THE VISIONARY SHADOW: A DESCRIPTION AND ANALYSIS OF THE ARMAMENTS ABOARD THE SANTO ANTONIO DE TANNA.

A Thesis
by
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ABSTRACT

The Visionary Shadow: A Description and Analysis of the Armaments aboard the Santo Antonio de Tanna. (December 1986)

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This thesis concerns the armament collection from a shipwreck in the Old Harbor of Mombasa on the Kenyan coast. The wreck is that of the Santo Antonio de Tanna, a Portuguese vessel that was sunk in 1697 during an attempt to relieve Fort Jesus.

In the 17th century the Portuguese were under threat in the Indian Ocean, and their ability to withstand attack and wage war at sea was crucial to their survival. The decline of Portuguese power is clearly illustrated by the story of the siege of Fort Jesus, and this study indicates the range of weaponry that the Portuguese were using at the time.

The history of the siege is given first to set the shipwreck in its historical context. Then, a brief description of the excavation is followed by a catalog of the armaments and related artifacts found during excavation. From the objects described in the catalog
some conclusions are drawn about the range of armaments on the *Santo Antonio de Tanna*. The question of the vessel type is also discussed in the conclusions.

Research into the various categories of armaments made it clear that many of the artifacts, while conforming to a general pattern, are unique to the wreck, and have no parallels in museums or other collections. This is especially true of the smaller wooden objects. I suggest that this is because they were fairly standard naval issue of the time and that because they are lacking in aesthetic appeal or intrinsic value they have not been preserved.

Only five guns were found on the site, and this restricts our understanding of the *Santo Antonio de Tanna*\'s ordnance. Because of the absence of guns the projectiles, cartridge moulds, and powder ladle have been analysed in order to predict what types of ordnance the *Santo Antonio de Tanna* probably was carrying.
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Many people and institutions have been extremely helpful to me in my research. Mr. Robin Piercy, director of the Mombasa Wreck Excavation, provided innumerable details about the artifacts and their distribution, as well as copies of the photographs. Netia Piercy, helpfully and promptly, answered all my requests for the drawings that she, Caroline Sassoon and Chris Checketts had made. Mr. Ali Abubaker, Curator of Fort Jesus, allowed me to use the facilities in the Fort while I studied the artifacts. Professor James Kirkman has been unfailingly enthusiastic and supportive. Mr. Seymour de Lotbiniere was always ready to give advice and talk about the gunflints about which he was so knowledgeable; sadly he died at the end of 1984. Mr. P.N. Jones of the Royal Armament Research and Development Establishment examined some of the metal samples for me. Mr. Daehnhardt of Cascais, Portugal, was most kind in giving his time and expertise as I tried to identify the various objects found on the site. The staff of the Tower of London, especially Ms. Ruth Brown and Mr. P. Robinson, and of the Greenwich Maritime Museum, London, the Museu de Artilharia, the Museu de Marinha, the Biblioteca
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CHAPTER I

INTRODUCTION

The discovery of the trade route to India in the 16th century allowed Portugal, a relatively poor country with only 1.3 million people, to build an empire stretching from the shores of Brazil to the coast of China. The Portuguese entered the East with two primary motivations: profit, and the dissemination of Catholicism. A Papal Bull, the *Dum Diversas*, issued on June 18, 1452, authorized the King of Portugal to attack, conquer and subdue Saracens, pagans, and other unbelievers who were inimical to Christ; to capture their goods and their territories; to reduce their persons to perpetual slavery, and to transfer their lands and properties to the King of Portugal and his successors (Boxer, 1969: 21).

This papal dispensation enabled the Portuguese to develop their empire unhindered by humanitarian considerations. Stimulated by the profits realised from the first expeditions to India, as much as 60 times the cost of financing the voyages (Strandes, 1961: 26), the Portuguese rapidly extended their domain. Their hold on this distant empire, however, was

This thesis follows the format of the *International Journal of Nautical Archaeology* (IJNA).
tenuous; it was based on a flimsy line of strategically-situated forts and factories and supported only by the superiority of the Portuguese navy. Although their navy never mustered more than 300 seagoing ships at one time (Boxer, 1969: 56), these were more than a match for the unarmed vessels of the Indian Ocean. The Portuguese were unable to maintain their maritime primacy, however, when faced with competition from the comparable vessels and weapons of the Dutch and English.

Since the end of the 16th century, the Dutch and English had been encroaching upon the Portuguese monopoly on Indian and South-East Asian trade. At the same time the Arabs were vigorously rebelling against a century of Portuguese exploitation and oppression. This Arab threat, the Dutch and English competition, and the avarice and corruption of the Portuguese were the major reasons for the downfall of the Portuguese empire. The attempt to maintain the empire in the face of such obstacles was the source of significant economic distress for Portugal during the 17th century. What had initially appeared a limitless source of revenue was transformed into a severe drain on her population and economy, and it was only with considerable difficulty that the Portuguese could
maintain any part of their eastern empire.

To some extent the ability of the Portuguese to withstand attack and wage war at sea in the 17th century can be derived from an analysis of the Santo Antonio de Tanna's artifact assemblage. This is the purpose of my thesis.

The Santo Antonio de Tanna was one of the vessels engaged in the struggle to counter the threat to the Portuguese. She was built at Bassein, near Bombay, in 1680-81. After making a voyage to Lisbon and remaining there from the end of 1694 to April, 1696, she returned to Goa and was sent to relieve the siege of Fort Jesus (Sassoon, 1981: 98). A shipwreck in the Old Harbor of Mombasa has been identified as that of this vessel (Kirkman, 1972: 153-157). The examination of her armaments provides some detail of the range of weapons available to the defenders of the fast-dwindling Portuguese empire.
CHAPTER II

EARLY HISTORY

The East African coast was of great strategic importance to the Portuguese. For more than 90 years their main base was at Malindi, but its inadequate harbor provided no defense against attack and little shelter from inclement weather. In the 1580s, during the second Turkish invasion of the East African coast, the Portuguese managed to conquer and invest the island of Mombasa. Unlike Malindi, Mombasa had two excellent harbors: Mombasa Harbor on the north, used for centuries by Arab traders, and Kilindini on the south (Fig. 1). A viceregal proposal recommending that a fort be built on the island was approved in Lisbon, when it was suggested that a customs house be established at the same time (Strandes, 1961: 144).

The construction of the Fort began in 1593 to command the entrance to Mombasa Harbor (Fig. 2). The increased maritime activity associated with the construction of the Fort, and the revenues from the customs house, stimulated the development of Mombasa as an important settlement and trading center for the Portuguese.
Figure 2. Fort Jesus from the wreck site.
Earlier in the 16th century, the Portuguese had imposed a law requiring all dhows to carry permits to engage in trade. Any vessel without such papers could be seized with all her cargo and her crew enslaved (Axelson, 1960: 12). The further requirement that all vessels trading in East Africa must call at Mombasa to pay a 6% customs tax, along with other levies for the harbor and the Fort, put intolerable constraints on the traditional Arab trade with East Africa. Resentful of these drastic restrictions, the Arabs retaliated by supporting many of the small-scale wars against the Portuguese on the East African coast.

This antagonism came to a head in 1696 when an Arab force from Muscat besieged Fort Jesus. The details of this siege are reported in two contemporaneous accounts, the anonymous *Historia da Mombaca* (Museu de Marinha, Lisbon and Bibliotheca Nacional Fundo Geral 584 Lisbon) and de Castro de Mello, the *Planta da Ilha de Mombaca e discricao de principio do seu cerco ate o fim delle...* (Biblioteca Nacional, Rio de Janeiro 1-25, 28.2, no.5). These accounts are the primary source of information on the siege, and they have been used by all authorities who since have written on the siege, including Axelson (1960), Boxer & Azevedo (1960), Kirkman (1964, 1974)
and Strandes (1961).

The Arab fleet sailed into Kilindini harbor on March 11, 1696, without having to face any significant opposition from the Portuguese forces. In fact, when one of the Arab vessels fired at Fort Sao Joseph (a redoubt near the entrance to Kilindini Harbor), the fort's entire complement of more than 250 soldiers spiked their guns and fled to Fort Jesus. In the town of Mombasa there was panic as well; the inhabitants fired their buildings and took shelter in the Fort. The nearly 2,500 local people benefiting from the security of the imposing walls of Fort Jesus were doing so in direct transgression of a Portuguese order that denied shelter to Muslims in the event of attack. The invasion, however, hardly justified the initial panic, since, after landing on the island, the Arabs settled down and did nothing for two weeks. This inactivity enabled the defenders to stock the Fort with all available food supplies as well as to send for help.

The siege that followed was protracted—from March, 1696, to December, 1698. That it lasted so long was largely a result of apathy and cowardice on both sides and owed little to any heroic defense. During the first nine months, little action was seen. Apart from three unsuccessful attempts by the Portuguese
forces to dislodge the Arabs from the town, hardly a shot was fired between April and July. The Arabs, though, suffered increasingly from sickness, and when the southeast monsoon set in at the end of August, most of their force returned to Muscat. The Musungulos (African people from the mainland) then attacked the remaining Arabs, confining them to their positions. As a result the defenders were able to leave the protection of the Fort and collect food and firewood without fear of attack.

At sea, however, the Portuguese were not so fortunate. The Arabs managed to capture or sink any ship bringing supplies to the Fort, and attacked and raided Zanzibar, the source of most supplies. These setbacks and the ensuing shortages, compounded by a lack of firewood that forced people to eat rice and other foodstuffs raw, caused a spate of desertions and many deaths, including that of the Portuguese Captain of Fort Jesus.

The situation was so bad that the new captain, Antonio de Mogo Melib, offered free passage to all Muslims who had taken shelter in the Fort if they wished to leave. They, however, decided to stay, and thereafter were rostered to hold watches on the walls. Despite this show of support, the number of people in
the Fort had dropped by this time to 1500, of whom only 20 were actually Portuguese.

The Arabs, aware of the weakness of the defenders and of the possibility of aid from Goa, became more serious in their prosecution of the siege. During one night attack, they managed to construct earthworks at both ends of the beach below the Fort. This was a severe blow to the Portuguese because this beach had been their only access to the sea. The Arabs also built a battery on the mainland opposite the Fort, and two more in the town. The situation for the defenders, threatened as they were by five gun emplacements, began to look desperate. Then, late on the afternoon of Christmas day, 1696, a Portuguese relief fleet arrived from Goa.

Under the command of General Luis de Mello Sampaio, aboard the Santo Antonio de Tanna, the fleet consisted of one other frigate, two galliots and three large auxiliary boats. There were 770 men with the fleet (Strandes, 1961: 220), most of whom were untrained native forçés. They had been sent to Mombasa in response to vague information that had filtered back to Goa by way of Muscat.

General de Mello Sampaio was singularly uninterested in risking his life to relieve the fort.
For the first two days his fleet sailed around the harbor entrance, making no attempt to aid the besieged forces. In desperation those in the Fort rowed out to the fleet with a request for supplies and reinforcements. In response the general sent a galliot and a boat, with some fifty soldiers, directly to the Fort. The vessels were bombarded by the Arabs, the boat ran aground below one of the enemy entrenchments, and only ten men managed to reach the safety of the Fort. The galliot, although beached during the attack, fared rather better, and it was later refloated and drawn up below the Fort.

Finally, on New Year's day, the fleet anchored closer to the Fort, and the provisions that had been brought from Goa were handed over. The Arabs, using armed boats, tried to prevent the transfer but were forced to withdraw with heavy losses. Their battery on the mainland, however, kept up a heavy fire at the beach below the Fort, causing chaos as the supplies were offloaded there.

The majority of officers aboard the Portuguese ships felt that an action against the Arab ships in Kilindini promised an easy victory and considerable relief for the Fort. General Luis de Mello Sampaio, because of a viceregal order forbidding the fleet to
attack the Arabs or their vessels, would not concede this, nor would he allow the Portuguese ships to put into Mombasa Harbor.

With delivery of the supplies completed, General de Mello Sampaio considered his duty done and was eager to leave Mombasa and take up his position as Governor of Mocambique. The relief of Mombasa was emphatically not his main concern; he was far more anxious about disposing of the trade goods aboard the *Santo Antonio de Tanna*. To justify his decision to leave, he complained of the shortage of fresh water and the gathering strength of the monsoon. A non-existent Arab threat to Mocambique and the intention of soliciting aid from Portuguese strongholds south of Mombasa gave him added reasons for leaving. Captain Antonio de Mogo Mello argued that the fleet should remain until the end of the monsoon to prevent the Arabs' receiving supplies from Pemba and reinforcements from Muscat or Pate. All he managed to elicit from the general, however, was a reluctant agreement to transport the noncombatants to safety.

In the end, General de Mello Sampaio made a compromise. He sailed for Mocambique on January 27, 1697, with the *Santo Antonio de Tanna*, leaving the other frigate and a galliot in Mombasa under the
command of Henrique de Figuereido Alarcao, who immediately left for Zanzibar, claiming that he had no option but to do so because of the inclemency of the monsoon. Both he and de Mello Sampaio neglected to take the non-combatants from the Fort. Furthermore, a galliot, detailed to carry messages to Goa, followed the general to Mocambique, also ostensibly because of the monsoon weather.

The fleet had left about one hundred men as reinforcements for Fort Jesus, as well as supplies of food and ammunition. Initially these additions brought optimism to the defenders, but the reinforcements proved fatal, for the new soldiers were carrying a plague. This swept the Fort, and by the end of January there were again only 20 Portuguese capable of carrying arms.

During February and March, four Arab galliots and a schooner sailed into Kilindini. An Arab force captured the Fort's four remaining boats and burnt the galliot beached below the Fort. On August 28, Antonio Mogo de Mello died. The last Portuguese defender in the Fort, he entrusted his command to Bwana Daud bin Sheikh, the seventeen-year-old Prince of Faza. This young man held the Fort for Portugal for the next 17 days, with the aid of a few Arabs, nine African men and
about 50 African women (Strandes, 1961: 226-227).

In Mocambique, a few days before the young prince took command of the Fort, General de Mello Sampaio set sail for Mombasa again. His fleet included the *Santo Antonio de Tanna*, with 250 men on board, and 50 men on a galliot, borrowed from the trading company in Sofala. The general wanted to return directly to Goa and was reluctant to help Mombasa. He attempted to discourage his crew by telling them of the great danger involved in trying to aid the Fort. When this tactic failed, he is said to have used accomplices to try to encourage the crew to mutiny (Strandes, 1961: 229). This scheme also failed, not only because the troops were reluctant to mutiny but because his lieutenant-captain, Joseph Pereira de Brito, exposed his machinations to the sailors. De Brito then virtually forced Sampaio to sail to the aid of Fort Jesus, and the fleet arrived on September 15, 1697, unaware of the death of de Mogo Mello. The ships dropped anchor between the Fort and the Arab battery on the mainland. The *Historia da Mombaca* (para. 105) reports that the enemy stockades were so close that even the wads from their cannon were causing damage to the fleet.

Disastrously for the Portuguese, the *Santo Antonio de Tanna* was lost during the battle. A description of
her sinking is given by Captain Antonio Marques Esparteiro (in Kirkman, 1972: 155):

It [the frigate] was moored near the outwork of the fortress with anchors fore and aft, so as not to swing with the tides. Under heavy fire from the enemy batteries, it was set on fire by the chance explosion of a barrel of grenades, but fortunately this was extinguished by the crew though not without loss. On 18th September an attempt to change the moorings was unsuccessful because the anchors were held fast in rocks on the bottom.

On 20 October the cables broke and the ship, with 150 men on board, was carried onto a reef north-east of the island, where it lost its rudder. When the tide rose it cleared itself from the reef and was swept near to an enemy battery to the great danger of the crew. A party of 28 men from the Fort succeed in taking the battery and towing the frigate close to the fortress, but the frigate was lost, how it is not exactly known...

General de Mello Sampaio died in Fort Jesus on November 18, and de Brito was elected to his command. The Prince of Faza, in recognition of his services, retained the title of captain.

The Fort was therefore once again in a state of siege with no sea support until December 28, when another relief force arrived from Goa. Unfortunately for the Fort, though, it was relieved by another commander who wished only to offload supplies. Despite pleas and arguments from the Portuguese in the Fort, he
sailed for Zanzibar on January 18, carrying with him de Brito and nearly all of the loyal Muslims who had defended the Fort for so long.

At the end of 1698, another relief fleet sent from Goa did not even approach land because the Fort was flying the Arab flag. Consequently, the tale of the end of the siege was not heard until 1701, when two Indians, captured by the Arabs at the final downfall of the Fort, managed to make their way to Goa. They reported that after the departure of the second relief fleet, the people in the Fort had continued to die from the plague and other diseases until the only defenders left were eight Portuguese, three Indians and two African women. A young African captured by the Arabs revealed this weakness, and the Arabs immediately occupied the Fort. The few remaining defenders attempted to resist, but after their captain was fatally wounded they laid down their arms and were taken captive. It was said that two of the Portuguese managed to set off the powder magazines, destroying the chapel, storeroom, two hundred Arabs and themselves in the process (Axelson, 1960: 174).

Thus ended the siege. Although the Portuguese reoccupied Fort Jesus in 1728, they lost it again to local forces in 1729, and never again regained
possession of it.

Sometime after the siege the Arabs salvaged some of the artillery from the sunken Santo Antonio de Tanna. In an account of the fall of the Fort (Viceroy to Crown, 1701), the viceroy reported that the Arabs placed five pieces in the Fort of the Hermitage of Nossa Senhora, a redoubt that commanded the convergence of Kilindini and Mombasa harbors. Another five were employed in a redoubt guarding the entrance to Kilindini, and ten were placed in Fort Sao Joseph. Although these guns have long since disappeared, the wreck of the Santo Antonio de Tanna apparently has remained undisturbed until its discovery over 250 years later.
CHAPTER III

HISTORY OF THE EXCAVATION

In the 1960s two local divers, Conway Plough and Peter Phillips, independently discovered a shipwreck in the Old Harbor of Mombasa, below the seaward walls of Fort Jesus. They collected some artifacts which were handed to James Kirkman, then curator of the Fort Jesus Museum, who dated them to the late 17th century.

At the end of 1970 Kirkman directed an attempt to clear part of the silt overburden from the ship's timbers. The excavation was short-lived, but the artifacts retrieved confirmed the late 17th-century date. The date and position of the wreck enabled Kirkman (1972: 153-157) to identify it as the remains of the Santo Antonio de Tanna.

A survey by the Institute of Nautical Archaeology (INA) in 1976 revealed extensive hull remains and a large number of well-preserved objects. INA was then invited to undertake excavation of the wreck in co-operation with the National Museums of Kenya.
THE SITE

The Old Harbor of Mombasa is a deep, narrow channel; its sides slope steeply up to the flats of coral reefs, which are exposed at low tide. The site is about 40 m from the shore and approximately 150 m from the outworks of Fort Jesus. The wreck lies diagonally across a 30 degree slope in 13 m of water at the shallowest point, and 16 m at the deepest. It came to rest on its port side with its bow pointing seaward.

The sea bed is silty with a considerable quantity of fragmented coral mixed with the silt. This covered the wreck to a maximum depth of about 2 m and helped preserve the hull remains.

There is a strong tidal movement, as much as 4.2 m at high spring tides, which causes poor visibility for much of the time. Average visibility was 1.5 m, although at spring tides this could drop to zero on the low tide or, on the high tide, extend as far as 20 m. There is a strong current when the water is at peak flood, and this sometimes hindered the excavation.
THE EXCAVATION

The 1976 survey was conducted by Dr. Donald Frey and Robin Piercy. They laid down five nylon lines 3 m apart, parallel to the original base-line laid by Plough and Phillips, and 21 buntings were tied at 2-m intervals along these lines. This produced a grid of 2-m by 3-m rectangles, covering an area 15 m by 44 m (Piercy, 1976: 2). The grid contained the two distinct rows of massive frames which outline the ship (Fig. 3).

A local diving company, Divecon, lent the survey team a proton magnetometer, a boat and an underwater telephone. With the use of this equipment the site was surveyed and a magnetic contour map produced, which revealed a number of ferrous anomalies. Some of these were later shown to be cannon and a huge cannon-ball concretion.

Full-scale excavation began in 1977. A 27-m-long lighter was moored over the excavation site as a diving platform and base for the archaeological operations. A system of 2-m grid squares constructed from angle iron was laid across the center section of the hull, along the axis of the original base line. During the course of this excavation campaign, three main areas were excavated, and the keelson was uncovered from just
Figure 3. Mombasa Wreck Excavation Site Plan.
forward of the mast step to the stern knee (Piercy, 1977: 332-337).

The entire hull was excavated during the following two seasons (Piercy, 1978a, 1978b, 1979). Two trial trenches dug outside the hull, on the port side, revealed a great deal of material that had evidently fallen from the ship as her sides rotted. A huge concretion consisting almost entirely of cannon balls was broken into manageable pieces with small explosive charges. The pieces were raised and the cannon balls extracted and cleaned.

In the 1980 campaign a 7-m by 3-m area was excavated in the downslope area at the stern end of the shipwreck (Piercy, 1981: 109-110). This area proved far richer in artifacts than had been anticipated, and the plan to excavate a 3-m-wide band along the entire length of the downslope area of the wreck had to be modified. As a result, plans were made for a curation season in 1981 to be followed by two further excavation seasons.

The 1981 season was spent working on the artifacts stored in Fort Jesus. All of the pottery was cleaned, sorted and analysed, and a report entitled Ceramics from the wreck of a Portuguese ship at Mombasa, by Hamo Sassoon, was published in Azania in 1981.
Conservation was begun, or carried out, on many objects. Three heated, polyethylene-glycol (PEG) tanks were built, and some of the wooden objects were placed in these and impregnation begun.

As this work progressed it became clear that there would be insufficient funds for another excavation season in the foreseeable future, and so it was decided to have one more curation season during 1982. In 1982 all the drawings, photographs and catalogs from the previous years were copied and taken to Bodrum, Turkey, to enable the project director, Robin Piercy, to continue analysis. At the same time, many of the concretions were cast and the casts drawn and cataloged. The computer catalog was brought up to date and the artifact lists were printed out, not only in numerical order but by square number, fabric and category.

It is unfortunate that the excavation remains unfinished. Sufficient material was recovered, however, to provide a representative sample of the armaments aboard. I detail this sample in the following catalog.
CHAPTER IV

CATALOG

INTRODUCTION

The artifact collection from the Mombasa Wreck Excavation is housed in Fort Jesus where some of those objects already conserved are on display in the Museum. All items were given individual MH (Mombasa Harbor) catalog numbers at the time of excavation. Their provenances were recorded at the same time. The location of the 2-m-grid squares was designated by letters and numbers, shown on the plan in Figure 3, page 21. The scale of the drawings in the catalog is 1:1 unless otherwise indicated. I have reported accession numbers only for those objects discussed individually in the text of the catalog.
EDGED WEAPONS

This class of weapon (swords and knives) is scantily represented in the artifact assemblage. There are a number of grips whose blades are no longer present, and two sword hilts (Fig. 4). Three blades have been identified from concretions already cast.

Blades

None of the three blades found in the concretions was complete, but the two illustrated fragments provide some interesting details.

Catalog Number: MH 4360

Provenance: No location.

Dimensions:
Ricasso width: 1.56 cm
Blade width: 2.26 cm at forte
2.165 cm at lower end
Thickness: 0.75 cm
Fuller: 0.6 cm wide
Length: 12 cm (excluding ricasso).

Portion of a slightly tapering blade with the ricasso and part of the tang intact (Fig. 5). The blade is double-edged, diamond in section and fullered; i.e., a flattened or elongated diamond shape with a single groove running down each side. The ricasso has
raised edges giving the appearance of a fine, slightly raised lip.

![Diagram of a sword showing parts labeled Pommel, Knuckle-guard, Grip, Quillon, Ricasso, Shell-guard, Pas d'ane, Fuller, Hilt.]

Figure 4. The parts of a sword.

The sharp angle between the ricasso and the blade in this example is a diagnostic feature. It suggests that the blade belonged to a rapier rather than to the small sword that was in vogue at this time. The two small swords in the Wallace Collection (London) that have ricassos have no angle at all between the ricasso and blade. In contrast the majority of the rapier blades in the collection possess this angle.

The swept-hilt rapier gave way to the cup-hilt rapier in the early 1600s, and the latter remained popular until around 1660 when it, in turn, was largely replaced by the small sword. It seems probable, therefore, that this blade may have belonged to a
Figure 5. Sword Blades.
cup-hilt rapier rather than to the more outdated swept-hilt version. Most cup-hilt rapiers are of Spanish origin although they may have German or Italian blades (Mann, 1962: 328).

Catalog Number: MH 6370
Provenance: 28J

Dimensions:
  Blade width: 2.265 cm at forte
  1.57 cm at lower end
  Thickness: 0.7 cm
  Fuller: 0.49 cm wide
  Length: 19.5 cm

Portion of a double-edged blade, diamond in section and fullerred (Fig. 5, p.27). A pair of incised crosses in one fuller indicates that the blade was a product of the Toledo workshops in Spain (Daehnhardt, pers. comm.). The blade cast had traces of the original wooden scabbard adhering to it. There is a thin layer of iron over most of the wood, which may be evidence that the scabbard was sheathed in this metal.

Sheathing of wooden scabbards was standard practice, as can be seen in the collections in the Tower of London (also Mann, 1962: passim), but as leather was the material most commonly used this
example is unusual.

Catalog Number: MH 3718

Provenance: 23K

Dimensions:
- Blade width: 2.2 cm at thicker end
- 1.92 cm at thinner end
- Thickness: 0.75 cm
- Fuller: 0.58 cm wide
- Length: 14.5 cm

Fragment of a double-edged blade, diamond in section and fullered. This blade is very similar in design and dimensions to the two described above. Thus it is probably also the blade for a cup-hilt rapier. No hilts for this type of rapier were found during the excavation.
Grips

Seven identifiable grips were found on the site. These grips could, in a number of cases, equally well belong to knives as to swords. As with much of this collection, identification of individual artifacts has been difficult. Comparative examples found in museums and contemporary paintings are of much finer workmanship than those in the Santo Antonio de Tanna's artifact assemblage and can only be used as guidelines rather than direct parallels.

Catalog Number: MH 2356

Provenance: 15J

Dimensions:
  Length: approx. 7.1 cm
  Diameter: approx. 2.9 cm
  Tang socket:
    larger end: 1.1 x 0.95 cm
    smaller end: 0.75 x 0.75 cm

Material: wood with brass inlay and wire binding.

Shape: cylindrical, thicker in the center and tapering at both ends.

Decoration: the body of the grip is bound with fine wire and overlain with six fine, vertical bands of flattened brass wire. The ends are bound with brass strips 0.935 cm wide, which hold the vertical bands in position (Fig. 6).
In the Wallace collection there are five contemporaneous grips with these vertical bands (A655, A656, A661, A665, A666); four are Spanish and one (A666) is German. All of these belong to cup-hilt rapiers dated to the latter half of the 17th century. Three date to between 1650 and 1660, and it is possible that MH 2356 is of similar date. On the evidence available a later date is not precluded, but seems less likely because the cup-hilt rapier was not a common weapon after the 1660s.

Figure 6. MH 2356.
Catalog Number: MH 5695

Provenance: 28I

Dimensions:
Length: 7.1 cm
Diameter:
    larger end: 2.47 cm
    smaller end: 2.24 cm
Tang socket:
    larger end: 1.24 x 0.92 cm
    smaller end: 1.07 x 0.83 cm

Material: wood with wire binding.
Shape: tapering cylinder with flat ends.
Decoration: wire binding that probably covered the entire body of the hilt.

This grip is of indifferent workmanship and may be a type of knife handle common to this period (Fig. 7). The binding was functional rather than decorative because the wire gave the user a better grip (Wilkinson, 1970: 29).

Figure 7. MH 5695.
Catalog Number: MH 2377

Provenance: 24L

Dimensions:
Length: 7 cm
Diameter: 2.65 cm
Tang socket:
larger end: 1.32 x 1 cm
smaller end: 0.96 x 0.85 cm

Material: wood with copper wire.

Shape: cylindrical, tapering slightly toward both ends.

Decoration: copper wire bound rather clumsily around the center of the grip in a 2-cm-wide band. This is probably functional rather than decorative (Fig. 8).

Figure 8. MH 2377.
Catalog Number: MH 289

Provenance: 27H

Dimensions:
Length: 7.5 cm
Diameter: 1.73 x 2.19 cm
Tang socket: 0.955 x 0.8 cm

Material: wood with pewter wire binding.

Shape: rectangular wooden block, square in section.

Decoration: these grips are almost identical. The body is bound with fine wire while at each end the wire was laid together and plaited as a whole to form raised bands, commonly known as Turks' heads (Fig. 9).

Turks' heads are not useful for dating or identification as they are common from the 16th century to the 18th century and can be seen on small-swords, rapiers, estoc and dagger blades.

Figure 9. MH 289.
Catalog Number: MH 4014

Provenance: 26J

Dimensions:
   Length: 7.2 cm
   Diameter: 1.3 cm
   Tang socket:
      larger end: 0.77 x 0.52 cm
      smaller end: 0.62 x 0.465 cm

Material: brass or bronze, cast in one piece with a hollow center for the tang of the blade.
Shape: flattened cylindrical grip, tapering at both ends, which are slightly everted.
Decoration: two decorated panels, one on each side of the grip. These are decorated with chiselled, low-relief scrollwork.

Figure 10. MH 4014.

This form of decoration was common on the grips of the cup-hilt rapiers, as were solid metal grips of similar design to this one (Fig. 10). There are some
rather elaborate examples of this type of grip in the Wallace Collection (A647, A648, A649, A650, A651). These all belong to Spanish cup-hilt rapiers dating to about 1650, and so it seems fairly safe to assign a Spanish Toledo origin of around the middle of the 17th century to MH 4014.

Hilts

Two hilts were recovered, both in fairly good condition.

Catalog Number: MH 507
Provenance: 22H
Dimensions:
  Tang socket:
    larger end: 1.52 x 0.7 cm
    smaller end: 1.335 x 0.7 cm

Material: Brass or bronze.
Shape: The slender knuckle-guard swells gently in its center and is oval in section. There is a single, short, downward-curving quillon with a lobated end opposite the knuckle-guard. One of the two diminutive pas d'ane has degraded, and the other is no longer attached to the shell-guard, as it must have been originally. The shell-guard consists of two equally sized oval panels, large portions of which are
degraded. The rims are thicker than the actual shells. The shell-guard was made separately and then fixed to the body of the hilt, mounted over two projecting flanges. To judge from the depression on the hilt into which the grip would have fitted, the tang of the blade was rectangular, and the grip oval.

Decoration: The decoration is not elaborate, but the work is delicate and fine (Fig. 11).

This hilt belongs to a small sword, and a number of its features indicate a slightly later date than that of the cup-hilt rapiers discussed earlier. Oakeshott (1980: 247) mentions that in the last quarter of the 17th century the grip for the small sword changed from rectangular to oval or square in section. Oakeshott (1980: 247) also points out that the knuckle-guard became more evenly curved at this time. Norman (1980: 200) says that if the shells of the hilt are made in one piece, as they are in this example, a later date is indicated. There is however no direct parallel for this particular sword, and to assign it a definite date and provenance is not possible.
Figure 11. MH 507.
Catalog Number: MH 3710
Provenance: 23K
Dimensions:
   Length 12.3 cm

Material: wood with iron fittings.
Shape: The grip is a wooden cylinder, thicker in the middle with a circular iron pommel. The slender, curving knuckle-guard was attached to the grip by a metal spike.
Decoration: Although the amount of concretion indicates that some kind of wire binding or metal sheathing on the grip (Fig. 12).

The total absence of ornamentation suggests that this was a utilitarian weapon. Daehnhardt (pers. comm.) believes this is standard naval issue and has dated it to about 1690. It has not been possible to verify his identification.
Figure 12. MH 3710.
MAIL

The presence of mail on a ship of this period is puzzling. As personal protection it had been largely superseded by plate armor in the 16th century, and it is extremely unlikely that the Portuguese would still have been wearing it in 1697.

Catalog Number: MH 2, MH 2247
Provenance: Surface find, 15J

Two separate pieces of mail were found, both relatively small: one measures approximately 14 x 9 cm; the other is somewhat smaller and more fragmentary. The fine-gauge brass rings (0.9 cm in diameter) of the mail were joined with tiny, now corroded, rivets of a different unknown metal (Fig. 13).

The use of rivets and the fine gauge suggest a European origin (Robinson, pers. comm.).

An interesting interpretation of the mail has been suggested by Daehnhardt (pers. comm.). A late-17th-century document in his possession authorizes the personnel at the Lisbon armories to cut up their stocks of mail shirts and distribute the pieces for use as pot scourers. In view of the small size of the two
pieces, this authorization could easily account for their presence.

Figure 13. Portion of MH 2.

SMALL ARMS AND ACCESSORIES

Unfortunately this part of the armament assemblage is represented by only a few objects. Because the Santo Antonio de Tanna sank over a period of days and there was time for her crew to remove the smaller firearms, it is not surprising that no muskets or pistols were found.

Musketoon

Similar to a blunderbuss in its application, the musketoon differed in that it had a straight barrel, sometimes with a slight flare at the muzzle, rather than a bell-shaped mouth. Both weapons were commonly
carried as a part of shipboard armament, since they were ideal for repelling boarders and suitable for warfare in a confined space (Blackmore, 1961: 32).

Catalog Number: MH 5340
Provenance: 27I
Dimensions:
- Length: 52.5 cm
- Internal diameter of barrel: 4.27 cm
- Wall thickness: 0.55 cm

This is the smoothbore barrel of a musketoon. It is very plain, the only decoration being the raised ring at the muzzle. Straight for most of its length, the barrel curves sharply at the butt-end to form another hollow tube which is 3.5 cm in diameter. This second section has much thicker walls than the main barrel and a flange protruding from the butt-end. There are two small, pierced lugs along one side of the main barrel that were probably for connecting the stock (Fig. 14).

There is an armorer or gunsmith's mark on the very end of the barrel (Fig. 15), that is superficially similar to the coat of arms of the city of Amsterdam. It is not this however (Dr. B.J. Slot, pers. comm.), and it has not been possible to identify the mark.

The function of the flange at the butt-end of the
barrel (Fig. 16) is not clear. A musketoon barrel described by Morris (1984: 76-77) is threaded at the butt-end, probably to accommodate a screw-in breechblock. Such a breechblock is also part of a late-17th-century musketoon in the Tower of London (Brown, 1984: 243). These examples suggest that the flange in MH 5340 might be the protruding end of such a block. The barrel, however, has what appears to be a touch-hole on the side of the larger tube, suggesting that it was a muzzle-loading weapon. Furthermore, another hole in the smaller tube may have held a pin which would have held the block permanently in place, converting it to a flint-lock muzzle-loader. A muzzle-loading musketoon of the early 18th century (Brown, 1984: 243) may also have been converted in this way because its barrel is identical to those 17th-century breechloading examples described by both Brown (1984: 243) and Morris (1984: 76-77).

Figure 15. Armorer's mark on Musketoon.
Figure 16. Flange on Musketoon.

Stock butt

Catalog Number: MH 4295
Provenance: 26J

Figure 17. MH 4295.

Rounded, wooden butt of a firearm, heavily stained with iron oxide that may denote the presence of an iron heel plate (Fig. 17).

The rounded shape of this butt is not common to
muskets of this period, suggesting that it belonged to a different type of weapon. Daehnhardt believes it may be from the musketoon, MH 5340, because its shape is similar to that on a similar weapon he has in his possession (pers. comm.).

Musket barrel

Catalog Number: MH 516
Provenience: 22F

This is a section of iron tube in a state of advanced corrosion. The internal diameter is approximately 2 cm and it may be a fragment of a musket barrel. A musket barrel of this size would accommodate practically all the small shot found on the site.

Lead shot

Lead shot, besides being used in muskets and pistols, was also used in case and canister projectiles, and the musketoon too would have used small shot, albeit in handfuls rather than as individual balls. Average dimensions for musket and pistol lead shot in the seventeenth century were 1.7 cm and 1.3 cm respectively (McBride, et.al., 1975: 248).
Over 1000 musket balls were found on the site. These were concentrated inside the remains of the bow, largely in squares 14H and 15I. Diameters vary between 1.6 cm and 2.05 cm and weights between 23 and 35 g. The great majority of the shot had an average weight of between 28 and 32 g and diameters of 1.75 cm to 1.9 cm (Fig. 18).

It is possible to determine the calibre of musket for which these balls were carried by using the measurement of bore size. Bore size is defined as the number of spherical shot which, exactly fitting the barrel, would make one pound in weight. The calibre of the shot had to be one or, at the most, two bore sizes less than that of the weapon because of the tendency of black gunpowder to foul the barrel (Perkins, 1983: 340). Thus 15 balls weighing 30 g each would equal a pound, and this ball size, the most common in the assemblage, would be used in a 14-calibre-musket.

More than 400 pistol balls were found downslope of the stern of the vessel in 26J, or very close by. Diameters are between 1.1 cm and 1.55 cm and weights vary from 5 to 18 g with most being between 9 and 14 g. This rather wide variation in size could reflect either a range of pistol types or, more likely, that the more extreme sizes were used in musketoons or other weapons.
Figure 18. Graphs showing weights and diameters of lead shot.
firing a quantity of shot in a single burst.

Many of the shot have a central raised line and sprue marks, showing that they were made in moulds. Shot moulds have been found on other 17th-century shipwreck sites, for example the two bronze moulds on the 1664 *Kennemerland* site (Price & Muckleroy, 1974: 263). There are none, however, in this assemblage.

**Gunflints**

Most ships carried large quantities of prepared flints as part of their stores. As a flint could only be used about 20 times before having to be changed, it was necessary to carry a large supply (Lotbiniere, pers. comm.). The manifest for a Scottish merchant-ship, the *Olive Branch*, that sank off the coast of Panama in 1699 (Jameson, 1699), shows that she carried 5,500 flints.

More than 120 gunflints were found on the wreck site. A group of eight was found in 17F and another small group in 22k. All the rest were found in the stern area outside the hull, suggesting that these last were all stored in the same place, possibly in barrels or sacks.

A certain amount of raw flint was found downslope of the hull and aft of the main mast. It is probable
that this raw material was carried on board to allow gunflints to be knapped as they were required, but this was not common practice.

Most of the flints were made from an opaque, dark gray material[1], although some of the square examples are made from different types of flint and chert. One flint is made from obsidian and the others are black, yellow or white. There is one core of brown, yellow and black material. All of the other raw flint is of the common gray material. Very few of the flints show any sign of wear.

There were three different types: rectangular (or square) flints, scraper-shaped flints known as early-wedge or gunspall, and three small circular flints (Fig. 19).

![Figure 19. Gunflint types.](image-url)
Square Flints

Dimensions between:
3.45 x 3.05 cm and 2.25 x 2.2 cm
thicknesses between 1.0 and 0.7 cm

Of the 56 flints in this group, 84% are 2.8 cm or more long, suggesting that these were largely flints for muskets (Lotbiniere, 1984: 207). Smaller flints make up only a small proportion of the collection, and their size difference could be accounted for by a natural inaccuracy, as each flint was individually knapped. Alternatively, they could be for smaller weapons, but, at this early stage of firearm development, size limits for flints were fairly arbitrary, and it was more a case of using whatever might fit.

Square flints seem to be a Portuguese innovation and unknown in other nations. The only other one in the literature (Lotbiniere, 1984: 209) is merely identified as Portuguese.

Early Wedge Flints

Dimensions between:
2.35 x 2.5 cm and 3.45 x 3.25 cm
thicknesses between 0.6 and 0.9 cm.

Before 1775 this kind of gunflint was common to almost all western nations (Lotbiniere, pers. comm.).
Circular Flints

Catalog Number: MH 5188, MH 6218, MH 6268

Provenience: 27I 28J 28J

Dimensions:
  Diameter: 2.3 cm 2.1 cm 2.0 cm
  Thickness: 1.0 cm 0.95 cm 0.55 cm

MH 5188 and 6268 both have flat undersurfaces and domed top surfaces. On MH 6218 both surfaces of the flint are domed. None of these three flints shows signs of wear.

Circular flints are almost entirely unknown outside of being a single flint found on the Portuguese galleon Santissimo Sacramento (1668) off the Brazilian coast (Lotbiniere, pers. comm.). It is possible that this type of flint might have been used in a pistol because of its small size. Its rarity may be explained by its inconvenient shape: the central dome would have made it hard to mount securely in the jaws of the cocking mechanism. Possibly these flints may have been reversible, being turned over and reused when one side had been worn out.
Powder flasks

Twenty-one of these fragile objects were found on the *Santo Antonio de Tanna*, some in an excellent state of preservation. There are three different shapes with different volumes:

Type I: Two oval-shaped pots with globular bodies. Below the lip there is a distinct flange under which a slight indentation runs around the body. Neither flask has a lid or any form of decoration (Fig. 20).

Type II: Short, squat, nearly cylindrical pots with flat bases and a single incised line below the lip. Each is associated with a lid and traces of red paint can be seen on the exterior of MH 2071. The volumes of these pots vary between 9.8 cm and 11.2 cm. A fragmentary pot, MH 2168, is grouped here on the basis of its decoration (Fig. 21).

Type III: Relatively tall, slender pots which taper to a slightly rounded base. They are all damaged to some degree so it is not possible to calculate their volumes with any accuracy. The scale of the decorative lines on the pots is similar in most cases, and it may be that the pots also had similar dimensions. This group
Figure 20. Powder Flasks Type I.
Figure 21. Powder Flasks Type II.
has been sub-divided on the basis of decorative style.

III a: Three upper incised lines and a lower pair of shallow incised lines (Fig. 22A).

III b: A single deep groove with a shallow incised line on either side (Fig. 22B).

These three shapes and volumes may indicate that the flasks carried specific charges for certain weapons, e.g. more powder for a musketoon than for a musket, but this is not the only possibility. Normally a soldier carried a number of flasks on a bandolier or leather strap. The flasks from the site, however, do not carry the small pierced lugs commonly used to attach the flask to the bandolier. These flasks may, therefore, have been used for a weapon other than a musket. A gunner for the large ordnance, for instance, might have used one to charge the touch-hole of his piece.

The dimensions of the flasks are given in Table I.
Figure 22. Powder Flasks Type III.
<table>
<thead>
<tr>
<th>MH and Sqr No.</th>
<th>Dimensions in cm.</th>
<th>Decoration</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>559 26H</td>
<td>Ht: 7.52</td>
<td>None</td>
<td>Oval, rounded base, distinct flange below lip. No lid.</td>
</tr>
<tr>
<td>4673 SF</td>
<td>Ht: 6.81</td>
<td>None</td>
<td>Oval, rounded base, distinct flange below lip. No lid.</td>
</tr>
<tr>
<td>375 21H</td>
<td>Ht: 7.055</td>
<td>Single groove below lip.</td>
<td>Cylindrical, tapering slightly to flat base. Lid: top very slightly rounded, knob degraded.</td>
</tr>
<tr>
<td>601 26H</td>
<td>Ht: 7.68</td>
<td>As above</td>
<td>Cylindrical, tapering slightly to flat base. Lid: pinched in at sides, knob on very short stem.</td>
</tr>
<tr>
<td>530 20H</td>
<td>Ht: 7.52</td>
<td>As above</td>
<td>Cylindrical, tapering slightly to flat base. Lid: top slightly rounded knob on very short stem.</td>
</tr>
<tr>
<td>2071 15I</td>
<td>Ht: 5.89</td>
<td>As above. Red paint exterior.</td>
<td>Cylindrical, tapering slightly to flat base. Lid: pinched in at sides, knob degraded.</td>
</tr>
<tr>
<td>2168 15I</td>
<td>none possible</td>
<td>As above.</td>
<td>Cylindrical, warped fragment.</td>
</tr>
<tr>
<td>MH and Sqr No.</td>
<td>Dimensions in cm.</td>
<td>Decoration</td>
<td>Description</td>
</tr>
<tr>
<td>---------------</td>
<td>-------------------</td>
<td>------------</td>
<td>-------------</td>
</tr>
<tr>
<td>III a</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2212 13I</td>
<td>none possible</td>
<td>Single deep groove with shallow incised line on either side. Two thin incised lines further down the flask.</td>
<td>Cylindrical, fragment only. No lid.</td>
</tr>
<tr>
<td>5440 SF</td>
<td>none possible</td>
<td>As above</td>
<td>Cylindrical, fragments only. No lid.</td>
</tr>
<tr>
<td>4602 26J</td>
<td>Ht: +6.69</td>
<td>Same as above but top three lines damaged. Two lower incised lines present</td>
<td>Cylindrical, rounded base. No lid.</td>
</tr>
<tr>
<td>4843 25J</td>
<td>Ht: 8.6</td>
<td>As above</td>
<td>Cylindrical, rounded base. No lid.</td>
</tr>
<tr>
<td>III b</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4497 SF</td>
<td>none possible</td>
<td>As above</td>
<td>Cylindrical, fragment only. No lid.</td>
</tr>
<tr>
<td>663 SF</td>
<td>Ht: 8.32</td>
<td>As above</td>
<td>Cylindrical, fragment only. Flat bottom. No lid.</td>
</tr>
<tr>
<td>MH and Sqr No.</td>
<td>Dimensions in cm.</td>
<td>Decoration</td>
<td>Description</td>
</tr>
<tr>
<td>---------------</td>
<td>-------------------</td>
<td>------------</td>
<td>-------------</td>
</tr>
<tr>
<td>681 SF</td>
<td>none possible</td>
<td>As above</td>
<td>Cylindrical, fragment only. No lid.</td>
</tr>
<tr>
<td>5616 29K</td>
<td>none possible</td>
<td>As above</td>
<td>Cylindrical, fragments only. Flat base. Lid: Single incised line just below top, straight-sided</td>
</tr>
<tr>
<td>6045 29I</td>
<td>Ht: 10.95</td>
<td>As above</td>
<td>Cylindrical, round bottom. Lid: straight-sided, with single-incised line below top.</td>
</tr>
</tbody>
</table>

**OTHERS**

<table>
<thead>
<tr>
<th>MH and Sqr No.</th>
<th>Dimensions</th>
<th>Decoration</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>4228 SF</td>
<td>none possible</td>
<td>Incised lines but too damaged to identify the pattern.</td>
<td>Cylindrical, tapering to flat bottom.</td>
</tr>
<tr>
<td>4875 27J</td>
<td>NA</td>
<td></td>
<td>Lid only: Straight-sides, mushroom-shaped knob. Single incised line below top.</td>
</tr>
<tr>
<td>4412 27I</td>
<td>NA</td>
<td></td>
<td>Lid only: Straight-sided, incised line around knob and single incised line below top.</td>
</tr>
</tbody>
</table>
ORDNANCE

Portugal had always suffered a shortage of ordnance because of a dearth of metal ore, which allowed the growth of only a modest metallurgical industry. Consequently there were few competent gun founders in the country (Cipolla, 1965: 32), and much of her fleet was poorly and inadequately armed (Scammel, 1981: 292). The only Portuguese-made ordnance readily available to the Portuguese in the colonies was cast in Macao with Chinese labor. Ordnance from this source was in limited supply, however, especially after the middle of the 17th century when these foundries suffered a decline, although cannon were still produced there until 1680 (Allen, 1978: 14). The Portuguese were therefore forced to import guns from other countries in Europe in order to support their expansionist activities. It was also necessary to import foreign gunners, and a large proportion of those aboard Portuguese ships were Flemish or German (Cipolla, 1965: 31).
Bronze swivel guns

Two bronze swivel guns were found on the wreck. One, MH 32 (Fig. 23), was found during the 1970 excavation season; unfortunately, its position was not recorded. The second, MH 6513 (Fig. 24), was found in 27J, downslope of the stern area of the wreck. It is damaged, having a hole in the barrel as though a cannon ball or other projectile had hit it with considerable force. The damage is unlikely to be the result of an interior explosion because the broken metal does not flare outwards at the edges of the hole.

In the Museu de Marinha, Lisbon, there is an almost identical Portuguese gun of unknown provenance. An iron tail for aiming the gun is attached through the cascabel in the Lisbon example, but this feature is no longer present on the guns from the wreck. A comparison of the respective dimensions of the guns shows no significant size difference.

Dimensions

<table>
<thead>
<tr>
<th></th>
<th>MH 32</th>
<th>MH 6513</th>
<th>Lisbon</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
<td>108.5 cm</td>
<td>107.5 cm</td>
<td>110 cm</td>
</tr>
<tr>
<td>Calibre</td>
<td>8 cm</td>
<td>8.05 cm</td>
<td>8.2 cm</td>
</tr>
</tbody>
</table>

All three guns carry the Portuguese coat of arms (Fig. 23) and are decorated on the breech. MH 32 has acanthus decoration behind the muzzle ring and the coat
of arms as does the Lisbon gun.

Bronze swivel guns of this size were anti-personnel weapons, they fired shot weighing 3.75 lbs. They normally were mounted on the bulwarks of the forecastle or the poop deck where they could be trained on enemy boarders. In a combat situation as many as twenty breech blocks were carried for each gun (Daehnhardt, pers. comm.); these were stored close to the gun for which they were to be used. It is surprising, therefore, that only two breech blocks have been found. Possibly one or more guns of this type were salvaged from the ship as she sank, and all available breech blocks were salvaged at the same time.

Breech Blocks

<table>
<thead>
<tr>
<th>Catalog Number:</th>
<th>MH 364</th>
<th>MH 5681</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provenance:</td>
<td>21K</td>
<td>28I</td>
</tr>
<tr>
<td>Dimensions:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Length:</td>
<td>24 cm</td>
<td>24 cm</td>
</tr>
<tr>
<td>Diameter of chamber:</td>
<td>3.8 cm</td>
<td>3.5 cm</td>
</tr>
<tr>
<td>Depth of chamber:</td>
<td>18 cm</td>
<td>18 cm</td>
</tr>
</tbody>
</table>

These bronze blocks are of almost identical dimensions, showing that they were interchangeable powder charges for the bronze breech-loaders. Letters or marks can be seen on both blocks (Fig. 25) above
Figure 25. Breech Blocks showing Incised marks.
their touch-holes. These marks were incised after the blocks had been cast, but it is not known what they signify.

The blocks taper slightly from base to mouth and have rectangular lifting handles. A wedge driven through the slots in the side of the breech, pressing down on the projecting lip on the base of the block, would have held the block tightly in place. A third slot in the base of the breech was probably for drainage and could have been used to help lever the block free after firing.

Gun turret

Catalog Number: MH 6515

The concretion around the trunnions of the bronze swivel gun MH 6513 (Fig. 26) was cast and found to be that of an iron turret for the gun. Such a turret would have been mounted on the bulwarks of the ship. The gun was pivoted by means of the tail that passed through the cascabel.
Figure 26. MH 6515.
Iron Cannon

Of the six guns found in the 17th-century level of Fort Jesus (Kirkman, 1974: 150), none is Portuguese. One is French, one Venetian, one Swedish and the other three are English. The trend toward the use of foreign ordnance by the Portuguese is likely to have been reflected on the Santo Antonio de Tanna. It therefore seems likely that her ordnance was neither homogeneous in calibre or country of origin.

The three iron cannon found during the final excavation season were not raised, and neither, unfortunately, were they recorded in any detail. They were found amidships (Sqr. No's: 24I, 23K and 24K) in excellent condition with a minimum of corrosion or concretion, probably a result of their having been buried in the silt sediment at an early stage of their immersion.
PROJECTILES

There are a number of different types and sizes of projectiles in the armament assemblage, and they help identify the range of firearms that might have been present on the ship before she sank. We know that twenty cannon were salvaged by the Arabs and, as a result, there is a dearth of ordnance. Thus, only the projectiles are left to provide clues to what might have been present.

Shot

There are more than 600 shot in the artifact assemblage. A huge concretion of balls was found in 191, close enough to the area in which the shot locker would have been located to assume that this was indeed their original location.

The weights of the shot were calculated from their diameters because of the changes that occurred in the composition of the iron under water[2]. The variations in size and weight cover a wide range, with extremes of 2.5 lbs at the lower end and 38.05 lbs at the other. Even if some of the smaller size variations found are due to corrosion, the range of shot on the Santo Antonio de Tanna is very great indeed (Table II).
TABLE II. Numbers of Shot and their sizes\(^3\).

<table>
<thead>
<tr>
<th>Cannon Type</th>
<th>Calibre Shot dia.</th>
<th>Shot wt. number</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>inches inches</td>
<td>pounds</td>
</tr>
<tr>
<td>Falcon</td>
<td>2.75 2.51</td>
<td>2.50 1</td>
</tr>
<tr>
<td>Ordinary Minion</td>
<td>3.00 2.63 - 2.91</td>
<td>3.25 14</td>
</tr>
<tr>
<td>Large Minion</td>
<td>3.25 2.95 - 2.99</td>
<td>3.75 20</td>
</tr>
<tr>
<td>Small Saker</td>
<td>3.50 3.03 - 3.22</td>
<td>4.75 81</td>
</tr>
<tr>
<td>Ord. Saker</td>
<td>3.75 3.26 - 3.50</td>
<td>6 151</td>
</tr>
<tr>
<td>Extra Saker</td>
<td>4.00 3.54 - 3.74</td>
<td>7.31 87</td>
</tr>
<tr>
<td>Sm. Demi-culverin</td>
<td>4.25 3.78 - 3.90</td>
<td>9.00 77</td>
</tr>
<tr>
<td>Ord. Demi-culverin</td>
<td>4.50 4.09 - 4.25</td>
<td>10.26 9</td>
</tr>
<tr>
<td>Extra Demi-culverin</td>
<td>4.75 4.29 - 4.49</td>
<td>12.69 19</td>
</tr>
<tr>
<td>Small Culverin</td>
<td>5.00 4.53 - 4.72</td>
<td>14.90 12</td>
</tr>
<tr>
<td>Ordinary Culverin</td>
<td>5.25 4.76 - 5.00</td>
<td>17.31 44</td>
</tr>
<tr>
<td>Extra Culverin</td>
<td>5.50 5.04 - 5.24</td>
<td>20.00 68</td>
</tr>
<tr>
<td>Ordinary Demi-cannon</td>
<td>6.50 5.28 - 5.76</td>
<td>32.00 32</td>
</tr>
<tr>
<td>Extra-ordinary</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Demi-cannon</td>
<td>6.75 6.18 - 6.45</td>
<td>36.00 3</td>
</tr>
</tbody>
</table>

* The shot were measured in centimeters but were converted to inches in order to use the 17th-century gunnery manuals from which the gun calibres and shot weights in the above chart were derived\(^4\).

The extant shot could clearly have supplied a varied gun-deck. This variation might reflect a shortage of ordnance, since the necessity of ensuring that the correct charge and ball were supplied to the correct gun meant that batteries of similar-sized guns were the rule rather than the exception in maritime warfare.

The sizes of the shot in the concretion reflect the whole range found on the site. Those in other areas of the ship are largely (at least those so far excavated) in the 5 to 9 lb range. This distribution
suggests that the guns in use at the time of sinking were of fairly low calibres. The heavier shot found in the concretion could have represented supplies for Fort Jesus stored in the shot locker. Support for this interpretation comes from the distribution of the bombs. Of the two found on the wreck site, one was found in the shot-locker concretion and the other only two meters away from it. Since it is almost certain that these bombs would not have been used aboard ship, their location in the shot-locker makes it likely that other shot supplies were also stored there.

Bar shot

Bar shot were specifically designed to damage ships' rigging and were only employed in maritime warfare. The defenders of Fort Jesus would have used them against enemy shipping on their seaward sides.

Catalog Number: MH 6576
Provenance: None

In the single example found on the wreck the end-weight is disc-shaped and attached at right angles to an eight-sided bar that tapers away from the weight. This tapering might mean that the shot was designed to
incorporate two weighted bars linked at the center (Fig. 27). Such a bar spun rapidly in the air.

An 18th-century Dutch shipwreck, found in Cape Town in 1970, yielded a large collection of bar shot (Lightly, 1976: 305-316). Some shot had spheres or hemispheres as end weights. Others had one disc mounted at right angles to the bar with the opposing disc attached at a different angle. This arrangement is another method of facilitating the swinging action of the bar shot in the air. It is unlikely that the example from the site would have needed this refinement, however, if it was actually a linked shot.
Figure 27. MH 6576.
Bombs

Bombs were fired from mortars: squat, short-bored guns with reinforced chambers. Mortars, however, were not commonly a part of ships' ordnance. The French navy introduced them in 1682 (Boudriot, 1983: 125), but this was on large ships of the line, not on vessels of the size of the Santo Antonio de Tanna.

Catalog Number: MH 1649, 1704, 1832, 2123

Provenance: 10H, 18G, SF, 19I (shot concretion).

Dimensions:
- Diameters: 19.2 - 19.4 cm.
- Diameter of fuse holes: 2.35 - 2.75 cm
- Wall thickness: 1.4 - 2.3 cm

Large, heavy, iron shells which, when found, still contained quantities of corned powder (Fig. 28). All are of almost identical dimensions. The two on the wreck were found forward of the mast step, in association with the shot-locker concretion.

Because of their large diameters and the infrequent use of mortars aboard ships, it is extremely unlikely that these were part of the shipboard ordnance. They were probably being carried as supplies for Fort Jesus.
Catalog Number: MH 1649, MH 1832

Dimensions:
- Length: 9.95 cm 12.37 cm
- Dia. Top: 2.78 cm 2.675 cm
- Base: 2.24 cm 2.58 cm
- Hole: 0.885 - 0.6 cm 1.0 - 0.62 cm

These two bombs were found with their wooden fuses still in place. The fuse in MH 1649 (Fig. 29) is of very fine workmanship. Its base is flat, and the top is a bulb-shaped, hollow piece of wood driven into the stem of the fuse. There are twenty-one graduations, 0.44 to 0.46 cm apart, on the hollow, tapering stem (it is possible that there were one or two more on the damaged top).
These graduations were time markers for the fuse. The gunner cut the stem at the graduation he considered correct before inserting the fuse into the bomb.

Figure 29. MH 1649.

The fuse in MH 1832 is of cruder workmanship, the stem plain and not so carefully rounded. The bulb-like bowl at the top of the fuse is broken off, and it is not possible to tell if this was a separate attachment. The base is notched, a feature common to many of the fuses in the assemblage and probably designed to present a greater area of the firing composition to the powder.
Catalog Number: None

Dimensions:
  Height: 1,87cm
  Dia. of hole: 0,675cm

The top of a third bomb fuse, found alone, is a truncated dome with a flat lower surface, allowing it to lie flush with the surface of the bomb (Fig. 30). The shape of this is similar to that of some of the grenade fuses, but its larger size indicates that it must be for a bomb.

Figure 30. Top of a bomb fuse.
Iron grenades

Seventeenth-century iron grenades were shells filled with gunpowder with vents for fuses. The fuse was generally a wooden plug with a central hole which held the slow-burning composition, or quickmatch, that carried the fire to the gunpowder. The fuse was first lit from a constantly-burning slow match. A slow match was a cotton cord soaked in saltpetre or brandy and dipped in melted sulphur (Ffoulkes, 1916: 36). The grenade was thrown by hand, or sometimes from a catapult (Venn, 1672: Bk. 3: 7). This was often a hazardous operation since it was not possible to predict the time of explosion with any accuracy. After the end of the 17th century, there was a decline in the use of grenades because of their unreliability (Lens, 1967: 10).

Grenades commonly were used at sea in order to clear the decks of the enemy ship before boarding. Made from a variety of fabrics—tin, glass, wood and pasteboard among them, but most commonly from iron—they were a popular weapon with a high potential for destruction, and a good deal of ingenuity was used in designing some of the more complex models (e.g., Simienowicz, 1729: Bk. 4).

Venn (1672: Bk. 3: 7) says that the iron used in a
grenade should be the most fragile and least wrought available. Obviously a good quality wrought or cast, iron ball would not shatter easily and would therefore be less suitable for shrapnel. Most 17th-century gunnery and artillery manuals of Western nations give considerable detail about the design and dimensions of grenades (e.g., Venn, 1672: Bk. 3: 7).

More than thirty grenades were found on the site; twenty-two in a group in the bow area of the ship, outside the hull, and six in 26K. This grouping suggests that they were stored in containers, a normal procedure because of the danger of sparks. The grenades vary in diameter between 7.8 cm and 10.7 cm but are so badly corroded and oxidized that these measurements must err on the large side. A range of 7.5 to 8.5 cm would be a realistic estimation of their diameters. The extreme degradation of the iron suggests that the metal was an alloy. An attempt at analysis by P.N. Jones of the Royal Armament Research and Development Establishment, Kent, was unsuccessful because virtually no metal remained beneath the corrosion products (Jones, pers. comm.).

Some of the grenades still contained quantities of well-grained powder, and iron nails were embedded in the walls to make them even more destructive (Fig. 31).
Figure 31. Grenade with fuse.

The fuses in the grenades are not uniform; some are simple tubes, others have cupped or rounded heads with flat bases, while still others are similar to the one in Fig. 31. They all were found filled with a black deposit that must be the remains of their charges.

Five isolated fuses were found, and these proved to have roughly the same dimensions as those that were found in the iron grenades. Diameters are between 1.73 cm and 2.05 cm. No lengths are given because all the fuses were damaged at their top ends where the wood had been affected by the oxidation of the metal.
Glass grenades

Three glass grenades were found close together in 27I and 27J. The onion bottles were broken, but their fuses (Fig. 32) indicate that they were grenades. Many bottles of this shape (Fig. 33) were found, but in the absence of fuses it is impossible to tell if they were also to be used as grenades. These examples have no parallels in museums or in any published sources, but glass grenades are mentioned in Venn (1672: Bk. 3: 7) and in the manifest for the Olive Branch (Jameson, 1699).

Figure 32. MH 5245.

The fuses are simple hollow wooden tubes similar
to those in the iron grenades; they all have notches in their ends as in MH 5245. The function of the fuse would have been to ignite the powder as the bottle broke, rather than to act as a delayed action fuse as in the case of the iron grenades.

Fire pots

These usually were filled with a mixture of one part finely-mealed quick-lime and two parts good quality corned powder (Simienowicz, 1729: Bk. 4). This mixture would have been sealed with some strong paper or a wooden lid, and a cloth impregnated with tar laid over the top. A length of slow match, tied through the handles of the pot, was lit from both ends before the pot was thrown. As the pot hit the enemy deck it broke open, allowing the match to ignite the powder which, as it exploded, caused the quick-lime to fly up in a cloud of dust, blinding and confusing the enemy.

Alternatively, the pots were sometimes filled with a mixture of powder and broken musket shot (Sellar, 1691: chap. 19), which was sprayed across the deck as the pot exploded.
Dimensions:
  Height: 10 cm.
  Interior diameter of neck: 1.5 cm
  Diameter at shoulder: 10 cm

Thin-walled pots with four small handles on their shoulders. The necks are narrow and everted and the bases indented (Fig. 34). There are eight to ten broken pots and two complete ones. The fabric is fine, brick-red earthenware and is quite fragile.

Figure 34. MH 193.
POWDER LADLE

Powder ladles were used to load the charge into the cannon and carried a specific amount of powder. Examples in the Tower of London show that the ladle was often combined with a rammer, which was mounted on the opposite end of the long wooden handle. Such a combination cut down the number of tools on the already extremely cluttered gun deck.

Catalog Number: MH 3483
Provenance: 25J
Dimensions:
  Length: 30 cm
  Width: 9.1 and 9.3 cm
  Depth at handle: 5.7 cm

The blade of the ladle is of iron and the handle of wood. Most of the handle has degraded, leaving only that part actually in contact with the iron (Fig. 35).

There were rules governing the correlation between ball and ladle sizes, Binning (1676: 56-62) states that: For 1-8 lb shot the ladle should be 3 times the diameter of the ball in length. For 8-18 lb shot the ladle should be 2.5 times the diameter of the ball in length. For 18-48 lb shot the ladle should be twice the diameter of the ball in length. And that the
breadth of the ladle should be five-sixths of the diameter of the ball.

Thus, this ladle could have served either a 10-cm ball (one third the length of the ladle) for a small saker or a 12-cm ball (2.5 times its diameter equalling the length of the ladle) for a small culverin. The breadth of the ladle, between 9.1 and 9.3 cm, falls between the ideal for either ball, as five sixths of 10 cm is 8.3 cm and of 12 cm is 10 cm. In the light of the distribution and frequencies of shot on the wreck suitable to weapons, it is likely that this ladle was used for the small saker.
CARTRIDGE MOULDS

Cartridge moulds were in regular use by all of the seafaring nations in the 17th century, having been developed in Henry VIII's time (Padfield, 1973: 66).

A seventeenth-century Italian writer, Moretti (trans. Moore, 1683: 70) says "all pieces of artillery are loaded with powder after two manners, vis either with a ladle,....., or with cartridges, which are used upon the sea for dispatch and security in not firing the powder."

An English writer (Sellar, 1671: 172) stipulates that, at sea, a gun should be charged with a cartridge and not with a ladle. This would have been especially important after the larger, breech-loading guns were replaced by muzzle-loading ordnance. Moving powder in a ladle from a budge barrel to a muzzle loading gun was hazardous, as any stray spark could ignite the powder. A budge barrel is "a little barrel containing 100 cwt of powder - has a leather purse made fast at the end which is to shut over the powder to keep it from fire". (A Military and Sea Dictionary, 1711).

That the Portuguese also used cartridges at this time is shown in the Tragic History of the Sea: "We fought on until we had only two barrels of powder left
and twenty-eight cartridges left" (Boxer, 1959: 92).

Catalog Number: MH 282, 283, 284, 253, 415

These are solid, wooden, truncated cones (Fig. 36). All five were found on the port side of the ship's main mast step, just forward of the pump lockers.

Fashioned from canvas or heavy paper, cartridges were constructed with a wooden mould, or 'former', of a specific size for each gun. Binning (1676: 56-62) gives a general rule for making cartridges which states that for balls of 1 lb to 8 lb the corresponding cartridge is three times the diameter of the ball in length. For balls of 8-18 lb the cartridge is two and a half times the diameter of the ball in length.

According to this rule, there is a significant discrepancy between the wooden cones and the dimensions of the ideal mould. A tapering cartridge, however, would need to be longer than a cylindrical cartridge made for the same size ball. The volume of a tapering mould of 10.3 cm diameter (at the widest end) is very similar to that of a shorter cylindrical mould with the same diameter.
MH 282
(Vol of a cylinder = \( \pi r^2 h \))

Volume of cylinder based on diameter of large end:
\[ A = 3.14 \times 26.52 \times 35.4 = 2947.86 \text{ cm}^3 \]

Volume of cylinder based on diameter of small end
\[ B = 3.14 \times 12.78 \times 35.4 = 1420.57 \text{ cm}^3 \]

\[ A + B = 4368.43 \quad 2 = 2184.21 \text{ cm}^3 \]

Volume of cylinder using the height as 2.5 x the larger diameter (Binning's rule):
\[ C = 3.14 \times 26.5 \times 25.75 = 2144.27 \text{ cm}^3 \]

The volume of the ideal cylinder was calculated twice; once with the height being three times that of the diameter of the ball and once with it 2.5 times that of the diameter (to establish the weight of the ball by Binning's rule). The figure that correlated most closely with the actual volume was then compared with the weight of the ball corresponding to the diameter of the widest end of the mould. The correspondence was satisfactorily close to Binning's guidelines in three and possibly four of the five cases. MH 284 would have produced a cartridge for a ball in the 1-8 lb range while MH 282, 353, 415 and 1775 would have been for balls in the 8-18 lb range (Table III).
TABLE III. Dimensions and Volumes of the Cartridge Moulds.

<table>
<thead>
<tr>
<th>MH No.</th>
<th>Length (in cm)</th>
<th>Max. dia. (cm)</th>
<th>Min dia. (cm)</th>
<th>Actual vol. (cm³)</th>
<th>Ideal Ball vol. (cm³)</th>
<th>wt.* (lb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>282</td>
<td>35.4</td>
<td>10.3</td>
<td>7.15</td>
<td>2184</td>
<td>2144</td>
<td>9</td>
</tr>
<tr>
<td>353</td>
<td>35.2</td>
<td>10.1</td>
<td>6.6</td>
<td>2011</td>
<td>2021</td>
<td>9</td>
</tr>
<tr>
<td>415</td>
<td>32.5</td>
<td>10.2</td>
<td>7.4</td>
<td>2025</td>
<td>2082</td>
<td>9</td>
</tr>
<tr>
<td>1775</td>
<td>36.5</td>
<td>11.75</td>
<td>6.7</td>
<td>2619</td>
<td>3182</td>
<td>12.5</td>
</tr>
<tr>
<td>284</td>
<td>21</td>
<td>9.8</td>
<td>6.85</td>
<td>2356</td>
<td>2216</td>
<td>7.06</td>
</tr>
</tbody>
</table>

* Derived from Sellar "A table of the weight of iron shot in pounds and ounces . . . ." (1671: 132).

MH 1175 and MH 284 have been conserved in polyethylene-glycol, and their volumes do not show the same correlation to the ideal as those that are still wet and unconserved. It could be that the PEG conservation process has distorted the dimensions of these two moulds.

Because the cartridge diameter was the same as the diameter of the shot it was used with, it is possible, using 17th-century gunnery manuals as a guide (i.e., Smith, 1691: 96), to determine what kind of cannon they served. Thus, MH 284 would have made a cartridge fitting an Extra-saker, MH 1775 an Ordinary demi-culverin and MH 282, 353 and 415 a Small Demi-culverin. Although none of these manuals are
Portuguese, the rules and measurements they give would have applied to the majority of 17th-century ordnance, since the latter was fairly standardized throughout most European nations. It should also be remembered that the Santo Antonio de Fanna may well have been carrying English or other foreign-made cannon.

LINTSTOCK

Lintstocks were used to light the charge in the great gun or pole to allow the gunner a safer distance in case of a misfire.

Catalog Number: MH 4406
Provenance: 27I
Dimensions:
  Remaining length: 9 cm

One of the concretions was found to contain this lintstock with a length of lint still in place (Fig. 37).
Figure 37. MH 4406.
CANNON QUOINS

In 1781, Mountaine (p.61) described the cannon quoin as "a piece of wood in the form of a wedge, used between the Stool Bed and the Cannon which serves to elevate the ordnance." Quoins could be used in multiples, one on top of the other, to achieve the desired elevation.

At least ten of these were found on the wreck in varying degrees of preservation (Table IV). They are all made of wood and are wedge-shaped with rounded handles protruding from the flat end. The handles, in all cases, are carved as single units with the bodies of the quoins. This description applies to a quoin of any period in any nation; it being a simple tool that needed no refinement.

A number of the quoins found on the Santo Antonio de Tanna show signs of considerable wear at the thin end where much of the weight of the cannon would have rested (Fig. 38).
<table>
<thead>
<tr>
<th>MH No.</th>
<th>Sqr No.</th>
<th>Length</th>
<th>Width</th>
<th>Depth</th>
<th>Handle: 1. dia</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1022</td>
<td>24H</td>
<td>30 cm</td>
<td>26 cm</td>
<td>&gt;10 cm</td>
<td>6.7 cm</td>
<td>Badly worm-eaten. Measurements approx.</td>
</tr>
<tr>
<td>468</td>
<td>Sp.</td>
<td>40 cm</td>
<td>24 cm</td>
<td>12 cm</td>
<td>5.5 cm</td>
<td>Good condition. Handle roughly carved following grain of wood. Distinct striations on the base of the quoin, (wear traces?). Considerable wear on thin end of wedge.</td>
</tr>
<tr>
<td>5849</td>
<td>28J</td>
<td>32 cm</td>
<td>16.5 cm</td>
<td>8 cm</td>
<td>5.5 cm</td>
<td>Extremely worn at thin end to the extent that a semi-circular hole is worn away in its center. Also thin at the sides on the thicker end. As in MH 468, sections on top of thick end at the center and sides are worn down.</td>
</tr>
<tr>
<td>30</td>
<td>NL</td>
<td>35 cm</td>
<td>23 cm</td>
<td>10 cm</td>
<td>5.5 cm</td>
<td>Untreated, dried out. Surface very badly cracked large pieces have broken off. Measurements approx.</td>
</tr>
<tr>
<td>740</td>
<td>NL</td>
<td>41 cm</td>
<td>27.5 cm</td>
<td>12 cm</td>
<td>degrad-</td>
<td>Very good condition, no apparent wear.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>ed</td>
<td></td>
</tr>
</tbody>
</table>
### TABLE IV (continued)

<table>
<thead>
<tr>
<th>MH No.</th>
<th>Sgr No.</th>
<th>Length</th>
<th>Width</th>
<th>Depth</th>
<th>Handle: 1. dia</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>519</td>
<td>21K</td>
<td>&gt;31 cm</td>
<td></td>
<td>10 cm</td>
<td></td>
<td>Half only.</td>
</tr>
<tr>
<td></td>
<td>NL</td>
<td>27.5 cm</td>
<td>24 cm</td>
<td>11 cm</td>
<td>6.6 cm</td>
<td>Very worm-eaten and degraded.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>10 cm</td>
<td></td>
</tr>
<tr>
<td>423</td>
<td>20H</td>
<td>44 cm</td>
<td>&gt;26 cm</td>
<td>10,5 cm</td>
<td></td>
<td>Only half present.</td>
</tr>
<tr>
<td>466</td>
<td>24H-G</td>
<td>29 cm</td>
<td>18 cm</td>
<td>11 cm</td>
<td></td>
<td>Possible quoin, badly distorted.</td>
</tr>
<tr>
<td>784</td>
<td>NL</td>
<td>35 cm</td>
<td>22 cm</td>
<td>7 cm</td>
<td></td>
<td>Possible quoin, badly degraded.</td>
</tr>
</tbody>
</table>

Sp - Spoil
NL - no location
CARRIAGE TRUCKS

Gun carriages had small, solid timber wheels, called trucks, which were specifically designed for shipboard use. A carriage had four trucks with the two on the ship's side being the largest (Padfield, 1973: 58).

Eight trucks were found on the site (Table V.); the two largest are almost identical in size and were found close enough together to make it likely that they were from the same carriage (Fig. 39).

Figure 39. MH 6349.
<table>
<thead>
<tr>
<th>MH No.</th>
<th>SQ No.</th>
<th>Thickness</th>
<th>Ext. dia</th>
<th>Int. dia</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>3649</td>
<td>25J</td>
<td>12 cm</td>
<td>52 cm</td>
<td>15 cm</td>
<td>Made from two pieces of wood, joined by a dove-tail joint and two iron bolts.</td>
</tr>
<tr>
<td>6466</td>
<td>23I</td>
<td>13 cm</td>
<td>53 cm</td>
<td>13.4 cm</td>
<td>As above.</td>
</tr>
<tr>
<td>392</td>
<td>21/20F</td>
<td>9 cm</td>
<td>33 cm</td>
<td>10 cm</td>
<td>Carved from a single piece of wood.</td>
</tr>
<tr>
<td>4623</td>
<td>24K</td>
<td>10.6 cm</td>
<td>30 cm</td>
<td>13.7 cm</td>
<td>As above. Measurements approx. Only half of truck present.</td>
</tr>
<tr>
<td>4965</td>
<td>25K</td>
<td>11 cm</td>
<td>29 cm</td>
<td>12 cm</td>
<td>As above, only half of truck present.</td>
</tr>
<tr>
<td>6170</td>
<td>29J</td>
<td>10.7 cm</td>
<td>25 cm</td>
<td>10 cm</td>
<td>As above, only half of truck present.</td>
</tr>
<tr>
<td>3989</td>
<td>26k</td>
<td>10.7 cm</td>
<td>24 cm</td>
<td>10 cm</td>
<td>As above, only half of truck present.</td>
</tr>
<tr>
<td>5519</td>
<td>28J</td>
<td>&gt;8 cm</td>
<td>&gt;22 cm</td>
<td>&gt;11 cm</td>
<td>Extremely degraded.</td>
</tr>
</tbody>
</table>
GUNPORT LID

Corrosion caused by sea water was a major threat to the safe functioning of the ordnance aboard a ship. When not in combat, therefore, the guns were kept inboard and their ports sealed with wooden lids.

Catalog Number: MH 6194
Provenance: 29I

The lid is made of three flat sections of horizontal planking (Fig. 40). The two outer planks are considerably wider than the central one:
Top plank: 25 cm broad
Central plank: 13 cm broad
Bottom plank: 30 cm broad
The planks are held together on the exterior by two, or possibly three (only one is present), vertical wooden straps. Two interior vertical iron straps would have been hinged to similar straps attached to the hull of the ship.

The wooden exterior straps are held to the planks by small 0.55 cm square-headed iron nails. These straps are firmly fixed to the interior iron straps by four bolts which pass on both sides of the central plank.
Figure 40. Gunport Lid.
To achieve the curve on the gun lid the two outer planks are thicker on their outer edges (6 cm and 5.5 cm respectively) than on their inner ones (4 cm). The central plank (3.5 cm) is thinner again than both of these. The distinct curvature of the gun lid must reflect that of the hull. Thus it was probably from a gun port near the stern of the ship, as its location in 29I suggests.

The lid would have been held open by chains or ropes passing through the two holes in its lower corners. The absence of concretion in these holes suggests that ropes rather than chains were used in this case. An iron ring attached by a pair of iron bolts to the lower plank on the interior of the port lid would have been used to pull the lid closed.
CHAPTER V

CONCLUSIONS

Of the naval power of Portugal, it is totally unnecessary to give any detail, for where there is a perfect absence of substance, the visionary shadow can neither amuse, nor instruct. (Charnock, 1801: 305).

This 19th-century statement reflects how completely the Portuguese had failed to maintain the advantages their discovery of the sea-route to India had conferred on them. At the time of the sinking of the Santo Antonio de Tanna they were already well on their way to the ignominious position so scathingly described by Charnock a century later. A number of factors had contributed to this decline. The religious conviction that had carried the Portuguese explorers to such heights in the 16th century had been compromised in the struggle to retain power, and the priesthood was no longer the driving force it had been. Likewise, those 17th-century Portuguese who wielded secular power in the Indian Ocean did not rally to the cause of Portugal when she was threatened by the Arabs, Dutch and English. Instead, their primary concern was for personal wealth and self-aggrandizement as evidenced by
the shameful behavior of General Luis de Mello Sampaio during the siege of Fort Jesus. His self-seeking attitude was pervasive, and this attitude contributed in no small measure to the appalling mismanagement of Portuguese affairs in the Indian Ocean.

The India fleet is a case in point. Conditions and pay were poor, and few Portuguese were willing to join a service in which the mortality rate was between 30 and 50% (Boxer, 1969: 222). Furthermore, there was a shortage of ships because of the poor state of the economy. At the time of the siege of Mombasa the major part of Portugal's Indian Ocean fleet was in the Persian Gulf, blockading the Arabs. As a result there were only three frigates and two galliots in the whole of Portuguese India (Axelson, 1960: 162). The Viceroy and his Council were hard pressed to decide what they should do about the siege, since sending these vessels to Mombasa meant that important Portuguese settlements such as Goa were left undefended. Eventually, however, they dispatched two of the frigates and both galliots to the relief of Fort Jesus. The subsequent loss of the Santo Antonio de Tanna was, therefore, a serious blow to the Portuguese.

It is not clear what kind of vessels the Portuguese fleet would have comprised. The terms
'frigate' and 'galliot' pose a problem of definition, since they were not used to describe specific vessel types. Galliot, for example, just meant a small coastal vessel (Boxer, 1969: 57), while the term 'frigate' was used rather indiscriminately to designate any fast, armed vessel. In Europe the term was applied more restrictively to mean a fifth- or sixth-rate carrying a single gun-deck with an average complement of 36 guns. It was not used in this sense by the Portuguese as evidenced by the complaints of two 18th-century viceroys that the use of large frigates in the Indian Ocean with 50 to 70 guns was uneconomical (Boxer, 1969: 211). Large vessels such as these probably were uneconomical because they required large crews, which presented difficulties in view of the shortage of skilled personnel. They were probably also unsuitable because they were more powerful than necessary for Indian Ocean warfare.

A comprehensive definition of the term 'frigate' as it was used in the late 1600s is proposed by Gay (1982: 3):

After 1650 larger frigates had a main battery on a flush lower deck under a flush upper deck carrying a half battery abaft the mainmast and sometimes a few guns forward. Smaller frigates had either a single battery on a completely exposed upper deck or carried
also a small quarter deck covering the aftermost guns.

It is a fair assumption that this definition applies to the Santo Antonio de Tanna. The Historia da Mombaca says that she had a lower gundeck but this could mean either a flush lower deck or a quarter deck. Whichever the case, the gunport lid found on the site signals the presence of a covered gundeck of some description.

The Historia da Mombaca also says that the Santo Antonio de Tanna was a 42-gun frigate carrying 50 guns. The fact that she was carrying more guns than her normal complement indicates that the frigate had been up-graded to cope with the siege. To judge from the frequency and distribution of shot on the site, her 50-gun complement seems to have been largely made up of fairly small ordnance. A large proportion of the shot in the assemblage are in the 17-32 lb range, but almost all of these were found in the shot concretion. Those balls weighing 17, 31 lb and 20 lb (Table 2. p. 77) could have been used on the Santo Antonio de Tanna, since their weights are in accordance with those used at sea, but their location suggests that they were not in use during her final battle.

It is highly unlikely that the 32 lb shot would have been used aboard, and I have argued that they were
probably supplies for the Fort. The majority of shot this size were found in the shot locker concretion and were not distributed around the site as would be the case had they been supplies for ordnance on the gundeck.

The shot found outside the shot locker concretion were largely in the 5-9 lb range. It appears, therefore, that the guns actually in use on the ship's gundecks were the 9 lb Small demi-culverins, and 6 lb Ordinary sakers, or similar types. It is surprising, however, that the range of ordnance that appears to have been in use on the Santo Antonio de Tanna should reflect so closely that of the smaller Dartmouth. Wrecked off Mull in 1690, this British frigate carried a complement of 18 demi-culverins on her lower deck, ten sakers on her upper deck and four minions on her quarter deck (McBride, 1976: 190). This similarity suggests that the Santo Antonio de Tanna was carrying very light ordnance for her size and task. Although we can make this assumption about the complement on her gundecks, it is not possible, from the archaeological evidence, to say how many of these pieces she carried.

The objects in the catalog show, however, that the Santo Antonio de Tanna was carrying all the normal accoutrements of a ship of war. The presence of small
firearms is confirmed by the quantities and sizes of the lead shot. The carriage trucks, quoins, powder ladles and cartridge moulds confirm her status as an active warship, and the utilitarian nature of the weapons indicates that they were carried for use rather than status or adornment. That so many of the smaller, more fragile objects, such as the edged weapons and powder flasks, are not present in museum or other collections reveals not only that they had no intrinsic value but that they were considered tools by the men who used them, and not worth collecting or saving. It might also reveal an Indian Ocean origin, though there is no evidence for this.

The lack of standardization in the flasks, gunflints and projectiles suggests that the Portuguese had to make do with what was readily available, rather than the equipment of their choice. This expediency is also reflected in the low calibre of the ordnance aboard. Had large guns been at hand, the Portuguese no doubt would have mounted them on the Santo Antonio de Tanna's gun decks because of the seriousness of the siege. It seems, therefore, that this collection reflects the straitened circumstances of the Portuguese at this time.

The Santo Antonio de Tanna, nevertheless, seems to
have been the ideal vessel for the Portuguese needs (other than relieving Fort Jesus) as she would have been capable of outfighting the less sophisticated Arab vessels and of outrunning those of the more powerful Dutch and English.

In the event of a future excavation some of these conclusions could be tested. First, a more rigorous recording of the sizes and positions of all the shot would test the assumption that only small ordnance was in use on the gundecks of the Santo Antonio de Tanna. The locations of many of the shot excavated from the site are not clear, and this should be prevented in future. Second, careful measurement and description of those cannon on the sea bed also would clarify the size of ordnance. And, third, future excavations possibly would confirm whether the larger balls on the ship might have been used as ballast, which was a fairly common practice at this time (McBride, 1976: 196).

An aspect of the ordnance that I have been unable to study is the breeching of the guns. It is certain that numbers of the blocks and much of the rope excavated must be breeching and tackle for the ordnance, rather than rigging. The guns needed to be strongly anchored to the decks and sides of the ship to control the recoil. If it were possible to identify
the blocks used for the ordnance, an analysis of their distribution might reveal the location of the pieces they served when in use.

The excavations already completed have provided some insight into the state of the Portuguese fleet in the Indian Ocean in the 17th century. This study reveals that the ordnance on the *Santo Antonio de Tanna* was inadequate, which is not surprising in view of the economic plight of the Portuguese. She seems, however, to have been a good ship and an adequately-equipped vessel in other respects. This examination, therefore, has helped to dispel the shadow obscuring our vision of the *Santo Antonio de Tanna* as she was during the struggle for the Indian Ocean.
NOTES

1. Newly cut or broken flint rapidly undergoes a change in appearance as the surface of the stone reacts with the atmosphere (Lotbiniere, 1984: 207). This cortication hides the true color of the flint. The cortication on the flint from the site was mainly a pale grey. On the examples that had fresh chips the true color appeared to be an opaque dark grey.

2. The calculations used to reckon the weight were simple specific gravity/volume equations. First the volume of each ball was determined using $V = \frac{4}{3}\pi r^3$. With the density of cast iron taken to be 7.5, the weight of the ball was deduced:

- Diameter of ball = 6.4 cm:
  
  \[ V = \frac{4}{3} \times 3.142 \times 3.75^2 = 220.92 \text{ cm}^3 \]

  Weight of ball = $V \times$ specific gravity of iron:
  
  \[ 220.92 \times 7.5 = 1656.9 \text{ g} \]
  
  \[ = 3.69 \text{ lb} \]

3. It is unwise to place too much emphasis on the names of the guns listed in this chart because of the great variation that occurred between guns of the same name in the 16th and 17th centuries.

Guilmartin (1981: 74) stresses the competence and efficiency of the early gun founders. He shows that
the Portuguese and British bronze guns on the
Santissimo Sacramento follow established, standardized
models with great dimensional precision. The two
bronze swivel guns on the Santo Antonio de Tanna and
the one in the Museu de Marinha are clearly made to the
same standard model.

In contrast, Blackmore (1976: 391) says that there
was a wide divergence of opinion among contemporary
writers on the different size of the different cannon
types. He quotes Tartaglio, a 16th-century writer as
follows:

through the intolerable fault of careless or
unskillful gunfounders all our great pieces
of one name are not of one length, nor of one
weight, nor of one height in their mouths,
and therefore the gunner's books and tables
which do show that all our great pieces of
one name are of an equal length, and of an
equal weight, and of an equal height in their
mouths, are erroneous.

These comments, and many others along the same lines by
16th- and 17th-century writers, show that the
standardization of which Guilmartin (1981: 74) writes
is the exception rather than the rule and probably
applied to bronze guns more than to iron ones.

The reason for the lack of standardization is that
all guns prior to the 18th century were cast in
individual moulds. Only the better gun founders seem
to have used models for the different sizes.

Another factor militating against the identification of the ordnance aboard the *Santo Antonio de Tanna* is that of windage. This, the difference between bore size and ball size, might vary with the gunner. One gunner might follow Sellar's rule (1691: 174) and "divide the bore of the piece into 20 equal parts and one of these parts is sufficient vent for any piece," or, as Sellar goes on to say, other gunners might allow the shot to be 0.25" less in diameter than the bore of the gun. This, however, "makes the shot too big for a cannon and too little for a faulcon."

If the gunners aboard the *Santo Antonio de Tanna* were sloppy, it is likely that they would have allowed more windage than necessary, making their guns less efficient but reducing their variety, i.e. shot to fit a small saker might have been used in an ordinary saker.

4. The Portuguese weight unit was the arretal (Lewis, 1961: 203). This probably differed only very slightly from the English pound used in the gunnery manuals.
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