Wrecked ships and ruined empires: an interpretation of the *Santo António de Tanna*'s hull remains using archaeological and historical data

BRIAN JORDAN

Introduction

While attending the International Symposium on *Archaeology of Medieval and Modern Ships of Iberian-Atlantic Tradition* in Lisbon last September, I was fortunate to be invited with the rest of the speakers to attend a function at the Expo'98 Portugal Pavilion. A ship graciously provided by the Navy picked us up near the Academia de Marinha and transported us down the Tagus River. As we approached Expo'98 I saw for the first time the newly restored *D. Fernando II e Glória*, majestically anchored and serving as a living museum for the thousands of visitors during the summer of 1998. I felt a connection with this great ship that had served Portugal commendably for over 100 years. Launched in 1843, the *D. Fernando II* was the last frigate under sail to serve in the Portuguese Navy and the last warship on the *Carreira da Índia*, the regular route from Portugal to its colonies since the sixteenth century. In a sense, this ship was the direct descendant of the *Santo António de Tanna*, a ship that had served in much the same capacity more than 300 years ago. Both ships had more than their classification as frigates in common. Both were built in India and outfitted in Goa: *D. Fernando* in Damão and *Santo António* in Baçaim. Constructed entirely of teak, both ships were full-rigged and carried a complement of 50 guns on two decks. Each frigate made runs on the *carreira*, and was instrumental in supplying troops, provisions and armaments to Portugal's colonies and fortifications in and around the Indian Ocean. Lastly, both vessels were wrecked and left unattended for many years before specialists became interested in restoring them to their previous glory: *D. Fernando II e Glória* caught fire in 1963 and partially sank in the Tagus River until she was refloated in 1992 and restored for the Expo'98; *Santo António de Tanna* sank in 1697 under enemy fire at the base of Fort Jesus in Mombasa, Kenya, was rediscovered in the late 1960's and excavated by a team of archaeologists and volunteers from 1977 to 1980. To better understand the history of a ship-type such as the frigate, one must re-visit its origins in the seventeenth century. My purpose in Portugal was to attempt this, for I had been asked to provide a lecture on the interpretation of the *Santo António de Tanna*'s hull remains using archaeological and historical data.

The Ship

Research into the history of the *Santo António de Tanna* was conducted in 1984 by Jean-Yves and Maria Luísa Blot in India and Portugal (Blot and Blot, 1984). In 1996, the author conducted additional research in Lisbon. The *Santo António* was named after St. Anthony of Padua and the city of Tana, situated near Baçaim, India. Since Tana possessed no known shipyards, the 42-gun frigate was probably named for the area that supplied the wood for its construction. The Baçaim region was noted for its massive teak (*Tectona grandis*) forests and in 1678, the *Santo António de*

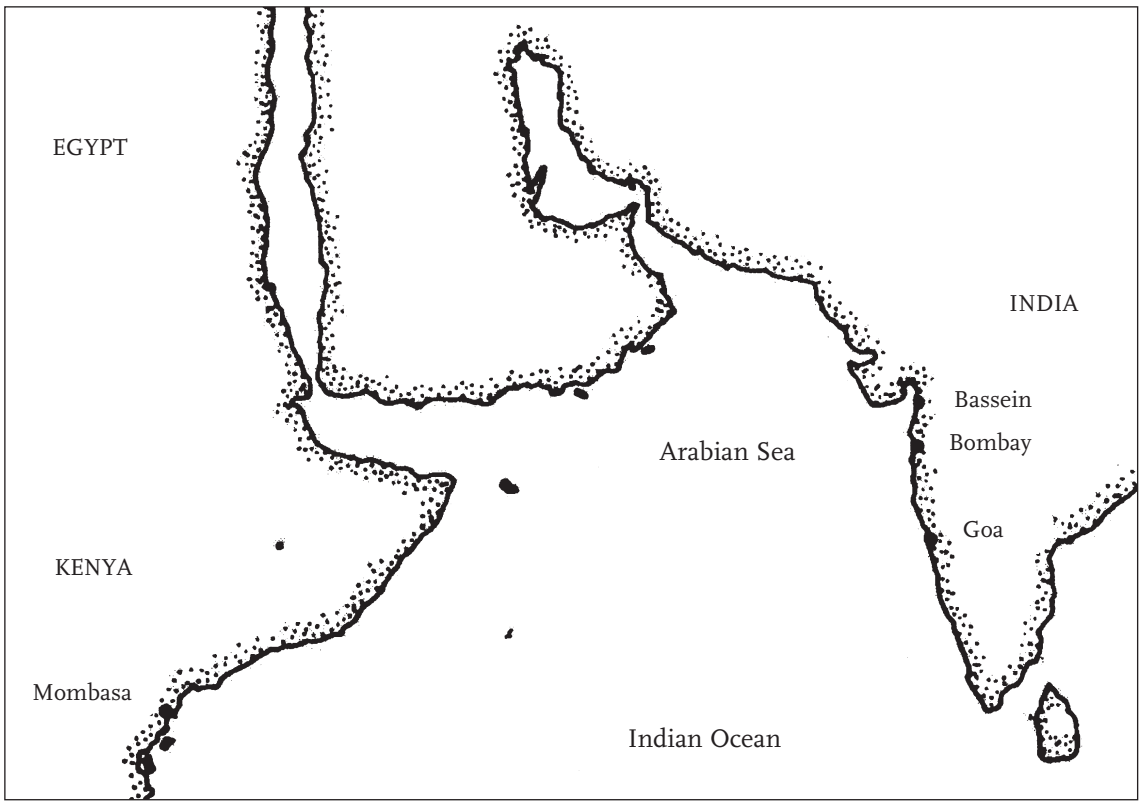

FIG. 1 – Map of India, based on original map drawn by M. Jacobsen.

Tanna was commissioned as a *fragata* in the Baçaim shipyards (Fig. 1). The shipbuilding facility in Baçaim was known for constructing vessels of superior quality and was the third most noted shipyard in Portuguese India. Difficulties in funding and procurement of adequate supplies delayed the completion of the frigate until 1680. *Santo António* was finished up to the gun decks and floated to Goa in September of 1681. In the royal shipyards the new frigate was outfitted with sails, rigging, cannon, supplies and men. Over the next eleven years, the *fragata's* whereabouts are sparsely recorded. In 1689 the *Santo António* carried bronze cannon to Diu and gunpowder to Mombasa (AIG, 1173, f° 239v, in Blot and Blot, 1984, p. 42; Esparteiro, 1978, p. 56)[1]. After two ships failed to arrive from Lisbon in 1693, the *Santo António* was the only vessel available to carry a cargo consisting almost entirely of 424 barrels of saltpeter to Lisbon (AIG, 1174, f° 91, in Blot and Blot, 1984). The frigate returned to Goa in 1696 and was prepared for a relief mission to Mombasa (Esparteiro, 1978)[2]. During this time, new portholes were opened in the hull and the *Santo António* was converted from 42 to 50 guns (AHU, n.° 61, Caixa 365 (ex-39), in Blot and Blot, 1984, p. 26)[3]. In addition to the food and supplies for Fort Jesus, the frigate probably carried a complement of between 100 and 125 soldiers and sailors of both Portuguese and Indian descent (AIG, 1174, f° 281, November 20, 1696, in Blot and Blot, 1984, p. 60). Two major historical sources survive today which detail the accounts of the siege of Fort Jesus and the subsequent sinking of the *Santo António*[4]. In efforts to relieve the fort from enemy attack in 1697, *Santo António's* anchor cables were severed by heavy cannon bombardment from Arab fortifications: the frigate drifted into the shallows under the walls of the fort and lost its rudder. Eyewitness accounts of this final siege show that the *Santo António de Tanna* was strongly built and had the frigate not lost its rudder, probably would have survived the engagement. During the next high tide the *Santo António* took on water and sank to the bottom of the harbor, where the hull remained until rediscovered almost 300 years later.

Excavation and Recording

In 1976 the National Museums of Kenya invited the Institute of Nautical Archeology (INA) to survey and assess a shipwreck site believed to be the *Santo António de Tanna*. The survey revealed extensive hull remains and several magnetic anomalies. With the assistance of the National Museums of Kenya and many volunteers, INA conducted the excavation of this site from 1977 to 1980 under the guidance of Robin Piercy. The hull remains were preserved from the stern to the bow (approximately 30 m of extant keel length) and to the bottom of the first deck on the port side (Fig. 2). In addition to these structural remains, thousands of artifacts dated to the seventeenth century were mapped and recovered.

During the 1978 and 1979 field seasons Jeremy Green of the Western Australian Maritime Museum recorded the shape of the hull to the inside ceiling planking by taking lateral sections at 1-meter intervals along the ship at right angles to the keelson (Fig. 3). Photogrammetric documentation was completed and the datum points were plotted so that the hull sections and photogrammetric data could be related and incorporated in the overall plans. Sections of ceiling planking were also removed and some of the principle structural timbers were recorded, providing a limited scantling list. Unfortunately due to the political climate in Kenya and lack of adequate conservation facilities to properly document and preserve the wood, the excavation of the ship's timbers was not completed. The remaining 1980 and 1981 seasons were devoted to the conservation of the artifacts recovered during the previous field seasons. Several publications and two unpublished Master's theses discuss in detail the artifacts found during the excavation (Thompson, 1988; Darroch, 1986; Green, 1991, p. 8-9; Hall, 1991, p. 18-22; Oertling, 1991, p. 14-15; Piercy, 1977, p. 331-347; 1978, p. 301-319; 1979, p. 303-309). Artifacts of particular significance to the interpretation of the ship's hull remains will be discussed in the appropriate sections.

Hull remains

The *Santo António de Tanna* was built entirely of teak (*Tectona grandis*) and secured with iron fasteners. This corresponds with Lavanha's early seventeenth-century manuscript in which he states that wooden treenails were inferior for building ships that sail in warm waters (Lavanha, 1996, p. 147). Teak is often mentioned in historical texts and for good reasons: teak is easily worked with hand tools, has excellent dimensional stability, and possesses a very high degree of natural durability. An added benefit not often discussed is that teak does not cause rust or corrosion when in contact with metal (Forest Products Laboratory, 1987 rev., p. 1-37).

The wreck spans approximately 30 meters and includes the keel and keelson along this entire length. The keelson measured approximately 0,30 m square in cross-section and 26,5 m in length (Scantling list provided in Table 1). One horizontal hook scarf approximately one meter in length was recorded 0,63 m abaft of the mast step; no scarf details of the keel were recorded[5]. The mainmast step is formed from a 4 m long expanded portion of the keelson with a support piece added to each side for a total width of 0,70 m. The mast-step mortise was measured at 0,48 m in length with a cross-section of 0,21 m by 0,16 m. Several deck stanchions were also observed during the excavation, five still *in situ*. The longest preserved stanchion was three meters in length, and all were approximately 0.22 m square in cross-section. They were stepped into the keel in much the same way as the mast. The distance between stanchions ranged from 1,3 m (in the mast-step region) to 3,5 m, but the majority of mortises were 2,3 m apart.

Surrounding the mast step was a pump well, of which several walls and vertical support beams were recovered. This area was used to house the pumps, pump supplies, and also may

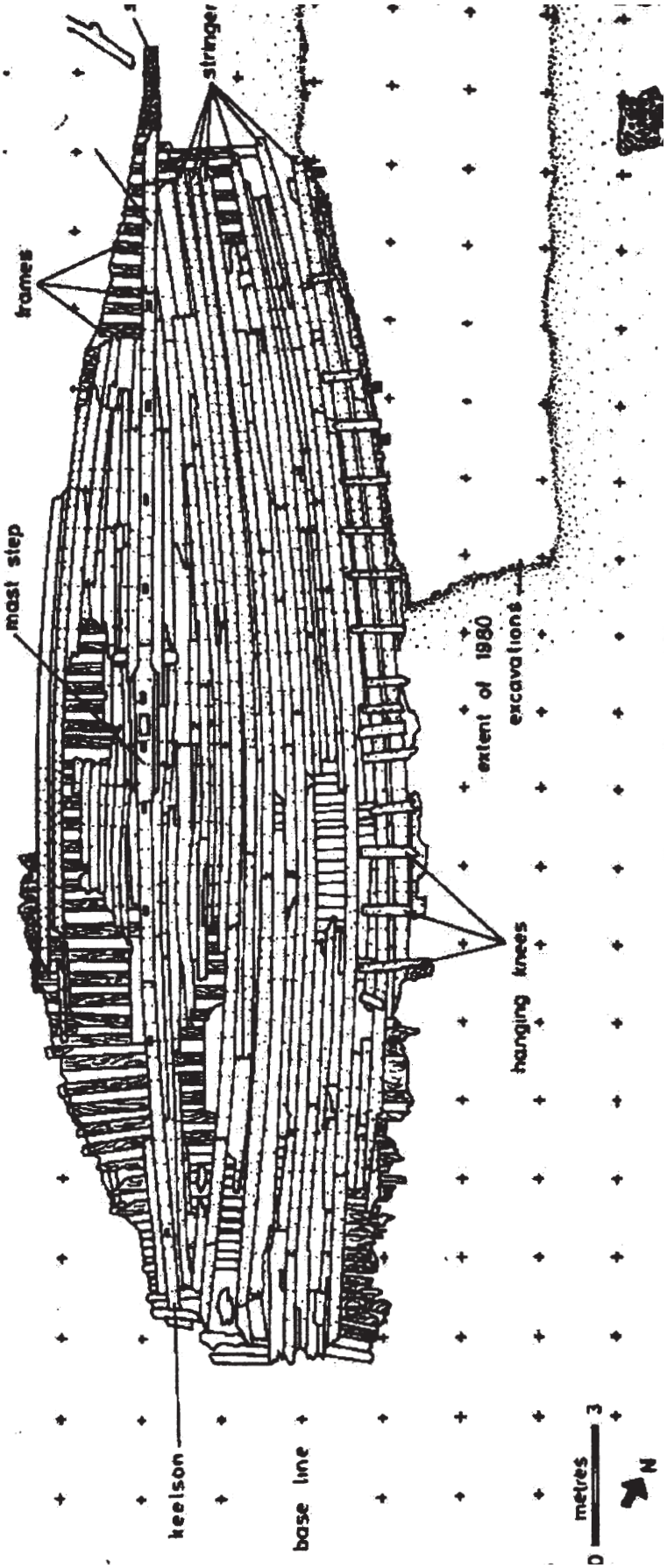

FIG. 2 – Hull Plan. Drawn by Robin Percy.

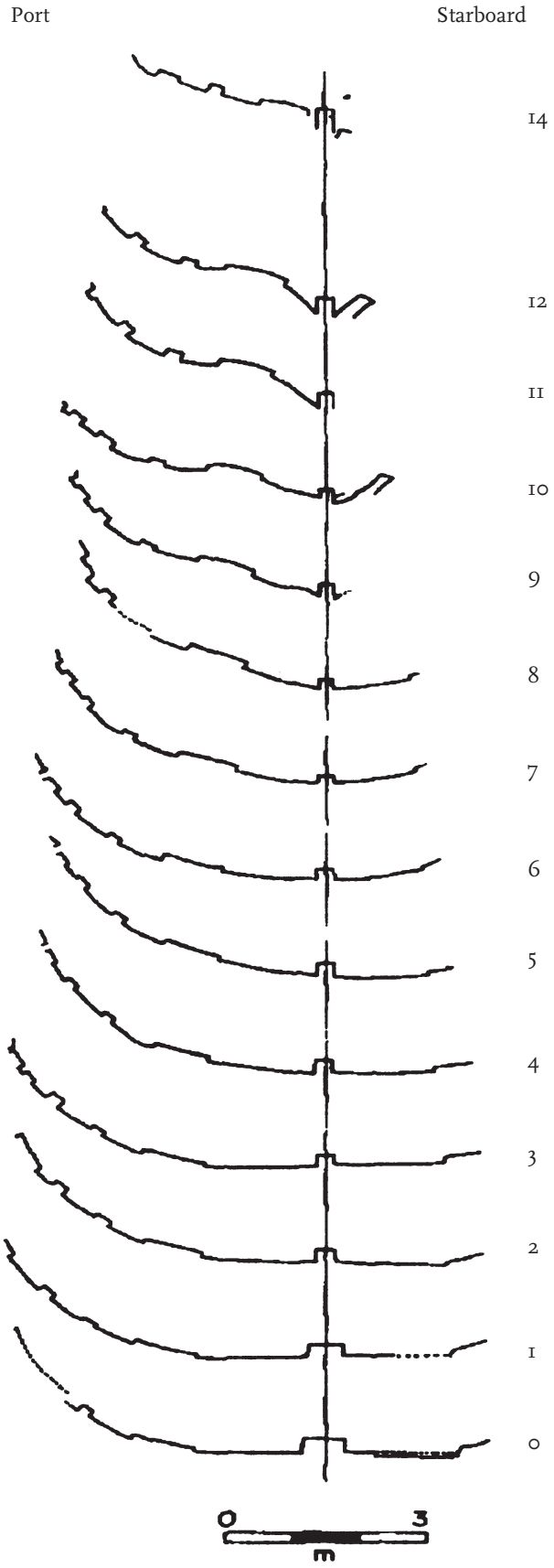

FIG. 3 – Hull profiles. Drawn by R. Percy.

have doubled as the gun locker; a large amount of shot and several gun-carriage trucks were observed in this area. The remains of three pumps were also found: parts of two suction pumps and one chain pump (Oertling, 1996). Two of these pumps could have been set within the pump well, between the frames through two holes in the ceiling (see Fig. 2). These were the only openings found in the ceiling planking. This suggests that the pumps were switched out periodically for necessary repairs or maintenance. The chain pump may have been used for emergencies as it could pump a high volume of water very quickly.

Dimensions of eleven frames and nine futtocks were also recorded. The average sided dimension for the frames was 0,23 m and the average molded dimension was 0,265 m. The futtocks were all fairly similar in size with a cross-section of 0,14 m square.

Ceiling planking was of varied width with a thickness between 0,02 and 0,05 m. An interesting feature was noted in the stern area: by fastening a light framework of timbers transversely across the stern deadwood the ceiling was kept level as the deadwood increased in height. The planking was then nailed down to these pieces in a fore-and-aft direction. Artifacts found in this area suggest that the boatswain used this part of the ship to store supplies and excess material. Related items include compasses, an hourglass, sounding weights, a tortoise-shell lantern, parceled rope, a bundled sail, sailor's palms, and various rigging elements. A fallen post was also recovered in this area and may have been used as a support for a partition. Outside hull planking was recorded where accessible, and measured approximately 0.10 m in thickness.

Nine stringers were recorded *in situ*: seven port and two starboard. The average dimensions were 0,125 m molded and 0,20 m sided. Fifteen deck knees were also measured *in situ* in varying states of degradation. Each knee was bolted over two stringers with two nails per stringer. All of the knees were broken off below deck level, making it difficult to determine if the deck beams rested on top or alongside the knees. The majority of the 237 rigging artifacts were recovered along a 4-meter line outside of the portside hull remains. When the ship heeled over and slid down the slope beneath Fort Jesus it lost most of its rigging and masts. One of the more unusual artifacts recovered from this area was a standing rigging bit which, based on the rope thickness, type and its location on the wreck, may have been used to secure the topsail sheet (Thompson, 1988).

Elements of the stern and some of the upper structures are evident from artifacts recovered during the course of the excavation. A single porthole lid measuring 0,67 m square, a complete gun carriage, several cannons, gunpowder flasks, musket flints, and hundreds of shot, mortars, and grenades provide evidence for the gun deck. Angels, a small child, and a Portuguese coat of arms all carved of wood suggests that the outside of the stern was highly decorated. Lead window caming and several parts of turned wood furniture offers fleeting, fractured glimpses of some elements of the cabin.

Analysis of the hull remains

Since the information recorded from the excavation was not adequate for a detailed reconstruction of the ship's structure, historical documents were consulted to provide additional insight into the vessel's construction. Seven documents containing information of Portuguese frigate proportions from the seventeenth century were examined for comparative purposes (Appendix A and B). These documents provide a wealth of dimensional and structural information about ships of this period. As a basis of comparison with other ships from the seventeenth century, proportions of English ships of similar size were also studied. Lastly, the dimensions and structure of the *Dartmouth*, an English ship from the same period as the *Santo António*, provided comparative archaeological data (Martin, 1978).

The *Santo António de Tanna*'s principal timber dimensions are provided in Table 1. Due to the integrity of the hull structure the keelson was not removed during the excavation. This proved to be a problem when attempting to interpret the hull data. Portuguese ships of the seventeenth century were based on a system of proportions determined by the length of the keel that does not include the rake of the stem and stern. Without direct examination of the keel, there is no way of knowing whether the 30 m of estimated keel length includes parts of the stem and stern rake. Using the position of the knees a depth of hold was calculated at 3,2 m. From this information and the estimated keel length of 30 m a maximum beam of 9,65 m was determined (Thompson, 1988). Using these figures, the *Santo António* would have had a depth to beam to keel length ratio of 1:3:9.4. These proportions in no way reflect the proportions obtained from historical documents of ships from this period with similar amounts of artillery (Table 2). Two such documents list the basic dimensions, deck heights, porthole sizes and amount of ordnance of two frigates from 1696: *São Boaventura* and *Nossa Senhora de Madre de Deus, São Francisco Xavier, e São António*, carrying 44 and 56-60 guns respectively. The other documents are from 1692 and discuss the basic dimensions, deck heights, porthole sizes and placement, and mast configurations of five frigates of between eleven *rumos* and twenty-one *rumos* of keel length. By comparing the *Santo António*'s proportions with those of the documents, one would believe that the 21-*rumos* vessel of 1692 would be the best for comparative purposes. The *Madre de Deus* has similar length of keel and beam, but the depth of hold is much larger in proportion to its other dimensions than any of the other frigates. This may be an error due to transcription, or for some reason this ship may have been built differently[6]. Both of these rules show a keel length much longer than that of the *Santo António*. If the estimated keel length of 30 m (19,5 *rumos*) is correct, then the proportions should be closer to those found in the rules of the 19 *rumos* frigate. Blot and Blot's (1984) research in India and Lisbon uncovered evidence that the 44 gun *São Boaventura* may have been built off of the proportions of the *Santo António*: a new frigate ordered in the Baçaim shipyard was to be "finished as *Santo António de Tanna*". This suggests that the dimensions or rules of *Santo António* were still around after 13 years. There is no direct correlation that the *São Boaventura* was the new frigate ordered in 1694, but she is being finished in the Goa shipyards in 1696 at the same time *Santo António* is being modified and outfitted for the relief mission to Mombasa (Blot and Blot, 1984, p. 38-41)[7]. Based on this evidence, I propose that the *Santo António de Tanna* was built based on a keel length of between 16 and 7,5 rumos. Using the proportions of the *São Boaventura* and those of the 16 *rumos* frigate of 1696, the dimensions of the *Santo António* were corrected[8] (Table 3).

TABLE 1

Santo António de Tanna's Scantling[a]

Keel length (est.)	30,0 m
Keelson	0,30 m square x 26,5 m (l)
Mast Step	0,70 m (s) x 0,30 m (m) x 4 m (l)
Mast step mortise	0,21 m (s) x 0,16 m (m) x 0,48 m (l)
Frames (average)	0,23 m (s) x 0,265 m (m)
Futtocks	0,14 m square
Ceiling	0,02 – 0,05 m (t)
Planking	0,10 m (t)

[a] The letters enclosed in parentheses pertain to measurement information: s = sided, m = molded, l = length, t = thickness

TABLE 2

Comparison of principal hull dimensions between the *Santo António de Tanna* and proportions found in the historical record

	S. António (19.5 rumos) 1681-1697	S. Boaventura (17.5 rumos) 1696	Me de Deus (21.3 rumos) 1696	11 Rumos 1692	13 Rumos 1692	16 Rumos 1692	19 Rumos 1692	21 Rumos 1692
Keel Length	30,0 m	26,88 m	32,77 m	16,90 m	19,97 m	24,58 m	29,18 m	32,26 m
Beam	9,65 m	8,19 m	10,75 m	5,63 m	6,66 m	7,94 m	9,22 m	10,24 m
Depth	3,20 m	3,32 m	5,12 m	2,82 m	3,07 m	3,20 m	3,33 m	3,33 m
D:B:K_L	1:3:9.4	1:2.5:8	1:2:6.4	1:2:6	1:2.2:6.5	1:2.5:7.7	1:2.8:8.8	1:3:9.7
Cannon	42-50	44	56-60					

TABLE 4

Comparison of the *Santo António de Tanna* (including corrected values) with English ships of record

	S. António (19.5 rumos) 1681-1697 Uncorrected	S. António 1681-1697 Corrected 1	S. António 1681-1697 Corrected 2	Mordaunt 1681	Bonaventure 1683	Tiger 1681
Keel Length	30,0 m	25,6 m	24,64 m	31,1 m	31,27 m	31,7 m
Beam	9,65 m	8,00 m	8,00 m	9,88 m	9,81 m	10,0 m
Depth	3,20 m	3,20 m	3,20 m	3,96 m	3,78 m	4,21 m
D:B:K_L	1:3:9.4	1:2.5:8	1:2.5:7.7	1:2.5:7.9	1:2.6:8.27	1:2.4:7.5
Tons	526	308	296	567	564	590
Cannon	42-50	Same	Same	46	48	48

TABLE 5

Comparison of the *Santo António de Tanna* (including corrected values) with the *Dartmouth*.

	S. António (19.5 rumos) 1681-1697 Uncorrected	S. António 1681-1697 Corrected 1	S. António 1681-1697 Corrected 2	Dartmouth 1655-1690
Keel Length	30,0 m	25,6 m	24,64 m	24,2 m
Beam	9,65 m	8,00 m	8,00 m	7,60 m
Depth	3,20 m	3,20 m	3,20 m	3,05 m
D:B:K_L	1:3:9.4	1:2.5:8	1:2.5:7.7	1:2.5:7.9
Frames	0,23 x 0,265 m	Same	Same	0,25 x 0,20 m
Planck Thickness	0,10 m	Same	Same	0,063 – 0,076 m
Tons	526	308	296	266
Cannon	42-50	Same	Same	36

The proportions of the *Santo António* (uncorrected and corrected) were then compared to dimensions of English ships from the seventeenth century (Table 4). Depth to beam to keel length ratios of the English ships closely matched those of the corrected values, while their tonnage was closer to the uncorrected value[9]. If the corrected values are the actual dimensions of the *Santo António de Tanna*, it could indicate that Portuguese frigates of smaller size have the ability to carry more ordnance than English ships of similar dimensions. The *Madre de Deus*'s proportions and timber measurements closely resembles those of the represented English ships, but she carries 8 to 12 more guns. Another explanation might be the differences in cannon sizes aboard the English and Portuguese frigates of this period. In 1687, the *Dartmouth*'s ordnance was listed as follows: 16 9-pounders, 16 6-pounders, 4 3-pounders (Martin, 1978, p. 29-30). Since most of the cannon was salvaged from the *Santo António* after sinking, gun size was estimated by weighing the shot recovered during the excavation. Alison Darroch found that there was a wide range of sizes, spanning from 2 pounds to 38 pounds, with the majority of distribution falling between five and nine pounds (Darroch, 1986). From the little archaeological data we have, we can conclude that there does not appear to be a significant difference in the size of cannon aboard these English and Portuguese frigates in the seventeenth century.

The last basis for comparison is the English frigate the *Dartmouth*, the only other excavated frigate from the seventeenth century. The dimensions and proportions of the *Dartmouth* are listed in Table 5. From this data it is clear that while the keel length, depth of hold and beam of English ships increased (Table 4) from one rating to the next, the basic proportions of the vessel remained the same. If the corrected proportions of the *Santo António de Tanna* are correct, then she would fit in very well with the fourth-rate English frigates of the period. The *Dartmouth* provides fairly strong evidence for the similarity of frigates from all nationalities during the seventeenth century. Frigates were 'invented' as a ship-type by Spain in the early seventeenth century employing Flemish shipwrights in Dunkirk shipyards (Stradling, 1992, p. 28-30). Spain needed maneuverable, fine-lined vessels to run the Dutch blockades and wreak havoc upon the Dutch herring fisheries during the first half of the seventeenth century. Dunkirkers, as these frigates were known, were feared and respected by the enemies of Spain, and the hull design of these ships were highly sought-after prizes (Thrush, 1991, p. 31-32). England had attempted to copy Spanish frigates, but met with little progress until the 1640's (Thrush, 1991, p. 30-45). Sir John Tippets who laid down the *Dartmouth*'s keel had rebuilt the frigate *Constant Warwick* in 1666 (Martin, 1978, p. 30-31). Thus, the *Dartmouth* was indirectly built on the lines of the original Dunkirk frigates.

The rules of frigates (Appendix A and B) provide information other than principal proportions. One important piece of information that corresponds to findings from the *Santo António* is the spacing between gun ports. The rules for the frigate of 16 *rumos* states that the porthole spacing should be 7 *palmos* (1,8 m) from one another. This may also mean that the center-to-center spacing of the portholes is 10 *palmos* (2,56 m) — the spacing (7) plus the width of the porthole (3). Cannon were normally placed on every other beam to allow adequate space for the gunners' movements (Lavery, 1981, p. 60). The 1,8 m dimension fits almost exactly with the spacing of every two deck knees recorded from the hull remains. A porthole lid recovered from the wreck measured approximately 0.67 m square, which also corresponds to porthole lid dimensions from the upper deck of the 16 *rumos* frigate and those of the *São Boaventura*. Frigates of greater than 16 *rumos* in keel length have two gun decks, while those of lesser length only have one. Most of the historical documents also suggest certain superstructures above the upper deck. These include specifications for headroom on the quarterdeck and forecastle of the *São Boaventura* and the *Madre de Deos*, and deck spacing for the after-deck, quarterdeck, chamber (dining room), and cabin on the different vessels of the 1692 documents. The latter docu-

ments also provide information on mast placement and the height of the beak. On two of the 1692 documents specifications are given for oar ports between the gun ports on the lower deck. This is interesting, because it is generally thought that by the late seventeenth century, full-rigged warships were no longer rowed. The oar ports may be limited to the frigate class and are a hold over from when they did have oars at the beginning of the seventeenth century (Stradling, 1992, p. 41; Thrush, 1991, p. 32). Gun placement was detailed in the plans of the *São Boaventura* for a total of twenty-two guns on each deck. Blot's research uncovered the calibers of the various guns used onboard another 42-gun frigate the *Trafaria*: twenty 12-caliber, eighteen 8-caliber, and four 6-caliber guns, beside 20 swivel guns (*pedreiros*) with 40 breech blocks (*recâmaras*) (Esparteiro, 1975, p. 98; Blot and Blot, 1984, p. 26). Frame dimensions are also provided in the 1696 ship plans: *São Boaventura*'s timber dimensions are given at 6 by 6 *angûlas* (0,154 m square) and *Madre de Deus* are given at 8 by 8 *angûlas* (0,205 m square). Neither of these dimensions is adequate for the *Santo António*'s massive frames (0,23 x 0,265 m). This may indicate that some of the rules may not have been implemented in the shipyards; a not uncommon phenomena considering the role tradition plays in the continuation of time-proven techniques rather than trusting newer, unfamiliar methods.

Conclusion

Historical documents have been frequently cited throughout this article to bolster the scarce archaeological data gathered from the *Santo António de Tanna*'s hull remains, and to paint a hypothetical picture of a seventeenth-century frigate. These records however must always be used with caution because they can never be wholly substantiated when used alone. Only through the role of archaeology can most of the design, theory and proportions written on paper be validated. The excavation must be conducted with an eye toward the material uncovered by researchers. Unfortunately, when the *Santo António de Tanna* was excavated in the late 1970's much of the current research into Portuguese ship design was unpublished or even undiscovered. I believe it is fortunate in a way that the excavation of this important shipwreck was halted before its completion. The bulk of the *Santo António*'s hull remains are still present in Mombasa Harbor waiting for its secrets to be unlocked. With the analysis of the documents presented in this article and the continuing research into the shipbuilding practices of the seventeenth century, one day the remains of this important artifact can be studied with enough accuracy to help unlock the riddles of the past.

APPENDIX A[10]
Plans for frigates – 1692[11]

Rules of a frigate of 11 rumos of keel length between perpendiculars

The height of the stem on a perpendicular will be 18 palmos and the rake will be 12 palmos. The height of the sternpost will be 18 palmos and its rake, 4 palmos. The transom will be 19 1/2 palmos. The beam will be 22 palmos and the floor, 16 palmos. The narrowing[12] of the top timbers will be 1 1/2 palmos from each side. The depth of hold to the first deck will be 11 palmos from the upper face of the keel to the upper face of the deck beam[13]. The widest part of the ship will be placed 3 palmos above the deck beam. The bottom[14] of the portholes will be 2 palmos from the deck beams and 2 1/2 palmos high and will be of similar dimension from bow and stern[15]. The beams of the weather deck[16] will be placed 7 palmos above the upper face of the deck beams and the quarterdeck[17] will extend to the mizzenmast. The beams of the quarterdeck will be placed at 7 1/2 palmos (above the deck). The beak will be placed at 11 palmos, measured on a perpendicular at the stem. The mainmast will be placed 2 palmos abaft of midship. The foremast will be placed on a perpendicular above the foot of the bow[18]. The mizzenmast will be placed 12 palmos abaft of the mainmast. I declare all the palmos are equal to the Goa (palmos) and there are 10 polegados in each. Each rumo is 6 palmos de goa[19]. I declare that about halfway between the gun ports (portholes), oar ports of 1 palmos de goa in length and squared shall be placed at the height of the gun ports.

22 of March, 1692

Rules of a frigate of 13 rumos of keel length between perpendiculars

The height of the stem on a perpendicular will be 19 palmos and the rake will be 13 palmos. The height of the sternpost on a perpendicular will be 19 palmos, and its rake, 4 palmos. The transom will be 20 palmos. The beam will be 26 palmos and the floor will be 18 palmos and I declare that here is the beating line[20]. The depth of hold to the first deck will be 12 palmos. The widest part of the ship will be 3 palmos measured above the deck beam. The bottom of the gun ports will be 2 palmos from the deck beams and 2 1/2 palmos high and will be of similar dimensions from bow to stern. The gun ports will be placed 6 palmos from one another[21]. The deck beams (of the upper deck) will be placed at 7 palmos above the deck beams (lower deck). The bulwark will be 3 palmos above the (upper) deck[22]. The quarterdeck will extend until forward of the mizzenmast and its beams will be placed at 7 1/2 palmos above the main deck. The mainmast will be placed 2 palmos abaft of midships. The foremast will be placed on a perpendicular above the foot of the stem. The mizzenmast will be placed 20 1/2 palmos abaft of the mainmast. The beak will be placed 12 1/2 palmos[23], measured on a perpendicular at the stem. These rules can be used for other (frigates) of 12 rumos.

22 of March, 1692
Manoel Jacombe

Rules for a frigate of 16 rumos of keel length between perpendiculars

The height of the stem will be 22 palmos and the rake 14 palmos. The beam will be 31 palmos and the floor will be 20 palmos from bilge to bilge. I declare that at this place will be the beating line. The depth of hold will be 12 1/2 palmos and deck beams amidship will be placed 12 1/2 palmos from the upper face (of the keel) to the upper face (of the deck beam). The widest part of the ship will be placed 3 palmos above the deck beam. The bottom of the gun ports will be 2 1/2 palmos above the deck. The height of the same gun ports will be 3 palmos and the same length from the bow to the stern. The gun ports will be 7 palmos from one another. From the beams of one deck to the other there will be 7 1/2 palmos of clear span from bow to stern[24]. The bottom of the (uppper) gun ports will be 2 palmos above the (upper) deck. The gun ports will be 2 palmos in height, and the same portholes will be 2 1/2 palmos in length from the bow to the stern. The bulwark will be 4 1/2 palmos bove the (upper) deck. I declare that the height of the stern on a perpendicular will be 23 palmos. The transom will be 23 palmos. The quarterdeck[25] extending to the mizzenmast will have deck beams 7 1/2 palmos high. The cabin[26] will be as high as the quarter rail will allow, and will be placed at 13 palmos measured on a perpendicular.[27] The mainmast will be placed 3 palmos abaft of midship. The foremast will be placed on a perpendicular of the bow.[28] The mizzenmast will be placed 26 palmos abaft of the main mast. This rule can be used for frigates of 14 and 15 rumos.

22 of March, 1692
Manoel Jacombe

Rules for a frigate of 19 rumos of keel length between perpendiculars

The height of the stem on a perpendicular will be 24 palmos and the rake 17 palmos. The height of the sternpost on a perpendicular will be 25 palmos and the rake 7 1/2 palmos[29]. The transom will be 27 palmos. The beam will be 36 palmos. The floor will be 22 palmos from bilge to the curve of the beating line.[30] The depth of hold to the first deck from the keel to the upper face of the deck beam will be 13 palmos. The widest part of the ship will be 3 palmos above the deck beam. The bottom of the gun ports will be fixed 2 1/2 palmos above the deck. The gun ports will be 3 palmos in height and of similar length from the bow to the stern. The gun ports will be 7 1/2 palmos from one another. The (upper) deck beams amidship will be placed at 7 1/2 palmos above the deck, and this measure will remain constant from bow to stern[31]. The bulwark amidship will be placed 5 palmos above the (upper) deck. The top timbers will narrow at this deck 2 palmos from each side. The chamber, its deck beams forward of the mizzenmast, for the protecting sides because it doesn't have a quarter deck, but a tiller room, and its beams will be placed 8 palmos in height[32]. The bottom of the (upper) gun ports will be placed 2 1/2 palmos from the upper deck beams. The height of the gun ports will be placed at 2 1/2 palmos, and the same from stem to stern. The stern cabin will be as high as the bulwark allows[33]. The beak will be placed 14 palmos at a perpendicular with the forwardmost section of the keel[34]. The mainmast will be placed 3 palmos abaft of midship. The foremast will be placed on a perpendicular with the forwardmost section of the keel. The mizzenmast will be placed 31 palmos abaft of the mainmast. This rule can be used for a frigate of 18 and also 17 rumos. I declare that in all these rules there are to be made oar portholes on the lower deck.

22 of March, 1692
Manoel Jacombe

Rules of a frigate of 21 rumos of keel length between perpendiculars

The height of the stem will be 26 palmos, and the rake will be 20 palmos. The height of the sternpost will be 26 palmos and have a rake of 8 palmos. The transom will be 30 palmos. The beam will be 40 palmos. The floor will be 24 palmos from bilge to bilge and I declare that here will be the beating line. The depth of hold to the first deck will be 13 palmos and will be measured from the keel to the upper face of the deck beam. The widest part of the ship will be three palmos above the deck beam. The bottom of the gun ports will be 2 1/2 palmos above the deck, and they will be 3 palmos wide and the same in height. The gun ports will be 8 1/2 palmos from one another. The top timbers narrow at the deck 3 palmos from each side. The beams of the upper deck will be 7 1/2 palmos high amidship and 7 palmos high at the bow, and 8 palmos high at the stern. The bulwark will be 5 palmos above the (upper) deck. The quarterdeck reaches to the main mast and 7 1/2 palmos at the mainmast. In the stern (the height) for the quarterdeck will be 8 palmos. The stern cabin will be as high as the quarter rail allows. The bottom of the gun ports on the main deck will be 2 palmos above the upper deck. The gun ports will be 2 1/2 palmos in height and 3 palmos in length from bow to stern. The beak will be 14 1/2 palmos in height measured on a perpendicular from the foot of the stem. I declare all of these palmos will be measured as palmos de Goa, each palmo has 10 polegadas, and each rumo has 6 palmos de Goa. I declare that the mainmast will be 3 palmos abaft of midship. The foremast will be on a perpendicular with the forwardmost section of the keel. The mizzenmast will be 36 palmos abaft of the mainmast. These rules can be used for a ship of 20 rumos.

22 of March, 1692
Manoel Jacombe

APPENDIX B

Plans for frigates – *São Boaventura* and *Madre de Deus, São Xavier* e *Santo António*[35]

Proportions of frigates that are stationed at the dockyard of the city of Goa who are called S. Boaventura *and the other* Nossa S^{ra} de M^{e} de Deus, S. Fran^{co} X^{er} *e* S. Antonio *in the following manner*

A frigate has a keel length of 52 1/2 covados[36] between perpendiculars, which is equal to 17 1/2 rumos. The height of the stem is 30 palmos, which is equal to 15 covados, and a rake of 8 palmos, which is equal to 4 covados[37]. The transom counter is 26 palmos, which is equal to 13 covados. The transom is 24 palmos, which is equal 12 covados. The depth of hold will be 13 palmos, which is equal to 6 1/2 covados. The height on the first deck is 8 palmos, which is equal to 4 covados. From the upper deck to the quarterdeck is 8 palmos, which is equal to 4 covados, and 7 1/2 palmos to the forecastle, which is equal to 3 1/2 covados. The beam of the ship is 32 palmos, which is equal to 16 covados.

11 cannons per side is placed on the first deck, and the same on the second deck, which equals to a total of 44 cannons. The gun port openings of the frigate are 2 1/2 palmos from the height of the bottom of the porthole to the wale at the widest part of the ship, which is equal to 1 1/2 covado.

The portholes are 3 palmos square, which is equal to 1 _ covado.

This frigate is now finished and sea ready. The work that it is missing is to line the ship and prepare the "*tanques*". These proportions are for the frigate named *S. Boaventura* with all wooden scantling of teak of 6 angulas square.

Proportions of the frigate Nossa Sra de Me de Deos, S. Franco Xer *e* S. Antonio *known in the following manner*[38]

It has a clean keel length of 64 covados between perpendiculars, which is equal to 21 rumos. The height of the stem is at 36 palmos, which is equal to 18 covados, and a rake of 26 palmos, which is equal to 13 covados[39]. The stern counter is 30 palmos, which is equal to 15 covados. The transom is 34 palmos, which is equal to 17 covados[40]. The depth of hold is 20 palmos, which is equal to 10 covados. The height of the first deck is 9 palmos, which is equal to 4 1/2 covados. The height on the second deck is equal to 8 palmos, which is equal to 4 covados. The beam is 42 palmos, which is equal to 21 covados. The twelve porthole openings at the first deck are 3 1/2 palmos to the widest part of the ship. The openings are 3 1/2 palmos square. ... The scantling timbers are all of teak and are 8 angulas square. These proportions are for the frigate named *N. S^ra de M^e de Deus, S. Francisco e S. Antonio.*

NOTES

1 Goa Historical Archives (Goa, India), hereafter AIG. Cte Esparteiro does not cite his archival sources so it is next to impossible to tell if this is from the same quoted source.

2 The *Santo António* left Lisbon on April 6 with the nau *N.ª S.ª da Glória*, and reached Goa on September 16.

3 Arquivo Historico Ultramarino (Lisbon), hereafter AHU.

4 *Cerco de Mombaça*. Codice n° 584 from the Lisbon National Library. A transcription of this exists in the Arquivo da Marinha. Lisbon. Caixa 385, artigo n° 39. The second document is *Cerco de Mombaça ano 1697*. In the Lisbon Maritime Museum Library, n° 5407-10-5. Both of these sources are cited in Blot and Blot, 1984 and in Kirkman and Dias, 1989. I believe the version that Kirkman and Dias used came from the National Library in Rio de Janeiro, Brazil.

5 A vertical diagonal scarf was recorded during the excavation of the *Dartmouth*, (Martin, 1978). A similar illustration can be seen in the facsimile copy of the Lavanha text (1996, f.° 62v°).

6 See notes in Appendix B.

7 Several documents are cited in this section, chief among which mentions the frigate based on the *Santo António*, AIG 1174, f° 136, Goa, February 17th, 1694.

8 The depth of hold was kept constant for these corrections, although obviously it might have changed along with the keel length and beam for the hull lines to remain fair. Unfortunately, without more detailed recording measures, these numbers can only be a merest approximation.

9 He English fifth-rates were obtained from Fox (1980, p. 31). The tonnage formula he stated that was used for English ships during the seventeenth century was: (beam x beam x keel length)/188. I applied this formula to the *Santo António* as well. This is not the correct formula for Portuguese ships of the period, but should suffice for comparative purposes.

10 The English translation of these records represents the author's first attempt at such an endeavor. I hope that scholars can find a use for such documents, despite the many obvious mistakes and naïve blunders that were surely made. Words and phrases whose meanings were not clear were left in <<brackets>>, while phrase that I substituted to make a passage more clear were placed in (parentheses).

11 The originals are from the Arquivo Geral e História da India Portuguesa - *Livro das Monções do Reino*. Lisbon. Hereafter AGHL, n° 57 f°207, 208, 208v, 209, and 209v. Copies were obtained from the Instituto de Investigação Científica Tropical's - *Boletim Filmoteca Ultramarinho Portuguesa*. Collection, n° 57 35/1-5, 36/1-2. I used these documents along with transcribed copies from Esparteiro (1978, p. 52-54). These transcriptions proved invaluable to me in my efforts. Any mistakes in the translation are the blame of the author alone.

12 *Recolhera* can also mean sweep.

13 The expression *a fassea do dromente* was taken throughout the document to mean, to the upper face of the deck beam. This gives important information about where the height of the first deck was taken - under the deck and not including the thickness of the deck planking.

14 *Batente* is the side of a window where it 'beats' when it closes (i.e. the opposite side of the hinges) (Filipe Castro, personal communication).

15 The phrase *...e de alto, terão as portinholas dous palmos e meyo e o mesmo de largo de popa a proa...* means that the gun ports or portholes are 2 _ palmos square, since the expression *...de largo de popa a proa...* refers to the length in the fore and aft direction or more commonly - the width.

16 *Coberta de sima* means the upper deck.

17 Leitão and Lopez (1974, p. 129) state that the *camara* was a name applied to the commanders' and officers' dining room. I have taken this to mean quarterdeck for these translations.

18 The expression ...*do cousse de Proa*... refers to the "kiss" of the bow. According to the glossary provided by João Pimentel Barata (trans. R. A. Barker) in the Academia de Marinha's publication of Lavanha (1996, p. 232), refers to the *couces* as the extremities of the keel - in this case, where the bow is scarfed to the keel. A drawing of this section is located in the facsimile included in the book, f° 63v.

19 The table of measurements in Lavanha (1996, p. 229-230), give the metric equivalents of these terms as follows: *Palmo de goa* is equal to 0.256 m; *Polegada* (*inglesa*) is equal to 0.0254 (though according to these rules the amount should be 0.0256 or the *palmos de goa* should be 0.254); *Rumo* is equal to between 1.536 m and 1.540 m.

20 This is the literal translation for *linha batida*. I have been informed by Filipe Castro (personal communication) that this is a line obtained by striking a stretched string that has been previously impregnated with burned cork ashes, much like a chalk line used today. I have taken this to mean a line was placed at the overlapping of the floors and futtocks.

21 The total spacing should include the 6 palmos plus the width of the porthole, 2.5 palmos. This rule should be followed using the correct dimensions for the rest of the translations.

22 *Mareagem* can be translated as a bulwark (*borda falsa*) or wah strake. It may also mean quarter rail when associated with the *tolda*. Leitão and Lopez (1974) associate *mareagem* with *chapitéu* with *alcáçova* which means a construction on the stern castle above the quarterdeck, p. 345-346.

23 In Esparteiro (1975, p. 52), the translation *dous palmos e meyo* is surely incorrect (see the other rules). Although the copy of the original is hard to read, the word in question appears to be *doze* instead of *dous*, AGHL, n° 57 f° 208v.

24 Filipe Castro (personal communication) suggests that this is a stevedor measure, indicating from above the deck planking to the lower face of the main deck beam.

25 The word used here is *tolda*. I have not been able to discern the difference between *camara* and *tolda*, but *tolda* may be used when there is an additional deck or cabin (*camarote*) on top of, or associated with the quarter deck.

26 *Camarote* can be defined as a cabin or sleeping quarters. Its position in this case is most likely behind the mizzenmast.

27 This passage gave me a lot of trouble and the meaning still remains unclear. In this rule, it may be that the measurement of the cabin plus that of the after-deck (on top of the cabin and quarterdeck) is measured 13 palmos on a perpendicular. This needs more contemplation and should be treated as suspect.

28 Another troublesome passage. I have taken ...*o de proa será pasto, a escoadria de proa*... to mean the foremast should be placed on a perpendicular with the foot of the stem.

29 In Esparteiro (1975, p. 53), the translation 27 _ palmos is surely incorrect (see the other rules). Although the copy of the original is hard to read, the word before *sete* appears scratched out, AGHL, n° 57 f° 209v. While this may due to the quality of my copy, the next line has another *vingte e sete* for comparison and the formation of the words does not appear the same. Using seven for the rake of the stern also fits in with the rest of the rules. Although the rake is not included for the frigate of 16 rumos, the rules for a frigate of 21 rumos shows the rake of the stern to be 8 palmos.

30 This section including the *linha batida* may simply mean that the floor is straight along this area (Filipe Castro, personal communication).

31 The expression *todo de popa a proa* can mean the entire length of the ship.

32 This passage was very confusing and its translation is suspect. This may be referring to the absence of a quarterdeck and the inclusion of a room for the end of the tiller.

33 Another suspect translation. The original is ...*o camarote de poupa terá de alto, o q der a mariagem*... .

34 In Esparteiro (1975, p. 53), the phrase is transcribed as ...*não da escoadria*. The copy of the original (AGHL n° 57 f 209v) looks more like '*na*' instead of '*não*'.

35 These frigate rules were translated from copies of AGHL, n° 60 f° 207. Esparteiro (1975, p. 100), attributes these documents to Conde de Villa Verde and are dated 20 of December, 1696. These documents were also translated from documents in the Goan archives by Blot and Blot (1984, p. 27-28) from AIG n° 60 f°206.

36 One *covado* is equal to two *palmos* (de goa) or 0.512 m.

37 The rake of the stem seems too small (see Appendix A, for frigates of similar size)

38 This rule proved troublesome, as there appeared many discrepancies and re-writings of sections of the same phrases for no apparent reason. The last part of the rule is not completed and so the sections have been omitted from this translation.

39 The heights of the stem and stern are considerably larger than the heights proposed in the 1692 rules for a frigate of 21 rumos.

40 The transom appears here to be higher than the stern counter, where in the *Boaventura*'s rules, the opposite is true.

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