasa on the East African coast. The fortress was besieged by an Arab force from Oman. After several attempts to supply and relieve the fort the *Santo António de Tanna* was sunk, disastrously for the Portuguese who could ill afford the loss of either Fort Jesus or the *Santo António de Tanna*.

Conservation has continued in Fort Jesus since excavation ceased, and a number of studies of the artifacts have been made. The armament assemblage and the rigging components have provided material for two master’s degree theses. A preliminary review of the ceramics has been published, and several artifact groups have been described in preliminary papers. As archaeologists have begun work on the final publication of the Mombasa Harbor Wreck it seems suitable to review in this issue of the *INA Newsletter* some of the research completed.

Sponsors for the excavation include INA, the National Museums of Kenya, the Gulbenkian Foundation, the National Geographic Society, and Harry C. Kahn.

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Contributions and queries by members are encouraged.

Photo on page 3: This carved wooden angel (MH 450), approximately 1 meter in length, adorned the stern of the *Santo António de Tanna*. 
The Weapons from the *Santo António de Tanna*

by Alison Darroch

At the time of the sinking of the frigate *Santo António de Tanna* in 1697 the Portuguese were struggling to retain control of their few remaining *factories* (settlements) and the vital sea routes linking these with each other and with Portugal. The glory of the Portuguese discoveries and conquests of the 16th century had given way to a situation in which the Portuguese presence in the Indian Ocean was threatened by the Dutch, Arabs, and the English. At the onset of the siege of Fort Jesus the major part of Portugal’s East Indies fleet was in the Persian Gulf blockading an Arab force, and as a result there were only three frigates and two galliots in Portuguese India. The dispatch of both galliots and two of the frigates to Mombasa was a severe drain on Portuguese resources, and the subsequent loss of the *Santo António de Tanna* was a serious blow indeed.

Contemporary records say that the *Santo António de Tanna* was designed and built as a 42-gun frigate but that she had been upgraded to carry 50 guns by the time of her sinking. Determining the range and type of these guns was one of the primary goals of the armament study.

The *Santo António de Tanna* was actively engaged in battle with Arab forces on the mainland when she sank. Projectiles for the active guns would have been kept close to those guns during battle. It was anticipated, therefore, that the dimensions of the projectiles found around the wreck site would reflect the sizes of guns in use at the time of sinking. Accordingly all shot excavated were measured and mapped. A huge concretion found close to where the shot locker would have been located contained hundreds of projectiles, suggesting that these had been stored in the locker at the time of sinking.

Measurements of the projectiles in the large concretion revealed a wide range of shot size (from 2.5 to 38.5 lbs), a range not reflected in the loose shot found in other locations on the site. The loose shot were found to fall primarily into the 5 to 9 lb range.

The presence of more than a hundred shot of larger sizes in the shot locker concretion suggests that, although the majority of the guns on the *Santo António de Tanna* were probably light, there were certainly some heavy pieces in her gun assemblage. Interestingly there are very few shot for medium range guns. It is not known why so few of the heavier shot were found outside the shot locker location, but it is possible that more of these might have been found around the site if excavation had been completed.

Lack of conservation facilities precluded the raising of three iron guns found on the site, and considerable corrosion products did not allow viable bore dimensions to be taken underwater. The two bronze swivel guns found would have used shot weighing 3.75 lbs or less (fig. 1). A cast of concretion adhering to the swivels of one of these weapons revealed a yoke that would have supported the bronze gun on the gunnel of the frigate (fig. 2). Contemporary records mention that the Arab forces carried out salvage operations on the wreck of the *Santo António de Tanna* and retrieved at least twenty cannon, which would explain why so few guns were found during excavation.

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*Figure 1. A bronze swivel cannon, dated 1678, and breech block recovered from the Mombasa ship.*

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As is often the case in an excavation there were a few artifacts that were not easily identifiable. There were also the inevitable misidentifications as people tried to imagine the uses to which unfamiliar objects could have been put. Some little wooden flasks were first identified as ink pots, mainly because they were filled with a black liquid that stained everything it touched; however, someone soon connected these finely-turned little containers with the elaborately decorated wood and silver powder flasks in a display of Arab weapons in the Fort Jesus museum (fig. 3). All guns of this period required a powder charge, and soldiers carried a number of small wooden flasks, each filled with the requisite amount of powder, to allow them to reload as quickly as possible. As can be seen from the photograph, the design of the flasks differed very little regardless of who was using and manufacturing them although the decoration was quite varied.

The identification of some truncated wooden cones like the one illustrated in figure 4 (at right) is still not certain. Initially it was thought they were to be used to plug holes made if the ship’s hull was pierced by a cannon shot, then a reference in a 17th-century gunnery manual led me to believe that they were cartridge molds. Cartridges were made from canvas or heavy paper which was wrapped around a wooden mold of a size specific to the cannon for which the cartridges were to be used. The mold was then withdrawn and the paper or canvas cartridge filled with gunpowder. At sea, cartridges were often used in preference to ladles for charging the guns as it was considered safer to have the gunpowder contained rather than loose in a ladle. But molds were normally cylindrical not conical and had a handle to allow them to be easily withdrawn from the paper cartridge. Jeremy Green of the Western Australian Maritime Museum has found a reference to tapered cartridge molds (albeit with handles) in what he describes as a very obscure Dutch gunnery manual written in the late 17th century. The caption for the illustration in the manual describes these as molds for guns with tapered chambers.

The bronze barrel shown in figure 5 was first identified by Robin Piercy as a blunderbuss barrel. Then two articles appeared in the *International Journal of Nautical Archaeology* (IJNA) in 1984 (13.1:76-77 and 13.3:243) dealing with a barrel found on the wreck of the 17th-century Association. This barrel is very similar to the one found on the *Santo António de Tanna*. In the first article the barrel was identified as belonging to a late 15th-century hand-cannon. The second article produced further evidence suggesting that the barrel was actually that of a musketoon, a weapon similar to a blunderbuss with an iron breech block. These guns were introduced to the British navy in the second half of the 17th century and were a regular part of a ship’s armament. They fired a heavy charge of large shot and were used for
Research in India Provides Clues

by Jean-Yves Blot

A search for information dealing specifically with the building of a vessel in a remote Portuguese colony of the west Indian coast back in the 1680s will sound familiar to any blind hunter who ever fired at a partridge hidden in a corn field. Historical investigation usually proceeds the other way, gathering its data along a wide spectrum and narrowing its search according to the potential revealed by the documentation examined. Only then are specific sources cultivated and explored. Fortunately I was still missing that kind of knowledge when discussing with project director Robin Piercy my plans to search in India for the "fragata nova," until the full "fragata nova feita em Bassein por nome S' 0 A• de Tanna" appeared in a document dated from the 12th of September 1681.

The whole mission in India was to last only a few weeks, and before leaving the country we decided to complete the stay with a trip to the former Portuguese province where the ship had been built. After seeing the rich wooden carvings recovered from the "fragata nova" in Mombasa, we were particularly interested in finding any survival of Portuguese artistic and naval techniques in the Bassein area. Anything seemed possible in India where the visitor interested in the past is struck by the physical dimension of the historical heritage. Even modern aluminum containers on sale at the Mapusa market, north of Panjim, echoed the shape of old ceramic jars and reminded us of some forms recovered from...
the Mombasa wreck.

Taken from the Portuguese by the Mahrats in the late 1730s, Bassein today remains surprisingly untouched. With a fortified wall many miles long facing the sea to the west, the former Portuguese site (now called Bassein Port) lies several miles away from the Indian town of Vasai Road. Abandoned monuments, churches and dark stone convents open to the sky. Ruias were everywhere, brought alive by the colorful dresses of Indian women from a nearby village carrying water in copper containers high on their heads. But besides numerous tombstones lying flat on the ground and abundant Portuguese inscriptions, no sign could be found echoing the riches of the Mombasa wreck's wooden sculptures. Bassein was prized by the Portuguese for its proximity to rich teak forests, and a native did point them out to us somewhere near the foot of mountains low on the horizon to the east; but where had been the shipyards in Portuguese times? The nearest one in 1984, a tiny but busy one, was several miles away from the fortifications, and while providing a surprising time-travel with pure shell-first boatbuilding techniques, no sign of any Portuguese naval techniques seemed to be left there.

The crowded city of Tanna itself, far away from the ruins of Bassein, had still less to show for its links with the Portuguese past. It was market day in Tanna, but no maps were available in town, and no one seemed able to converse in English. We searched the city for a river of some kind in order to evaluate the watery communication linking Tanna to the Bassein area and to determine if the Santo António de Tanna could have been built in Tanna at all, but most of the time we could not figure out where we were among the maze of recently dried waterways of the area. We were, as far as we understood later, in the eastern part of Salsete Island, a few dozen miles north of Bombay.

Back in Panjim, the old archives delivered a last clue: the Santo António de Tanna, once afloat, had been towed down to Goa as a pontoon and fitted at Goan shipyards on the river. Situated a few miles inland and away from the modern town of Panjim, Old Goa, with its many churches and ruins, remains a massive testimony to Portuguese colonial architecture. While exploring one of the churches, São Francisco de Assis, by the river, we were struck by the figure of a carved wooden angel standing in the shadows above an altar. The intriguing part was the angel's dress, or better, a tiny detail of the lower part of the dress. Robin Piercy had provided us with many documents showing the major artifacts recovered from the Mombasa wreck. One of them was a carved cherubim (MH 450), one of the wooden sculptures originally nailed to the stem part of the vessel, near the gallery of the officers' quarters (see the photograph on page 3). The cherubim wore a long dress very similar in design to the one observed in the Old Goa church.

A look at the history of the church revealed that the building was under full restoration at the time our vessel was completed in the river nearby. This was when the Santo António de Tanna was towed behind another vessel up the river to Goa. Checking one step further, we found that the royal shipyards at that time were located in the immediate vicinity of the old town, in fact a few minutes away from the church where we had seen the carved wooden angel.

In Lisbon sometime later, while the Goa documents were being translated and a report was under way, an auction of old books was held. I had been sent by the director of the Lisbon national museum of archaeology to select titles for the museum's library. The only title I was personally interested in was a unique, beautifully illustrated book printed in the 1950s containing a detailed map of Bassein's Portuguese ruins, with the name of every cavalheiro quoted on Bassein's tombstones. Every bastion
of the Bassein outer wall was there too. The book was the Portuguese version of an English manuscript sent from Bombay by an amateur historian of Portuguese ancestry. The Indian researcher had carefully surveyed the whole ancient Bassein area, stone by stone. At the Lisbon auction nobody seemed to care about a former Asian colony lost after a fierce fight 250 years ago. I had never raised my arm at an auction before, a gesture costing only a few dollars in this case, but enough to claim the book. Inside was the clue to the building place of our frigate. It was there that we finally understood a detail already spotted elsewhere in the old Portuguese colonial iconography: the Bassein shipyards, on the southern part of the walls. All we had to do now to identify the place was to count the southern bastions on the book’s map. Sheer luck had driven us months earlier to take a photograph of that precise area while visiting Bassein’s fortifications. On that spot, a few yards away from the wall in a freshly dug hole, Chinese porcelain fragments were lying in the sun.

Facing the water, their back to the great dark wall, the old Bassein shipyards, most likely the Santo António de Tanna’s birthplace and untouched since the early 1700s, wait to be excavated. A dry land job.

Hull Recording Methods
Used at Mombasa

by Jeremy Green

The hull structure of the Santo António de Tanna was recorded over a number of seasons as methods and techniques gradually evolved to take into account the orientation of the wreck, which lay on a slope and was canted to port. Essentially three types of records were made: photogrammetric, profiles, and trilateration.

Photogrammetric recording

The whole of the inside structure was recorded by 35 mm black and white photographs. An underwater Nikonos 15 mm lens, which is extremely accurate and distortion free, was used. At times visibility on the site was exceptionally good, greater than 10 m, particularly at high water spring tides, but more often the conditions made photography almost impossi-

A photomosaic of the site made from several overlapping photos shows hull remains from the wreck’s bow.

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ble, requiring team members to time work carefully to coincide with optimum conditions.

In most cases the photographs were made in stereo pairs, with two cameras mounted on a stereo bar and attached to a photo tower. A 2-meter grid frame graduated with black and white marks at 200 mm intervals formed the base of the tower. The cameras were accurately aligned on the stereo bar and then leveled in relation to the grid frame. Thus the grid frame, which appears in each photograph, could be used to establish orientation control if necessary.

The site was recorded by moving the grid frame across the wreck in a systematic manner and taking the stereo pairs at measured intervals. One side of the stereo run was then used to lay up a photomosaic. This served as an extremely useful tool for recording the site in a fairly detailed manner and could be used during the excavation as a method for describing the site and the progress of the excavation. The photographs were also used to examine the wreck in stereo using a stereoscope, which proved to be helpful in site interpretation.

It was intended that the stereo photographs could be used to produce an accurate three-dimensional map of the site, but there was a problem in the recording method. The stereo tower could either be placed flat on the site or it could be leveled. Using a leveled tower makes it easier to relate the site plans to a common datum, but on a wreck like the one at Mombasa, where there is extreme curvature on the site, there are problems using leveled photographs. The extreme curvature means that gradually the projection disappears, and there is almost nothing to photograph in the horizontal plane. A solution to this problem is to make a series of stereo pairs that are leveled relative to the ship structure. This approach produces a series of plans related to randomly orientated planes. It is then necessary to reduce each datum to a common plane. This latter approach is more difficult to implement but produces a more useful result.

Profiles

Some of the most important information to be obtained from a ship site is the shape of the hull since this can provide information on the theoretical considerations that went into the building of the ship. Because so much of the Santo Antônio de Tanna was preserved it was possible to attempt to reconstruct her lines. A series of profiles were made across the wreck using a simple profiling device which consisted of a bar, about 2 m long, that could be clamped to the keelson. On the top of the bar a large circular protractor, about 750 mm in diameter, was mounted. This was used in conjunction with a tape measure to take the profiles at 1 meter intervals along the ship’s keelson. The operators measured the distance and angle for particular points on the profile across the width of the wreck. The tape operator would take the working end of the tape measure from the keelson to points, usually plank joints, and measure the distance from the origin of the protractor. The protractor operator then recorded the angle at which that measurement was taken. This was a rather cumbersome method of recording, particularly as the records had to be reconciled carefully to ensure that the measurements did not get out of step with each other. Additionally, the two operators had to be able to signal each other to ensure that both readings were taken simultaneously. At times this was difficult because visibility was poor and the operators could not see each other. As a result, a system of signals had to be devised.

On the whole, the system was simple and reasonably accurate considering the circumstances. The coordinates were calculated using a small programmable calculator and then plotted on graph paper.

Trilateration

It was appreciated at the time of the survey of the wreck that some form of accurate control of the photography on the site would be necessary. A series of control points were arranged along the keelson and at the periphery of the site. The distances between these points were measured to build up an accurate control network. At the time of the survey there was no trilateration program that could handle the resulting information.

Recent research on the data

When the original survey work was carried out between 1977 and 1980, computers were not available, nor was the sophisticated software that is currently available for small but powerful PCs. A particularly useful program, developed in Western Australia, is a line drawing program called Mac Surf (available for the Macintosh range of PCs). In this program, continued on page 31
Reconstructing the Rigging Elements

by Bruce F. Thompson

It is truly ironic that the Portuguese, often cited as the provocateurs of the great Age of Discovery, should have left us with so little information about the ships that carried them through both the early exploratory period and the later empire years. The Mombasa Harbor Wreck (MHW), replete with hull remains and rigging components, and now identified as the Portuguese frigate Santo António de Tanna, offers a rare glimpse into the construction techniques and rigging practices of 17th-century Portuguese shipwrights and riggers. A good deal of the lower hull survived the centuries underwater, and 246 rigging objects were recovered.

We know from historical sources that the Santo António de Tanna was a 42-gun warship upgraded to 50 guns at the time of her last departure from India. The fact that she could accommodate so many extra guns may have been due partly to extra deck space, and to a greater extent to the use of smaller guns. The following hull reconstruction efforts set the basis for understanding the Mombasa ship’s rigging features. Basic criteria chosen in reconstructing the hull shapes of shipwrecks include length of keel, deck beam size, depth-inhold, tons burden, and gunport locations. Since excavations under the hull were never completed we can only estimate the

Figure 1. Deck knee positions are critical in developing a working hull shape for reconstructing the standing rigging. At left, a plan of the Mombasa wreck appears above a proposed reconstruction of the ship’s general hull shape and gunport placements, which in turn provide clues to the placement of rigging elements.
length of her keel. Probably the most important clues to the Mombasa wreck’s basic hull form are the size and location of fifteen deck knees uncovered on the port side of the vessel (fig. 1). According to Sir Anthony Deane, a 17th-century shipwright for the British navy, deck beams connected to the knees were placed in such a fashion that every other deck beam supported a cannon. This provided space for the gunners to do their job and at the same time allowed proper clearance for the lower gunports and standing rigging chains. This practice is further verified by most cut-away views on ships' plans for 17th-century warships.

By comparing our hull measurements to contemporary sources, excavated 17th-century shipwrecks, and depictions of period vessels, I have been able to produce a possible gunport plan for the *Santo Antônio de Tanna*. When the resulting upper hull shape is compared to the best surviving chain plate and chains, found downslope from the mainmast, major similarities become apparent and a hull profile can be deduced. When the hull remains are compared to the plans of one example in particular, the Danish *Delmanhoest* (recorded in 1707), a pattern of gunport locations emerges. In 1987 Robin Piercy acquired photographs of the *Delmanhoest* plans from the Rigsarkivet Museum in Denmark. These photographs were used as the basis for our gunport locations.

The *Delmanhoest* carried 50 guns and had two gun decks and a quarter deck. She had a keel length of 122 feet, a beam of 37 feet, and depth-in-hold of 16 feet. This vessel was somewhat larger than ours, so the total number of gunport locations had to be reduced for the illustration. Although it cannot be established that the *Santo Antônio de Tanna* would have had exactly the same sheer lines throughout, the gunport placement follows our deck knee pattern very closely.

Upon sinking, the Mombasa Harbor ship settled on an upper ledge, where it began a slow deterioration process. In time it slid off the ledge and down to its present location. Despite the ship’s initially “gentle” deposit on the upper shelf, once the hull slid off and down a 30 degree slope, cannon movements on the decks, masts tearing from their steps, and rigging holding tight at anchor points caused some calamitous changes to the hull. Surviving chain plates are twisted at the bow and stern and bent over at midships.

Standing rigging

The Mombasa Harbor Wreck excavation did not produce masts, yards, or bowsprits but did produce 16 deadeyes, 12 pieces of standing chain, 7 chain plates, 7.08 m of shroud-laid rope, and 8.34 m of hawser-laid rope. These are some of the components which, when joined together, support the masts laterally and longitudinally.

Deadeyes and chains represent the best possible evidence for this ship’s standing rigging. The deadeyes from this wreck were made of teak, were well constructed, and well preserved (fig. 2). There is evidence for six large deadeyes amidsthips and at least eight for the stern. Evidently, when the vessel heeled to its port side upon reaching the seabed, both sides of the mizzen shrouds fell downslope and remained in a concentrated area.

The chain plate, which would have contained the deadeyes, was of a Dutch style, according to R.C. Anderson. Chain straps secured the lower deadeyes, and rope straps were lashed around the upper deadeyes. A purchase between each pair of deadeyes facilitated the necessary adjustments for the shrouds.

Mainmast standing rigging was easiest to reconstruct since several of the artifacts were discovered next to their adjoining components. Deadeye sizes and equivalent size deadeye straps fell into place when laid against the proposed broadside plan (fig. 3). Where strap and strop deadeyes were available for the mizzen area, outer diameter measurements were used to match the appropriate pairs. It is difficult to interpret the exact configuration for the stern of the ship since several of the deadeyes for that area were discovered under structural remains. I have only projected those artifacts which have been excavated from above the fallen structural remains.
The number of shrouds supporting each mast varied with the size of the ship. R.C. Anderson, who has studied 17th-century rigging practices extensively, feels that a lesser number of shrouds were used at the end of the 17th century than at the beginning. His evidence for this argument comes from the variation in the number of shrouds used on ships of equal firepower built during different quarters of the 17th century. Following this assumption then, a vessel of 42 guns might have had as few as 6 to 8 shrouds per side for the mainmast, 4 to 6 shrouds for the foremast and 2 to 3 shrouds for mizzenmast. More likely the mizzenmast would have required at least 4 shrouds, despite the apparently smaller size of our ship.

Hull fittings

Deck and hull fittings include those wood and iron objects that were originally fastened either to the deck or hull and used in the ship’s rigging. On 17th-century ships, deck fittings would have included such things as knightheads, bitts, timberheads, masts, mast partners, and capstans; hull fittings included such items as ring bolts, preventer bolts, chain bolts, hook bolts, channels, clevets, cleats, fairleads, and belaying pins.

The use of timberheads, knightheads, small knights and bitts dictated their location on the deck or decks. A bitt, HF 01 (fig. 4), from the Mombasa wreck was found downslope of the hull remains and in line with a point just aft of the main mast step. The size of HF 01 suggests a topsail sheet bitt, which would have been located just in front of the main or mizzen mast. A sheet bitt was used to make fast the topsail sheets while larger jib bitts, located just abaft the mast, were used to make fast the lower halyards and other top ropes.

Running rigging

Artifacts representing the running rigging for this vessel include eye hooks, ring and eye bolts, shoe blocks, parrel beads, fiddle blocks, and several various common blocks. A comparatively large shoe block was discovered, along with the only two parrel beads from this wreck, downslope from the stern area. A two-plane block of this size may have been for raising a large lateen mizzen yard. Its relation to the parrel beads may support this hypothesis and further indicate that the

Figure 3. Excavations of midship and stern sections of the wreck produced enough information for a preliminary reconstruction of the standing rigging when the ship’s remains are compared to plans of 17th-century vessels.

In the figure above, “SR” stands for standing rigging. The number of strop and strap deadeyes, straps, links, and chain plates that were recovered are listed at their projected midship and stern locations. The numbers refer to artifacts believed to have been from the Santo Antônio de Tanna’s port side only. An “x” means that none of the designated artifacts for the location shown in the figure were recovered.
A Dutch-style bitt (left) was found amidships. On the bitt, an upper notch is cut to allow a crosspiece which was connected by means of forelock bolts. The lower notch probably fit into a deck beam or ledge and was fastened by a forelock bolt. The beveled lower portion of the bitt may have been set into a chamfered fitting that would have been attached to another beam or was set into a step. A purposely-cut gouge is located just below the bitt’s lower deck notch and may have been made to fit over an exposed bolt head below decks.

Figure 4. HF 01.

A sail bundle, approximately 1 m by 50 cm by 68 cm, was found just behind a port partition discovered in 1978. Due to a lab accident in the early months of its recovery the canvas had decayed to a black crust, and rope portions of the sail had lost their integrity completely. It was decided that some information could still be gained from this bundle, so it was placed in Lippasol for two months, then gently unfolded, photographed, and drawn. A large clew and three cringles along a parcelled portion of the sail’s footrope (fig. 5) indicate that this may be just one-quarter of a small topsail. Due to its provenience on the site and to three artifacts found within the folds of the bundle, it is possible that the sail was under repair and below decks at the time of the vessel’s sinking. Three artifacts were found within the bundle: a badly oxidized iron needle (near the needle a repair stitch was sewn over a double seam), a banana peel, and a bamboo food tag. Iron and brass sailmaker’s palms were found at three locations over the site, possibly indicating that they were in use before the wrecking event.

We have only begun to write the story that this late 17th-century warship might tell. Its artifacts relate a tale of long voyages to far off shores; its artillery defines its function; and its construction and rigging express quality and strength.

Figure 5. Footrope around the sail material survived in some quantity.
The Pumps

by Thomas J. Oertling

All wooden ships leak to some extent, even new ones, so it is essential to have an efficient and operative bilge pump: if a hull no longer displaces water but contains it, it becomes a shipwreck. Since the 15th century, ships have carried suction pumps, also called common pumps, to meet their needs. The suction pump was invented in the early part of that century; its first recorded use was in the mining industry in Germany in the first quarter of the 16th century, and an archaeological example was found on the Molasses Reef shipwreck which dated to the same period. Warships, in anticipation of battle damage, had an additional need for a high volume pump. This need was met in the late 16th century by the chain pump. The chain pump had been in use in the ancient world up to the 7th century AD but then disappeared from use. It was re-introduced in Italy in the early 15th century and by the end of the next century was being used in European ships.

The Santo António de Tanna carried both suction and chain pumps, which were located near the main mast. The pumps were operated from the main deck and below this deck were enclosed in a room called the pump well (ca. 3.8 x 2.2 m) whose purpose was to keep the pumps clear of ballast and cargo so that they could be serviced and to provide some protection from shifting cargo in rough weather.

The bottom parts of two suction pump tubes were still in place at the aft end of the well on either side of the Santo António de Tanna’s keelson. The bottom of each tube fit between the ship’s frames through holes cut in the ceiling planking. A cruciform channel was cut in the tube ends to allow water to pass to the bore. No fragments of the pump valves were found.

The basic form of the chain pump, the same form that was found on the Santo António de Tanna, did not appreciably change over the three centuries it was used in European warships. S-shaped chain links (see figures 1 & 2) formed a continuous loop on which were located special stirrup-shaped links at approximately 50 cm intervals. Valves, made of pieces of leather over a metal disc, were fastened to the stirrup link by another modified link. At the top of the loop the chain lay over a wheel, by which it was moved. To catch hold of the valves on the chain there were four U-shaped irons set in the perimeter of the wheel (see figure 3). Long tangs at the base of these irons indicate that the wheel was made of wood. The wheel axle connected to one or two crank shafts which extended from the center of the wheel along the deck so 15 to 20 men could operate the pump by turning the crank handle. The chain then descended down the “back case,” a square chute made of plank that protected and contained the chain on its way to the base of the pump. Normally an access door was cut into the back case so that the chain could be reached if it broke and fell. Before the loop traveled up a wooden tube, called the "round chamber," it passed beneath a roller that prevented the chain from jamming. The valves were approximately the same diameter as the tube bore so that water was raised above the valves as they ascended in the tube. On the deck, where water exited the tube, a cistern usually enclosed the round chamber and the back case. The back case was taller to prevent water flowing back into the hold. An opening on the side of the cistern and a chute or trough, called a dale, channelled the bilge water to the side of the ship.

The identification of the chain pump was not as simple a matter as this description makes it appear. It was only some time after the pump well had been excavated that the existence of the chain pump was recognized; after all, there were two suction pumps found and no trace of any other pump mechanism in the well. The first piece of the chain pump to be identified was the tube, which was thought to be a piece of cargo until someone noticed metal sticking out either end. The form of the chain could then be identified, and many concreted fragments were discovered. Two pieces of plank joined at a right angle were concreted to a fragment of the chain; these
were fragments of the back case. In a box of tools found in the stern of the ship were sections of the chain, two roller bearing plates, and the U-shaped irons of the drive wheel. The tools most likely belonged to the ship’s carpenter, who would have been responsible for keeping the pumps in working condition. It was not unusual to have on board two complete chain loops for each pump so that one loop could be repaired or have its valve leathers changed while the other was on the machine.

The round chamber was found at the forward end of the pump well, suggesting that the chain pumps were located here, at the opposite end from the common pumps. No opening in the ceiling planking or other obvious sign marks the exact location of the chain pumps. There were, most likely, two of these pumps set on either side of the keelson, just as the common pumps were arranged.

The chain pump was a great improvement over the suction pump in that it could move a vast quantity of water and was easier to handle. A man would work at the common pump until he made two hundred strokes (about five minutes), whereas a spell at the chain pump was reckoned in “glasses” (probably half-hour glasses).

There were some disadvantages to the chain pump: it required a large number of men to operate continuously; its many leather valves were more difficult to replace than the valves in common pumps; and the efficiency of the pump, even though it out-performed the common pump, was only about 50 percent. For these reasons, the chain pump was not used on the smallest warships and never became popular in merchant ships. Also, for unknown reasons, the French never adopted it for their warships.

In the mid-18th century, the British navy took steps to find an improved chain pump. None were satisfactory until William Cole and John Bentinck developed their new pump in 1768. Their improved chain design decreased wear put on the links and also decreased the probability that the chain would slip or jerk back when it was raising water. The new pump could be taken apart quickly and easily for maintenance and repair and, with fewer men working it, discharged more water than did other pumps.

The only extant chain pumps are the two on the 18th-century HMS Victory. The chain pump from the Santo António de Tanna, though, is the oldest archaeological example and is a testament to the European ability to assimilate technological advances where needed.
THE COMPASSES

by Lisa Shuey Richardson

During the course of excavation, elements of four, possibly five, wooden compasses came to light near what appears to be a bos'n’s store in the aft section of the ship. Two of the compasses were composed of square boxes set on gimbals within square boxes (fig. 1); one was of a round bowl and gimbals within a square box (figs. 2-4); and one of a bowl with gimbals minus its accompanying box. A small fragment of what looks like a round bowl with a section of metal gimbals may represent a fifth compass. All the compass bowls and square inner boxes were fitted with detachable bases, and all had a central metal spindle upon which a magnetic needle would have been mounted. No traces of the needles, compass cards, glass covers, box lids, or binnacle remains were found, with the exception of a few small bits of glass found in one of the square inner boxes.

At the time of excavation, these were the only 17th-century examples of mariners' compasses in existence, although three earlier compasses had been found on the mid-16th-century British shipwreck the Mary Rose. Since then more examples have been found; one from a 16th-century Basque galion in Red Bay, Labrador; and 10 to 12 from the Swedish warship Kronan, sunk in 1676. Based upon these early examples and what we know about compass development from written sources, the Mombasa compasses would seem to be typical of types known from the 16th, 17th and 18th centuries—that is, consisting of a square box or round bowl fitted with brass gimbals and mounted in a square outer box. But many gaps remain in our knowledge of compass development since we have so few actual examples from this early period. The Mombasa compasses in particular have provided us with compass box construction details that were not evident from contemporary sources and illustrations, and they may have more to tell us still about the evolution of the gimbaled compass box.

The earliest known compasses date as far back as the 12th century in Europe and the 11th century in China. In its earliest form the compass was simply an iron needle magnetized by a lodestone and floated on a reed or cork in a bowl of water, then observed until it settled pointing north. But it was not until the "dry compass" (a bowl with no liquid) came into use that the main elements of the mariner’s compass as we know it today had evolved. The first detailed description of such a
The compass appears in Europe in 1269 in a treatise on magnetism, where the compass needle is described mounted on a pivot upon a vertical pin so that it could swing freely in a horizontal plane until it came to rest pointing north. The pin was set in the base of a bowl and the bowl was fitted with a "verge" ring engraved with the 32 points of the wind.

Following a gap of nearly 300 years in the written record, the next detailed European description in 1561 shows further advances in positioning the needle relative to the horizon with the substitution of a compass card or "fly" in place of the graduated verge ring. The card was made from a circular piece of chart paper and was painted with the 32 compass points in the form of a wind rose. The compass needle (commonly a wire bent into a lozenge shape) was glued on the bottom side and the whole was mounted with a pivot on a vertical pin at the base of the bowl. A lodestone was necessary to re-magnetize the needle as it weakened, an operation facilitated by making the base of the bowl detachable.

In order for the compass to function properly one more improvement was needed: a way to compensate for the roll of a ship at sea. This development took place some time between the 13th and 16th centuries, by which time the compass had developed into two boxes, one within the other, and fitted with gimbalis. Exactly how or when this development occurred we can only guess until more pre-16th-century compass evidence is uncovered. But we do know that by 1545, the date of the Mary Rose, the compass consisted of two well made gimbaled parts, a round bowl within a square box.

The three Mary Rose compasses were all similar in type, the best preserved one (perhaps a spare) coming from a sea chest stowed near the bow. The round compass bowl was intact save for the compass needle which had eroded away, leaving only an iron stain close to the pivot point. As with the Mombasa examples, no sign of a compass card was found, but we know what the compass cards and needles looked like from contemporary illustrations. Unlike our Mombasa compasses, the glass cover of the Mary Rose compass was found intact, sealed to the bowl lid with a putty-like substance which unfortunately was destroyed during conservation. The wooden compass bowl was supported on bronze gimbalis within a square-lidded box, which was fastened with iron nails! Although several 16th-century sources refer to the problem of "deviation," or error (caused by the presence of iron), the influence of such nails evidently was not appreciated until much later. Iron fasteners do not appear to have been used in the 17th-century Mombasa compasses; all their boxes were fastened neatly with dovetail joints.

In fact, these dovetail fasteners are but one of several previously unknown details of compass box construction brought to our attention by the Mombasa examples. Another feature evident in the Mombasa compasses but neither described nor illustrated in contemporary sources is the existence of two raised lock notches in the base of one of the round compass bowls which fit into two similar sized grooves at the bottom of the bowl's interior wall. A less sophisticated design, also undocumented, was employed on the square inner compass box's removable base, whose rabbed edges formed a slight platform against which the sides of the compass box rested. Also, traces of white paint found on the inside of
A Fire in the Bowl, A Medicine in the Smoke: Evidence of Smoking Aboard the Santo António de Tanna

by Jerome Hall

Many artifacts recovered from the Santo António de Tanna appear to have been personal possessions of the ship's crew. One such group includes 12 items associated with pipe smoking. Composed mostly of fragments, these artifacts exhibit a variety of form and material composition, representing production centers on two, and perhaps three, continents.

Eleven of the 12 smoking pipe artifacts were excavated from the port side of the vessel, most likely the result of the ship's orientation, a port list of 30 degrees, on the sloping harbor floor. Three fragments were found forward of the mast step; nine were located aft (fig. 1). Six pieces were excavated within the confines of the ship, with the remaining six located outside the limits of the extant hull structure, within 9 meters of the port quarter. The latter most probably spilled from the vessel, although the possibility that they represent intrusive artifacts cannot be discounted.

Archaeological artifacts always carry certain inherent questions regarding their production, transportation, and deposition. An artifact is never simply a thing; it is always a potential clue enabling the archaeologist to interpret a site. Several questions arising from the careful examination of these smoking pipe pieces are relevant to our understanding of the people, places, and events surrounding the sinking of the Santo António de Tanna. What does the relatively small number of artifacts related to smoking imply? Does the distribution of these artifacts on the wreck site allow us to further interpret the site? Is it likely that English or Indian manufactured smoking pipes would be found on a Portuguese vessel in East Africa? Yet unanswered, these questions are leading researchers to ask and answer many more questions concerning ship construction, trade patterns, and shipboard life in the late 17th century.

By the autumn of 1697, the production and trade of tobacco, as well as the trade in tobacco smoking pipes and their related accessories, was well established in Europe, the Americas, Africa, and Asia. The supposed benefits of "herba panacea" were introduced to Europe in the early 16th century by Bishop Bartolomeu de las Casas, who noted that the New World Indians "became somewhat intoxicated, but felt no fatigue" when inhaling the smoke of Nicotiana tabacum. For the next two centuries, Europe would laud the miracle plant as a preventive measure against plague, a cure for boils and sores, and as a prescription for those who suffered from colds and low blood pressure. A tobacco-smoke enema syringe was used to treat persons suspended in "catatonic states," as well as being the preferred method of resuscitation of drowning victims. It is no wonder that this universal remedy for so many illnesses and discomforts found its way into the damp and unsanitary
confines of both war and merchant sailing vessels. Considerable debate exists regarding when and where tobacco was introduced in the Old World, but general agreement implicates Portuguese involvement in the vast distribution of both the plant and smoking practices. While tobacco was not known to be cultivated in Portugal until 1558, the Portuguese, along with Arabic and Persian seafarers, are credited with bringing the plant into Madagascar shortly after 1506. In 1559, smoking was prevalent among both Spanish and Portuguese sailors in Spanish ports; however, the means by which tobacco was inhaled is uncertain. A paucity of both documentary and archaeological evidence for pipe manufacture supports the idea that the Iberians were primarily cigar and cigarette smokers. Seldom, if ever, are Portuguese or Spanish made smoking pipes recovered in excavations. In the latter part of the 16th century, the Portuguese brought two species of tobacco to Africa. *Nicotiana rustica* was introduced directly from Portugal, followed later by *N. tabacum*, from Brazil. It has been suggested that while Arab slave traders learned a great deal about smoking from native Africans, it was from the Portuguese, in the 16th century, that they “grew to know, and become inordinately fond of, tobacco.” By the early part of the 17th century, smoking was a common practice in Ceylon, India, Korea, and Japan, all owing to Portuguese introduction.

The European artifacts
Seven pieces recovered from the *Santo António de Tanna* were bowl and stem portions of European kaolin (clay) smoking pipes. During the 17th century, Germany, France, England, and Holland were major pipe producing countries, and principal manufacturing and export centers were located in Bristol and London, England, as well as Gouda and Amsterdam, Holland.

A great diversity in European pipe form, specifically with regard to bowl shape and stem length, has evolved gradually from the beginning of the 16th century up to the present. Because these changes are quite distinct, and because pipes are commonly found on dated sites in both the Old and New Worlds, it is often possible to date European clay pipes within two decades of their manufacture, based mainly on bowl shape and size. Pipe stems are usually not found in their entirety as their fragile nature allows them to be broken easily; consequently, stem length is a less reliable means of dating.

The earliest European pipes were called “elfin pipes” because of their miniature bowls and short stems. Tobacco, a novelty in early 16th-century Europe, was not readily available, and filling even a small pipe bowl was quite costly. With increased importation of the New World plant, prices decreased, and this new affordability was reflected in larger pipe bowls. But this presented a problem: a larger bowl held more tobacco, resulting in a hotter fire. In order to allow smoking in reasonable comfort, the pipe stem had to be elongated to move the bowl away from the smoker’s face. The stem bore—the hole through which smoke was inhaled—had to be narrowed to facilitate the increased length of the stem.

It can be seen then, through time, that European clay pipes exhibited an increase in bowl capacity and stem length, while stem bore diameter decreased. The typical 17th-century clay pipe of English manufacture had an elongated bowl with a diameter ranging from .90 cm, in the early part of the century, to 1.30 cm in later years. Most stems were straight, with bore diameters ranging between 5/64 and 8/64 inches. Bowls were usually plain, although occasionally a ring of
small hash marks, called "rouletting" or "milling," appeared around the rim. With the exception of an occasional maker's mark, these pipes were quite plain.

All seven of the European pipe fragments from the *Santo Antônio de Tanna* are stylistically and compositionally characteristic of 17th-century English clay pipes. The presence of seams in three of the stems indicates that they were manufactured in a two-piece mold, the most common method of pipe production in 17th-century Europe. Stem bore diameters for these six pieces all fall within the prescribed range for this time period.

Two of the seven pipe fragments contain bowls, either partial or entire (figs. 2 & 3). Comparison of these bowls with those of typologies developed by Adrian Oswald and Ivor Noel Hume results in a viable date range of 1680-1720. Artifact MH 3787 bears an oval-shaped heel which is distinctly separate from the bowl, with the maker's mark "IB" appearing in relief (fig. 3). Comparable pipes, bearing similar initials on the heel, have been excavated from sites at Port Royal, Jamaica, and from seven sites within the United Kingdom, including Hartlepool, Chester, Scilly, York, and Coventry, as well as in North Wales. Historical documents have produced 39 possible pipemakers from Great Britain whose initials and date of production match those of MH 3787. No known German, French, or Dutch pipe manufacturers using the stamp "IB" or bearing those initials have yet been determined for the period of the *Santo Antônio de Tanna*’s sinking.

The Non-European artifacts

Five artifacts are of non-European origin, with the possible exception of MH 4176. Fragments MH 3137 and MH 5249 (fig. 4) are from African manufactured "stem and socket" or "two-piece" pipes, a form thought by many to have originated in the Americas, finding its way to Africa via the English participation in the slave trade. The short bowl, made of coarse earthenware, was fashioned by hand or cast in a one-piece mold. It possessed a wide socket into which was inserted a long vegetable stem, usually a reed.

Fragments MH 3137 and MH 5249 both have three incised lines which extend partially around the stem. This was a common decorative pattern on many West African pipes, and comparative material culture has been excavated from sites at Yendi Dabari, Ghana, as well as New Bupbe, on the Southern Black Volta of Ghana. Fragment MH 3137 possesses a small hole centered in a "pinched edge" rising from the stem socket. This feature probably was present on MH 5249 as well, but because this fragment is broken much closer to the terminus it is impossible to make a positive determination. A variety of African pipes possess such a hole, commonly referred to as a "hook" as it is used to secure the removable reed to the bowl socket. Often instruments used to clean spent tobacco from the pipe bowl and stem bore, called "prickers," were also attached by means of a cord to such a hook.

Comparative material culture possessing "hooks" have been reported from Accra, Ghana, and the island of Barbados in the...
West Indies. Excavations in a slave cemetery at a Barbadian sugar plantation yielded a pipe dating from the late 17th to early 18th century, appeared to be West African. The two-piece form possessed a hook at the juncture of the bowl and stem. Dimensional measurements were nearly identical to those of MH 5249 from the Mombasa shipwreck. The pipe was excavated from a gravesite most probably belonging to an African obeah (medicine) man of considerable age.

Two coarse earthenware vessels, artifacts MH 89 and MH 191 (figs. 5 & 6), were excavated immediately aft of the mast step of the Santo Antônio de Tanna. These most likely represent the bowl portions of hookahs or nargilehs, commonly known as water pipes. In antiquity water pipes were referred to as "hubble-bubbles" in the Indian language, an onomatopoeia derived from the gurgling sound produced when smoke was drawn through the water.

While earthenware bowls were commonly used on Eastern water pipes, historical accounts written by Englishmen in India provide us with insight into other materials used in their production, as well as a bit of history regarding the practice of smoking. John Fryer, who traveled in India between 1672 and 1681 noted the use of "a silver Hubble-bubble," smoked by persons who were "bolstered up with embroidered cushions." In 1697, an unidentified source quoted in J.T. Wheeler's book Madras in Olden Time noted an Indian king who sent "a glass hubble-bubble . . . with a compliment." A sweet mixture of tobacco, fruits, spices, herbs, molasses, and sugar was placed in the bowl which was situated atop a large stem, which in turn penetrated a hollow vessel filled with water. Smoke was drawn down through the bowl and stem and was cooled and purified by the water before passing out of the mouthpiece positioned at the upper part of the water vessel.

Lest one should think that the earthenware vessel was the most common form used in the water pipe, it is helpful to point out that the term nargileh is an Indian word which translates as "coconut." A small earthenware bowl, such as MH 89 or MH 191, was commonly placed on a wooden stem and inserted into a water-filled coconut. This method of
smoking was quite widespread among the Arabs on the east coast of Africa. The practice of smoking tobacco in a water pipe, while well known throughout the Orient and Africa, was never customary in Europe and was probably unknown in the Americas.

Perhaps the most interesting piece recovered from the site of the *Santo Antonio de Tanna* was an anthropomorphic pipe bowl, MH 4176, found in a spoil pile immediately aft and upslope of the vessel (fig. 7). At present, this is the least understood of all the pipe fragments. The wide, flaring nostrils and the fillet about the head are features typical of the anthropomorphic fetish pipes of the Bali tribesmen of Cameroon, Africa, but the bowl/stem angle and accompanying measurements are indicative of 18th- to 19th-century European design. Several possibilities are readily apparent: the pipe may represent a European imitation of African stylization, or perhaps is an African pipe which duplicates European design. The fact that the measurements reflect a pipe from a later century, combined with the fact that this artifact was excavated from a spoil pile located above the shipwreck, possibly indicates that this pipe was intrusive on the site.

Conclusions

Seven of the 12 smoking related artifacts from the ship are of European origin, and it appears that MH 3787 was definitely of English manufacture. As the *Santo Antonio de Tanna* departed Goa, India, in 1696, it is possible that the pipe was purchased or traded for there, or perhaps in Bombay, where an English presence is well documented.

Two fragments of African manufactured "stem and socket" pipes exhibit West African artistic, stylistic, and compositional features, perhaps indicating trade interaction or transport between the two continental coasts.

Two artifacts (MH 89 and MH 191) most likely represent hookah bowls, ubiquitous in East Africa as well as the Orient. It is probable that these are of Indian manufacture, and archival research showing that a large contingent of the crew aboard the *Santo Antonio de Tanna* were Indian "lascars" (soldiers and sailors) supports this identification.

The small number of artifacts related to smoking, as well as the fact that several of the European manufactured pipes contained charred bowls, suggests these pipes belonged to the ship's personnel. The variety of pipe forms probably reflects the heterogenous human population aboard the ship and tells us something about trade interaction in Africa and Asia. More study of the distribution of these artifacts around the wreck site may help us to understand further the shipboard life of the *Santo Antonio de Tanna*.

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The Portuguese Faience

by Hamo Sassoon

One of China's outstanding achievements was the invention of porcelain. Excavators of tombs from the Han dynasty (206 BC-AD 220) have found vessels of a glazed stoneware which is described as proto-porcelain, and there is little doubt that by the earlier centuries of the Christian era the Chinese were making true porcelain. They themselves defined this ware as a white ceramic substance which gave a resonant note when struck. Although one or two travelers in Arab areas, notably Marco Polo, reported the existence of this sort of pottery, it seems that Europeans did not become aware of it until the Portuguese began to sail to the Far East in the early years of the 16th century.

To begin with, Chinese porcelain was an exotic curiosity for Europeans, usually reserved for royalty; by 1600, King...
Philip II of Spain had one of the finest collections, which included hundreds of blue and white pieces. Yet Europeans still did not know how porcelain was made. Portuguese potters tried to imitate the Chinese wares, but the best that they could manage was a creamy white glaze on an ordinary earthenware fabric, which certainly did not give a resonant note when struck; however it did prove to be an excellent background for the blue and purple pigments which the Portuguese were using. This type of tin-glazed earthenware came to be known as "faience." It was made in Coimbra and Lisbon.

The Santo António de Tanna was in Lisbon harbor from the end of 1694 until April of 1696, and it is reasonable to suppose that it was during this time that some of the local faience pottery was taken on board the frigate. Two large unbroken faience jars were found in the central part of the ship; they are decorated with bird and plant designs which suggest Persian origins (fig. 1). The white glaze had become pale gray and rather powdery in the mud on the seabed; this is probably due to the lead in the glaze combining with sulphur to form lead sulphide, which is gray. Laboratory treatment with dilute hydrogen peroxide has done much to reverse this chemical change. Nothing was found which might suggest what these jars were used for on the ship, but food storage is an obvious possibility. Similar jars are displayed in museums in Coimbra, Oporto and Viana do Castelo (in northern Portugal).

When a pot is smashed on board ship, the obvious way to dispose of the bits is to throw them into the sea. The corollary to this supposition is that when a ship sinks she will go down with unbroken pots on board, unless of course part of a broken pot continued to serve a useful purpose. This may well be the case with the barber’s bowl; the only one found on the wreck had several large pieces missing from its rim. Two of these pieces were found during the excavation. Although they do not fit directly on to the body of the bowl, they prove that at least some of the damage occurred after the sinking.

Two complete faience plates were found (figs. 2 & 3); on one, the center design is a crown, and on the other an "M," which probably stands for "Majestade." The cavetto, or rim, of the crown plate is decorated with a series of alternating symbols: three double fruits like plums with leaves, and three leaf-like shapes surrounded by eight curvilinear lines. Because of this symbol, such a border design is known in Portugal as the "spider pattern." This type of decoration is probably derived from plates of the Wan-Li period (1573-1619), which often have borders divided into panels depicting flowers, fruits and Buddhist auspicious symbols. Some plates of the late Ming period (ca. 1620-1640) show transitional stages between the Wan-Li and the spider pattern plates.

Small flat-bottomed bowls or porringer bowls were the most common type of faience found on the wreck (fig. 4). More than two dozen were accounted for; almost all were damaged.
to a greater or lesser extent. Their frequency suggests that they may have been issued to crew members, whereas the crown and the "M" plates were perhaps reserved for high-ranking officers.

All the pieces of Portuguese faience so far described are decorated with blue and manganese purple pigments on a white background. But a few bowls and plates decorated with narrow blue lines on the white glaze also were found; these are much more suggestive of Chinese blue and white ware, although the Chinese potters never would have been content with such simple decoration.

We know from Portuguese records that during the three years before she sank in Mombasa Harbor in 1697 the Santo António de Tanna had been to Vigo in northern Spain, and then to Lisboa, Mozambique, Goa, Mombasa, Mozambique again, and Zanzibar. She is likely to have taken on board pots from any or all of these ports, either as containers for stores purchased, or simply to replace breakages. She therefore provides a corpus of closely dated pottery which is of great value as a reference collection for archaeologists working on land sites in the regions of these ports.

Figure 2. MH 1114 (diameter 21.2 cm).

Figure 3. MH 3651 (diameter 21.3 cm).

Figure 4. MH 861 (diameter approx. 15 cm).
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*Figure 2. MH 1114 (diameter 21.2 cm).*

*Figure 3. MH 3651 (diameter 21.5 cm).*

*Figure 4. MH 861 (diameter approx. 15 cm).*
THE MARTABAN JARS

by Farid Paul Willoughby

Derived from the name of a city in Burma known to have been a center for the production and distribution of storage vessels the term "martaban jar" or "martaban" is applied to a broad range of jars that were produced in China, Kampuchea, Vietnam, Thailand, and Burma. Prior to the invention of modern-day light-weight containers, martaban jars were vessels of commerce par excellence. Sixteenth- and 17th-century accounts relate to their use as containers for the storage and transportation of water, ginger, pepper, lemons, mangoes and "nype," an alcoholic beverage made of the *Nipah fruticans* plant. They probably also were used as containers for grain, salted fish, wine, sugar, salt, tea, candied fruit, butter, oil, opium, holy water, mud from the Ganges, and ceramics.

All martabans are made of highly-fired (1100-1250°C), thus partially vitrified, strong, durable stoneware fabrics. The jars usually are finished crudely. Glazes, often applied with an uneven consistency, frequently form into drips at the bases of these jars. Most martabans have three, four, or five loops oriented horizontally, though sometimes vertically, on their shoulders. Too small to have been used as carrying handles, these loops served as tie points to secure lids to the jars' rims.

Eight martaban jars of four types have been recovered from the Mombasa wreck.

**Type 1**

The medium-sized Type 1 jars are coated internally and externally with an opaque, matt green-brown glaze. MH 2428 (fig. 1), the only martaban from the Mombasa wreck to bear any markings, has a relief stamp consisting of two Chinese characters impressed on its shoulder. The upper character, *li,* and the lower character, *yong,* mean "benefit" and "use" respectively (fig. 2). When the characters are used in combination they represent the English word "useful," not, unfortunately, very useful in terms of suggesting what these jars may have contained!

The best parallels for jars of this type have been found at Fort Jesus and among the remains of the Dutch East Indiaman *Witte Leeuw,* which sank off the coast of St. Helena in 1613. Unfortunately, the stamps these parallels bear are undecipherable and thus also provide no indication of what these jars may have carried. Similar jars, up to 7 cm larger than the Mombasa specimens, have been found on the China-built Shinan Ship (ca. 1271-1368) and in Japan and the Philippines. Many of these bear stamps which read *qingxiang,* meaning...
"clear and fragrant." According to current wisdom these jars were used to export tea-leaves from China to Japan and the Philippines. Other jars similar to, though less bulbous than, the Mombasa Type 1 jars have been found in Sarawak. The stamps on some of these jars, read as "clear wine;" "warm perfume;" "use for old," as in, "use this for storing old . . . [substance];" and "use for new," as in, "use this for storing new . . . [substance]." indicate that these vessels carried wine.

Clearly, the Type 1 jars were manufactured in China, perhaps as early as the mid-13th century. The question is, what were they being used for? Were they carrying tea-leaves, or were they being used to store wine or something else?

Type 2

With heights ranging between 25.9 cm and 27.4 cm, the Mombasa Type 2 jars are the smallest of the martabans recovered from the Mombasa wreck. Their coarse gray fabrics are coated externally with a thin, honey-colored brown glaze, and glazes terminate at points above their bases. Each jar has four horizontal loops arranged in a circle close to its neck. One jar, MH 291, has a fifth loop, oriented vertically, positioned between two of its other loops (fig. 3). The extent to which the necks of these jars are constricted is perhaps an indication that these jars were made to carry wine, or a pourable solid like tea-leaves, sugar, or salt.

Apart from jars recovered at Fort Jesus, no good parallels for the Mombasa Type 2 martabans are known; however, honey-colored glazes, and the termination of glaze short of the jars' bases are characteristics quite typical of martabans known to have been produced in Guangdong Province, China. Jars similar to the Mombasa Type 2 examples have been found in Sarawak in 14th- and 15th-century contexts. Although the Sarawak forms are different from those of our Type 2 jars, their neck height to body height ratios, glaze characteristics, and number and orientation of loops are comparable to those of the Mombasa martabans. One Sarawak example even has the fifth vertical loop. All these jars have been attributed an origin in Guangdong Province.

Although good parallels for the Type 2 jars have yet to be found, one tentatively proposes that they were manufactured in Guangdong Province, China, possibly as early as the 14th century.

Types 3 & 4

The Mombasa Types 3 and 4 jars vary considerably in their sizes and shapes, but similarities in their fabrics, glazes, and decoration strongly suggest that they represent products of the same tradition, if not kiln.

The Mombasa Type 3 jars are represented by one fairly well preserved specimen and the fragments of another. Both examples are made of coarse gray fabrics. Standing at a height of 91.5 cm,
The Mombasa Type 4 martabans are represented by a single well preserved jar, 54 cm tall (fig. 5). This jar and the Type 3 jars were made, glazed, and decorated according to the same method. One authority suggests these vessels were modeled and glazed to take on the appearance of leather and were intended to be carried in specially designed wooden racks on ships.

Three unprovenienced parallels for the Type 3 jars have been found in Mombasa, and another three-quarter sized one was found among the remains of the Witte Leeuw. Excavations of the Witte Leeuw also yielded a good parallel for the Mombasa Type 4 jar and examples of yet a third small squat member of this family of jar types.

A rim fragment of a Type 4 jar found on Pulau Tioman, Malaysia, has been attributed an origin in Thailand and a date within the 15th- to 19th-century range. If the Type 3 and 4 jars were not manufactured in Thailand they may have been made in Martaban. Early in the 16th century, the Portuguese chronicler Duarte Barbosa noted the production of very large "black-glazed" jars in Martaban. Could he actually have been referring to our dark-brown jars?

Conclusions

That some of the martabans from the Mombasa wreck may have been upwards of four hundred years old at the time they were loaded should not be considered extraordinary. Japan was importing jars of a similar vintage from the Philippines in the 16th and 17th centuries. Other more dramatic examples of the extended use of martabans come from Borneo, where 10th-century jars are still, today, used in shops to store preserved foods.

The determination of precise origins and dates for the Mombasa martabans has been limited by the absence of convincing kiln-site parallels for these jars. But on the basis of available evidence one can suggest that the Type 1 and Type 2 jars were manufactured in China, most probably in the provinces of Zhejiang and Guangdong, respectively, perhaps as early as the 13th century. The Type 3 and Type 4 jars probably originated in Thailand or Burma, perhaps as early as the 15th century.
Report from Fort Jesus: Conservation and Recent Developments

by Wazwa Mwadime

Although specialists trained in the conservation of water-logged objects began the process of conservation at the time of excavation, the time-consuming and labor-intensive techniques necessitated two conservation and study seasons after the end of underwater excavation.

The 1981 season saw the construction of two small twin-tubbed tanks for treating wood with polyethylene glycol. The tanks were made of two stainless steel baths welded approximately 10 cm apart onto a cover and set into a heavy-gauge steel outer tank. The latter was filled with water and fitted with two immersion heaters, ensuring that the treatment tanks were surrounded with hot water at an even temperature. Evaporation in each treatment bath was controlled using a weighted polystyrene lid. Initially a variety of low priority objects was treated to allow any problems that manifested themselves to be remedied and to familiarize the resident conservation staff with the method.

The sorting, cleaning, and casting of the more than 800 concretions stored in the museum was carried out in 1982. Techniques developed during INA’s conservation work in Bodrum, Turkey, were used under the guidance of Alison Withey. Three members of the team, Bruce Thompson, Manuella Lloyd, and Wazwa Mwadime, quickly learned the process.

The concretions were first sorted into rough groups, such as nails, fittings, chain, and tools, although selection was often based on informed guesswork because of the anomalous shapes of the concretions. By far the largest of the categories was that of the nails. Priorities within each group were established, and each concretion to be cast was photographed. The concretion was then broken rather than cut, cleaned, and prepared for casting. Polyester resin obtained locally in Kenya was used in conjunction with a retarding agent. The latter increased the hardening time, thus avoiding serious cracking and shrinkage as a result of excessive heat buildup. This was of particular concern if the object to be poured was very large; some of the largest objects required many pours over several days.

Once a number of concretions had been cast and the technique had proved satisfactory two assistants were hired to use air scribes to remove the concreted material from the epoxy casts. When the original surface adhering to the casting compound was revealed the object was photographed again and drawn.

A number of interesting and unique objects were recovered. The largest of these was an almost complete rudder pintle, of which there are undoubtedly more lying in the unexcavated portion of the stern area. The metal part of the lintstock was well preserved with some fiber from the slowmatch still in place. Two padlocks of traditional pattern and many chain pump components were found. These latter pieces corresponded well with spares found among the large concreted lump in what had become known as the tool box. Tom Oertling has suggested that the latter were spare sprockets for the chain pump turning mechanism at deck level. A second similar box was studied, but it appeared to contain only nails, of which many separate examples already existed. The box was returned to wet storage to await future work. Other single concretions revealed hooks, cleats, bolts, lengths of chain plate, large strap hinges, and a number of unidentifiable rigging fittings.

After the final departure of the project team from Mombasa in 1982, I, as the Fort Jesus Conservation Officer, continued the conservation of artifacts from the excavation. With the
Robin Piercy (left) and Wazwa Mwadime (right) use air scribes to dismantle the "tool box," a concreted mass from which several tools and other objects, including parts for a chain pump, were recovered.

In 1986 the museum employed Miss Aisha Fadhil to work on the project, and the arrival in that same year of Mr. Frederick Zink, a conservator from Germany, was another welcome addition to the laboratory staff. A further important development has been the conversion of a large basement area into a more modern conservation laboratory, which has greatly increased the area available for conservation work. The treated material from the Santo Antônio de Tanna is now housed in the former laboratory under controlled conditions, and work is continuing on the collection.

The new conservation facility also acts as a training center with the development of a conservation internship for museum professionals from Kenya and other African countries south of the Sahara. I myself went to Rome in 1984 to study at the International Centre for the Study of the Preservation and the Restoration of Cultural Property and thereafter did an internship at the National Maritime Museum in London. In 1987 I completed my training at the University of Paris, returning to Mombasa at the end of 1988 to continue work on the artifacts.

A padlock (MH 5509) was recovered from one concretion.
Ulu Burun Shipwreck

The eighth excavation season of the Ulu Burun Late Bronze Age Shipwreck will run from June 1st to mid September. Under the direction of principal investigator George Bass and field director Cemal Pulak, the excavation team plans to remove all remaining copper ingots (ca. 100) and other large artifacts, such as stone weight anchors and large storage jars.

Excavators for the 1991 season include INA staff members Don Frey, Robin Piercy, Tufan Turanh, and Sheila Matthews; archaeologists Faith Hentschel, Mike Fitzgerald, Doug Haldane, and Mike Halpern; Texas A&M Nautical Archaeology Program graduate students Bill Charlton, Edward Rogers, Mark Smith, Valerie Stewart, David Grant, Claire Peachey, Sam Mark, Claire Calcagno, and James Coggeshall; and volunteers Patricia Sibella, David Perlman, M.D., and Tom Sutton, P.A.

The 1991 season will be the next to the last season. Excavators hope to recover all wooden hull remains and completely excavate areas underneath the hull during the final 1992 campaign. Conservation of artifacts from earlier campaigns continues in the Bodrum Museum of Underwater Archaeology under the direction of Jane Pannell with Güneş Ozbay assisting. The current backlog of large artifacts such as copper ingots and ceramic jars will require several years of work.

Funding for the 1991 season is provided by INA, the National Endowment for the Humanities, the National Geographic Society, the Institute for Aegean Prehistory, Shell of Turkey, Ltd., and Cressi-Sub of Italy.

16th-Century Ottoman Wreck

Gökhan Öz苦笑lı continues to work under the direction of Cemal Pulak on material from the Ottoman Wreck, excavated in 1982 and 1983 at Yassi Ada. Nearly two-thirds of the surviving hull has been recovered, recorded, and, just recently, drawn completely in preparation for a preliminary reconstruction study. Gökhan has been engaged fully in casting several hundred concretions recovered from the site. He currently is working on the lower pintle and gudgeon that held the rudder in place.

The casting of concretions from this wreck will require several more seasons of work. The project is funded by INA.

Bodrum Museum

Fred van Doorninck of the INA faculty will spend the summer continuing research on the amphoras from the Glass Wreck. His work will focus on determining where clay jars of the type found on the Glass Wreck may have been made and the extent of the trade routes along which they were carried.

Cheryl Haldane has received a Harriet Pomerance Fellowship in Aegean Bronze Age Archaeology from the American Institute of Archaeology in order to study plant remains from the Ulu Burun Shipwreck. Retrieval and analysis of plant remains began in 1984 at Ulu Burun but continued isolation and study has been limited since 1986. At the Bodrum Museum she plans to process samples from the past five years of excavation. She also will travel to Ulu Burun and Ankara while working on a coastal flora inventory and doing library research.

Conservation and research on artifacts from earlier projects progresses round in the museum. Selma Karan and Netia Piercy continue to draw artifacts from past and present excavations, while Jane Pannell carries on with the conservation of artifacts.

Turkish Survey

A survey is planned for the first two weeks in October. George Bass, Don Frey, Cemal Pulak, Robin Piercy, Tufan Turanh, and Murat Tilev will be joined by INA Board Director Marty Wilcox in identifying wrecks near Bodrum and searching for any anomalies in the vicinity of the Yalikavak site (where a statue of an African youth was found several years ago). The team will use side-scan sonar equipment developed by Marty Wilcox. INA Board Director Jack Kelley plans to join the team's investigation at Yalikavak. The survey crew hopes to use mixed gas diving equipment at the deep site there.
Horse Ferry Project

Kevin Crisman, from INA, and Arthur Cohn will co-direct an excavation of a 19th-century horse ferry in Vermont. In 1989 and 1990 they began recording the hull and created preliminary plans of the wreck, which sank in 55 feet of water at Lake Champlain. This year's project, conducted as a field school, will be undertaken by 12 students between June 3 and July 5. They will complete excavation of the forward end of the hull to obtain information on the ship's construction and possibly information on the vessel's career and the cause of her sinking.

Texas A&M Nautical Archaeology Program graduate students Tina Erwin, Tommy Hailey, John Bratten, Joe Cozzi, and David Robinson will participate. The project is funded by the Vermont Division for Historic Preservation, the Cecil Howard Charitable Trust, and INA.

Columbus Caravels

The search for two caravels abandoned by Columbus in St. Ann's Bay, Jamaica, will continue under the direction of Jim Parrent. Jim will lead a field school on the archaeology of Jamaica which will feature visits to historic and prehistoric sites throughout the island along with lectures and field experience. The search for two caravels abandoned by Columbus in St. Ann's Bay, Jamaica, will continue under the direction of Jim Parrent. Jim will lead a field school on the archaeology of Jamaica which will feature visits to historic and prehistoric sites throughout the island along with lectures and field experience. During the final weeks of the field school, the students will assist in the survey at St. Ann's Bay. Also assisting will be Nautical Archaeology Program graduate students Bob Neyland, Jack Neville, Bess Manning, Greg Cook, and Amy Rubenstein. During a survey in the fall of 1990, INA staff members, using an advanced sub-bottom profiling system developed by Steven Schock, discovered anomalies on the seabed that match conditions archaeologists expected from their research in historical sources. Dr. Schock will rejoin the archaeologists during part of the survey. The current project is funded by donors to INA, including support from Texas A&M University, the John Brown Cook Foundation, Cambridge Seven Associates, and Kaiser Aluminum.

Mombasa Harbor Wreck

From the project's office in Bodrum, Robin Piercy continues to work toward the final publication of the Mombasa Harbor Wreck. Work has focused on preparing material (photographs, drawings, and notes) for the publication. The work is funded by INA.
On the cover: A barge, which served as the base for diving operations and for preliminary recording and conservation of artifacts, was anchored below the walls of Fort Jesus, Mombasa.