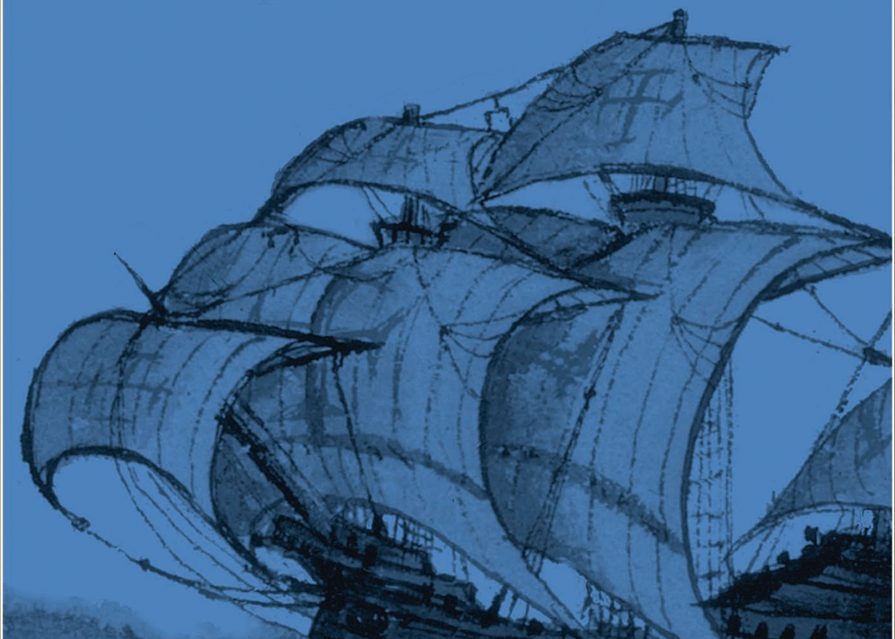
# THE PEPPER WRECK

## A Portuguese Indiaman at the Mouth of the Tagus River

Filipe Vieira de Castro



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A PORTUGUESE INDIAMAN AT THE MOUTH OF THE TAGUS RIVER

*Filipe Vieira de Castro*

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*To my wife, Siaska*

# Contents

# Acknowledgments

This book is based on my Ph.D. dissertation, which I began in 1996 with the excavation of the SJB2 site at the mouth of the Tagus River, near Lisbon, Portugal, and completed in 2001 at Texas A&M University, in the Nautical Archaeology Program of the Department of Anthropology.

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# The Pepper Wreck

# Introduction

After a six-month voyage from Cochin, India, and a three-month layover in the Azores, the Portuguese East Indiaman *Nossa Senhora dos Mártires* arrived in sight of Lisbon on September 14, 1606. A heavy storm forced its captain, Manuel Barreto Rolim, to drop anchor off Cascais, a small village a few miles from Lisbon. Here the nau *Salvação,* another returning Indiaman from the 1605 fleet, was already struggling with a southerly gale. Dangerously dragging its anchors in the direction of the beach, *Salvação* was too heavy to be towed against the wind by the galley that was sent from Lisbon to help it. The next day, after watching *Salvação* run aground on the Cascais beach, Rolim decided to head for the mouth of the Tagus River, hoping to escape the tempest in the calmer waters of the estuary.

Getting past the sandbars, however, was not easy. Two large sandbanks narrowed the entrance to the river, making the waters run dangerously fast in both the northern and southern channels. Rolim headed for the northern passage, which by the early seventeenth century was already considered too narrow and shallow to drop anchor in and too crooked for any galley to tow a large vessel. In the middle of the passage, the nau *Mártires* lost headway and was dragged onto a submerged rock. It sank in front of the São Julião da Barra fortress in a matter of hours; soon afterward *Mártires* was broken up into such small pieces that witnesses commented that it looked as if it had sunk long ago.

Its main cargo of pepper, stored loose in small compartments in the hold, spilled out upon wrecking and formed a black tide that extended for leagues along the coast and in the Tagus estuary. A large amount of this pepper was saved and dried by the king's officers. The population also salvaged a notable quantity, as it was impossible for the soldiers to stop the locals, who despite the dreadful weather conditions, went to the sea every night in small craft to salvage what they could. During the subsequent summers, the officers of King Philip III of Spain—who was also King Philip II of Portugal—may have salvaged a great part of the cargo from the shallow waters where the ship came to rest, and certainly rescued many cables, anchors, and guns.

Like many other shipwrecks that occurred in this dangerous channel, *Nossa Senhora dos Mártires* was soon forgotten. The tidal wave that followed the earthquake of 1755 probably rolled heavy rocks over its remains, and in 1966 a codfish trawler wrecked near the site, covering a large area with other debris.

Stories of treasure troves in the vicinity of the fortress of São Julião da Barra were told by generations of local fishermen, and the growth of scuba diving from the early 1950s heightened interest in the area. In the late 1970s a few archaeological surveys were carried out by avocational archaeologists, but no government action was taken to protect the site. As a result, it was heavily looted by sport divers during the 1980s.

In 1993 the Museu Nacional de Arqueologia sponsored a survey of the site under the guidance of its director, Francisco Alves, and identified two main areas of archaeological interest. The first was designated as São Julião da Barra 1 (SJB1) and encompassed a large area littered with iron guns. The second—designated as São Julião da Barra 2 (SJB2)—consisted of the remains of a wooden hull with shards of Ming porcelain and Chinese earthenware dating from the late sixteenth or early seventeenth centuries. Based on the information from the Museu Nacional de Arqueologia's shipwreck archives, *Nossa Senhora dos Mártires* was identified as the most likely name for this shipwreck. The timbers tell us as well that the India nau that once sank at this place was almost certainly *Nossa Senhora dos Mártires,* which had a keel approximately 18 *rumos* (27.72 m) long and a displacement of around 1,200 tons by today's standard.

In 1996 and 1997 excavations were conducted on the SJB2 site under the direction of Francisco Alves and me. The wooden hull was recorded and an area of approximately one hundred square meters was excavated. Many artifacts were recovered from directly below an ubiquitous layer of peppercorns. These included three nautical astrolabes and two pairs of dividers, several sounding leads, as well as porcelain, stoneware, earthenware, and artifacts of brass, copper, pewter, and silver. Among the organic materials many peach pits were recovered along with rope, fabric, leather, and straw, the latter being found between seven stacked porcelain dishes. Several of these artifacts were exhibited in the Portuguese Pavilion at EXPO '98, the world exposition held in Lisbon during the summer of 1998.

A historical investigation led by the team of the Portuguese pavilion at EXPO '98 brought to light information about the lives of some of *Mártires*'s crew and passengers. Among them was Aires de Saldanha, the seventeenth viceroy of India (1600–1605), who died just before reaching the Azores on his return trip to Portugal; the ship's captain, Manuel Barreto Rolim, who was trying to make his fortune in the India trade after being disinherited by his father because of an unapproved marriage; and one of the ship's boys, Cristóvão de Abreu, who survived this shipwreck and the wrecks of another three India naus, only to die at sea in 1645, while returning from India as the boatswain of the nau *S. Lourenço*. No less interesting are the stories of Father Francisco Rodrigues, a Jesuit priest who lost his life in this wreck en route from Japan to see the pope on matters concerning the future of the whole Japanese Jesuit mission; and a Japanese Catholic, named Miguel, accompanying Father Rodrigues, who survived and eventually returned to Asia, dying in Japan many years later.[1]

In the summers of 1999 and 2000 the Instituto Português de Arqueologia, through its Centro Nacional de Arqueologia Náutica e Subaquática and the Institute of Nautical Archaeology, sponsored two excavation seasons on the SJB2 site, aiming for what is perhaps the most exciting part of this wreck—the hull remains. A portion of the bottom immediately forward of the midship frames was preserved, including a section of the keel, eleven frames, and some planking. Construction marks carved on the surfaces of the floor timbers allow us not only to understand the method used by the shipwright to conceive the hull shape but also to reconstruct some of the hull dimensions with a fair degree of certainty.

Several types of vessels sailed to and from India during the period of Portuguese maritime expansion, but the India nau was the true workhorse of the Portuguese overseas fleet. Although the word "nau" means literally "vessel" and seems to designate several types of ships during several different periods of Portuguese history, we know that the India naus were large vessels specially built for this trade, with forward and after castles well integrated into the hull, and three or four masts, of which the mizzen and bonaventure bore lateen sails.

India naus evolved during the sixteenth and seventeenth centuries, changing their shape, size, and rigging. In spite of their size and special characteristics, which attracted the attention of many people, no details about these vessels were recorded at the time. Several descriptions and images of India naus are known, both from Portuguese and foreign authors, primarily from the middle of the sixteenth century, and several important texts pertaining to their construction have been published from the late nineteenth and into the twentieth century. Nevertheless, these ships remain largely unknown. Although the sites of several Portuguese India route wrecks have been identified, and the remains of a few have actually been found, the Pepper Wreck remains the only Portuguese nau of this period to have been excavated and documented by archaeologists. All the other known remains have either been salvaged by treasure hunters or looted by fishermen and sport divers.

This book is the result of seven years of research aimed at reconstructing the hull found on the SJB2 site—hereafter referred to as the SJB2 wreck or the Pepper Wreck—using the data retrieved from the archaeological site, interpreted in light of a set of texts on Portuguese shipbuilding of this period. However, the study of a ship makes little sense in isolation from its social and historical context. Therefore I attempt to relate the ship to what is known about the people who built and sailed it, their understanding of the world, their objectives, and the technology available at the time of its construction.

The archaeological data were interpreted in light of contemporary texts on shipbuilding from around the time the ship was wrecked. After making a strong case for the identification of this wreck based on the dating of the extensive collection of artifacts in it, we have concluded that it is the wreck of a Portuguese Indiaman, most probably that of *Nossa Senhora dos Mártires,* lost in 1606 at this location.[2] Once the ship was identified, the next step was to analyze the types of timbers used in its construction and the scantlings of the preserved structure. Both reinforced the idea that this was a Portuguese Indiaman built in the late sixteenth or early seventeenth centuries. Then the geometric characteristics of the timbers preserved were analyzed. I have concluded that there is a close match between the shape of the timbers preserved on this wreck site and the model prescribed in one of the shipbuilding texts studied, the *Liuro da Fabrica das Naus,* first written in Latin by Father Fernando Oliveira around 1570.

Chapter 2 provides a brief introduction to the history of Portugal and the India route. The golden age of commerce in the sixteenth century, the goods traded and the dynamics of this trade, the voyages to India and life aboard the India naus are also reviewed. Following an account of the decline of Portuguese power in Asia and the rise of Dutch influence, I offer an overview of the voyages of the India route and a short description of the shipwrecks whose whereabouts have been identified.

Chapter 3 includes the origins of the India naus in the context of the Iberian shipbuilding tradition and explains the construction sequence, emphasizing the techniques used at the Portuguese shipyards and their peculiarities. This chapter also includes important texts pertaining to the construction of ships in the early seventeenth century in Italy, France, England, and Spain, detailing the sources in existence for Portugal. The chapter closes with a discussion of the problems related to the evaluation of the size of a vessel based on its tonnage data from written sources and addresses the units of measure in use in Portugal in the late sixteenth and early seventeenth centuries.

Chapter 4 describes the voyage to India in the early seventeenth century, in particular the context in which *Nossa Senhora dos Mártires* departed for India in 1605. It includes a description of life aboard such vessels: the devotions, the gambling, the distribution of the space, the cargos, the crews, and the food. The few names that have been associated with this nau and its last voyage are also mentioned.

Chapter 5 delineates what is known about the site's formation process. Following a description of the Tagus sandbar and its characteristics is an account of a well-documented process of silting that occurred in that locale for a short period in the late sixteenth and early seventeenth centuries. Regardless of how near to the wreck this silting may have occurred, it certainly influenced the site formation process. The second part of this chapter refers to the human influence on the site, from the first documented attempts to salvage guns from the wreck, to the avocational archaeologists who exploited the site in the 1970s, and the intense looting that occurred during the 1980s.

Chapter 6 includes the archaeological circumstances in which the Pepper Wreck was found, starting with the survey that led to the location of the site. A description of the site and the methodology adopted in its excavation follow. Finally, the chapter focuses on the question of identifying the wreck, detailing the clues from both the historical and the archaeological record. A list of the wrecks registered around the fortress of São Julião da Barra is compared with a second, much larger list of the known wrecks in the mouth of the Tagus River.

Chapter 7, which includes a detailed description of the hull remains, focuses on the hull and the size of the scantlings, and describes each component. The last section of this chapter looks at the puzzling question of the nonexistent ballast pile or its possible mixture with the local rocks.

Chapter 8 deals with the interpretation of the data presented in the seven previous chapters and offers a proposed reconstruction of the vessel. This chapter begins with a critical discussion of the size of these vessels from contemporary written descriptions, and moves into the interpretation of the timbers. The probable design of the floors and futtocks is presented, as well as the narrowing and rising of the bottom. A lines drawing depicts the proposed hull shape. My goal is to demonstrate how the archaeological evidence relates to the model proposed in the learned literature of its time, especially the work of Father Fernando Oliveira.

Chapter 9 summarizes the assumptions and conclusions in this book and critiques the methodology, stressing its most important strengths and weaknesses.

I hope this book will contribute to our understanding of these great vessels, of which so much has been said and yet so little is known. Since the proposed reconstruction is based on perhaps no more than 10 percent of the lower hull, it should be looked upon as an educated guess and a working hypothesis rather than a final reconstruction, even where the data seem to fit so perfectly the theoretical predictions.

# 2

# The India Route

PORTUGAL is a beautiful country that stretches along the western coast of the Iberian Peninsula, gently sloping toward the sea. Its territory is a long rectangle that borders Spain to the north and east, and meets the sea to the south and west. The frontier with Spain was fixed in the thirteenth century. Mainly running along natural barriers such as rivers and mountains, it encompasses an area of about 92,000 $km^2$. The coastline is more than 800 km long and offers good natural harbors, river estuaries, and inner bays. It was natural that the Portuguese economy developed strong connections with the sea from the earliest times of the country's creation in the late medieval era (fig. 2.1).

Part of the Iberian cultural and demographic universe, the Portuguese nation began as a feudal county given in the eleventh century by Alfonso VI of Leon to a certain Henry, the fourth son of Henry of Burgundy, as a reward for his deeds in the wars against the Muslims, or Moors, known as the Spanish *reconquista*. Henry married a daughter of Alfonso VI and was made lord of the region of Coimbra in 1095 and of Braga in 1096. When his father-in-law died in 1109, Henry declared himself count of Portugal. His son Afonso Henriques (1108–85) became the first king of Portugal in 1143, after Alfonso VII of Leon recognized the independence of this small kingdom. The kingdom's independence was not acknowledged by the Holy See until 1179.

During the twelfth and thirteenth centuries Portugal expanded its frontier toward the south, the only direction available for the small country squeezed between the kingdom of Leon and Castille and the sea. In 1249 the conquest


Fig. 2.1. Iberian Peninsula c. 1300. (Drawing Filipe Castro)

of Silves, the last fortified Moorish city on the south Atlantic coast of the peninsula, the Algarve, marked the end of the Portuguese *reconquista*. On the Spanish side, efforts to expel the Muslims from the peninsula went on until the fall of Granada, in 1492, thus keeping the spirit of the Crusades alive.

In the late thirteenth century a few rich Italian cities opened commercial trade with the north Atlantic centers of England and Flanders. Seville and Lisbon were located at strategic points on their route and soon became ports of call. During the fourteenth century the Iberian peninsula underwent a population growth. In spite of a short period of cold weather in the early 1300s and the spread of the black death in 1347, the population of Leon and Castille grew from 3 to 6 million during the fourteenth century, and the population of Aragon rose from 500,000 to 1 million in the same period.[1] Around 1400 Portugal also may have had about 1 million people.[2]

Almost a natural continuation of Portugal's *reconquista,* the conquest of the north African city of Ceuta by King John I (1385–1433) in 1415 is the generally accepted date for the beginning of Portuguese expansion overseas, which eventually led to the establishment of the India route.

During the fifteenth century Portuguese mariners and merchants sailed south down the western coast of Africa, engaging in trade with the local populations, frequently backed by bankers and merchants from Genoa and other Italian cities. In exchange for wheat, cloth, and manufactured goods, the Portuguese bought red peppers, gold, and slaves. The Atlantic islands were explored and colonized: the Islands of Madeira and Porto Santo during the 1420s and 1430s, followed in the 1440s by the Azorean archipelago, and in the 1460s the Cape Verde Islands. The Canary Islands were lost to Spain in 1436, after a series of conquest attempts by the Portuguese crown. From the 1450s on, the production of sugar in Madeira added important profits to the growing African trade. In 1482 Portugal established a trading factory and outpost at São Jorge da Mina, in the Gulf of Guinea to support a rich trade of gold and slaves.[3] Finally in 1487, a small Portuguese fleet under the command of Bartolomeu Dias reached the southern tip of Africa. In 1498 Vasco da Gama arrived at Calicut, on the Indian subcontinent, opening a fast and comparatively cheap maritime route to the Far East markets. A number of important trading products converged at Lisbon, including spices, silks, fine cottons, precious stones, exotic artifacts and animals, and many other goods under the designation "drugs," which encompassed products from dye woods to perfumes.

By 1500 Lisbon was a rich and rather cosmopolitan city with a population of around fifty thousand. It was praised for its newly built Rua Nova dos Mercadores, literally "new street of the merchants," which offered all sorts of exotic products, and for its royal palace—the famous Paço da Ribeira—with its beautiful Renaissance portico leading to the river, from which the commercial activity of the harbor could be enjoyed. Sophisticated and expensive, the court of King Manuel I (1495–1521) organized lavish events for its local and foreign visitors, such as parades of the king's elephants and wild beasts, and the celebrated fight between an elephant and a rhinoceros, which was staged to amuse the queen in one of the palace's yards in 1515.[4]

The India route, as the round-trip voyage from Lisbon to Goa and Cochin is known, developed during the first half of the sixteenth century, and soon the Portuguese held an important share of the Far East trade with Europe. This lasted until the 1560s, when the Venetian Republic managed to reclaim a fair share of this trade by reestablishing the Red Sea and Levant routes through Mecca, Alexandria, and Syrian ports, which had been the traditional European supply routes of oriental products since the time of the Roman empire.

A small nation of around 1.2 million people, Portugal built during the sixteenth century an extensive sphere of interests, possessing fortresses, factories, and cities throughout four continents. By the late sixteenth century, the Portuguese were established in Macao, and their ships were sailing to Japan. Portuguese men were found throughout Asia, married to local women, living in the Moluccas, Timor, Bengal, and Pegu. Other Portuguese adventurers served under the Great Mogul (the Mogul Empire then extended from the Indian subcontinent to Persia). Sugar factories populated the Brazilian coast, and parties of explorers called *bandeiras* explored the South American jungle as far as

Potosí and up the Amazon River. In Africa, envoys of the king of Portugal visited Mali and Gao, the capitals of gold; other *bandeiras* walked along the Zambezi River, reaching Great Zimbabwe and exploring the interior of the African continent from the Angolan coast to the east in search of a mythic Silver Mountain. There were Portuguese convents in Basra and in Persia, and Portuguese men accompanied the Venetian and Armenian merchants in the caravans that went from Basra to Tripoli and Aleppo. Portuguese merchants and sailors traveled aboard the Spanish ships that carried silver ingots and coins from Acapulco to Manila, and silk and porcelain on the long and dangerous return trips from Manila to Acapulco. Every year Portuguese ships dropped their fishing nets on the codfish banks of Newfoundland, in the New World, and visited the Biscayan and French fishing stations there. Portuguese merchants carried sugar to Venice and fish to Chios and Constantinople. Finally, Portuguese ships transported African slaves from Guinea and Angola to Brazil and, profiting from the unification of the crowns of Portugal and Spain, also to the Antilles and other Spanish ports in the New World, returning home with gold and silver.[5]

In the Far East, Portugal managed to become a useful intermediary in the commerce between China and Japan, forbidden long before the arrival of the Portuguese, as a consequence of the losses inflicted by Japanese pirates on the Chinese fleets.[6] Established in Macao since the 1550s and in Nagasaki since 1571—the year of the foundation of the Spanish city of Manila, in the Philippines—Portuguese merchants were participating actively in the newly established trade route between Asia, the New World, and Europe.[7]

Portuguese interests were extensive and varied, both in the India route (*carreira da Índia*) that encompassed the trading relations between Asia and Europe, and in the Asia trade (*estado da Índia*), as the intense European trade in Asia was referred to.

The private trade of the India route brought an average annual profit of 5 million *cruzados* around the end of the sixteenth century, roughly 90 percent of the total traffic. The king's share may have been slightly less than half a million cruzados. For comparison, the Venetian Levantine trade amounted to 3 million cruzados at its peak in 1600. This volume of business was only surpassed by Spain's New World silver fleets, whose total value ranged annually between 7 and 10 million cruzados, the equivalent of 6 to 9 million ducats.[8]

Nevertheless, however hectic and rich this trade may have been, the public expenditures necessary to maintain these routes and protect the merchants were probably larger than the returns almost from the beginning.[9] During the sixteenth century the king's expenses included the building, maintenance, and operation of an ever-growing number of fortresses and factories on the west and east coasts of Africa, the Persian Gulf, the Indian Peninsula, Malacca, the

Moluccas Islands, China, and Japan. Numbering more than fifty in the 1570s, these strongholds certainly consumed more capital than they yielded. To these costs the crown had to add the building, maintenance, and operation of several fleets, which had to be kept at sea to protect the Portuguese ships both on the India route and on the Asia trade.

The India route traffic was generally seen as a royal monopoly, both in the India route and the Asian trade. In the first years of the India route the king allowed a few private ship owners to send vessels on the voyage. The king alone could not exploit all the commercial opportunities offered by the opening of this route, and there were already two private ships in Cabral's fleet of 1500. Private ships sailed along with the royal ships almost every year until 1521.[10] Between 1504 and 1506 the trade was even theoretically free—although a royal authorization was needed to send a ship to India—and merchants only had to pay taxes on their return.[11] Then, in the half century that followed—from 1521 to the 1570s—all ships in the India fleets were owned by the king, with an occasional exception.[12] During King Sebastian's reign (1568–78) contracts were established with private ship owners to send a certain number of ships to India every year, during a given period of time, frequently five years. In the period in which Portugal fell under the administration of the Habsburg kings (1580–1640) the participation of private investors in the *carreira* became the rule.

Distribution of eastern goods was controlled by the Casa da Índia, a large bureaucratic organization where all merchandise was received, appraised, stored, and sold under the control of an army of public workers. The Casa also supervised the loading and unloading of the ships, paid the crews, and inspected all vessels in an attempt to prevent, or at least reduce, the inevitable contraband.[13]

In addition to the Casa da Índia, the crown maintained and managed a large shipyard in Lisbon. This shipyard—the Ribeira das Naus, or Ribeira de Lisboa—included the naval yards as well as a series of warehouses, a foundry, and a powder factory.[14] The king's vessels were built, rigged, and equipped in the shipyards by a large number of employees organized according to their different tasks, and supervised by a team of officials and masters of each of the trades involved. In the warehouses were stored and maintained in good order all the necessary fittings for the ships, such as cables, sails, masts, and spars. Guns were stored in the foundry, situated on the east side of the royal palace. The Ribeira das Naus was one of the largest institutions of commerce in sixteenth-century Europe, employing at one time fifteen hundred men.[15] Other shipyards were eventually built in Asia, namely in Goa, Cochin, Bassein, and Daman, the Goa shipyard being the largest in the sixteenth century.

To keep account of the goods, the cargo was divided for custom duties into four major categories: *drogas, fazendas, miudezas,* and *pedraria.* Under the designation of *drogas* (drugs) were listed all the spices—pepper, cinnamon, ginger, cloves, nutmeg, and mace—along with indigo, lacquers, resins, borax, camphor, china wood, sandalwood, incense, ebony, and ivory. *Fazenda* (cloth) included bales of cotton cloth, silk, and thread, as well as slaves. *Miudezas* (odds and ends) was a vast designation that comprised most miscellaneous products, from chests and writing desks to musk oil. Finally *pedraria* (gems) referred to all semiprecious and precious stones, such as diamonds, pearls, and rubies.[16]

We know a great deal about the spices and drugs produced and traded in India in the sixteenth century. Western inquisitiveness produced several excellent descriptions of the trade very soon after the arrival of the Portuguese. Naturalists like Duarte Barbosa and Tomé Pires in 1515, and Garcia de Orta in 1564, wrote impressive treatises on the exotic products found in the East and their many uses and qualities.[17] Toward the end of the sixteenth century Francisco da Costa, scribe of the Portuguese factory in Cochin between 1582 and 1612, started a book that was completed by his brother Luis da Costa after his death and that still stands as a valuable contribution to the understanding of the structure of the Portuguese pepper trade.[18]

Peppercorn (the fruit of the *Piper nigrum* Lineus, in Portuguese *pimenta*) was undoubtedly the most important trade good in the East when the Portuguese arrived. Marco Polo estimated that in the late thirteenth century only 1 percent of the total production was actually traded in Alexandria, the traditional last outpost of the long trade route overland from whence almost all merchandise was distributed into Europe.[19] Before the arrival of the Portuguese, China probably absorbed the most important share of the whole production, buying it in Sumatra (Samatra), Burma (Pegu and Bremá), Indonesia (Sunda and Java), Thailand (Sião), Malaysia (Malaca), and the Malabar Coast.[20] It was used both to season and to conserve food, and its economic importance was extraordinary. Peppercorn could be prepared through two different processes, either drying the whole fruit before full maturation and obtaining black pepper, or drying only the mature core of the fruit, and obtaining white pepper.[21] For the voyage to Portugal peppercorn was stored in wooden boxes built in the hold of the ships, which were carefully closed and caulked.[22] This practice is corroborated by a letter written by D. Luis de Bravo de Acuña to the king of Spain and Portugal in September, 1606, after the wreck of the nau *Nossa Senhora dos Mártires,* in which he states that not a grain was saved from soaking after the wreck, since the peppercorn was stored in specially built boxes in the hold.[23]

Other spices were also traded in the East. Ginger (the root of the *Zinziber officinale* Roscoe [*Amomum zinziber* Lineus], *gengibre* in Portuguese) was cheaper than pepper but not as largely traded during the sixteenth century.

Much appreciated as a seasoning for salad, it could also be used in fish, minced meat, and in preserves with sugar. The most prized ginger was produced on the Malabar Coast, but its production extended along the western base of the mountain chain that runs along the west coast of the Indian peninsula. To protect the ginger from worms and insects, it was sometimes sealed in red clay before storage. Because of this, it was called red ginger, different from the fresh white ginger, and cheaper. To make sweet conserves it was abundantly pierced, so that the water and sugar would penetrate more quickly. In the second half of the sixteenth century Garcia de Orta advised consumers that this pierced ginger should not be mistaken for rotten ginger, which had holes caused by insect infestations.[24]

Cinnamon, clove, and mace were expensive spices, traded in small quantities with large profit margins. During the sixteenth century these three spices had similar prices in the Cairo markets. Cinnamon (the bark of the *Cinnamomum cassia* Blume, *canela* in Portuguese) was a much appreciated condiment that, although not mentioned by Marco Polo in the thirteenth century, was referred to by Ibn Batutah in the fourteenth century, as well as by the Portuguese traveler Pero da Covilhã in the fifteenth century, during his voyage to India on behalf of King John II.[25] It was not cultivated, but gathered in the wild, and although it was traded on the west coast of the Indian peninsula, it was produced abroad, the best and most abundant coming from Sri Lanka (Ceilão).

A smaller variety of the plant grew on the Malabar coast and produced a bark of lesser quality (*Cinnamomum iners* Reinw). A highly odoriferous oil was extracted from the fruit of this tree and used as an unguent, or a "very gentle mixture for the stomach, and to alleviate the colic" and to "remove the bad smell of the mouth."[26]

Mace, the outer part of the nutmeg fruit (*Myristica fragans* Houttuyn, *maça* and *nós moscada* in Portuguese), was produced in the Banda Islands (Bandam or Banda) in today's Indonesia. It was sold preserved in vinegar or in sugar as a much-appreciated delicacy and was touted as being good for the brain and for treating certain nervous diseases. Its oil was prescribed as a remedy for sexual impotence. Each volume of mace was sold together with seven volumes of the nuts—nutmeg—whose price was one- seventh of the price of mace in the Banda Islands, but only one-third in Lisbon and one-half in Cairo.[27]

Clove was produced on five little islands in the Moluccas (Ilhas de Maluco or the Malucas), of which Ternate, Tidore, and Makian were the most important. Also a fruit from a small wild tree (*Eugenia caryophyllata* Thunberg, *Caryophyllus aromaticus* Lineus, *cravo* in Portuguese), it was dried in the sun after being lightly moistened with seawater. It was then sold as a rare and expensive condiment.

Under the designation of *drogas* some thirty other products—mineral, vegetable, and animal—were traded as perfumes, unguents, dyes, medicines, and drugs. These included the chewable leaves of pawn (*bétele* in Portuguese), opium, sperm whale ambergris, camphor from Borneo, and musk (*almiscar* in Portuguese) from Tibetan goats. Also from Tibet came rhubarb (*Rheum officinale* Baillon, *ruibardo* in Portuguese), a root that was indicated to treat liver malfunctions. Another root, *pau da China,* was collected from a climbing plant (*Smilax china* Lineus), and was used both as a powerful aphrodisiac and as a treatment for venereal diseases.[28]

Besides these spices, many other products were traded by the Portuguese in the East, along several trading routes of which the one from Goa to Macao was the longest and most important throughout the late sixteenth and the early seventeenth centuries. These products were precious and exotic woods like the sandal from Timor, silk, glazed earthenware, and porcelain from China, stoneware from Burma (named Martaban jars after the kingdom with the same name), as well as pearls, precious stones, jewels, furniture, and exotic animals from many different places.

Under the designation *fazenda* were traded silks from Persia, China, and India; cottons and silks with special prints; and bales of cotton cloth from the Indian peninsula. This profitable commerce was always an important one, and in the period from 1600 to 1610 may have accounted for 60 to 70 percent of the total of the declared private trade. The cotton cloth trade sustained a profitable traffic: cotton was traded for slaves in Northern Africa, the slaves then traded for sugar in Brasil, and the sugar traded for wheat, copper, iron, and silver in northern Europe. Cotton cloth was also traded for gold and ivory in Northern Africa, or shipped to Turkey, where it was greatly valued. Although Portugal was a minor player in the overall trade in Asia, the Portuguese demand for cotton cloth is said to have led to great developments in textile manufacture in the Gujarat, Coromandel, and Bengal regions.[29]

*Miudezas* was a vast category that comprised almost everything else brought back from these exotic places. Asian furniture was treasured in the West. Chests made of precious woods, lacquered or inlaid with ivory, tortoise shell, or mother-of-pearl, were carried to Lisbon along with writing desks, screens, cabinets, chests of drawers, bed frames, and chairs. Curiosity made smaller objects highly desirable as well. Boxes, statuettes, fans, porcelain pieces, lapis lazuli, azurite, amber, gold, pearls, and jewelry were all top commodities for the Portuguese market.

Finally, *pedraria* included the presumably profitable traffic of diamonds from India and Borneo, as well as rubies and sapphires. This trade was always surrounded by a certain degree of secrecy and was fully controlled by a small number of specialized dealers who held a near monopoly until the 1630s, diverting the flow of stones from Venice, the main lapidary center in the sixteenth century, toward Antwerp. It is difficult to estimate its volume and economic importance since it was largely undeclared. However, we know that the diamonds salvaged from the wreck of *Nossa Senhora da Luz*, which ran aground in the Azores in 1615, were valued at more than 1 million cruzados.[30]

Nevertheless, considering only the profits declared by the merchants, there is no doubt that the most important source of revenues in Portugal during the whole sixteenth century and the first decades of the seventeenth century was the commerce with India. This in spite of the fact that during the first half of the sixteenth century African gold and slaves were still arriving in Portugal in notable quantities, mainly from the Portuguese factory of São Jorge da Mina on the Gulf of Guinea but also on a smaller scale from the eastern coast of Africa. This slave trading included supplying African slaves to the Spanish New World, a highly profitable business that complemented the already profitable sugar production from the colonies of Madeira and Brazil.[31]

Less than a decade after Vasco da Gama opened the maritime route to India in 1498, the Portuguese were a dominant power in the Indian Ocean, building fortresses, fighting those who threatened their interests, making alliances with the cooperative local powers, and perhaps most importantly, establishing the East India trade. Every year a fleet sailed from Lisbon to India, departing in March and returning sixteen to eighteen months later loaded with spices, drugs, and other trade goods, among which pepper was by far the most important for the crown.

The first leg of the outward voyage, which invariably started in Lisbon, consisted of a long, straight line passing south-southwest through the Canary Islands and the Cape Verde archipelago, taking advantage of the prevailing northeast trade winds. Crossing the calm and windless equatorial zone of the Atlantic to the proximity of the Brazilian coast, the route then continued to approximately 4° south, the latitude of Fernando de Noronha Island. There the vessels started a long arc, encircling the southernmost tip of Africa, the Cape of Good Hope, near 38° south latitude. The ships left Lisbon in March or April and tried to round the cape in July, in the middle of the southern winter. Once the cape was rounded, the fleet's pilots and captains had to decide whether they would sail east of the island of São Lourenço—today's Madagascar—directly to Cochin following the "outside" route, or take the "inside" route to Mozambique, through the Mozambique Channel, and pray not to encounter the Bassas da India atoll during the night. Everybody with a word to say inside the ship opposed the idea of spending the winter in Mozambique, because of the extra costs incurred in food, housing, and business delays, and the "corrupt airs" of the African coast. However, this stop sometimes saved passengers and crew from disease—most frequently scurvy—and starvation, both of which plagued the India route for at least the first two centuries. If all went well and the Cape of Hope was rounded before the twenty-fifth of July, the ships took the "inside" route directly to India, sailing past Mozambique to the Comoro Islands, from there to the Queimados Islets, and then to Goa or Cochin, where they would arrive between mid-August and mid-September (fig. 2.2). If the cape was rounded too late, the "outside" route was advisable in order to avoid the monsoon, the prevalent northeast wind that blew in te Northern Indian Ocean from October to April. The ships continued by following a northeast course to the islands of João Lisboa, Pedro Mascarenhas, or Diogo Rodrigues, and from there across the sixteenth parallel to the Queimados Islets and Goa. The duration of these voyages was usually around six months.

Once they arrived in India, the ships were either repaired and sent on missions in several parts of Asia, or simply loaded in Cochin and sent back to Lisbon. Loading was a careful process, generally performed under the supervision of the king's officers and the ship's master. The Dutch traveler Linschoten left us a detailed description of the loading process, as he saw it in December, 1588. By then the king was leasing the pepper trade to merchants for periods of five years, and both the merchants' representatives and the king's officials supervised the loading operations. The pepper was stored in the two lower decks, in small holds built over a wooden platform, which rested immediately above the ballast. These holds occupied almost the entire area of the two lower decks with the exception of the clearance area beneath the main hatch. After being filled, closed, and their lids caulked, the holds were all numbered and the quantities loaded in each one carefully noted.

The clearance space beneath and around the main hatch was then used to store water, wine, timber, and small items necessary for maintaining the ship during the voyage.[32] Then, all the other merchandise was brought aboard, carefully registered, and stored in areas specially assigned either to the king's commerce or to private trade (fig. 2.3).

Since the king's pepper took up most of the space in the holds, many boxes, barrels, bales, and everything else was stored in every possible corner—in the holds, on the weather deck, and sometimes even hanging outside the hull supported by ropes. Manuel de Mesquita Perestrelo, a survivor of the 1554 wreck of the nau *S. Bento* on the coast of South Africa described, "the lower decks were solid. On the main deck were about seventy-two boxes and so many bales and boxes stacked that they equaled the height of the castles."[33]

After about three months in one of the Indian ports it was time for the homebound fleet to sail back to Portugal. The return trip, or *torna-viagem* as it was then called in Portugal, was generally much more dangerous. Ships were frequently overloaded with cargo, and rounding the Cape of Good Hope

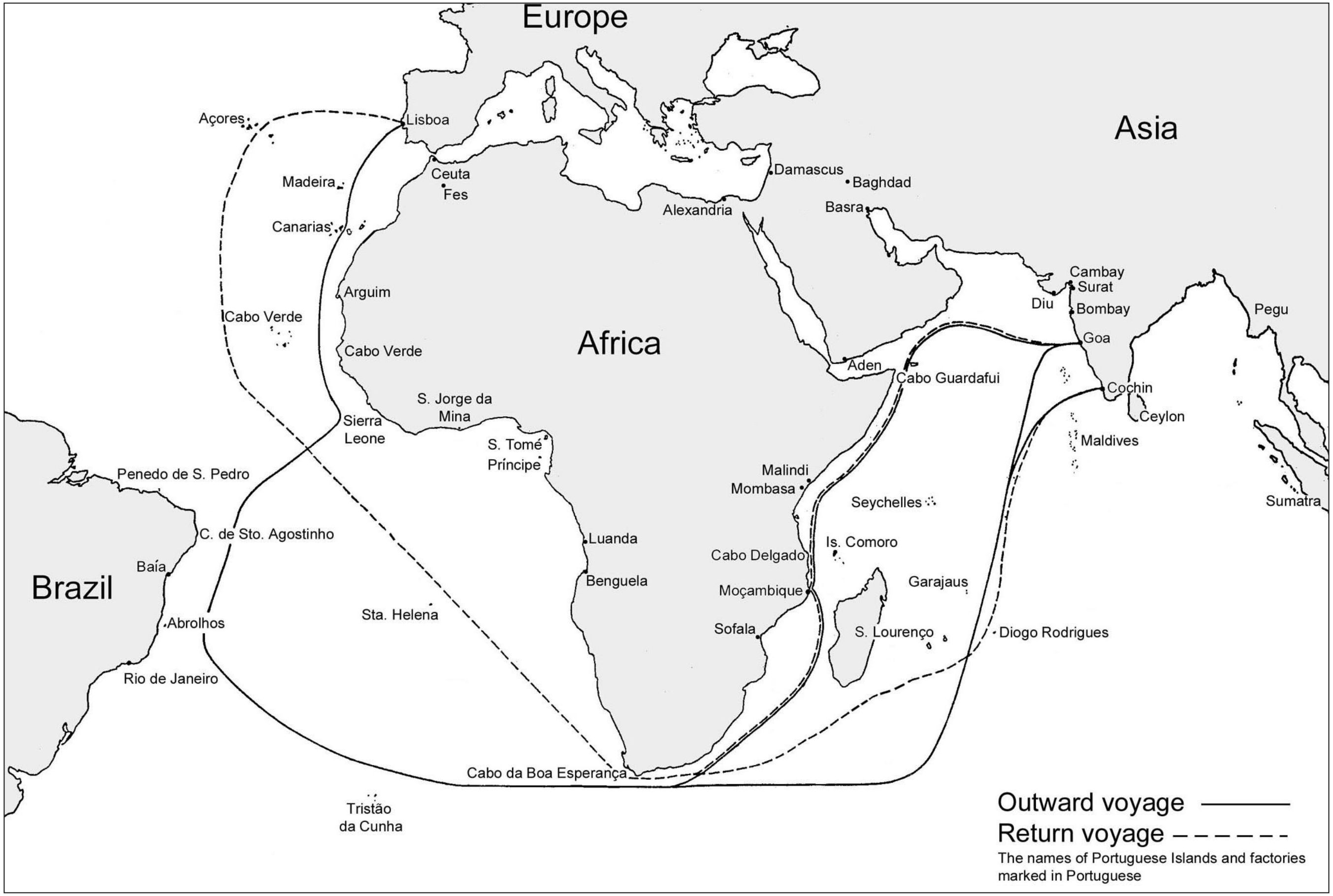



Fig. 2.2. The India route. (After Boxer)

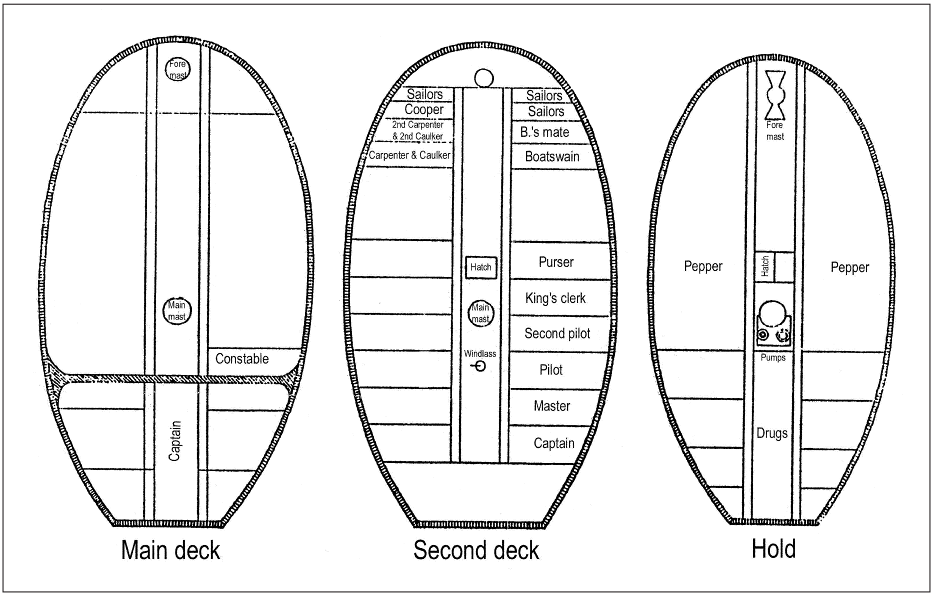



Fig. 2.3. Distribution of cargo in an India route nau (two-decker), after Figueiredo Falcão.

claimed many ships. Despite the additional dangers, overloading was inevitable since toward the end of the sixteenth century the crown frequently defaulted on the payment of salaries. To ensure that a minimum crew of able seamen would risk the trip, a large private trade was tolerated; otherwise it would have been too difficult to recruit skilled sailors to man the ships. Spanish *flotas* to the New World were much safer than Portuguese naus, and many Portuguese sailed Spanish ships to Central and South America every year.[34]

The shortage of sailors was an endemic problem from the beginning. A small country, Portugal had to recruit sailors from all available sources, and resorted to the extensive use of slaves as sailors. The lack of skilled seamen was proverbial, and it is said that in 1505 Captain João Homem had to nail a garlic braid on one side of the main yard and an onion braid on the other, for soon after departure it became clear that no one knew the difference between port and starboard:

> And the weather improving the governor sailed from Belem on March twenty-fifth of fifteen hundred and five, and the king went by sea to see his departure, watching the fleet unfurl after raising anchor in the midst of great shouting and artillery fire, from both the ships and the tower. And sailing this fleet down river, ordering the pilots to the

> helmsmen so that they sailed to port, and to starboard, as they used when they are sailing in a river, the sailors were confused, because they did not know yet that vocabulary, specially the ones aboard the caravel of Joao Home, and when they had to maneuver to port which is the right hand, they sailed to starboard, which is the left hand; Joao Home seeing this ordered the pilot to speak to the sailors with words that they understood; and when he wanted them to sail to starboard to say garlic, and when to port to say onions, and to each side of the ship he had a bundle of onions and a bundle of garlic tied, and as the pilot said those words, the sailors were not confused anymore and they sailed straight and true.[35]

Certainly an anecdote, this story is even more delightful since the chronicler Castanheda also confuses starboard and portside.

Ships left Goa or Cochin in December, sometimes in January, and either made it to Mozambique, where they were supposed to arrive approximately one month later, or to the Cape, following the "new" or "outside" route, which was used from 1527 onward. If they took the "old" or "inside" route to Mozambique, they would take on fresh supplies of water. Without these supplies, the trip could be dangerous if they missed the island of Saint Helena in the South Atlantic after rounding the Cape of Good Hope. If they sailed according to the rules, they were to leave Mozambique in January and round the Cape before the end of February with good weather, before the southern autumn. If they took the "new" or "outside," as most vessels that sailed from Cochin did, they were to sail down the coast of the Indian subcontinent to Cape Comorin on its southern tip, and from there to the Maldives. Then they followed a southwest route with the southeast trade winds to the Island of Diogo Rodrigues, the shoals of the Garajaus, and the Cape of Good Hope. Even on the "outside" route, it was as important to try to pass the Cape before the peak of the winter as on the "inside" route, and a departure after Christmas Day could mean disaster.

However, economic difficulties could delay the acquisition of pepper and other goods, and departures as late as February were frequent. During the seventeenth century the presence of the Dutch and the English made it preferable to leave in the last days before the monsoon, or even in the first days of the contrary monsoon, in order to avoid encounters at sea. This is certainly one of the main reasons for the substantial increase of losses after 1590. In the period from 1590 to 1640, the number of voyages interrupted by a winter sojourn in Mozambique rose considerably, and so did the number of wrecks.

After rounding the Cape of Good Hope, the ships turned north to find the island of Saint Helena or, from the beginning of the seventeenth century onward, tried to avoid it because of the possible presence of Dutch and English enemies. In either case they would sail northwest, with the southeast trade winds astern, in the direction of the Island of Fernando de Noronha near the coast of Brazil. From there the ships would sail north and try to catch the northeast trade winds by starboard, and then head east, as soon as the prevailing westerlies allowed, to the Azores and Lisbon.

In 1580, soon after the death of King Sebastian, Portugal lost its independence to Spain, and Philip II of Habsburg became also King Philip I of Portugal. As a direct consequence Portugal was sucked into the religious wars that swept through Europe during most of the second half of the sixteenth century. Portuguese harbors were closed to Dutch merchants, who had traditionally distributed Portuguese goods in northern Europe, and merchants relying on Portuguese vessels were forced to distribute their products into northern waters, where they fell prey to English, French, and Dutch privateers and pirates. Moreover, the closure of Lisbon to Dutch traders pushed them into seeking a route to India, and this meant the entry of new competitors in the Asia trade.

The Portuguese situation was nearly ruinous for Dutch merchants in the late sixteenth century. In response to the closing of Lisbon to their ships, the Dutch Republic sent Cornelis Houtman with four ships to India in 1595. Guided by the notes of Jan Huygen van Linschoten, a Dutchman who had sailed to India in the service of a Portuguese clergyman, thus began the Dutch expansion overseas.[36] Before the end of the century, the Dutch were purchasing their spices in India and salt in Cape Verde and Venezuela, starting a profitable trade in the New World, establishing contacts in Madagascar, and building forts in the Lower Amazon region. In the early 1600s the Dutch established posts in the Guiana; their huge merchant fleet consisted of around twelve hundred Dutch ships in the Baltic Sea trade alone. To this trade of timber, grain, fish, beer, textiles, and salt, the bulk of the Saint Lawrence fur trade was soon added, along with a large share of the slave trade to the New World.[37]

The Spanish king's inability to defend Portuguese possessions overseas from its Dutch and English Protestant enemies led to a slow but continuous erosion of the Portuguese empire. At the same time, Spain drained Portugal of a significant part of its merchants and sailors engaged in the Spanish New World trade. However, during the first two decades of the seventeenth century the core of the business was still held by a powerful and well-connected merchant class established in Lisbon. In fact, from 1599 to 1610 Portuguese merchants invested more capital in the India route than the Dutch and English merchants together.[38]

In 1602 the Vereenigde Oostindische Compagnie (VOC) was formed to promote, sponsor, and regulate the Dutch republic's Asian trade. As there was no minimum amount required to take part in its ventures, this highly sophisticated business organization combined the efforts of large and small investors. The VOC developed rapidly by spreading the risks over many investors and lending well- developed financial tools to the Far East trade. The policy of the small Asian trading companies before 1602 had been to avoid any conflict with the Portuguese vessels at sea; now, war with the Portuguese was expressly mentioned in the guiding principles of the company.[39] Although in the early seventeenth century the Dutch Republic posed a serious threat to Portuguese power in Asia, this was not fully understood until 1605, when news of the blockade of Goa by the fleet of van der Hagen one year earlier reached Madrid. In India the viceroy Aires de Saldanha immediately realized the vulnerability of the *estado da India* to European attack.

The arrival of the Dutch in India forced the Portuguese to spend more money on the defense of their strongholds, and to change routes and practices. For instance Cochin, the main cargo port of the sixteenth century—where at least half the pepper bought by the Portuguese in India was loaded every year—was superceded in the first decade of the 1600s by Goa because the former port could no longer assure the security of the loading ships. The move was made in spite of the fact that Malabar pepper bought in Cochin was cheaper than pepper bought in Goa, and the cost of repairs to ships in Goa before their departure to Portugal was double the price in Cochin.[40]

When a highly desired peace treaty was finally signed between the English and the Spanish in London in 1604, the Portuguese could foresee a small decrease in the English privateers' pressure on their trade, especially during the last part of the voyage, between the Azores and Lisbon. At this time, however, the Dutch increased their activities in the Far East, blockading Goa for twenty-three days in September and October, 1605.[41]

Leaving the Netherlands in December, 1603, a powerful Dutch fleet of thirteen vessels had sailed to Asia under the command of Steven van der Hagen. Its mission was to seize the Portuguese fleet of 1604 either off the coast of Mozambique or off the port of Goa. However, the 1604 Portuguese armada did not arrive in Mozambique on time, nor did it appear in Goa that year. Of the five intended vessels, three were forced back into port due to bad weather, one was shipwrecked, and the fifth, carrying the new viceroy Martim Afonso de Castro, arrived late in the Indian Ocean. Having to winter in Mozambique, waiting for the monsoon to sail to Goa, it finally arrived in 1605.[42]

When news of a Dutch war fleet in the Far East reached Madrid, a large fleet was sent to confront them. In March, 1605, four galleons and six naus sailed from Lisbon to Goa.[43] Of these ships, five were intended to reinforce the fleet defending the Portuguese positions. The other five were to load a large cargo of pepper and transport it to Portugal, a vital concern due to the failure of the fleet of 1604. One of the six naus of the 1605 fleet was the newly built

*Nossa Senhora dos Mártires*. It left under the command of Manuel Barreto Rolim, one of the three captains of the 1604 armada who had not sailed due to the bad weather conditions.

Deploying an armada of ten vessels was a huge effort for Portugal in the early seventeenth century. The last decade of Philip II's reign and the early years of Philip III's saw a constant drain of money and energy from Portugal for wars with England and the Netherlands. Although the loss of an India nau such as the *Nossa Senhora dos Mártires* was not uncommon in the beginning of the seventeenth century, this shipwreck is nevertheless connected to a particularly important event: the 1605 blockade of Goa, the first of a series of war actions that would slowly but steadily erode the Portuguese power in Asia, starting a long decadence of the Estado da Índia.

In 1622 a combined force of English and Persian troops took Ormuz, in the Persian Gulf. Two years later, the Dutch drove the Portuguese from the coasts of Angola and Benguela, in West Africa. In 1628 they conquered the factory of São Jorge da Mina, and in the following year managed to provoke the Portuguese expulsion from Japan. By 1630 the Dutch had invaded the northeastern coast of Brazil, not to be expelled until 1654.

In 1640 revolution arose in Lisbon following the enactment of a Spanish tax on the nobility for the protection of Brazil. With England's help, Portugal regained its full independence that year, but this status was not recognized by Spain until 1667, when King Charles II of Spain acknowledged defeat and the loss of Portugal.

Portugal was by then economically exhausted, and had an archaic social and economic structure compared to that of England or the Netherlands. In 1640 there were eleven ships in Portugal, eight galleons of Portuguese construction—of which one was not fit for navigation—and three other ships, one galleon seized from the French and two hookers seized from the Dutch.[44] However, the India route was quickly reestablished, and although the revenues from the Asia trade lost their importance when compared to the profits from Brazil and Africa, the trade route survived until the last days of sail.

No complete study of the journey between Lisbon and India has yet been made. The available data are dispersed throughout several sources. Quirino da Fonseca, João Vidago, Vitorino Magalhães Godinho, Leonor Freire Costa, and the collective work of Paulo Guinote, Eduardo Frutuoso, and Afonso Lopes provide, to my knowledge, the most complete and reliable studies.[45] Of the large number of studies and articles, Charles Ralph Boxer, Luis de Albuquerque, Francisco Contente Domingues, Artur Teodoro de Matos, James Boyajian, and Sanjay Subrahmanyam deserve special mention, both for the quality and the extent of the work behind them.

As for the contemporary written sources, only a few lists of departures and arrivals—*relações de armadas*—are available, and these unfortunately do not match exactly. In 1755 the archives of the Casa da Índia were completely destroyed by the violent earthquake, followed by a series of tidal waves and a huge fire, that crushed Lisbon on November 1. Close to thirty of these *relações* survived the earthquake in private libraries, of which two are marvelously illustrated: the *Livro de Lisuarte de Abreu,* which covers the period between 1497 and 1563, and the *Memória das Armadas,* covering the period between 1497 and 1566. Since the 1980s, Comandante Encarnação Gomes has published eleven of these texts.[46] To assert with any certainty the exact compositions of the fleets of 1604 and 1605 is not possible. But since there is not a single reference to the nau *Nossa Senhora dos Mártires* before 1605, presumably it was a newly built vessel when it left for Cochin in March, 1605. This period is considered one of the darkest in the history of the India route, and the number of losses at sea certainly suggests the existence of major organizational problems. However, a closer look reveals that despite the disproportionate number of shipwrecks that plagued the *carreira* in the first decades of the seventeenth century, the Asia trade brought more money to its private investors than any other period in the long history of the India route.

Many authors divide the history of the India route into two main periods. The first period reflects better overall control by the crown and fewer losses at sea between 1498 and the late sixteenth century, certainly before the 1588 Spanish armada episode, which resulted in the default of many payments to private contractors and generated both a cash shortage and a distrust of crown officials. The second period lasted from the late sixteenth century until 1640 and saw the trade threatened by other competitors. After 1598 King Philip III diverted part of the profits from the India route to his war efforts in the Low Countries, and in spite of contributions from the merchants of Lisbon, the necessities of the *carreira da Índia* were never satisfied.[47] Furthermore, in 1603 the English brought their first shipment of pepper to London, joining the already competitive Dutch traders in supplying the European market.[48] Losses to piracy and privateering increased dramatically during this period. Before 1580 only two vessels had been taken by privateers: the ship of Captain Job Queimado in 1509, and the nau *Santa Catarina do Monte Sinai* in 1525. Then in 1587, Francis Drake seized the nau *São Filipe* in the Azores, loaded with additional cargo from the nau *S. Lourenço* left behind in Mozambique. The nau *São Filipe* was the first of a small number of rich catches that included the mythical *Madre de Deus* seized in 1592 and taken to London with its cargo. It is estimated that between 1586 and 1635 at least fifteen ships were lost due to Dutch, English, or Turkish attack. This number is roughly 20 percent of the Portuguese global losses and about 3 percent of the Portuguese total voyages.[49] Unfortunately for the pirates and privateers, most of these captures were lost to the sea before any cargo could be salvaged.

The changes in routes and timing may have had a more important effect than pirate raids on the performance of the Portuguese fleets and were eventually the cause of many more losses. Departures late in the season became almost the rule because this practice diminished the probability of an encounter with enemies, but greatly increased the chances of being caught in heavy storms.

India route shipwrecks have been counted and estimated by several authors, according to different sources and criteria. A study by Guinote, Frutuoso, and Lopes, places the number of shipwrecks at 219 for the period between 1498 and 1650.[50] This number is substantially larger than those advanced previously by Magalhães Godinho, who estimated the losses between 154 and 159 from 1500 to 1635; Quirino da Fonseca, who estimated the losses around 112 for the period 1550 to 1650; or James Duffy, who presented 130 losses for the same period. The Guinote team study is close to the estimates of João Vidago, who placed the losses at 201 between 1497 and 1640.[51]

According to Guinote, Frutuoso and Lopes, when all the data are carefully considered, the loss of ships to the India route is apparently higher than has been previously acknowledged. These authors place the losses at 20 percent of the overall trips, a number much higher than Luís de Albuquerque's 10 percent, or Magalhães Godinho's 10 percent on the voyages to India and 15 percent on the returns from India.[52]

Only a few India route shipwreck sites have been found, and almost all were heavily looted before archaeologists arrived. Moreover, almost no written references to any hull remains exist, with the exception of a small portion of the hull of a late sixteenth-century wreck believed to be the *Santo Antonio,* wrecked in 1589 on the Boudeuse Cay, one of the Amirante Isles in the Seychelles archipelago.[53] However, several collections of artifacts from these wrecks have surfaced in the past, and a few have been donated or sold to museums, or analyzed by archaeologists and published. I have compiled references to fourteen India route wrecks, dating from the period 1498–1650 (table 2.1). Of these, the sites of the *S. João* (1552), *S. Bento* (1554), *Santiago* (1585), *Santo António* (1589), *Nossa Senhora dos Mártires* (1606), *Nossa Senhora da Luz* (1615), *S. Gonçalo* (1630), *Santa Catarina de Ribamar* (1636), *Santíssimo Sacramento* and *Nossa Senhora da Atalaia do Pinheiro* (1647), have been tentatively identified with differing but fair degrees of certainty. The remaining shipwrecks have been suggested to be those of *Santo Alberto* (1593), *Santo Espiritu* (1608), *S. João Baptista* (1622), *and Santa Maria Madre de Deus* (1643).

With a registered weight of 900 tons, the "great galleon" *S. João* was one of the largest India route naus built in its time. The account of its loss is included in the eighteenth-century anthology *História trágico-marítima* of Bernardo Gomes de Brito and stands as one of the most popular stories of the period of Portuguese expansion overseas. It was built in 1550 in Lisbon's ship-

**TABLE 2.1 INDIA ROUTE SHIPWRECKS**

| DESIGNATION | DATE OF WRECK | SITE OF SHIPWRECK | HULL REMAINS |
|---|---|---|---|
| *São João* | 1552 | Natal coast, South Africa | No |
| *São Bento* | 1554 | Natal coast, South Africa | No |
| *Santiago* | 1585 | Indian Ocean, Bassas da Índia atoll, France | Not known [not published] |
| Seychelles wreck / *Sto. António* | 1589 | Seychelles | Yes |
| *Santo Alberto* | 1593 | Sunrise-on-Sea, South Africa | Not known |
| *Nossa Senhora dos Mártires* | 1606 | Tagus mouth, Portugal | Yes |
| *Santo Espiritu* | 1608 | South Africa | Not known |
| *Nossa Senhora da Luz* | 1615 | Isle, Azores, Portugal | Not found [no hull remains] |
| *São João Baptista* | 1622 | South Africa | Not known |
| *São Gonçalo* | 1630 | Plettemberg Bay, South Africa | Not found |
| *Stanta Catarina de Ribamar* | 1636 | Cape Roca, Portugal | Not known |
| *Santa Maria Madre de Deus* | 1643 | South Africa | Not known |
| *Santíssimo Sacramento* | 1647 | South Africa | Not found |
| *Nossa Senhora da Atalaia do Pinheiro* | 1647 | South Africa | Not found |

yards and sunk in 1552 on its way back to Portugal before concluding its first voyage to India.

It left Cochin on February 3, 1552, under the command of Manuel de Sousa Sepúlveda with a load of 12,000 *quintais* of pepper, a great quantity of Chinese porcelain, and other merchandise. A heavy storm damaged its rigging and hurled it against the coast, breaking its hull into three parts against the rocky bottom near today's Port Edward in South Africa. In the wreck, 120 of its more than 600 passengers perished. The survivors endured a grueling five and a half month march to the mouth of the Maputo River, during which the majority died of starvation, disease, and attacks from the indigenous populations. Out of almost 500 people that undertook the march, only 25 arrived at the Maputo River. In 1980 a sport diver recovered part of a bronze gun from the place believed to be its wreck site. The area was surveyed in 1983 by a team of sport divers who recovered many artifacts in spite of poor visibility, a difficult rocky bottom, and strong surf and current. No hull remains were found. Some of the artifacts recovered were offered to the Natal Museum, in South Africa, including the fragment of the bronze gun, shards of Ming porcelain from the Jiajing period (1522–66), coarse earthenware, and glass beads from Cambay, India.[54]

*S. Bento* was built in Lisbon in 1551, with a registered weight of 900 tons, and lost on its return to Portugal on its first voyage. According to Bernardo Gomes de Brito's *História trágico-marítima, S. Bento* was lost in 1554 during a violent storm off the coast of South Africa with a load of pepper and other precious merchandise. Once again, the more than 300 persons who managed to make it to shore after the wreck had to walk to the mouth of the Maputo

River—only sixty-two people arrived two and a half months later. The written account gave precious clues to the sport divers who found its presumed wreck site in 1968 and recovered eighteen bronze guns and many artifacts. Judging from the reports, no hull remains were found. Part of the collection of artifacts is in the Natal Museum and another part is in the Durban History Museum.[55]

The nau *Santiago* hit the atoll of Bassas da India during the night at full speed, on its way to India in 1585. It lost its bottom against the coral reef, and parts of its upper works floated away and came to rest over the coral reef on the southern part of the atoll. The account of this wreck was also published by Gomes de Brito. *Santiago* was described as a 900-ton nau, with 33 m of keel length, and around 50 m of length overall. The wreck site was found in December, 1977, and several artifacts were salvaged in the next three years. Among many items recovered were twelve bronze guns, one astrolabe, several kilos of silver coins, religious objects, and a few jewels. The bulk of this collection would later be sold by Santiago Marketing, a company created for the purpose, and bought by the Portuguese Museu de Marinha and the South African Natal Museum.[56]

In the 1970s thirty bronze guns were retrieved by local fishermen from the wreck site of a Portuguese vessel in Boudeuse Cay, Amirante Isles, Seychelles, believed to be that of D. João da Cunha's *Santo António,* lost in 1589 at that island. Surveyed in 1976 by Warren Blake and Jeremy Green, this wreck still contained a small portion of its bottom planking and framing in place, occupying an area of about 50 by 10 m. The hull planking was 9 cm thick, and the frames 17 cm sided and 18 cm molded. The planking was nailed to the frames with square iron nails. The caulking method was similar to that found on *Mártires,* with lead straps 2.5–3 cm wide and lead strings 5–6 mm in diameter. The majority of the artifacts went into private collections, with a small portion going to the Carnegie Museum in Victoria, Seychelles.[57]

Lost en route to Portugal after springing a leak in midocean, the nau *Santo Alberto* is thought to have run aground close to the mouth of the Umtata River, on the east coast of South Africa, in 1593. The account of its wrecking is also included in Gomes de Brito's *História trágico-marítima,* and was originally written by João Baptista Lavanha, the author of the *Livro primeiro de arquitectura naval.* Its site was tentatively identified after Ming Dynasty porcelain shards of the Wan-Li period were found near Sunrise-on-Sea, in South Africa.[58]

The wreck site of the *Santo Espiritu,* an India route ship lost off the eastern coast of South Africa in February, 1608, may have been identified through the find of porcelain shards, between Double Mouth and Haga Haga. There is no mention of any wooden remains.[59]

The large *Nossa Senhora da Luz* was lost on November 7, 1615, at Porto Pim, Faial, Azores, and its presumed wreck site was found in 1998 by a team from Centro Nacional de Arqueologia Náutica e Subaquática/Direcção Regional dos Assuntos Culturais da Região Autónoma dos Açores under the direction of Paulo Monteiro. The site was surveyed the following summer. No remains of the hull have been preserved.[60]

Less sure is the resting place of the nau *S. João Baptista,* lost against the east coast of South Africa, after a battle with two Dutch vessels in 1622. Ship remains found near Cannon Rocks, in South Africa, have been speculatively associated with this vessel. As with many of the other sites, it has only been tentatively identified through the porcelain shards found on the beach.[61]

The small nau *S. Gonçalo* was one of five vessels offered by the Portuguese and Spanish crown to a newly created Companhia da Índia, formed in 1628 after the image of the successful Dutch VOC. *S. Gonçalo* was lost in 1630 on the south coast of South Africa. Its remains are known to lie somewhere at the bottom of Plettenberg Bay but have never been found. However, the camp built by the shipwreck's survivors was still visible in 1788, when the area was settled by Jan Jerling. After exposing part of the site during the construction of a new house, Jan's descendent John Jerling supported archaeological excavations in 1979, which were conducted by a team from Cape Town University. The Jerling collection includes more than one thousand porcelain shards and many other artifacts.[62]

*Santa Catarina de Ribamar* was lost in November, 1636, near the mouth of the Tagus River, Portugal, against the small islets of Cape Roca; the wreck site remained in the memory of the local population for many generations. Many locals still know the story of Dona Ricarda, an old woman who knew in the eighteenth century where to find golden coins at the nearby beach after storms. In 1966 a bronze gun was raised from this site, and another 2 may have been salvaged by looters (they are said to have been melted soon afterward). In the summer of 2000 a team from CNANS conducted a survey at the site, finding a large anchor but no sign of the several bronze guns reported by fisherman to be lying on the site, deeply encased in the rocky bottom. No mention has ever been made about any hull remains.[63]

The naveta *Santa Maria Madre de Deus* was lost off the east coast of South Africa in 1643. Its remains were tentatively identified after the discovery of porcelain shards in the 1960s. In 1993 a section of a wooden hull washed ashore after a storm at Bonza Bay. However, the description of the portion of hull found on the beach suggests a later date for its construction. It was 10 m long by 3 m wide and encompassed 18 thick frames planked on both sides. It was fastened with wooden treenails and "brass" nails, fasteners not typical of Portuguese shipyards in the seventeenth century.[64]

*Santíssimo Sacramento* was a large vessel built in India for the India route.

It left Goa on 20 February, 1647, bound for Lisbon and wrecked off the coast of South Africa, after being driven ashore by a storm. The account of its loss and the adventures of the survivors gave good indications to the whereabouts of its wreck site. In 1778 the captain of a Dutch garrison stationed nearby visited Algoa Bay and marked the wreck site on a map, referencing the location of huts built by the survivors. In 1949 an article referred to the existence of a gun and 2 anchors in the tidal area, and three years later a researcher named Harraway raised an iron gun from the site. In 1977 David Allen and Gerry van Niekerk located 21 bronze guns underwater in front of the site of Harraway's gun. Soon after, David Allen found another 40 guns—21 of iron and 19 of bronze.[65]

*Nossa Senhora da Atalaia do Pinheiro* left Goa with *Santíssimo Sacramento* on February 20, 1647, and wrecked a week after the loss of *Sacramento,* a victim of the same storm. The survivors met those of *Sacramento* and marched together to today's Maputo. *Atalaia*'s wreck site was located in 1978 by Bell Cross, director of the East London Museum. Eighteen guns were found on the underwater site (ten bronze and eight iron), together with many porcelain shards, Martaban jars, and other pottery remains. The remains of a camp were found on the beach in front of the wreck site, 25 m above the tidal zone. Both sites have produced abundant cultural materials that are now housed in the East London Museum.[66]

There are few doubts concerning the identification of this small group of wreck sites as those of Portuguese Indiamen, and the collections of artifacts, combined with the information contained in the accounts of the respective wrecks, make strong cases for their identification. However, none of these sites has yielded much information about the most important artifact—the ship. We have abundant information about the India route, its history, the historical period, and the politics involved. There are thousands of titles pertaining to the Portuguese expansion, and yet almost nothing is known about its main vehicle, the India route nau.

We have a few, unreliable images; a scant collection of contemporary descriptions of these vessels; and only a handful of technical texts pertaining to their construction. These data do not allow us to clearly answer all the questions raised about *Nossa Senhora dos Mártires*. How large was it? How was it built? How was it rigged? How strong was its hull? How were its officers, crew, and passengers lodged? Evidence suggests that the story began in Italy long before the shipwreck of *Nossa Senhora dos Mártires*. In the next chapter I discuss what we do know about the India route naus and their origin.

3

# The Ships

Information about Italian ships is important for the reconstruction of the *Nossa Senhora dos Mártires* because there is evidence of similar design and construction techniques in use in Portuguese shipyards of the sixteenth century. The model for Portuguese India route naus evolved from the Mediterranean round ship, which developed originally in Italy, and *Nossa Senhora dos Mártires* was conceived and built using methods that mirrored the Italian ways.

Written sources suggest that in the thirteenth century Italian master shipwrights of Naples, Genoa, and Venice had full control over the various craftsmen involved in the construction of ships, from the woodcutters in the forests, to the sawyers, carpenters, and caulkers in the shipyards. The definition of Italian hull dimensions was the result of a set of predetermined and simple proportions between the measurements of the keel length, beam, dimensions of the stem and sternpost, and depth in hold. The width of the floor timber on the lower, flat portion of the midship frame and the breadth of the section at certain heights above the top of the keel (e.g., *trepie,* three feet, and *sepie,* six feet) were determined from the maximum beam.

Italian archives house a great number of documents pertaining to the size and shape of vessels, the dynamics of the shipping business, and the work of its greater shipwrights. Although iconography is scarce and generally poor where the twelfth, thirteenth, and fourteenth centuries are concerned, a series of texts detailing the construction of vessels provide an important array of information about Italian shipwrightry.[1]

The evolution of Portuguese ships from Italian practices comes as no surprise when we consider the large resident community of Italians in Portugal, the involvement of Italian merchants in Portuguese commerce from at least the fourteenth century on, and contact with Italian shipwrights from at least the twelfth century.[2] The presumption of an Italian influence is further reinforced after examining the comparatively scarce sources pertaining to the shipbuilding industry in Portugal.[3] The same patterns appear in the relations between ship owners and ship builders, although these also existed in other regions of the western Mediterranean.[4] From the fifteenth century on, the archaeological record confirms the similarities in building techniques between Italy and southern Iberia.[5]

Another source of influence may have been the Arab world. However, the relations between Portugal and the Arab world are largely unknown, and although we suspect that Arabs may have been quite important, there is no solid evidence for involvement of *moçarabes,* as the Christianized Muslims were known in Portugal, in ship construction, as there is in other activities such as architecture. The presumption of Arab influence in the Portuguese shipping industry is a typical case in which the absence of proof does not make a case for the absence of activity. We know that Arabs, Jews, and Christians enjoyed close and peaceful relationships in Portugal during most of the period of Muslin domination (712–1249). Intense trade occurred throughout the entire late medieval period, which lasted at least until the expulsion of the *mouriscos* from Spain by Philip III in 1609 and 1610. And tailframes, important ship structural elements, bear an Arab name in Portugal, *almogamas,* and this is certainly not for lack of Italian designations.

Little is known about Arab shipbuilding, but evidence suggests the use of frame-based vessels in the Arab world since the tenth century. Three Saracen wrecks—Plane 3, Agay A, and Batéguier—found off the southern coast of France and dating from the tenth or eleventh centuries, show evidence of having their planks nailed to the frames. Not yet fully published, these vessels may have been similar to the *Serçe Limanı* shipwreck, having a flat floor, a hard chine, and flush laid planking nailed to the frames.[6] Furthermore, a frame-based type of construction may already be suggested in a seventh-century manuscript, the Aphrodito papyri, which mentioned the purchase of large quantities of iron nails for the Cairo shipyards.[7] It is regrettable that one of the best Portuguese sources on shipbuilding, Father Fernando Oliveira, did not give any details of his visits to Moroccan shipyards, in spite of finding them worth mentioning in his memoirs. Father Oliveira considered that his visits to North African shipyards increased his expertise and experience, and he certainly did not express any criticism of them in spite of his well-known candor. We can only suppose that Arab shipbuilding was as good and sophisticated as any other of its time.[8]

Besides those of Italians and Arabs, many other influences may have helped shape the model of the India nau. These can be seen even today in the traditional and local small craft, and were certainly much clearer in the sixteenth century outside the state-managed shipyards.[9] The Iberian Peninsula was and still is a heterogeneous region, comprised of many different communities. Although most of its territory is a large central plateau, rural and isolated from the sea, the Portuguese coast is occupied by many different populations, all closely related to the sea and traditionally subsisting on maritime activities such as fishing and the harvesting of algae or gathering of salt. All these people carry different traditions, devotions, and ethnographies. They speak at least five different languages (Basque, Galego, Portuguese, Castilian, and Catalonian) and build different water craft. However, tracing all influences with certainty is difficult, as Father Oliveira noted in his book *Liuro da fábrica das naus:* "and if our [craft] changes, and we forgot it from yesterday into today, what can I say of the Latin and Greek [craft] from so many years ago."[10]

The truly interesting aspect of *Nossa Senhora dos Mártires* is its construction in the state-driven shipbuilding industry, based on the new Renaissance trends of erudition. From the early fifteenth century on, when the crown got involved in commerce with the African coast, ships grew larger and trips grew longer. This was a period of discovery, contact, and accumulation of wealth, three factors that certainly encouraged creativity and eased change. The voyages of the beginning of the fifteenth century were undertaken in square rigged *barcas* and *barinéis,* vessels that Oliveira held to be similar to the *trincados da Galiza,* literally "clinkers of Galicia."[11] Nonetheless, quite early, a lateen rigged ship known as *caravela* seems to have become the prototype for the efficient middle-size vehicle of the discoveries. These vessels were first mentioned in Portugal as fishing ships in 1255, in the charter of the coastal village of Gaia, but were already mentioned as ship's boats in 1159, in a Latin manuscript from the Archivo di Stato di Genova.[12]

Drawing little water, tacking easily and rapidly, and capable of transporting artillery and victuals for middle-range trips, caravels were extensively used during the Portuguese expansion along the western coast of Africa. They were not discarded until the early 1500s, when they were found to be too small for trips beyond the Cape of Good Hope. Caravels are the icon of the Iberian shipbuilding tradition but may not be closely related to the large naus of the India route. Lateen rigged and presenting a fairly high length to beam ratio, caravels evolved during the sixteenth century into something close to a galleon, with four masts (of which three were lateen rigged), a pronounced beak, and low castles always present in the mid-sixteenth-century illustrations.[13]

Square rigged ships were also extensively used during the fifteenth-century expansion, in voyages of trade, piracy, and discovery; and from the early sixteenth century on, fully rigged ships appear together with large lateen rigged ships in almost all the views of Lisbon.[14]

However different these two types of ships may have been, they shared the same shipbuilding tradition, which consisted of frame-based round hulls with a characteristic flush-laid planking that is still known today as carvel planking. They were conceived and built in the same manner, with the hull thought of as a central portion and two ends. The shape of the central portion was defined by a master frame, the widest section of the hull and two tail frames, which marked the extremities of this central portion. The bottom of the master frame was narrowed and raised toward the extremities using a simple and old geometrical algorithm. The ends were shaped by bending a series of ribbands, wales, or planks at several levels over the predesigned central portion, and fairing their runs onto the posts. This concept entailed some sort of transversal control since the frames were determining the shape of the hull, at least at its central portion, and this was a relatively new concept in shipbuilding. Hulls had always been designed longitudinally, the shape obtained by the smooth runs of the longitudinal strakes. Evidence suggests that this system of frame-based construction developed between the fifth and tenth centuries in the Mediterranean, replacing the prevailing shipbuilding tradition. It is called frame-based in opposition to the prior shell-based systems used in the Mediterranean and northern European waters.[15]

Ships were built according to two major traditions during the Middle Ages. In the north of Europe, the outer hull was assembled with overlapping strakes and then reinforced with frames nailed to its internal surface. In the Mediterranean the strakes were edge joined, with tenons inserted in mortises cut into plank edges. These tenons were generally locked in place with pegs inserted perpendicularly to the planks' surface. There were many variations within these two broad traditions of shell-based hulls and many more styles of hulls and craft; but they all shared the fact that the hull was thought of as a shell reinforced with frames and that its shape was defined by certain longitudinal runs.[16]

In the late medieval era, however, most vessels in the Mediterranean were built following a completely different philosophy, showing varying degrees of evolution toward what would become the frame-based—or skeleton-first—tradition. By the late sixteenth century this designation still referred to the erection of only a certain number of frames over the keel before the insertion of ribbands that would fair and define the whole shape of the hull. There was already a different understanding of the hull, as Oliveira explains so clearly: "Nature teaches this in the bodies of sentient animals, in which there are also two parts that seem to respond to what I say and give an obvious example of these two necessities of the naus: one is the bones, that represent the strengthening pieces, because they support, straighten and form the body of the animal, such as the support does in the hull of the nau: the other is the skin that covers the support."[17]

Again, there were many variations of this method of hull construction. Many still persist along the shores of the Mediterranean in a system known today as whole-molding.[18] All whole-molding methods share one feature: the shape of a number of frames is predesigned. In other words, part of the hull shape is controlled transversely rather than longitudinally, since the shape of the hull is obtained from a number of predesigned frames fixed over the keel beforehand. Many times the hull is not fully defined until afterward with the help of ribbands. The shape of a hull may be controlled in two different ways using this method. The first one was generally used for long or oared ships and required the predesign of a certain number of noncontiguous frames placed along the keel at predetermined intervals (e.g., every fifth frame). The second one was used for round or merchant ships, such as *Nossa Senhora dos Mártires,* and required that the hull be divided into three sections along its length, with a number of contiguous, predesigned frames placed in the central section. This was just a general rule and sometimes only part of the frames in this central portion were predesigned.

Whole-molding was less labor intensive than the earlier mortise and tenon joinery technique and therefore cheaper, but it was also more complex since it required a good a priori knowledge of what the shape of the hull would be. However, the advantages of this method are obvious: first, it represented a good solution for control of hull symmetry, second, it enabled shipwrights to predict the size and capacity of a ship with a fair degree of accuracy, and third, it allowed for the replication of good prototypes.

During the Middle Ages in southern and western Europe, this method evolved into a relatively simple nongraphic way to predesign the frames of the central portion of a ship's hull.[19] This simplified system for building ships was slowly adopted in northern Europe during the sixteenth century and gradually replaced the more labor intensive and perhaps less sturdy clinker or lapstrake construction.[20]

The sixteenth century was a time of great advances in science and corresponded to a period in which India naus grew in size, encouraged by the desire for profit and the acquisition of new techniques and tools in several disciplines. By the late sixteenth century, reason and observation of nature coexisted with traditional medieval scholastic ideology, and a newborn critical reasoning refuted traditionally accepted "ancient" knowledge.

The decades before and after the wreck of *Mártires* saw many new religious, scientific, and artistic developments. In 1598 Henry IV published the edict of Nantes, allowing freedom of religion in France. In Rome the war against science and diversity held firm, and in 1600 the Holy Inquisition burned Giordano Bruno in Rome for heresy. A year later, Tycho Brahe died and left all his data to Johannes Kepler, who published his *Optics* in 1604 and *New Astronomy* in 1609. In that same year Galileo built his own telescope, a device invented in 1608 by Dutch scientist Hans Lippershey. In 1610 Galileo discovered the four largest moons of Jupiter and published this discovery in his *Siderus Nuncius*. In the very year of the wreck of *Nossa Senhora dos Mártires,* Shakespeare published *Macbeth,* following *Hamlet* (1602), *Othello* (1604), and *King Lear* (1605). In 1605 Cervantes published the first volume of *Don Quixote,* and in 1607 Claudio Monteverdi composed his first opera, *L'Orfeu,* in a new style that would influence European music forever.

In the midst of this intellectual context, new hull shapes were developed, built, and tested.[21] The overall size of ships grew; bow and stern castles were lowered for better performance when sailing at closer angles with the wind; the structure was reinforced to sustain more artillery; and ordnance became the primary concern in naval war. As batteries became heavier, engagement at sea could be held farther away from enemy ships and boarding avoided. By then frame-based construction had spread throughout the Mediterranean world and had been adopted by the sixteenth century along the French Atlantic coast, extending soon after to England, and in the early seventeenth century to the North Atlantic countries.

We are lucky to have a few late sixteenth- and early seventeenth-century texts that discuss the design and construction of this type of ship, the most important of which were transcribed and published during the nineteenth and twentieth centuries. They constitute a major source of information both on the ways in which vessels were built and on how they were conceptualized in the minds of their shipbuilders. Why the late sixteenth and the early seventeenth centuries saw the appearance of so many of these texts and treatises is not clearly understood. Before the 1570s only a handful of them existed, and to my knowledge all originated in Venice.

The description and analysis of India naus presented in this study depends substantially on the information contained in many of these texts and treatises. Following is a discussion of what these writings are, who produced them, and what information they contain.

The oldest texts date from the early and middle fifteenth century and are known as the *Libro di marineria,* or *Fabrica di galere,* as it is better known, and the Timbotta manuscript. A new fifteenth-century text, possibly dating to 1434, resurfaced at an auction in the late 1990s, under the title Michael of Rhodes manuscript. It includes material related to shipbuilding, but not much has been published about it.[22] The *Fabrica di galere* and the Timbotta manuscript are extremely important for the understanding of the history of the shipbuilding industry in postmedieval Europe. They are particularly relevant to this study, because they both mention a nongraphic method for predesigning the central frames, a practice followed in the skeleton-first shipbuilding tradition used in Portuguese shipyards in the early seventeenth century when *Nossa Senhora dos Mártires* was built. In this method, ships were considered to be formed longitudinally in three sections: a central section in which the shape of the frames was obtained through the use of molds and gauges, and the two ends of the vessel whose shapes were obtained through the runs of longitudinal ribbands or wales, positioned at given heights over the predesigned central frames, and running from post to post.

When we examine the *Fabrica di galere* or the Timbotta manuscript, or indeed any of the European shipbuilding texts of the fifteenth to seventeenth centuries, we have to ask: who wrote these texts and treatises, why, and with what kind of knowledge of their subjects? The majority should not be taken literally since either they were written by outsiders or theoreticians and contain inconsistencies or they were written by experts, for experts, and may contain data presented in a particular context that is unknown to us.

The two earliest published texts seem to be the product of two different types of authors. The *Fabrica di galere* is a copy of the writings of professionals, and the Trombetta manuscript consists of the notes of a cultured and well-informed dilettante. These two different sources were written by people with two fundamentally different approaches to the design of vessels: a theoretical one, and a practical one. The *Fabrica di Galere* was copied from originals, of which one may have been written by an admiral of the Venetian arsenal, not a shipwright, but certainly a professional of the sea, and an expert on ships and shipbuilding. As to Zorzi Timbotta, creator of the Timbotta manuscript, he was apparently a cultured Renaissance man with many interests and, therefore, an outsider who collected notes from some expert source.

The texts discussed in this chapter represent an important body of information on shipbuilding in sixteenth-century Europe and offer important insights in the history of science. They often show which tools were available to the shipwright in terms of mathematical and geometrical knowledge, and reflect the organization of labor within the industry in a period that saw the development of the independent naval architect. This kind of theoretician was already accepted in Venice in the first half of the sixteenth century in the person of Vettor Fausto (a humanist and Greek teacher whose galleys were well appreciated) but seemingly did not exist in the rest of Europe until the late sixteenth century.[23] Then, around the final quarter of the sixteenth century, the first of a large number of texts and treatises on shipbuilding made their appearance. Some were written by professionals such as the English shipwright Matthew Baker, but the majority were assembled by enlightened outsiders like the Portuguese priest Fernando Oliveira, the Portuguese kingdom's engineer João Baptista Lavanha, or the Spanish merchant Diego García de Palacio. The latter published in Mexico, in 1587, the first treatise on shipbuilding ever printed.

Considering the relatively narrow scope of my research, I focus on only a few of these works, namely the Portuguese ones directly related to the construction of naus for the India route. However, as the information contained in these Portuguese texts should be viewed in the context of various contemporary approaches, therefore I discuss a total of seventeen texts relevant to this shipbuilding tradition.

Besides the *Fabrica di galere* and the Timbotta manuscript, several other relevant Italian texts deserve mention.[24] Among these are the anonymous *Ragioni antique dell'arte del mare et fabriche de vasselli* and the *Arte de far vasselli,* the *Instructione sul modo di fabricare galere,* by Pre Teodoro de Nicolò, the latter known as Visione del Drachio, and Bartolomeo Crescenzio's treatise on galleys, *Nautica mediterranea.*[25]

Closely related to the Italian tradition of shipwrightry are a French text on the design and building of galleys called *La stolonomie,* and four important English texts: a collection of notes by Matthew Baker known as *Fragments of Ancient English Shipwrightry; Treatise on Shipbuilding & A Treatise on Rigging* attributed to John Wells; and two manuscripts with similar contents, dating from around 1600, and pertaining to the proportions of vessels, one known as the Scott manuscript (attributed to Phineas Pett), and the other surviving through a later copy by Isaac Newton.

Also important for this study are seven Spanish texts, of which three are true treatises: the *Ytinerario de navegación de los mares y tierras occidentales,* by Escalante de Mendoza; the *Instrucción nautica para el buen uso y regimiento de las naos, su traza y govierno,* by Diego García de Palacio; and the *Arte de construir naos,* by Tomé Cano. Three are royal decrees: the Ordenanzas of 1607, 1613, and 1618, and a seventh is a dialogue known as *Diálogos entre un viscaíno y un montañez.*

## Italian Texts

Part of the *Libro di Marineria* was published in the mid-nineteenth century by Auguste Jal under the title *Fabrica di Galere,* by which it is now better known. It is a Venetian manuscript dated to the mid-sixteenth century, with 123 folios, containing texts of several authors, some of which can be dated to around 1410. It is now in Florence's Biblioteca Nazionale Centrale, codex Magliabecchiano, XIX.7. Plentiful in comprehensive pen-and-ink drawings, it covers a galley of Flanders (folios 1–13), a galley of Romania with a digression on sailmaking (14–25v), a light galley (26–32), a lateen rigged ship (33–36), and a square rigged ship (37–49). It presents a formula for calculating displacement—the oldest I know of—and a description of a whaler (*ballanier*) as built by those of the West (*quelli de ponente*). There follows a section on rigging and spars (51–64v), sail-making (65–72v), and again the galley of Flanders (73–75v), the galley of Romania (75v folio number omitted in the publication available), and a light galley (folio numbers omitted). The next section is dedicated to smaller craft and contains a mention of the great Greek shipwright Theodoro Baxon, whose light galleys were praised as being among the best ever built in the arsenal. In 1407 eight of Baxon's galleys were ordered by the senate to be set aside to serve in emergencies and to be copied as models. Theodoro was not a young man, and there was a fear that he might not have taught everything to his Italian workers.[26] The manuscript then presents the measurements for a *falchioni* to be made in the arsenal (folio numbers omitted), followed by the prices of ironwork, timber, oars, and other equipment (folio number omitted 87v). The last folios are dedicated to the design of rigging for square rigged ships (88v–100v), sail-making (101–122v), and information n the tides (122v–123).[27]

The Trombetta manuscript was written in a Venetian dialect, dated to 1441–49, and signed by a Zorzi Trombetta from Modon in 1444. It is now in the British Museum, Cottonian manuscripts, volume Titus A.26. Bound in a small volume with several other manuscripts, it covers several matters: music (folios 28), a table of contents (8v), the virtues of rosemary (9–11v), sails and rigging (12–16), astronomy (16v–19v), a letter to the pope (20–23), accounts (23v–25v, and 26v), shipbuilding (27v–28v), engineering (29v–36), and again shipbuilding, sail-making, and arithmetic (37–60v).[28]

The *Ragioni antique dell'arte del mare et fabriche de vasselli* is a manuscript with sixty-seven large-format folios, dating from the late fifteenth century and the first half of the sixteenth century (more precisely 1470–1561), written by several different hands (eight, to be precise), whose author is unknown. The original is in Greenwich, at the National Maritime Museum, Cod. NVT.19.

It was started in 1470 and handed down until the mid-sixteenth century. As John McManamon describes it "there are texts that illuminate various facets of contemporary navigation: portolans describing the coastlines, charts for the position of the stars and sun an moon, lists of months that are unluky for sailors, discussions of tidal action, and accounts of the results of lead soundings." But it also includes texts on shipbuilding: "it has materials found in the Florence and Vienna codices [Father John is referring here to the text of the *Libro di Marineria,* or *Fabrica di Galere*], including the reference to the light galley designed by Theodoros Baxon." This manuscript was studied by Alvise Chiggiato and John McManamon. Although called *Ragione antique* (ancient methods), it pertains to the design of watercraft with predesigned frames and the use of molds and gauges to vary the width and dead rise of the floor timbers in a smooth, but not graphically predetermined, manner.[29]

The *Instructione sul modo di fabricare galère* is also a Venetian text, signed by

Pre Todaro de Nicolò, and dated around 1550. The manuscript is in the Biblioteca Nazionale Marciana, ms. ital. IV.26 (=5131) and refers also to the system of conceiving and building a vessel's shape from a number of predetermined frames. Another manuscript with the same text, entitled *Arte de far vasselli,* is at the Archivo di Stato di Venezia, Archivio Proprio Contarini, no. 19, Todaro de Nicolò.[30]

The sixth of the Italian texts is the Visione del Drachio, a letter with fifteen folios dating from the end of the sixteenth century (1594), in which a shipwright named Baldissera Drachio Quintio explains how to build a galley of fourteen benches. It is now in Venice, in the Archivio di Stato, Archivio proprio Contarini, no. 25.[31]

The last Italian text is a book, *Nautica Mediterranea,* by Bartolomeo Crescenzio Romano, printed in Rome in 1607 by Bartolomeo Bonfadino. It is a treatise whose first chapter is dedicated to the construction of galleys and contains a clear description of the methods in use to predesign the frames that were to be preerected over the keel, showing the narrowing and rising of the bottom marked on the turn of the bilge, in the Mediterranean tradition.[32]

## French Text

The French text *Stolonomie,* subtitled *Tracté contenant la matière de dresser et fournir aequiper et entretenir en tout temps en bon ordre une armée de mer et raisõn des frais d'icelle,* is an anonymous manuscript dated from 1547 to 1550 and pertains to the design, building, handling, and maintenance of galleys. Colbert purchased it in 1682 from the private library of Mr de Montmort, Henry-Louis Habert, whose grandfather had performed functions of treasurer of the galleys around 1580. The manuscript encompasses ninety-one folios still in the original binding, and starts with a dedication to King Henry II of France (1547–53), which stresses the importance of having an organized fleet of galleys in the Mediterranean (folios 1–2). There follows a short introduction (folios 3–4), and twenty chapters dedicated to several aspects of the building, manning, and maintaining a fleet of galleys (5–87). The last folios contain an index of the work (88–91). Only the first chapter deals with the question of building the vessels. It contains a complete description of the different timbers necessary to build a galley of twenty-four banks. The original is in the Bibliotèque Nationale de Paris, under the reference français 2133; Ian Fennis has published a study of this work.[33]

## English Texts

The *Fragments of Ancient English Shipwrightry* is a collection of miscellaneous notes and incomplete plans of ships. It was started by an English shipwright named Matthew Baker (1530–1613) in the 1570s and continued by one of his apprentices, John Wells, with annotations on mathematics. Baker was born in 1530, the son of a shipwright of King Henry VIII of England. There is notice of him traveling to the Levant in January, 1551, at the age of twenty-one, probably as a ship's carpenter aboard an English merchantman. He may have visited Italian and Greek shipyards and collected Venetian and Greek designs of midship frames. A fairly cultured man with a good understanding of mathematics, he certainly had contacts with and was influenced by the revered Italian shipwrights hired by Henry VIII in 1543. These Italians appear to have remained in the country for more than forty years, earning wages 30 percent higher than their English counterparts.[34] In 1572 Baker was appointed master shipwright of the kingdom. He worked with other men of knowledge, and his notes reflect the first steps of a trend to change English shipbuilding from the medieval empirical method to the modern standard of paper plans and conceptual models that could be repeated, improved, and enlarged. When he died in 1613, he seems to have left the manuscript to his neighbor and protégé John Wells. Baker's notes present a compilation of precious observations, abacus, tables, and drawings, comprising more than thirty geometrically defined midship sections—from the sections of four galleasses designed by his father, James Baker, in the second half of the sixteenth century to the early seventeenth-century midship sections that were in use when new methods to determine the rising and narrowing of the bottom of the vessels in the central portion were fully defined in England. The part added by John Wells is mostly occupied with calculations of spherical geometry, making extensive use of logarithms from 1617 on, only two years after they were rediscovered in England.[35]

The Scott manuscript is an important and still unpublished document, number 798 in the library of the Royal Institution of Naval Architects, dating from 1590 to 1605 judging by the watermarks on the paper. Since it seems to have been written by a very well informed expert, it has been suggested that its author may have been the English shipwright Phineas Pett.[36]

A document similar in content but by no means a direct copy of the Scott manuscript is in the Cambridge University Library, with the reference MSS. Add. 4005 Part 12. A copy of one or two late sixteenth- or early seventeenth-century manuscripts on shipbuilding in Isaac Newton's hand, it encompasses a section on shipbuilding, with proportions, dimensions, and rules for the building of ships, and a section on the proportions of masts and spars. A reference to the Queen's ship *Beare,* rebuilt between 1598 and 1603, in the section with the proportions on masts and yards places this document around 1600.[37]

The fourth English text, *Treatise on Shipbuilding & A Treatise on Rigging,* has been attributed to John Wells and dated to around 1620–25. It is not as important for this study as the previous ones, since it refers to an emancipated

English shipbuilding tradition in full development, in a period of change during which there is little in common with the Portuguese tradition.[38]

## Spanish Texts

The first of the Spanish treatises considered here was written by Juan Escalante de Mendoza in 1575 under the title "Ytinerario de Navegación de los mares y tierras occidentales." Born around 1530 in Valle de Riva de Deva in Santander, Mendoza served in the Spanish *carrera de las Indias* from a young age, reaching the position of *capitán general de la flota de la Nueva España* in 1595, one year before his death in 1596, in the city of Nombre de Dios. His manuscript was much appreciated in the *consejo de las Indias,* but never authorized for publication as it was found to contain too much information on the routes and secrets of New World navigation. It is composed of three books. The first presents a description of navigation down the Guadalquivir river, from Seville to the oceanic port of Sanlúcar de Barrameda and its sandbar, followed by a treatise on naval architecture. The second describes the navigation from the mouth of the Guadalquivir to the Gulf of Vera Cruz, for the fleet of Nueva España, and the port of Nombre de Dios, for the fleet of Tierra Firme. It includes dialogues on nautical instruments, measurement of latitude, and meteorology. The third describes the voyage back to Spain and includes several dialogues on diverse issues such as the compensation of the magnetic compass, the fires of San Telmo, seasickness, shipwrecks, privateers, and other topics related to sea voyages.[39]

Diego García de Palacio wrote the first treatise on shipbuilding ever published. His work was produced in Mexico in 1587 by editor Pedro de Ocharte under the title *Instrucción nauthica para el buen uso y regimiento de las naos, su traza y govierno.* It is a general work on navigation that includes a treatise on shipbuilding. Diego García de Palacio was born in Santander, in the Basque country, to a family with a long history of involvement with the sea. After studying law at the University of Salamanca, he was sent to Guatemala and Mexico, where he worked for the crown and wrote several works on China and the Philippines, eventually being appointed to the *consejo de Indias* for his knowledge and experience. His *Instrucción nautica* is written as a dialogue between two Basques, a Viscayan and a Montanes, and is divided into four books and a glossary. The first two are dedicated to navigation issues, the third to astrology, meteorology, and cartography, and the fourth to shipbuilding detailing a ship of 16 *codos* of beam (9.20 m). This fourth book provides sections on the design of hulls, masts and spars, rigging, sails, ship's boats, artillery, victuals, and crews, detailing the functions and obligations of the captains, masters, and pilots. It is available in Spanish and English.[40]

Tomé Cano's *Arte para fabricar, aparejar naos de guerra y merchante* was printed in Seville in 1611 and is the first monograph on shipbuilding published in Spain. Tomé Cano was born in Tenerife, in the Canary Islands, in 1545, and died in Seville in 1618. He wrote his treatise around 1608 in the form of a dialogue between three men—one of whom is the author himself—sailing down the Guadalquivir to their ships, which were undergoing some repairs at a place called los Pajares. Following a short introduction that he calls *dialogo primero,* Cano describes a nau of 12 *codos* of beam (6.90 m) in the *dialogo segundo,* with all the proportions required for a good performance. He follows the norms of 1607, but defends a practice that was strictly forbidden at that time, which consisted of adding a second deck to the vessel by connecting the stern and forecastles. In the third dialogue, he details a way to find the tonnage of his ship. The fourth and final dialogue pertains to the dimensions of the flat of the midship frame, and its narrowing and rising to the bow and the stern.[41]

We learn from Cano's *Arte para fabricar* that a master shipwright from Rentería, in the Basque country, was developing a new way (*nueva fábrica*) to build ships, which was followed in Portugal since 1597, the date of the construction of the galleon *San Mateo* in Lisbon, following the *fábrica neuva de Rentería.*

The *Ordenanzas de fábricas de navios* from 1607, 1613, and 1618 are sets of specifications issued by the Spanish government for the building of ships, which put this new style of hull on paper. The Ordenanzas of 1607 were published by Martín Fernandez de Navarrete.[42] The Ordenanzas of 1613 are an enlarged and corrected version of the 1607 ones, containing 106 articles. There the concept of official tonnage is established and detailed, and fifteen standards carefully defined, divided into *pataches, navios,* and *galeones.*[43] The Ordenanzas of 1618 are again a new version of the previous ones, establishing now only fourteen standard sizes for vessels, all called galleons. This third set of laws has been fully reprinted in Spanish.[44]

The "Dialogos entre un vizcaino y un montañez" is an undated manuscript in the library of the University of Salamanca. It has been attributed to Pedro Lopez de Soto and dated to 1631 or 1632. It generally follows the structure of Palacio's *Instrucción náutica* and is also written as a dialogue between a Vizcayan and a Montañes, but its ships are much different now. The vessel described in this text is much larger, with 22 *codos* of beam (12.65 m).[45]

## Portuguese Texts

The most important collection of texts for this study were written in Portuguese between the 1570s and 1610s. These are the treatises of Father Fernando Oliveira, *Ars nautica* and *Liuro da fabrica das naos;* those of João Baptista Lavanha and Manoel Fernandez, the *Livro primeiro de arquitectura naval* and the *Livro de traças de carpintaria,* respectively; and the two texts included in the manuscripts *Livro náutico* and *Coriosidades de Gonçalo de Souza.* To these texts we must add the two contracts for the construction of India naus by Sebastião Themudo and Gonçalo Roiz, Figueiredo Falcão's *O Livro de toda a fazenda,* and a list of prices pertaining to the construction of two India naus in the 1620s from Harvard University library. Finally, we must consider the comments of the commission charged with analyzing the size of the India naus in that period.

The *Liuro da fabrica das naus* has been dated to 1580 and is a translation of Father Oliveira's previous work in Latin *Ars Nautica,* although it does not contain—at least in its surviving version—the general drawings of the first Latin one. Fernando Oliveira was born around 1507 in Aveiro, a coastal city with great mercantile traditions. He studied at the University of Évora where he became a Dominican priest when he was twenty-five. Soon after becoming a priest he left for Spain, for unknown reasons. In 1536 he was again in Lisbon where he published his first book, a Portuguese grammar, the first known. Around 1540 he left again for Spain, and from there he sailed to Genoa, where he visited the shipyards. When his ship was seized by a French galley he was made a prisoner but managed to be engaged as a pilot. In 1543 he returned to Portugal, although not for long; in 1545 he engaged again on the French Mediterranean galleys as they stopped at Lisbon bound for England. He served as a pilot in the galley of Baron Saint-Blancard from which he probably witnessed the sinking of the *Mary Rose* at Portsmouth. In 1546 his galley was taken by the English and he was again imprisoned. In England he visited the shipyards, and may have met James Baker, the father of Matthew Baker. His resources must have been many, for soon he was serving as a diplomat near the future King Edward VI, whose Protestant inclinations did not seem to prevent his admiring Father Oliveira. He is known to have given him £110, which was certainly not for counseling in the shipbuilding industry. James Baker's salary was not more than 12 pence per day, less than £20 per year, and even Agustino Levello, one of the Italian shipwrights hired by Henry VIII in 1543, made only 16 pence per day.[46] We do not know what services Oliveira rendered to the king, but in 1547 he was back in Portugal and was arrested by the Holy Inquisition. He refused to comment on King Henry VIII's religious views because, in his own words, he "had been Henry's servant, and eaten his bread."[47] Freed in 1551, Oliveira engaged in the Portuguese expedition of 1552 against Algeria, where he was taken prisoner after the defeat of the Portuguese army. There, once again he visited the shipyards. Freed in 1554, he was back in Portugal, where he published his *A arte da guerra no mar* and was arrested soon after, again by the Holy Inquisition, although we do not know exactly why. In 1557 he was freed again and probably left Portugal forever. He died sometime after 1585, presumably in

France, leaving a series of unpublished works, among which are the *Ars nautica,* now in the Library of the University of Leiden, and the *Liuro da fabrica das naus* in the National Library of Lisbon, in the codex 3702.

The *Liuro* is the theoretical work of a scholar, not the practical work of a shipwright. It is comprised of a clear text, with few illustrations, and is, unfortunately, incomplete. As it survived, it is divided into nine chapters. Father Oliveira defines the dimensions of the primary structural components of a ship—stem, stern post, midship, and tail frames—as simple proportions of the length of the keel. He then describes the use of algorithms similar to those described by Timbotta—such as the *mezzaluna,* or the incremental triangle—to calculate the narrowing and rising of the floor timbers in the central portion of the hull, between tail frames (*almogamas*), the first and the last of the predesigned frames of a vessel. As Father Oliveira described it, all the frames in the central portion of the hull were predesigned. No indication is given of the conception of the frames before and after the tail frames, but the use of ribbands is suggested. The midship frame is quite simple: a flat floor and a single circular arc for the futtocks. The chapters on rigging are missing. The *Liuro* is available in two editions both of which contain a facsimile of the original, a transcription, and a translation into English. The second edition contains a translation into Cantonese.[48]

The *Livro primeiro de arquitectura naval* has been dated between 1608 and 1615, and is generally considered to have been written around 1608 to 1610 by João Baptista Lavanha, the chief engineer and chief cosmographer of the kingdom of Portugal at that time. Lavanha was born in Lisbon around 1550, son of a court officer, and he enjoyed a successful career in spite of his Jewish origins. He served as master of mathematics for four kings—Sebastian (1568–78), Philip I (1581–98), Philip II (1598–1621) and Philip III (1621–40). In 1586 he was appointed engineer of Portugal and in 1591 chief cosmographer. In 1601 he visited Flanders. In 1607 and 1613 he sat on the commissions in charge of the standardization of the shipbuilding industry in Spain and Portugal, which issued the Ordenanzas of 1607 and 1613. Between 1610 and 1615 he worked on a map of Aragon, and in 1616 he worked on a system to supply water to Lisbon, a city constantly plagued by the scarcity of freshwater. In that same year he was appointed chief chronicler. A friend of Cervantes and Lope de Vega, Lavanha died in 1624 after publishing many volumes, among which are *Description del universo,* written in Spanish; *Regimento náutico,* a *Tratado da arte de navegar, Tratado do astrolábio,* written in Portuguese; and a narrative of the shipwreck of the nau *S. Alberto* that was later included in the *História trágico-marítima* by Bernardo Gomes de Brito. The *Livro primeiro de arquitectura naval* is also the theoretical work of a scholar, and not a practical text of a shipwright. It deals with only one type of vessel: the four-decked nau for the India route. It is clearly more modern than Oliveira's *Liuro da fabrica das naus,* basing the construction of hulls on paper drawings. Nevertheless, Lavanha calls for the need to predesign a central portion of the hull, although only for five frames forward and abaft themidship section. The importance of this treatise lies in its accurate description of construction techniques and in its detailed illustrations. It is incomplete, ending abruptly in the beginning of a description of the drawing of plans. A facsimile was published in 1996, with a transcription and a translation into English.[49]

The naus of Gonçalo Roiz and Sebastião Themudo are two manuscripts copied by Lavanha and transcribed and published by João da Gama Pimentel Barata in his comments to Lavanha's *Livro Primeiro.* These two short descriptions of India naus contain only the measures and features considered by their authors fundamental to the definition of these ships and present precious information on the length of keel and posts, number of predesigned frames, and other basic characteristics, such as the shape of the transom.[50]

The *Livro de traças de carpintaria* is signed by a Manoel Fernandez, shipwright, and dated to 1616. We do not know with certainty who this shipwright was, although there are a few possible candidates, none of whom were ever entrusted with high-ranking responsibilities either in Lisbon or in India.[51] The *Livro de traças* describes a variety of vessels, from caravels to India naus, and is divided into two main sections. The first section has lists of dimensions of the primary structural components of a ship such as stem, stern post, midship, and tail frames. The second contains an impressive collection of drawings, mainly intended as descriptions of the structural components of the ships, and less concerned with the conceptual aspect of the shipbuilding process. When analyzed together with the one of the "Coriosidades de Gonçalo de Souza," it becomes clear that these two texts are copies of the same original. Manoel Fernandez's version contains a number of gaps and mistakes that reinforce the first impression of him as a practical man, as a shipwright should be, rather than a theoretical expert, as would be expected from a master shipwright or a naval architect.[52] His work was published as a magnificent facsimile in 1989, followed by a transcription and translation into English in 1995.[53]

The *Livro náutico* is a collection of manuscripts from the late sixteenth century, now located in Lisbon's Biblioteca Naciona. It contains many important data pertaining to the organization of the part of the Spanish armada of 1588, which was fitted in Lisbon, and several lists of all the timbers needed for the construction of vessels. Of these manuscripts, one pertains to the building of a 500-ton India nau. This list is available through a transcription published in the late nineteenth century by Henrique Lopes de Mendonça.[54]

The *Coriosidades de Gonçallo de Sousa* is a manuscript from the early seventeenth century; the original is in the library of the Universidade de Coimbra.

It also contains a list of timbers needed for the construction of an India nau. To my knowledge it has never been published; however, a copy of it is available in the Biblioteca Central de Marinha in Lisbon.[55]

The *Livro de toda a fazenda* is a large book written by the king's officer Luiz de Figueiredo Falcão, which lists all the rents and profits of the Portuguese crown in 1607. It contains an interesting schematic of the division of space within an India nau.[56]

The Harvard manuscript in the library of Harvard University is a list of prices for the construction of two vessels, the three-decked naus *São Bartolomeu* and *Santa Helena,* ordered by King Philip III of Portugal and IV of Spain in 1624 for the armada of 1625.[57] This manuscript, which as far as I know is still unpublished, refers to the naus visited by a committee formed by King Philip IV of Spain to analyze the famous letters of Admiral Corte Real on the size and performance of the India route naus in the early seventeenth century. These letters were transcribed and published by Christiano Senna Barcelos in *Construcções de naus em Lisboa e Goa para a carreira da India no começo do século XVII.*[58]

Although an in-depth analysis of the collection of Portuguese shipbuilding texts has not yet been done, it seems already possible to foresee the existence of a standard for the India nau, which underwent continuous transformation over time. All these texts present a more or less standardized idea of an India nau, with a capacity of around 500 or 600 *tonéis,* which roughly corresponds today to a displacement of 1,000 to 1,200 tons for a draft of 4 m. The length of keel grew slightly during the period under analysis, but the rake of the sternpost, the spring of the stempost, and the basic relations between defining dimensions such as keel/breadth, breadth/transom, keel/depth in hold, or keel/length overall did not vary much. It was at the level of the upper works, namely the number and height of decks, size of the quarterdeck, height of the forecastle, and other features related to the ship's cargo capacity and defense possibilities that we can trace some evolution.

## Building an India Nau: The Construction Sequence

Evidence shows that by the late sixteenth century the sequence of tasks and operations in the building process in Portuguese state-owned shipyards was remarkably similar to the one described in the Venetian arsenal of the same time.[59] Once the size and type of the vessel was defined, a length of keel was selected, which in turn determined the length, shape, and rake of the stem and stern posts. Then the shape of the midship frame was selected from many available models, and its fundamental dimensions obtained through simple proportions from the dimensions of the keel and posts. For a specific type of vessel such as *Nossa Senhora dos Mártires,* intended for the India route, the length of the keel was almost standard, with few variations. The midship section was probably chosen from a small number of possible types, as were the rake of the sternpost, and the height and spring of the stem. These vessels were fairly standardized by then, and keeping close to a known model was important to avoid unnecessary risks.

After defining the size of the vessel and its main structural elements, the master shipwright charged with the construction of *Nossa Senhora dos Mártires* had to define dimensions and create templates of the timbers required for its construction in order to shop around the shipyard for the appropriate logs and to order the remaining timbers from the usual suppliers. By the early seventeenth century, wood was a precious material, always in short supply on the Iberian Peninsula, and timber merchants had to fell their trees farther and farther away from Lisbon, adding the rising costs of transportation to the already high cost of timber.

To lay the keel, a place was chosen in the shipyard and a cradle built on sloping ground, perpendicular to the river. To avoid disasters, the structures were carefully designed to sustain the weight of the complete hull and the stresses of the launching operation. Most iconography from the sixteenth century on shows that the Portuguese built their ships with the stern to the water, while other nations built theirs facing the water front. Why Portuguese shipwrights did this is not known, but it is possible they were aware that this system reduced the sagging stresses imposed during the launching. The relatively even distribution of the load of a vessel over its cradle changed when the hull slid into the water and started rotating upward as it floated. At the last stage of the launching, most of the support of the cradle was localized at the end still resting on it. If a ship were launched stern first, its buoyancy was not felt as early as when the bow hit the water first, and therefore the localized stress imposed during the last stage of the operation represented a much smaller percentage of the total weight of the vessel.[60]

A slight arc was given to the keel in order to counteract the anticipated hogging of the hull. Keels of large vessels such as *Mártires* were assembled from several smaller logs for two main reasons. First, shipwrights preferred cork oak for keels, and cork oaks do not have the tall, straight trunks required for a keel almost 30 m long. Second, some shipwrights apparently believed it was dangerous to carve the entire keel from a single log because it could warp and twist in the process of drying, and eventually snap during the construction of the ship.[61] The stem and sternpost were designed, cut, assembled, erected, and then connected to the keel through traditional timbers called *couces,* which were basically knees fastened to the extremities of the keel in order to make the transition between keel and posts. The sternpost was sur-mounted by a transom beam, generally measuring half of the maximum breadth projected, to which the fashion pieces were attached, traditionally covering two-thirds of the sternpost's height.

With the keel and posts in place, the frames located in the central portion of the keel were erected. The shape of the midship frame had to be drawn in full size, because this building process demanded a construction mold. There was a marked tendency—perhaps reflecting the fashionable Platonic influence on Renaissance thinking—for the use of simple proportions relating the different measurements for the different parts of ships. Relative proportions were also used for the conception of masts, yards, rigging, and sails.

In Italy midship frames were first shaped following a series of offsets, or horizontal lines determining the width at certain heights, generally every foot or half a foot (an Italian foot being 34.7 cm). These horizontal lines became more widely spaced over time, and by the 1550s only three or four offsets were defined for small craft: *tre pie* (three feet), *sei pie* (six feet), and *bocha* (beam).[62] For larger craft the midship frames were drawn with a series of circular arcs, such as those reproduced in Matthew Baker's notes, making for fairly sophisticated and complex shapes with three or four arcs: a turn of the bilge arc, a futtock arc, a tumble home arc, and an inverted, concave arc to straighten the top timbers.[63] Although sections with four arcs do appear in Fernandez's book, evidence suggests that in Portugal and Spain the midship sections were generally drawn with one simple circular futtock arc, and the turn of the bilge and tumble home portions later faired during construction. Whether this taste for several arcs reflected simply an intellectual mannerism of the time or some other form of aesthetic option of the shipwrights is not known. It does not seem to translate into a better performance at sea, either in terms of speed or stability, when compared to the simpler shapes that are more characteristic of the Iberian midship frames (fig. 3.1).[64] Standard molds may have been used both for large and small craft, although there is no solid evidence for this practice in Portugal.

The central portion of the hull was defined by the number of predesigned frames before and abaft the midship frame. In Portuguese these predesigned frames were called *cavernas gabaritadas* or *graminhadas,* and in Spanish *cuadernas de cuenta* (fig. 3.2). The total narrowing and rising of the bottom was also predefined, the bottom being considered the portion of the frames limited by two points on each side of each floor, called "turn of the bilge points." The total rising and total narrowing were marked on the last of the predesigned frames, which were to be placed before and abaft the midship frame, defining the central portion of the hull that was predesigned, preassembled, and erected over the keel before any planking began. These last predesigned and preerected frames, or tail frames, had particular designations in Italian: *chodera chorba*

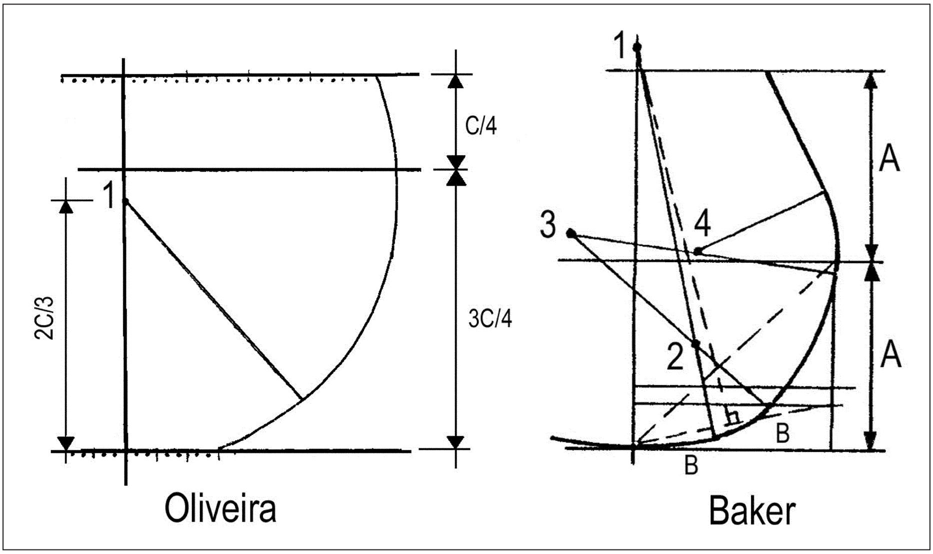



Fig. 3.1. A common Portuguese midship section, after Fernando Oliveira and a Greek one, after Matthew Baker. (After Richard Barker)

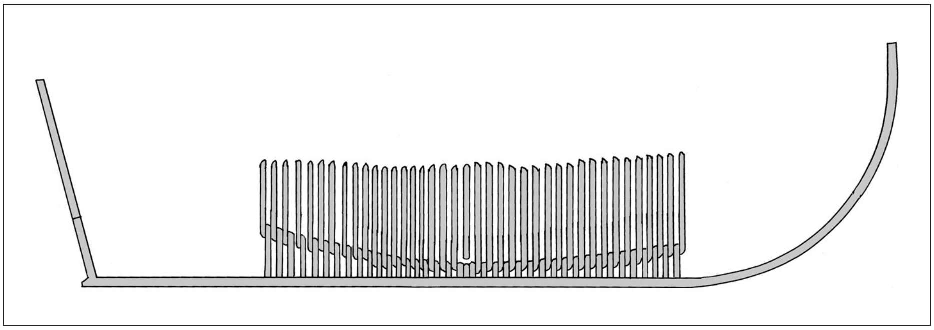


Fig. 3.2. Keel, posts, and central frames. Typically predefined in the construction of Portuguese ships in the late sixteenth century. (Drawing Filipe Castro)

("Fabrica di Galere"), *qudiera chorba* (Timbotta MS), *chavo di sesto* ("Instructione" of Pre Teodoro) and *capo di sesto* (Dracchio's Visione). However, in Portuguese they go by the Arab word *almogamas,* possibly following an Arab shipbuilding tradition whose rules and techniques are long forgotten.

The next stage of the building process was to define where the midship frame sat on the keel, and this was generally before the middle point of the keel, where some texts advised that the mainmast step should be placed. Then, the position of the tail frames was obtained from the number of predesigned

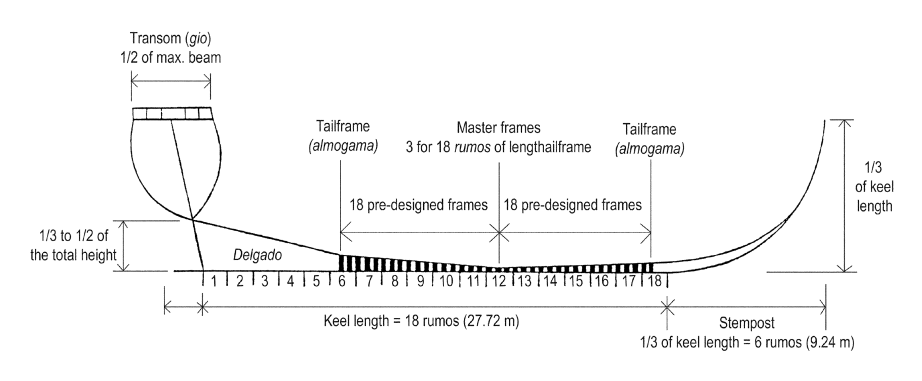



Fig. 3.3. Rising of the bottom of an India nau, after Oliveira.

frames required, generally a function of the keel length and the value of the room-and-space.

With the keel, posts, and master frame in place, and the tail frames' shape defined, the remaining predesigned frames were cut and assembled on the ground through a simple process that is today known as whole-molding. As these frames were being assembled, they were erected over the keel, forming the central portion of the hull where the main cargo capacity was located. The master shipwright had by then defined the rising and narrowing of the bottom forward and aft of the master frame, as well as the total number of predesigned frames required for the hull (fig. 3.3).

The design of each frame was then determined, with the progressive rising and narrowing of the bottom distributed over the frames using a simple and ingenious algorithm. First, a series of increasing values was obtained through one of several geometrical methods, known as *mezzaluna* (half moon) in Italian and *meia lua* or *besta* (crossbow) in Portuguese. This method is referenced in the Timbotta manuscript (fig. 3.4). These values varied between zero and the value of the total rising or narrowing required for the bottom of each particular vessel in each of the tail frames. The number of intervals obtained was the number of frames over which the incremental values were to be distributed, from the maximum breadth and minimum height on the midship frame to the minimum breadth and maximum height on the tail frames. Then a ruler was built for each sequence of incremental values. In Portugal both this ruler and the algorithm were called *graminhos*.

Each one of the predesigned frames could now be drawn, the timbers cut, and floor timbers and futtocks assembled to the required shape. The length of the flat part of each floor was obtained by subtracting the respective value of

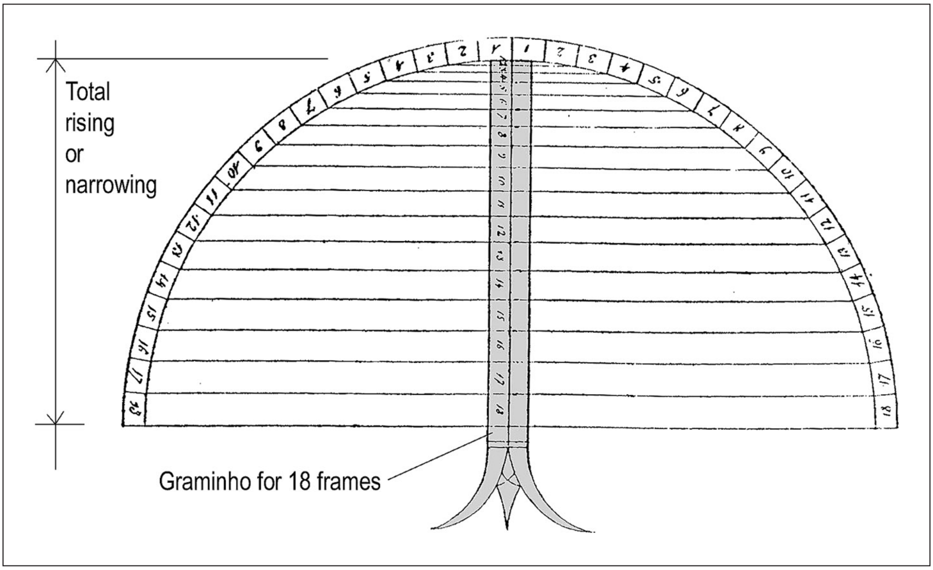



Fig. 3.4. The *besta* method to design a *graminho*, after Oliveira.

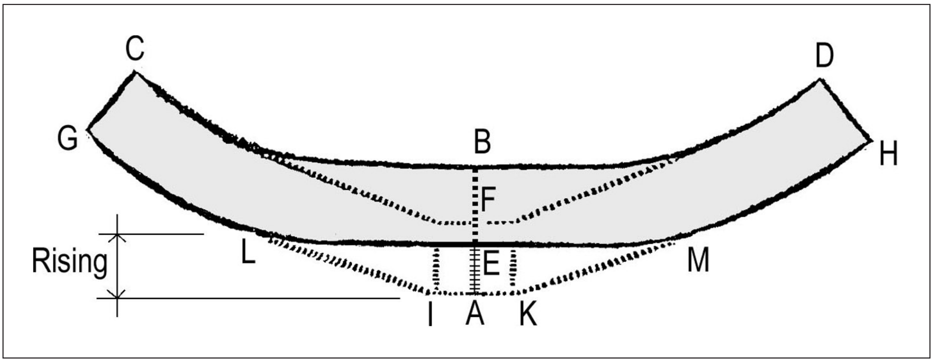



Fig. 3.5. Schematic representation of the rising of the floors, after Bartolomeu Crescêncio's *Nautica Mediterranica*.

the *graminho*, and the measure of the rising of each floor's foot (*pé*) by adding the respective value of the *graminho* (fig. 3.5).

Once all the predesigned frames were in place over the keel, the shape of the remaining parts of the hull was obtained with the help of wooden ribbands, wales, or planking strakes placed over these frames at given heights to determine the overall shape and to allow for the design of the remaining frames (fig. 3.6). This meant that, in practice, the ends of a ship's hull were designed by eye, making the outcome of a construction project somewhat unpredictable, as Oliveira remarked in his treatise. The runs of the ribbands are de-

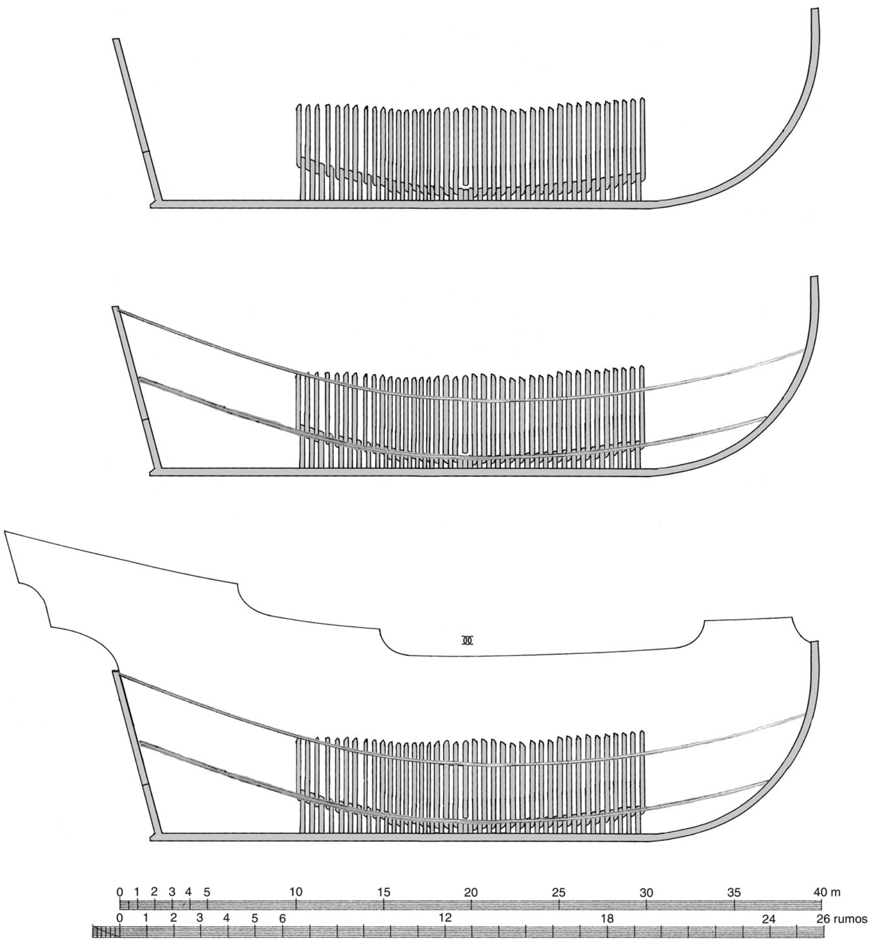



Fig. 3.6. After keel, posts, and central frames were in place, a series of ribbands was set over particular points of the frame to define the remaining shape of the hull. (Drawing Filipe Castro)

fined in Lavanha's work and follow the old Mediterranean tradition of placing a ribband exactly over the turn of the bilge (*paraschuxula*). A notched keelson was then fitted over all the frames, from stem to stern, and solidly bolted to the keel.

Carpenters started planking the hull over the preerected structure while another team inside finished the bottom of the ship with the footwales and stringers needed to give the lower hull additional longitudinal strength, as there were no wales on the outside of the hull below the water line. When all the lower stringers were in place, the clamp to support the lower deck was placed and the deck beams solidly fastened, starting with two adjacent beams placed precisely above the mainmast step that determined the masts' rake aft. The construction continued by repeated tasks, every deck preceded by a line of futtocks, wales, a clamp, and its beams and carlings. Clearly perceived as a much less important part of the vessel, the upper works were sometimes built by a different team of carpenters. When the hull was ready, it was launched, and masts, spars, rigging, and other fittings installed in place.

There are no detailed, accurate illustrations of India naus, and we must reconstruct their images from the evidence available, which consists mainly of sketches illustrating accounts of voyages (*relações*), itineraries (*roteiros*), and maps, as well as depictions in religious paintings, occasionally of very good quality, like the well-known *Retábulo de Santa Auta* in Lisbon's Museu de Arte Antiga. The great majority of these illustrations are, however, unreliable since most painters were generally oblivious to the secrets of the seafaring world. Flags pointing in the opposite direction of the wind that fills the unfurled sails below, ships sailing in different directions under impossible wind conditions, or misplaced rigging cables are common examples of the liberties taken by the artists who depicted these vessels. Nonetheless, the study of iconography can be helpful in understanding these long-gone vessels. A few scholarly representations remain, such as the illustrations of Manoel Fernandez' treatise, but again leaving many questions unanswered in what concerns, for example, the structural details and fastening solutions adopted in the construction of the decks and upper works. (See fig. 3.7.)

The first and most striking feature of the India naus was the size of their mainsails. In most illustrations from the sixteenth century, we see a sturdy mainmast, a long main yard, and a huge mainsail called *papa-figos*—literally figpecker—that exceeds all other sails shown on other vessels of the time. Exaggerated or not, this mainsail often bears a bonnet hanging outside, and sometimes even below, the gunwales, both kept in place by two sets of clewlines. In the beginning of the sixteenth century, four masts—fore, main, mizzen and bonaventure—are frequently shown. The rule seems to be three masts for naus, four masts for galleons. But toward the time of *Nossa Senhora dos Mártires* the bonaventure was being phased out and it was more usual to find only three masts. Although both the fore and mainmast bear two square sails each, topgallant masts are rarely shown. Large and heavy round tops, with a bowl-like shape, were placed in between these two sails. The mizzen and bonaventure masts were always rigged with a lateen sail, and at the bow, a long bowsprit invariably carried a large square spritsail.

The hulls look dark and sturdy, showing no decorations, paintings, or carvings. Strong wales stood out, sometimes with a pronounced sheer that

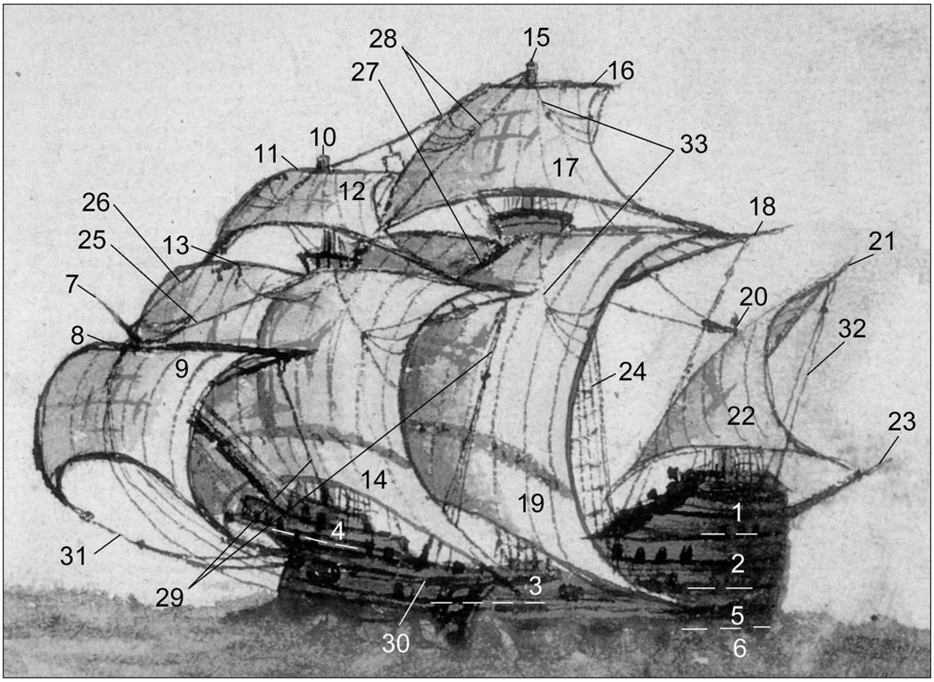



Fig. 3.7. A Portuguese nau in the mid-16th century, after Lisuarte de Abreu.

1
*Chapitéu*
Poop deck
2
*Tolda*
Quarterdeck
3
*Convés*
Main or weather deck
4
*Castelo de proa*
Forecastle
5
*Primeira coberta*
Gun deck
6
*Porão*
Hold
7
*Mastro da cevadeira*
Bowsprit
8
*Verga da cevadeira*
Spritsail yard
9
*Vela da cevadeira*
Spritsail
10
*Mastro do traquete*
Foremast
11
*Verga da gávea do traquete*
Fore topsail yard
12
*Vela da gávea do traquete*
Fore topsail
13
*Verga do papa-figos do traquete*
Fore yard
14
*Papa-figos do traquete*
Fore sail
15
*Mastro grande*
Mainmast
16
*Verga da gávea grande*
Main topmast
17
*Vela da gávea grande*
Main topsail
18
*Verga do papa-figos grande*
Main yard
19
*Papa-figos grande*
Main sail
20
*Mastro da mezena*
Mizzenmast
21
*Verga da mezena*
Mizzen yard
22
*Vela da mezena*
Mizzen sail
23
*Botaló*
Outrigger
*Mastro da contra-mezena*[a]
Bonaventure mast
24
*Enxárcea*
Shrouds
25
*Estai do traquete*
Fore stay
26
*Estai da gávea do traquete*
Fore topmast stay
27
*Estai do mastro grande*
Main stay
28
*Estai da gávea do mastro grande*
Main topmast stay
29
*Braços*
Braces
30
*Escotas*
Tacks
31
*Escotas*
Sheets
32
*Guardim*
Vang
33
*Carregueiras*
Leech lines

*Note:* Nos. 1–6, hull elements; nos. 7–23, masts, spars, and sails; nos. 24–33, standing and running rigging

[a]Not shown

does not correspond to what we know from the written treatises, and some illustrations show fender cleats amidships. The forecastle was generally high and short, ending in a triangular shape that distinguished carracks of the fifteenth and early sixteenth centuries. The quarterdeck extended all the way to the mainmast and hung generally one-fifth of its length abaft the transom. It was topped by a poop deck that covered more or less half the quarterdeck's length.

As with much of the iconography of Portuguese vessels from the sixteenth and seventeenth centuries, the drawing in figure 3.7 was done by a passenger, not by an officer, a sailor, or a shipwright. That is probably why the braces (*29*) of the foresail fall almost vertically, in a position impossible to handle. Note the existence of bonnets in both the fore- and mainsails.

Some of these parts also have several different names, and sometimes even nicknames, as for instance the mainsail, which is sometimes called *vela grande,* literally large sail, and other times *papa-figos grande,* literally large figpecker.

These vessels may have been quite standardized in view of the regularity of the voyages and the structure of the trade. Nevertheless, making an educated guess as to how *Nossa Senhora dos Mártires* looked, was built, rigged, and sailed is difficult, in spite of the details of the upper works, spars, sails, and standing and running rigging we may obtain from the iconography.

During the sixteenth and seventeenth centuries, a small fleet left Lisbon for India almost every year, making the India route one of the longest regular routes of its time. The ships were designed and built specifically to sustain a six-month journey. They had to provide enough space for the crew and passengers, together with their water and victuals, and leave enough free space for the merchandise brought back on the return trip. The main cargo—peppercorns—was a light commodity to store in the holds, especially if these vessels were to carry heavy artillery on the upper decks. Stone ballast was therefore added, reducing the space available in the holds. All things considered, it seems incredible that the average late sixteenth-century India route nau had a keel length of less than 30 m.

Driven by the demand for large and reliable vessels for this trip, Lisbon's shipyard developed from a modest medieval structure into a large and complex organization, employing thousands of workers. Records from the sixteenth and seventeenth centuries show clearly that ships for the India route were different from all other vessels built in and sailed by Portugal, and there was no possible interchange between the ships of this trade and those of other more traditional routes. The most obvious difference was in capacity. Sixteenth-century India naus may have averaged around 500 or 600 *toneladas* (about 1,000 tons displacement). The smaller trade ships that sailed the routes of northern Europe, the Mediterranean, the western coast of Africa, and Brazil, generally had capacities between 40 and 100 *toneladas* by the mid-sixteenth century.[65] The volume of the trade did not allow for larger vessels without increasing the risks of the business for a number of reasons. Larger vessels meant a more costly initial investment, higher maintenance and operating costs, bigger crews, slower trips, less maneuverability, and longer stops at harbors. Such ships were also prized by pirates and privateers. These risks meant that larger ships had to carry artillery, an expensive feature that every shipper wanted to avoid because of the extra weight, extra people, higher costs, and heavier maintenance—all for dubious results in confrontations with professional plunderers. Nor was there a guaranty of full-capacity freights year around for big ships. Everything weighed against the building of larger ships. Nevertheless, since at least 1470, the state issued a continuous stream of incentives to construct ships over 100 *toneladas*.[66]

These incentives did not enhance the shipbuilding industry, and they were soon extended to the import of ships above this capacity.[67] The state had an obvious interest in enlarging the fleet, however, both in number and in capacity, and restrictions were imposed on the sale of ships to foreigners as well as on the freights of ships owned by foreigners.[68] The volume of Portuguese trade did not seem to justify the purchase of ships bigger than 100 *toneladas,* and legislation issued in 1567, imposing the obligation of carrying artillery on all ships with capacities above that tonnage, met with the resistance of many ship owners who complained that this measure was going to increase costs to an unbearable point for the freighters, and could kill their activity.

From the beginning of the sixteenth century, the state tried to impose standards for stronger, more durable naval construction, extending the rules and designs in use in its Lisbon shipyards to all the shipwrights in the country. A system of weights and measures was also on the way to being unified, as were the taxes and benefits related to the trade and the shipbuilding industry. In this context, the standard for India route vessels was probably a good political instrument to implement new rules and increase the general quality of shipbuilding in Portuguese shipyards. Until this point, the great majority of shipyards were family businesses, operating under old rules, long held traditions, and techniques transmitted orally through generations, and they were producing ships that could not respond to the demand for strength imposed by the use of artillery. The arduous journeys of India naus required much more than the technology and materials Portuguese shipbuilding could offer.

The most prized feature now was space. And it is easy to understand why a tendency toward increased ship size had developed since the beginning of the India route, when Bartolomeu Dias's caravels were dismissed as too small to withstand the trip around the Cape of Good Hope. But perhaps the ships grew too large too quickly, and legislation was issued in 1571 fixing the capacity of the ships built for the India route at between 300 and 450 tons.[69] The workers, contractors, and suppliers of the Lisbon shipyards tended to increase their profits if the ships were bigger, but the first really large India vessels did not prove to be advantageous. In spite of being much praised, the three great galleons built in the 1550s wrecked one after the other on the east coast of Africa. First *S. João* (900 tons, built in 1550) was wrecked in 1552. *S. Bento* (also 900 tons, built in 1551) was wrecked in 1554. Finally *Graca* (1,000 tons, built in 1556) was lost in 1559.[70] The 1550s was not a good decade for super naus. Moreover, these large ships represented a smaller investment but greater risk in view of the value of the cargo that they could carry. When the nau *Madre de Deus,* said to have a capacity of 1,600 tons, was captured by the British in 1592, the Portuguese crown forfeited a huge fortune with the loss of just one vessel.[71]

In 1570, when King Sebastian supported the prohibition on construction of India route naus with capacities above 450 tons, his reasons were essentially financial: smaller ships were cheaper to build and outfit for the voyage, easier to load, required smaller crews, and if they had to winter in Mozambique they incurred fewer expenses. No mention was made of the unseaworthiness of the larger ships of 900 to 1,000 tons, but this omission does not exclude the possibility that the size of the ships elicited negative reactions among pilots and officers. The ships were probably more difficult to handle than the average 400-ton vessel and therefore riskier. The disadvantages of large vessels were expressed by João Pereira Côrte Real in the early seventeenth century, when shipbuilders again showed a tendency to construct larger ships and specifically to add a fourth deck to the already very high hulls.[72]

No matter how hard young King Sebastian tried to establish a standard for the India route ship, he was probably unable to implement his ideas. It was no easy task to establish a priori the final tonnage of a ship, especially against the will of the people involved with its construction—workers, officials, contractors, suppliers, owners, and the master shipwright. Whether Sebastian succeeded in establishing such regulations is impossible to say, because the available data pertaining to the tonnage of ships leaving Lisbon bound for India during the period between 1487 and 1604 cover less than 10 percent of the vessels. Of that number, less than 1 percent were smaller than 100 tons; 34 percent were between 100 and 300 tons; roughly 26 percent had estimated capacities between 300 and 450 tons, and 40 percent, above 450 tons.[73] By the late sixteenth century royal officials and shipbuilders were apparently reaching a consensus on the size of India naus, at least from the perspective of the written texts and treatises on shipbuilding.

# 4

# The Voyage of the *Nossa Senhora Dos Mártires*

The east India route was already more than a century old when *Nossa Senhora dos Mártires* set sail for India at the beginning of the seventeenth century. The mortality rates sustained in the first voyages diminished on later passages as experience grew. Vasco da Gama lost almost half his men on his first trip in 1498–99. (Cornelis Houtman, leading the first Dutch expedition to the Far East nearly a century later, in 1595, lost 153 of his 240 men.) Unfortunately, other problems faced by Portuguese crews were far from improved. Experience alone could not solve many of the difficulties and the seamen, soldiers, politicians, and merchants involved in the India route endured dreadful living conditions for periods of six months and more, no matter how skillful they were. Ships were always too crowded, and living space was minimal. Sanitary conditions were bad, even by seventeenth century standards. As late as 1687 Father Fernão de Queiroz complained about the lack of sanitary conditions, which he identified as the primary cause of disease at sea.[1] Food and water were almost always scarce, and their quality degraded rapidly in the tropical warmth. Vitamin deprivation generated terrible diseases such as scurvy, and many lives were lost.

To date, no complete scholarly study of life aboard fifteenth- or sixteenth-century India route vessels has been made that focuses on the ages, social status, social mobility, and economic status of crews, passengers, and soldiers—as has been done with the Spanish *carrera de las Indias* to the New World.[2] The destruction of the Casa da Índia's archives in the earthquake of 1755 makes this task far more difficult, but a number of accounts of voyages have survived in the form of chronicles, narratives, and letters, and these texts contain valuable information about life aboard the India route naus. The twelve best known, and perhaps most important, of these narratives were published in the eighteenth century by Bernardo Gomes de Brito under the title *História trágico-marítima,* to which a new apocryphal volume was added (also in the eighteenth century) with another six accounts of voyages.[3] Another collection of stories of voyages and shipwrecks was published by historian António Sérgio in the 1950s, and yet another by João Palma Ferreira in the 1970s.[4] One other compilation, containing six accounts, was published in *Biblos,* a history magazine, in 1916.[5] Foreign accounts of voyages to the East are another source of information. Around the time of the wreck of *Nossa Senhora dos Mártires* there are three main authors: Jan Linschoten, François Pyrard de Lavall, and Jean Mocquet.[6]

Especially important for this study are the accounts of three men—Frei Gaspar de S. Bernardino, Nicolau Orta Rebelo, and Antão de Mesquita—who embarked on the nau *Betancor* in the last days of December, 1605, bound for Lisbon, as *Nossa Senhora dos Mártires* was a few days later. Although *Nossa Senhora de Betancor* wrecked in Mozambique, these accounts of the first part of the trip offer a good insight into life aboard an India nau in the early 1600s. After the wreck, Frei Gaspar de S. Bernardino took the land route to the Mediterranean and sailed to Marseilles, where he took an overland route to Lisbon. Antão de Mesquita sailed back to Goa and embarked in the nau *Nossa Senhora da Conceição* to Lisbon in December, 1606.[7] As for Nicolau Orta Rebelo, he sailed to Mombassa and also took the land route to the Mediterranean, Marseilles, and Lisbon.[8]

There was a narrative of the loss of *Nossa Senhora dos Mártires,* written by a certain D. João Soares de Alarcão (1580–1618). The historian Patrick Lizé told me that it is referred to by Diogo Barbosa Machado in his *Bibliotheca Lusitana,* an eighteenth-century catalog of all the Portuguese literature existing at the time.[9] We have both tried to contact the family to see if there is an archive where this account might be preserved, since there was no trace of it in the public libraries. Unfortunately, this manuscript is almost certainly lost. By the second half of the nineteenth century, when Innocêncio Francisco da Silva published his *Diccionário Bibliographico Portuguez,* an equivalent to Machado's *Bibliotheca Lusitana,* this text is no longer mentioned among the works of D. João Soares de Alarcão.[10]

Another important source of information for the understanding of life aboard the India route naus are the numerous itineraries.[11] These generally dry and focused texts mainly describe the sailing conditions and the decisions made by the captain and pilots; the latitudes taken every day or so; the currents, winds, storms, islands and coasts sighted; the fauna seen around the ship; encounters with other vessels; and occasional accidents and happenings. These latter generally included deaths, births, and special religious ceremonies, and may occasionally prove a rich source of details. For instance, in Lisuarte de Abreu's narrative of the trip of the nau *Rainha* from Lisbon to Mozambique in 1558, a fast and calm trip of three and a half months—from April 7 to July 22—we learn of an encounter with a ship coming from India, the nau *São Gião,* on April 30, and the exchange of food between them: chicken, sweets, and wine from the *Rainha* for rice and coconuts from the *São Gião.* On the very night of the encounter between these two vessels, a sailor fell into the sea from the bow, but he managed to grab a cable hanging from the stern and was hauled aboard by the crew. Further on, Lisuarte de Abreu mentions how the only passenger to die on that trip, on May 11, was buried at sea the next morning with a cannon ball tied to his feet. His wife was aboard with three daughters, the eldest being eleven years old, and a boy of eight. As for the crew, Lisuarte tells us that a boy fell into the sea on the night of May 15 and could not be rescued because of the darkness, and that a fight on the twenty-third of the same month between two cabin boys, fourteen and eight years old, caused them to fall into the sea, one was retrieved but had already died from hitting his head on the anchor as he fell in the water. An hour later he was wrapped in a cloth and buried at sea by the chaplain. A fourth cabin boy died on June 14 of a disease that made his feet swell. He was also buried at the sea, inside a big basket. After rounding Cape Agulhas on June 30, the wife of a cooper gave birth to a girl, on July 10. About religious events, Lisuarte mentions a series of processions, on June 5, 13, 20, and 25, and on July 19, in which the faithful crowd walked around the deck with candles singing and reciting prayers.[12]

The death of sailors and cabin boys was inevitable: their work was risky and their lives certainly violent. These vessels could carry crews of 150 to 200 persons, of which approximately 60 were sailors, and 70 were cabin boys. The former were generally assigned tasks that required more practice and experience, such as steering, handling the sails, or fixing the rigging, and the latter carried out the tasks that required agility and strength, such as climbing masts and hanging from spars. The youngest cabin boys, like the eight-year-old boy who died on the nau *Rainha* in 1558, were generally protected by older kin or friends, and received jobs like cleaning and scraping, cooking, and fetching things. These boys also probably took the largest share of smacks, slaps, kicks, and punches distributed aboard.

A fair amount of data are available concerning the composition of the crews of Indiamen in the sixteenth and seventeenth centuries. Every crew included a captain (*capitão*), with ultimate authority over crew and passengers, a clerk (*escrivão*), charged with the cargo and its whereabouts, a chaplain (*capelão*) responsible for the care of the souls aboard, two pilots (*piloto* and *sota-*

*piloto*) fully responsible for all matters related to navigation, and the seamen and ship's boys with their internal hierarchies. The sailors reported to the master (*mestre*) and the pilot through the boatswain (*contramestre*), and the boatswain's mate (*guardião*). The former was responsible for the crew at the stern and the latter at the bow. Then there were the auxiliary people, such as the carpenters (*carpinteiro* and *carpinteiro sobressalente*), caulkers (*calafate* and *calafate sobressalente*) and the cooper (*tanoeiro*), ready to fix anything that was broken. Also aboard were the purser (*despenseiro*), in charge of food stores and stocks, the bailiff (*meirinho*) who filled the role of justice officer, the barber (*barbeiro*), charged with hair care and the bloodletting of the sick, and the constable (*condestável*) with his gunners (*bombardeiros*) and soldiers (*soldados*). Some officers were assisted by cabin boys or pages (*pagens*), generally charged with scrubbing and cleaning the ship, distributing meals, and cleaning up afterward. Their numbers varied from vessel to vessel. Contente Domingues cites the galleon *S. Bartolomeu* in 1589, which left for India with a crew of 150, and 250 soldiers. Figueiredo Falcão mentions a crew of 124 people in 1607, and describes their wages and benefits.[13] The jobs and the number of people performing each role also varied, as did the designations of the functions, but only slightly (see table 4.1).

To the ship's crew were added the passengers, generally businessmen, nobles, and priests, and frequently a number of soldiers. This crowd was packed on the main deck, castles, and weather deck, sharing their space with a number of animals brought by the rich for consumption during the trip; these usually included cows, sheep, and pigs, together with the ubiquitous chickens, ducks, and rabbits.

A certain social mobility is suggested in a 1654 letter from the widow of Cristovão de Abreu, in which she asks the king for a pension. In this letter we learn that Cristóvão de Abreu had survived the wreck of *Nossa Senhora dos Mártires* in 1606, at the end of his first round-trip to India. He completed another nine round-trips and died on his eleventh one in 1645, on the way to Lisbon, presumably of disease. He was a ship's boy until 1610, having made three round-trips to India in this capacity: in 1605–1606 on *Nossa Senhora dos Mártires,* in 1607–1608 aboard the nau *S. Francisco,* and in 1609–10 aboard the galleon *Santiago e S. Filipe.* In 1610, working as a seaman, he survived another shipwreck in the mouth of the Tagus when the nau *Nossa Senhora da Oliveira* was lost against the rocks of S. Lourenço da Cabeça Seca. The following year he again left Lisbon for India, aboard the nau *S. Filipe,* and did not return until 1616, on the galleon *Nossa Senhora de Jesus.* After one last trip as a seaman aboard the nau *S. Carlos* in 1619–20, he embarked as a boatswain on the galleon *Bom Jesus,* part of the fleet the king maintained to defend the coast. In

**TABLE 4.1. COMPOSITION OF SAMPLE CREWS ON THE INDIA ROUTE**

| GALLEON *S. BARTOLOMEU,* 1589[a] | INDIA NAU, 1607[b] | ENGLISH EQUIVALENT |
|---|---|---|
| 1 *capitão* | 1 *capitão*[c] | captain |
| 1 *escrivão* | 1 *escrivão*[c] | clerk |
| 1 *capelão* | 1 *capelão*[c] | chaplain |
| 1 *mestre* | 1 *mestre* | master |
| 1 *piloto* | 1 *piloto* | pilot |
| 1 *contramestre* | 1 *contramestre* | boatswain |
| 1 *guardião* | 1 *guardião* | boatswian's mate |
| 1 *sota-piloto* | 1 *sota-piloto* | second pilot |
| — | 2 *estrinqueiros* | sailors[d] |
| 2 *carpinteiros* | 2 *carpinteiros* | carpenters |
| 2 *calafates* | 2 *calafates* | caulkers |
| 1 *tanoeiro* | 1 *tanoeiro* | cooper |
| 1 *despenseiro* | 1 *despenseiro* | purser |
| 1 *meirinho* | 1 *meirinho* | bailiff |
| 1 *barbeiro* | — | barber |
| 50 *marinheiros* | 45 *marinheiros* | seamen |
| 50 *grumetes* | 48 *grumetes* | ship's boys |
| 4 *pagens* | 4 *pagens* | pages |
| 1 *condestável* | 1 *condestável* | constable |
| 29 *bombardeiros* | 11 *bombardeiros* | gunners |
| 250 *soldadosc* | — | soldiers |

[a] From: Francisco Contente Domingues, *A Carreira da Índia* (Lisboa: CTT Correio de Portugal, 1998), 57.
[b] From: Luiz de Figueiredo Falcão, *Livro em que se contem toda a fazenda e real patrimonio dos reinos de Portugal, India, e ilhas adjacentes e outras particularidades, ordenado por Luiz de Figueiredo Falcao, secretario de el rei Filippe II* (Lisboa: Imprensa Nacional, 1859), 198.
[c] Not mentioned by Figueiredo Falcão, but obviously always part of the crew.
[d] Sailors were in charge of the windlass that operated the main sail and the foresail on the naus. There were no estrinqueiros aboard the galleons since the sails were operated from the capstans.

1622 he was boatswain's mate on the galleon *Sto. António, capitânia* of this fleet. In 1624 he left for India on the galleon *S. Pedro,* this time as master.

In India he served in the armada that fought the Anglo-Dutch fleet in Ormuz and was appointed "captain of all people of the sea" in Goa, one year later. After serving as master on the galleon *S. Jerónimo* in India, he set sail to Lisbon as boatswain on the naveta *Madre de Deus* and served in the coastal fleet again, in 1629, aboard the *urca S. João*. In 1631–32 he again journeyed to India, on the nau *Nossa Senhora do Rosário,* and again in 1633–35, on the nau *Nossa Senhora de Belém*. This last vessel wrecked on the Natal coast, and Abreu survived both the wreck and the following death march through the deserted and perilous east African coast to the Portuguese base of Mozambique. Another survivor of this wreck, captain Joseph de Cabreira, wrote an account of these events but never mentioned Abreu's name, although he did write that "the boatswain was always punctual with his sailors."[14] In 1639 Cristóvão de Abreu was master of the Lisbon shipyards—the famous *ribeira das naus*—and departed again to India as master on the ship *Nossa Senhora do Rosário,* while retaining his position in the shipyard. In 1642 he suffered another shipwreck on the way to India, as master of the galleon *S. Bento,* but he was back in Lisbon by 1644, when he departed again to India. According to his wife's letter—in which she calls him captain—he died as master on the galleon *S. Lourenço* in 1645, on the return from India. If he were eight years old when he embarked in 1605 on his first voyage to India, he would have been fifty-three when he died, and far from an old man.[15]

On voyages the rich and powerful shared the after castle, namely the lodgings on the quarterdeck (*tolda*) and the small poop deck above it (*chapitéu*), and the after area of the main deck (*primeira coberta*) under the quarterdeck. The boxes and bales of their personal trade that would not fit in these areas were stored near the main mast, and their livestock was stored abaft the mainmast, birds and rabbits in cages carefully piled and tied. The remaining area on the main deck was supposed to be cleared, including the forward area, under the forecastle, where the ship's boys would bundle to sleep. Beneath the main deck on the lower deck (*segunda coberta*), were the lodgings of the crew and soldiers, and the storage areas of their private merchandise. To starboard and abaft the main hatch were the lodgings and storage areas of the captain, master, pilot, second pilot, clerk, and purser. The corresponding area to the port side and a portion of the deck situated before these two areas were used for storage. Toward the bow to starboard were the lodgings of the boatswain and boatswain's mate, and to port those of the carpenters, caulkers, and cooper. At the bow, under the foremast step, slept sailors and more ship's boys. The hold was used solely for drugs and spices, of which pepper was the main cargo, stored in smaller magazines built for that purpose (see fig. 2.3).

In the 1620s Admiral João Pereira Corte Real proposed a series of reforms to King Philip IV of Spain (1621–65)—and III of Portugal (1621–40)—which were primarily concerned with the size of the India route naus, but which included a few other changes. His letters indicate that by then there were several lodgings on the main deck, toward the bow, under the forecastle.[16]

The lower decks were almost entirely occupied with cargo. On the return trip from India, holds were built on the lower deck, atop the ballast, which were carefully caulked and closed after being filled with the precious peppercorns. Most of the boxes and bales were stored above, on the second deck. Although the weather deck was supposed to carry livestock, and otherwise be clear for proper maneuvering of the ship, food preparation, religious activities, and defense of the vessel against enemy attack, it was frequently laden with merchandise on the return trips from India. These were mainly foodstuffs in the first weeks of navigation, but also included all sorts of boxes and bales piled around and above the ship's boat, the bits, capstan, and hatches.[17] For example, in 1554 the nau *S. Bento* was not only packed solid with merchandise under the main deck, but "brought seventy–two boxes and five barrels piled on the weather deck, and had such an amount of boxes and bales here that its height equaled the castles and poop deck."[18] Sometimes the cargo would also hang outside, over the channels, and even cabins were occasionally built hanging on the outside of the hull. Referring to the galleon *Santiago* in 1602, Melchior Estácio do Amaral wrote: "and in the body of the ship and under the bridge, and above it, and on the quarterdeck, and on the poop deck, over the ship's boat, and around the capstan, and on deck, there were so many boxes and bales stacked that one could not fit a person in. And even outside the hull, on the bulwarks and channels, hung bales and cabins, as it is usage on these vessels, in such a way that one could not operate the sails, and nobody could use the capstan for eighteen days."[19]

The lack of living space combined with abject boredom generated frequent quarrels, fights, and threats of revenge at the port of arrival. There was not much social life aboard except for the regularity of meals, and there are no references to reading books, an activity documented aboard the sixteenth-century Spanish ships bound for the New World.[20] Gambling seems to have been a major occupation in spite of the efforts of the clergy. Father António Vieira claimed that gambling had been considered bad and dangerous since the time of King Manuel, and advised that instead of gambling, the idle should learn how to operate the different weapons aboard, train in the arts of music, learn how to read the clouds, the sea, and the compass, how to operate the whipstaff and the pumps, or learn what care was needed to handle the oven.[21] In the "Relação do naufrágio da nau *Santiago*," the author explains that priests incapable of stopping such a vicious practice as gambling, allowed it, if the proceeds of every first hand of every gambling table were given to help the poor and the sick.[22]

The *carreira da India* cannot be discussed without mentioning the ubiquitous seasickness, a nuisance that plagued almost everybody at least in the beginning of voyages. Manuel Godinho Cardoso mentioned an encounter with two Portuguese ships in the Atlantic early during the trip to India of the nau *Santiago* in 1585. The ships were first thought to be French and orders were immediately given to prepare to fight, but not much was achieved, because the majority of the men in arms were sick.[23]

Religious life aboard ship was taken seriously: prayers were said every day, mass held every Sunday and holy day, and processions and other religious ceremonies, sometimes plays, were carried on for the entertainment of all. Aboard the nau *Santiago*, mass was not only said every Saturday, Sunday, and holy day but also on so many other days "that sailors who had been in the *carreira* for fifteen and twenty years never had seen such solemn and divine performances."[24] Together with the schedule of the prayers the schedule of the meals must have dictated the rhythm of the whole day.

Apart from the time spent on devotions, gambling and small talk were the main occupations aboard, filling the long slow days. To eat was a source of great pleasure for the "haves," and much time, effort, and energy were spent on it. Slaves and servants prepared several meals a day, from which sweets were seldom absent. For the "have–nots" things were much simpler, but even they generally ate at least once a day, a privilege not granted to a substantial part of the European population in the sixteenth and seventeenth centuries.

A common sailor aboard a Portuguese Indiaman in the early seventeenth century would be supplied daily with a diet of hardtack—a hard bread, cooked two or three times—soaked in a mixture of wine and water, some salted meat, and beans, rice, or lentils. Fishing and personal supplies supplemented this diet. The personal supplies frequently consisted of some freshwater, smoked ham, sausages, pickled vegetables, onions, garlic, and a small portion of fruits and sweets, which were generally finished long before the trip was over.[25] A 1607 book gives a list of supplies for a nau of 550 tons, carrying a crew of 112 and 250 soldiers (see table 4.2).

**TABLE 4.2. AVERAGE DAILY RATIONS ON THE INDIA ROUTE**

| ITEM/QUANTITY | TOTAL | RATIONS[a] |
|---|---|---|
| Hardtack/1,074 *quintais* | 64.44 tons | 989 grams per person per day |
| Wine/115 *pipas* | 37.674 $m^3$ | 0.578 l per person per day |
| Meat/1,086 *arrobas* | 16.29 tons | 250 g per person per day |
| Hakes/150 dozen | 1,800 units | 5 fish per person for the whole trip |
| Azeite [olive oil]/315 *quartilhos* | 157.5 liters | 0.435 l per person for the whole trip |
| Vinegar/13 *pipas* | 4.259 $m^3$ | 0.458 l per person per week |
| Water/313 *pipas* | 102.539 $m^3$ | 1.764 l per person per day |
| Salt/25 *moios* | 19.5 $m^3$ | 0.3 l per person per day |
| Sardines/130 *arrobas* | 1.950 tons | 5.387 kg per person for the whole trip |
| Chickpeas/14 *alqueires* | 182 liters | 0.5 l per person for the whole trip |
| Almonds/10 *alqueires* | 130 liters | 0.36 l per person for the whole trip |
| Plums/10 *alqueires* | 130 liters | 0.36 l per person for the whole trip |
| Lentils/10 *alqueires* | 130 liters | 0.36 l per person for the whole trip |
| Mustard/2 *alqueires* | 26 liters | 0.07 l per person for the whole trip |
| Garlic/724 *cabos* [braids] | | 2 braids per person for the whole trip |
| Onions/724 *cabos* [braids] | | 2 braids per person for the whole trip |
| Sugar/8 *arrobas* | 117.52 kg | 325 g per person for the whole trip |
| Honey/8 *arrobas* | 117.52 kg | 325 g per person for the whole trip |

*Source:* Luiz de Figueiredo Falcão. *Livro em que se contem toda a fazenda e real patrimonio dos reinos de Portugal, India, e il has adjacentes e outras particularidades, ordenado por Luiz de Figueiredo Falcao, secretario de el rei Filippe II.* (Lisboa: Imprensa Nacional, 1859), 200.

[a]Rations based on 362 people for 180 days. Numbers are merely indicative, since the soldiers' portions of hardtack, wine, olive oil, vinegar, salt, sardines, chickpeas, plums, lentils, mustard, sugar, and honey were generally about one-third smaller than those of the crew.

For the upper classes, there are extensive records of all the delicacies brought aboard to ease the boredom of their six-month trip. Gambling may have been the major preoccupation on the mind of the clergymen charged with the salvation of each ship's souls, but their personal zeal was directed toward eating. Despite being one of the seven deadly sins, gluttony was widely practiced among the rich, and the clergy freely indulged in this earthly occupation.

Several accounts exist of the goods brought by Jesuit priests on their trips to India. One list of recommendations issued by the order in 1602 included a long inventory of delicacies. The fresh pork, smoked ham, sausages, dried dogfish, and sweets were not stored in the holds, but in an accessible locker, because they had to be eaten soon before they rotted in the warmth of the equatorial dead calm periods. Wine, olive oil, vinegar, and hardtack were loaded, as always, in such abundance that their sale in India was expected to bring some revenue, along with the pottery, pewter and copper wares, and empty barrels. The priest's daily diet was registered in detail along with other recommendations, which included advice for a harmonious trip such as always siding with the powerful and upper hierarchies during dissensions and quarrels, regardless of the reason for the argument. The meals consisted of a "stove breakfast" taken between 8:30 and 9:30 A.M., a substantial dinner around 2:00 P.M., and a frugal supper, consisting of fresh fruits, dried grapes or figs, cheese, olives, and almonds, which could be followed by cold meats from dinner (some ham, sausages, or pork). Considering the possibilities allowed by this light supper, one wonders what quantities of food were consumed at the substantial dinner. Moreover, to those accustomed to eating immediately after waking up, a glass of wine to soak a slice of hardtack was advised before breakfast. Chicken was saved for Sundays, and so were the most substantial sweets. These were generally jams of sour cherries, peaches, pears, apples, melons, or plums, boiled in sugar syrup, as well as quince jam and several other jams and jellies.[26] There is a list of the victuals brought aboard by another Jesuit priest, Father Alexandre Valignano, returning to Portugal in 1576. He later returned to Asia and became a colleague and friend to one of the passengers of the nau *Mártires,* Father Francisco Rodrigues, with wom he worked in Macao in 1603 and 1604.[27] Father Valignano's personal food list consisted of around 75 liters of wine, 4 barrels of water, 4 barrels of hardtack, 1 smoked pig, 30 kg of salted beef, 100 chickens, 50 pork sides (spareribs), 60 sausages, 20 hakes, 100 dried dogfish, 15 pumpkins, 10 bales of rice, 1 barrel of vermicelli, and 3 baskets of onions. Also included was a long list of different types of peas and beans, sweets, dried fruits, spices, and condiments, all in small quantities, that included chickpeas, beans, lentils, sugar, quince jam, dried raisins, plums, dates, mustard, garlic, pickled roots (*achar*), saffron, coriander, "one pound of each spice," olive oil, vinegar, and butter.[28]

As to the officers' needs, we know that in 1631 a Captain António de Saldanha embarked on his trip from Lisbon to Goa with 275 kg of sweets, consisting of the above mentioned jams and jellies, sweet yellow paste—a mousse made of egg yolks and sugar syrup—and several sorts of sugars and honeys.

Besides the smoked ham and multiple varieties of sausages, there were much-appreciated delicacies such as pork feet and cow tongues, which were stored in barrels with salt. The beef and deer were packed fresh in barrels with vinegar, salt, mustard, and oregano. Partridges were first roasted in the oven, and once cooled quickly fried in boiling olive oil and stored in layers, with olive oil, vinegar, and spices. Rabbits, headless, were prepared in the same way.

Livestock was considered indispensable and included chickens, turkeys, geese, rabbits, and lambs, and cow calves. Captain Saldanha brought six hundred chickens aboard for the six-month trip. Each Jesuit priest was entitled to a hundred chickens, which gives an impressive rate of consumption if one considers that they were to be consumed only on Sundays, and that there were about twenty-six Sundays in the average voyage.

Fish was considered quite healthy. In addition to the dried dogfish, smoked herring or salmon, as well as dried and salted fish, were common foods. Much appreciated were the *escabeches,* several species of fish and mollusks (mostly cuttlefish, sole, eels, mussels, and oysters) fried in olive oil and garlic, and stored with fried onion rings and spices.

All these meats were eaten with various kinds of beans, lentils, rice, or bread. Wheat and other types of flour were used to bake bread and many types of cakes, which supplemented the hardtack. Butter was preferred to pork fat because it lasted longer. Eggs were stored in large quantities, in glass containers filled with olive oil, as well as large amounts of cheeses of different qualities. Olives were stored in salt; pickled capers and other vegetables were used to strengthen one's appetite; and chestnuts were roasted with sugar and later used in the stews.

Fruits such as oranges, lemons, watermelons, and apples were also part of the diet and were eaten at the beginning of the voyages. Vegetables such as cabbage were preserved in salt, or fried in olive oil and stored with pepper, onions, vinegar, mustard, and olive oil. Onions were either pickled in vinegar or stored fresh, hanging in plaits, as was the garlic. Though no fresh food could remain uncontaminated during a six-month voyage, the same limitations applied on land. Fresh meat and vegetables were a luxury in seventeenth-century Europe.

The filth and the vile smells aboard ship have been well documented in the literature, but such conditions were not restricted to the high seas. Imagine what odors emanated on hot, breezeless afternoons from the narrow alley in late seventeenth-century Port Royal, Jamaica—the second most important city in the French and English New World—where the local butcher dumped the bones, guts, and other waste from his shop.[29] Likewise, the relatively small and highly crowded naus that sailed down the Atlantic Ocean during the spring, across the torrid equator during a perpetual summer, and around the tip of Africa in the peak of the southern winter, in order to reach the Indian Ocean and finally lay anchor in the wet tropical climate of the Indian peninsula were mired in stench. If the trips lasted no longer than the average six months, chances of surviving were actually quite high. Disease, commonly scurvy, would plague many, but by the early seventeenth century captains rarely lost more than a few people to fevers and scurvy. Some well fed, others nearly starving, all badly lodged, the majority suffering from thirst and lack of vitamins, and all permanently shaken by the sea, the majority, nonetheless, would arrive safely in India, with hopes of fortune, glory, or just a better life.

During the Habsburg period, the number of shipwrecks increased greatly, and many must have perished in these accidents. Numerous authors have addressed the substantial loss of Portuguese vessels at sea and have assigned several probable causes to it, building a picture of catastrophic decline that may not actually be true.[30] Apparently from 1582 to 1602, thirty-eight ships wrecked on the India route. Of these, a small percentage were captured or burned by English or Dutch privateers; the overwhelming majority sank due to bad weather conditions.[31] Some scholars contest this catastrophic view, arguing that a number of these lost vessels did not sink but were beached in Africa and Brasil instead, and therefore the cargoes were not lost.[32] In fact, there are records pertaining to transshipment of the cargoes from stranded vessels and arrivals of merchandise one year after the loss of a ship, as well as strong evidence for the sales of cargoes from lost ships in Brazil.

To give an idea of the sums involved in this trade, the building and fitting of an India nau, in the first decade of the seventeenth century, would cost 60 to 75 thousand *cruzados* (24 to 3 million *reis*), twice the amount needed to build and fit a galleon of 550 *toneladas*. If two vessels of a fleet of four completed the round-trip, as happened almost always, the king generally received 350,000 *cruzados* in pepper, plus another 150,000 in custom taxes. The merchants could make around ten times that amount, excluding the undeclared goods. This meant that the 250,000 *cruzados* spent building four vessels represented less than 5 percent of total gross returns.[33] Possibly for this reason, not many of these profits were invested in the India route—building new vessels, improving their performance, or studying the enemy's vessels. Apparently a general lassitude prevailed among those politically responsible, partly because the king was in Spain, and a foreigner anyway, and partly because the investors were not yet challenged by the competition of the Dutch and English East India companies.

In 1601 three galleons arrived safely in Lisbon—*São Francisco, Conceição,* and a third whose name is not referenced—and brought 9,914 *quintais* of pepper (roughly 595 tons) that sold at 52 cruzados per *quintal,* producing 515,529 *cruzados* of revenue, to which the king added an unknown amount in customs duties, and 250,000 *cruzados* extorted from the New Christian merchants in "voluntary" loans. Half the proceedings of 1601 were spent on the India route, fitting new ships and crews, and the other half wasted on the war with Flanders.

In 1602, only two of the three vessels that left Goa arrived in July, bringing 7,598 *quintais* of pepper. In that year the nau *S. Tiago Maior,* under the command of António de Mello de Castro, fell into Dutch hands in Saint Helena.[34] The king received close to 350,000 *cruzados* from the sale of the pepper, and another 150,000 from tax customs on private trade. Almost everything was spent on the war with Flanders, and the merchants and municipal corporations of Lisbon and Porto were forced to cover the costs of fitting the 1603 armada.

In 1603 four vessels arrived with 21,349 *quintais* of pepper, but since the Dutch and English also shipped some pepper that summer the prices dropped drastically, and the Portuguese merchants were forced to buy the entire cargo from the king at an inflated price. King Filipe III of Spain was given 800,000 *cruzados* from the pepper and another 350,000 from customs on private trade, which he spent on the war with Flanders.

In 1604 six vessels arrived safely in Lisbon with a large cargo of pepper and other goods. The custom fees alone yielded the king 385,000 cruzados. Once again, almost all was spent on the war in Flanders, provoking another shortage of funds in Lisbon that dangerously delayed the departure of the 1604 fleet. As a result, of the five vessels that left Lisbon that summer, only one managed to pass the Cape of Good Hope and make it to India. *Nossa Senhora da Palma, Nossa Senhora das Mercês,* and *São Nicolau* came back in October, failing to round the Cape. The nau *São Filipe* was lost at sea. Only the nau *S. Jacinto* with the new viceroy Martim Afonso de Castro arrived in Goa.

In September and October, 1604, a Dutch fleet of thirteen sails, under the command of Steven van der Hagen, laid a twenty-three-day blockade on Goa, waiting for the Portuguese fleet. They only missed the ship of the vice- king because it spent the winter in Mozambique waiting for the monsoon, and did not arrive in India until 1605. By late 1604 or early 1605, the news that a Dutch war fleet had blockaded Goa and was remaining in Asia forced the crown into action, and 10 ships were fit to sail to India in 1605.[35]

The voyage of *Nossa Senhora dos Mártires* to India in 1605 was said to have been a swift one, lasting exactly six months, and no one in the entire fleet died.[36] In that year two fleets left for India. The first was commanded by Brás Telles de Meneses, and composed of six naus and a galleon (or seven naus): *Nossa Senhora de Betancor,* Captain Brás Telles de Meneses himself; *Nossa Sen-*

*hora da Oliveira,* Captain Dom Francisco de Almeida; *Nossa Senhora da Conceição,* Captain Pero da Silva; *Salvação,* Captain Dom João de Meneses; *Nossa Senhora dos Mártires,* Captain Manuel Barreto Rolim; *Palma,* Captain Vicente de Brito; and *Salvador,* Captain Manuel Távora. The second was commanded by Álvaro de Carvalho and composed of three galleons: *Nossa Senhora das Mercês,* Captain Álvaro de Carvalho; *São Nicolau,* Captain Admiral Manuel Mascarenhas Homem; and *São Simão,* Captain Dom Francisco de Noronha.[37]

The first fleet was supposed to load with merchandise and sail back to Lisbon in December. The second was to remain in Asia, to chase and give fight to the Dutch enemies, whose aggressive actions were bringing much concern to the Spanish authorities and the Portuguese merchant community. The second fleet left the Tagus first, on March 9, with the vessels *Palma* and *Salvador.* The first weighed anchor two weeks later, on the twenty-first, now composed of five naus: *Nossa Senhora de Betancor, Nossa Senhora da Oliveira, Nossa Senhora da Conceição, Salvação,* and *Nossa Senhora dos Mártires.*[38]

*Nossa Senhora dos Mártires* arrived safely on the Goa sandbar on September 28, six months and one week after leaving Lisbon. Preparations started almost immediately to load the merchandise and leave for Lisbon no later than December, as was standard. The nau *Mártires* and another three vessels departed almost immediately for Cochin to load with pepper, to be purchased for the sum of 180.000 cruzados. The nau *Betancor* stayed in Goa with the nau *S. Jacinto,* from the 1604 fleet, and underwent repairs.[39]

On the voyage back to Lisbon, the former vice-king Aires de Saldanha chose to travel aboard the nau *Mártires,* probably because it was in better shape, and invited Father Francisco Rodrigues to this vessel together with his young companion, a Japanese Catholic named Miguel. Father Francisco Rodrigues was a Jesuit traveling to Rome to see the pope on an important mission pertaining to sustaining the Portuguese presence in Japan, which had been threatened by a cut of papal payments since 1597.[40]

*Nossa Senhora dos Mártires* departed from Cochin with the nau *Salvação* on January 16, 1606, two weeks later than the rest of the fleet, which departed from Goa on December 30, 1605.[41] The outcome of these voyages was unfortunate. The nau *Nossa Senhora de Betancor* was stranded and abandoned in Mozambique, the majority of its crew sailing back to Goa with part of the cargo. The nau *Nossa Senhora da Oliveira* lost its rudder opposite Sofala, Mozambique, and sailed back to Goa with an improvised side rudder made of a large oar. The nau *Conceição* ran aground in Madagascar, also damaging its rudder. It limped to Mozambique, where it spent the winter, and sailed back to Lisbon in 1607, arriving safely. The naus *Mártires* and *Salvação* apparently sailed without major incident to the Azores, where we know *Mártires* arrived safely in late June. There they seem to have delayed their departure to Lisbon for several months. Vice-King Aires de Saldanha died aboard *Nossa Senhora dos Mártires* on June 18, a few days before arriving at Terceira, and he was buried in the Cathedral of Angra do Heroísmo. His body was later transferred to the continent, to his hometown in Santarém, although nobody seems to know in which of the more than fifty churches in the city at the time he was buried.[42]

Almost certainly the naus *Mártires* and *Salvação* sailed together from Angra do Heroísmo, in the Azores, to Lisbon. *Salvação* was in sight of Cascais on September 12, 1606, during a violent storm with strong southerly winds that made it impossible for the galley *Santiago,* of Dom Diego Brochero, to tow *Salvação* into the harbor of Lisbon. *Salvação* lay at anchor over the night, but the next day it broke its mooring cables and beached on the sandy bottom of the Bay of Cascais, allowing for the safe rescue of the crew, soldiers and passengers, as well as almost all the cargo. *Nossa Senhora dos Mártires* arrived in sight of Cascais on September 13 and, unable to make it to the mouth of the Tagus against the strong southerly winds, dropped anchor to wait for improved weather. From its mooring place, Captain Manuel Barreto Rolim helplessly witnessed the loss of the nau *Salvação.* Two days later *Mártires* also lost its cables, the tide being low, and Captain Rolim tried to make it to the Tagus mouth. The Tagus bar was a difficult obstacle, however, since two large sandbanks narrowed the entrances, making the waters run dangerously fast in both the northern and southern channels. Rolim headed for the northern canal, which by the early seventeenth century was already considered too narrow and shallow to lay anchor in, and too crooked to allow a towing galey to pull a vessel out of it.[43]

The construction of the São Julião da Barra fortress in the late sixteenth century obstructed the channels between the small islets upon which the bastion of S. Filipe had been built, and had allegedly triggered a process of silting in the channel.[44] In the middle of the passage, the nau *Mártires* lost headway and was dragged onto a submerged rock. The nau sank in front of the São Julião da Barra fortress and was broken against the rocks in a matter of hours. The beaches from Lisbon to Cascais were soon filled with debris, and witnesses said that it looked more like the wreckage of an entire fleet than that of a single ship. On September 19, about two hundred bodies had already washed ashore, together with boxes, barrels, bales, and a black tide of peppercorns that extended several kilometers up and down the coast, pushed by the tidal currents. The officers of the crown recovered much of the cargo in the days that followed the tragedy, although nothing could be done to stop the populace from salvaging whatever washed ashore away from the soldiers.

An investigation led by the team of the Portuguese Pavilion at EXPO '98 brought to light information about the lives of some of *Mártires*'s crew and passengers.[45] These were Aires de Saldanha, seventeenth vice-king of India

(1600–1605), who died just before reaching the Azores on his return trip to the kingdom, and Captain Manuel Barreto Rolim, who survived the wrecking and continued trying to make a fortune on the India route after being disinherited by his father due to an undesirable marriage. Rolin died of disease in 1609 near the Cape of Good Hope. Pedro Álvares, a seaman who served fifteen years on the India route, survived this wreck and retired from his seaman's life as boatswain's mate in 1611. The long career of the ship's boy Cristóvão de Abreu is described above. Among the passengers were the Jesuit priest Father Francisco Rodrigues, who lost his life after he refused a place on the ship's boat with the captain. Instead he stayed behind to help others and give absolution to those who asked for confession in the face of death. Miguel, the young Japanese Catholic convert who was traveling with Father Rodrigues, survived the wreck. Miguel is known to have returned to Asia later, and is believed to have died in Macao around 1609 without ever returning to Japan.

This handful of individuals is an interesting sample of the people who traveled aboard the India naus: a vice-king, a captain, a sailor, a ship's boy, an experienced missionary, and a young Japanese Catholic. Of these six people, only Father Rodrigues lost his life, but more than two hundred people perished in the wreck of the *Nossa Senhora dos Mártires*. Among the artifacts found on this wreck was the tsuba of a Japanese saber (see fig.6.5) from the Momoyama period (1573–1603).[46]

# 5

# Site Formation

WHETHER the *Nossa Senhora dos Mártires* tried to enter the Tagus estuary through the southern or the northern channel is not known for certain. The letter from Don Luis Bravo de Acuña indicates the northern channel.[1] The wreck occurred during a southern storm and at ebb tide; that anyone would have attempted to navigate such a difficult passage is almost inconceivable. Rolim was an experienced sailor and must have known the risk he was taking.

Navigating the sandbars at the mouth of the Tagus was never easy. Two large banks known as the Cachopos narrowed the channels and made the waters run dangerously fast in all three possible entrances (fig. 5.1). In addition to the northern and southern routes, a third, less important channel, known as the Torrão, was squeezed between the southern Cachopo and the beach of Trafaria. By the early seventeenth century the Torrão channel was almost totally silted.

Rolim probably headed for the northern channel, which in the early seventeenth century was still the main entrance for vessels coming from the north, at least in fair weather. It was much larger and deeper than it is today, in spite of an ongoing process of intense silting that started in the early 1590s after the construction of the bastions of São Filipe and São Pedro extended the fortress of São Julião da Barra over the narrow channels separating the rocky promontory from the islets around it. The construction of the fortress of São Lourenço da Cabeça Seca, better known as Bugio fortress, also increased sedimentation rates.


Fig 5.1. The mouth of the Tagus River in the early 17th century showing the alignments used to enter the sandbar, after Leonardo Torriano's *Discurso*.

São Julião da Barra was originally built according to the plans of the architect Miguel de Arruda, dated 1553. The extension of the fortress to the east, through the addition of the two bastions, followed the design of the Italian friar Giácomo Palearo, dated 1582 (fig. 5.2). The fortress of Bugio was ordered by the Duke of Alba and designed by another Italian, Tibúrcio Spannochi, chief engineer of Spain. Its construction was started in 1590 as part of a system designed to defend the mouth of the Tagus using three strategically placed fortresses: São Julião da Barra, São Lourenço da Cabeça Seca, and Santo António do Estoril. The latter was also built in the 1590s, a project of yet another Italian friar, Giovanni Vicenzo Casale.[2]

The construction of the fortress of São Lourenço da Cabeça Seca involved dumping tons of rocks over the shallows on the northern part of the southern Cachopo, and soon after construction started an intense silting process arose at the sandbar. The deposited sand started to narrow the channels to dangerous widths and depths, making the entrance very difficult for vessels entering the Tagus. This threatened to destroy Philip II's plans to use Lisbon as the main port of his empire; he had already linked it to the inner plateau of Spain by expensive engineering work that allowed the Tagus to be navigated as far as the village of Aranjuez in Spain.

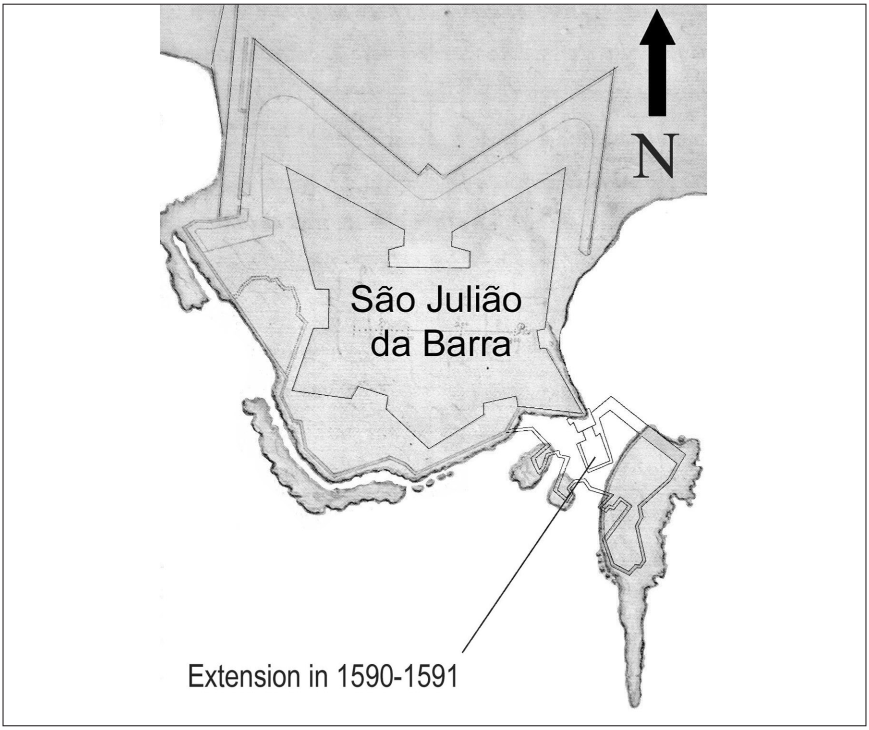



Fig. 5.2. The fortress extension over the islets to the east, as designed by Giácomo Palearo in 1582 and finished in 1590 or 1591, after Torriano's *Discurso*.

For the vessels of the India route, this was one last difficulty to add to an already long and dangerous voyage. Although most pilots remained optimistic during the last years of the sixteenth century, by the early seventeenth century Italian engineer Leonardo Torriano was quite apprehensive. Torriano was a strong-minded, straightforward personality whom the Habsburg king had promoted to engineer of the kingdom of Portugal. After many examinations and observations, the intensity of the silting process was documented by several tests that showed increasingly shallow soundings in the three channels. In spite of the pilots' general animosity toward Torriano, even some of them agreed that the sandbar was getting dangerous (fig. 5.3).

Gaspar Martinz, a pilot of the India route, stated that "he would not dare to put into the Northern Channel, because it was shallow, and not deep enough, and because it was narrow and therefore it was impossible to lay anchor in it, and also because it was crooked, making it impossible for the galleys to tow any nau out of there."[3]

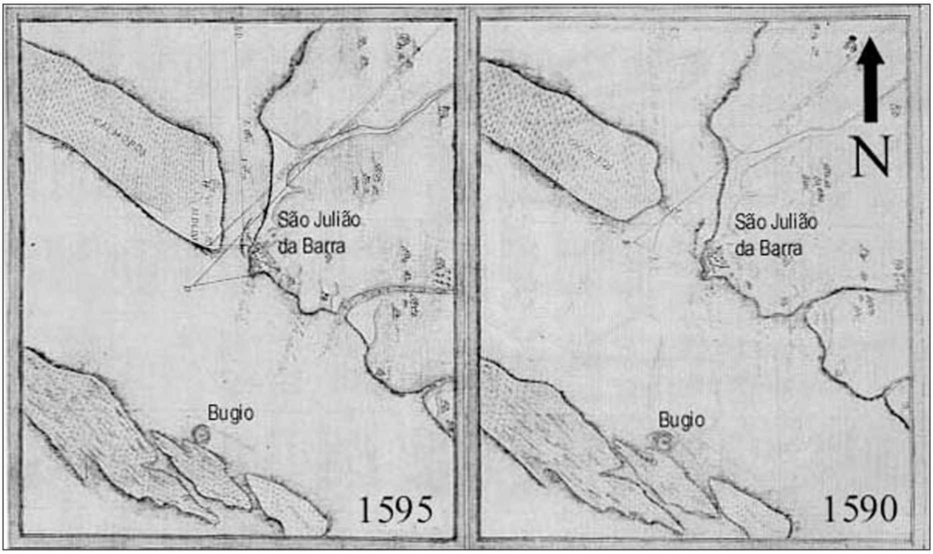



Fig. 5.3. The mouth of the Tagus River in 1590 and 1595, before and after construction of the fortress of São Julião da Barra, after Torriano's *Discurso*.

The nau *Mártires* is said to have lost its headway in the middle of the northern passage and been dragged toward a submerged rock by the current. It sank in front of the fortress of São Julião da Barra in a matter of hours and soon afterward was broken up into such small pieces that witnesses commented that it looked as if it had sunk long ago.[4] Fifty bodies washed ashore immediately after the wreck, and the total number rose to two hundred within the next two or three days.

The ship's main cargo of pepper, which had been stored loose in small holds, spilled out, forming a black tide that extended for leagues along the coast and the estuary of the Tagus. A substantial portion of the pepper was saved by the king's officers. The local population also salvaged a notable quantity. Despite the dreadful weather, many of them went out every night in small craft to salvage what they could, and the soldiers could not stop them.

During the following summers, the officers of King Philip III of Spain (who was also King Philip II of Portugal) may have salvaged a great part of the cargo from the shallow waters, as well as recovering cables, anchors and guns. In spite of its dangers for navigation, the area around the fortress is frequently calm during the summer, and it is possible to work there during periods of low current, at high and low slack tides. Furthermore, a zone near the fortress has almost no current during the whole ebb tide period. The historian

Patrick Lizé found a letter in the Arquivo Histórico Ultramarino in Lisbon, dated July 2, 1618, in which three divers asked permission to raise bronze guns from this site:

> The Marquis Vice-King sent to this council a petition from Domingos Pirez, Jorge Pirez and Luis Galvão, divers, in order that it be analyzed, and whatever issues that may seem relevant in it clarified, in which petition it is said that they [the divers] want to salvage the bronze guns that are in São Julião da Barra, for 30.000 reis each, on account of his majesty's treasury. After consultation by this council, the *Provedor dos Almazens* was of the opinion that this offer should be accepted at that price, in view of the value of the guns, and so that His Majesty should order the said divers to retrieve the guns and pay them 30.000 for each one, and pay any other remaining costs of the operation as well, in view of the great need for guns in the king's fleets.[5]

This proposal was almost certainly approved and an unknown number of guns retrieved from the area around the fortress. These guns may have belonged to the *Nossa Senhora dos Mártires,* the Spanish nau *San Juan Baptista,* lost nearby in 1587 while leaving Lisbon, or to a Portuguese galleon also believed to have been lost near the fortress in 1594, but about which there is almost no information.

Many other bronze cannons have since been found on the site, and at least two remain in situ, one deeply buried in the sand on the west side of the fortress and another covered by the wreckage of the trawler *Santa Mafalda,* lost in 1966. Another bronze gun was found quite close to the wreck during the 1994 excavation season. It was saved from disappearing into a private collection by a group of dedicated sport divers during the winter of 1994, following the introduction of treasure-hunting legislation. With their illegal, but very wise, initiative to raise this gun, these three divers saved an important clue for the dating of the wreck designated SJB2. Unfortunately, they also ran into trouble with the authorities, who were at the time devoted to the legalization of treasure hunting in the country and suspicious of anyone who claimed not to be interested in the monetary value of underwater cultural heritage. The divers were soon acquitted of all charges and we were left with a magnificent gun cast by the famous Flemish founder Remigy the Halut (fig. 5.4).

During inquiries conducted in the summers of 1999 and 2000, the existence of another three bronze guns was discovered. The first was found in 1972 by José Garcia, a sport diver, and sold to the Museu do Mar de Cascais soon afterward. It is badly eroded because of inadequate conservation treatment

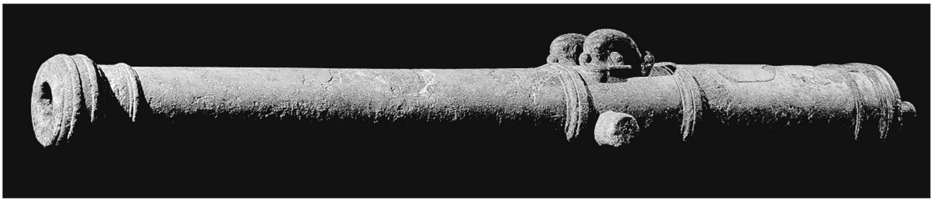


Fig. 5.4. Bronze gun recovered by sport divers in 1994 after conservation. (Photo José Pessoa, CNANS; used with permission of CNANS)

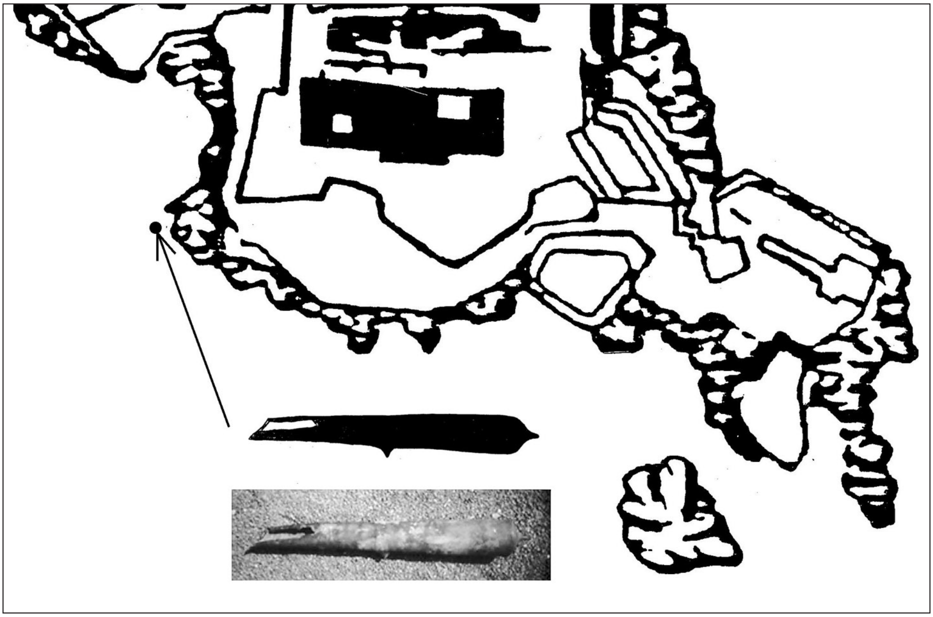


Fig. 5.5. Bronze gun retrieved by José Garcia in 1972. (Map and photo João Pedro Cardoso, CNANS; used with permission of CNANS)

and has not been formally studied (fig. 5.5). The second was recovered by a group of young divers and sold to an unidentified collector. However, two available pictures show a fairly small gun, probably dating from the eighteenth century and almost certainly not related to the SJB2 wreck. Although I could not get copies of the pictures, one of the divers showed me the spot were the gun was found (see appendix A, site SJB21). The third gun, which was quite large, was found close to the wooden hull structure. It was probably one of the *Mártires*'s guns, but unfortunately it was broken up in situ and sold for scrap in the 1980s. A picture of it was found in a private collection (fig. 5.6).

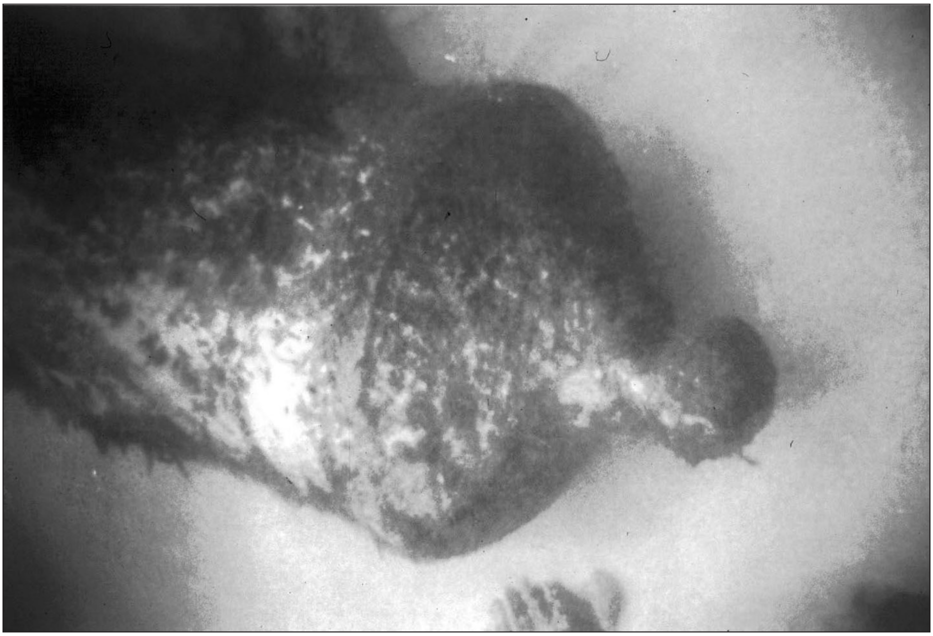


Fig. 5.6. Bronze gun sold for scrap in the 1980s. (Map CNANS archives; used with permission of CNANS)

As with many other ships wrecked in this dangerous channel, the *Nossa Senhora dos Mártires* was probably forgotten soon after its demise. By the 1620s the silting process had stopped and the sandbars slowly began to erode. There is no apparent explanation for this reversal, although the older fishermen and the riverside population blamed the 1531 earthquake for changes upriver, which at the turn of the sixteenth century were still associated with increased sedimentation. Time rolled over the wreck as annual winter storms slowly destroyed the remains of its heavy structure. In 1755 an earthquake again shook Lisbon. The tsunami that followed this violent earthquake rolled heavy rocks over the hull remains of the *Mártires*. During excavation in 1996 stones weighing more than one ton were found on top of the planking in the southern area and over a layer of debris to the north.

Other wrecks came to rest around the fortress, spreading their artifacts over the site, and the violent dynamics of the sea mixed them with the material from the *Mártires*. Finally, in 1966, a codfish trawler wrecked near the site. It covered a large area, and protected many artifacts from the curiosity of spear fishers and sport divers who discovered the site in the early 1970s.

Stories of treasure troves around the fortress of São Julião da Barra were certainly transmitted across many generations, and the spread of scuba diving

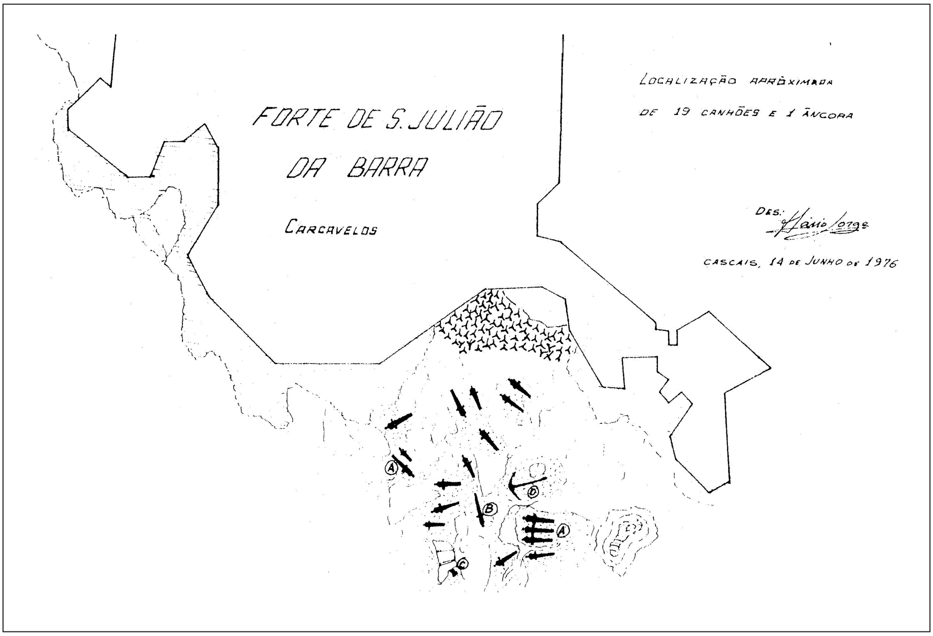



Fig. 5.7. First map of the SJB1 area, drawn in 1976 by Mário J. Almeida. (Map CNANS archives; used with permission of CNANS)

beginning in the early 1950s heightened interest in the area. In the late 1970s archaeological surveys were carried out by avocational archaeologists, but no government action was taken to protect the site (fig. 5.7). As a result it was heavily looted by sport divers during the 1980s. Other maps of the area were drawn during the early 1980s by a group of avocational divers (fig. 5.8).

Many artifacts have been retrieved from the area, the great majority ending up in private collections or simply degrading away for lack of conservation. However, three collections of artifacts were eventually donated to the Museu Nacional de Arqueologia in Lisbon. The first was gathered in the 1970s and early 1980s by Francisco Reiner Garcia, an avocational archaeologist who organized a group of divers to survey the site and tried to open a small museum in the nearby village of Cascais. The museum proposal was thwarted by the bureaucratic labyrinths of the municipality, but the majority of Garcia's collection was eventually donated to the Museu Nacional de Arqueologia. The second collection consists of a small number of artifacts mapped and retrieved by João Pedro Cardoso in the 1980s. The third collection, comprising 2,008 artifacts, was donated in 1993 by Carlos Martins and Sofia Marques, two sport divers who grew up near São Julião da Barra and knew the area well. When they joined the association Arqueonáutica they brought with them an intimate

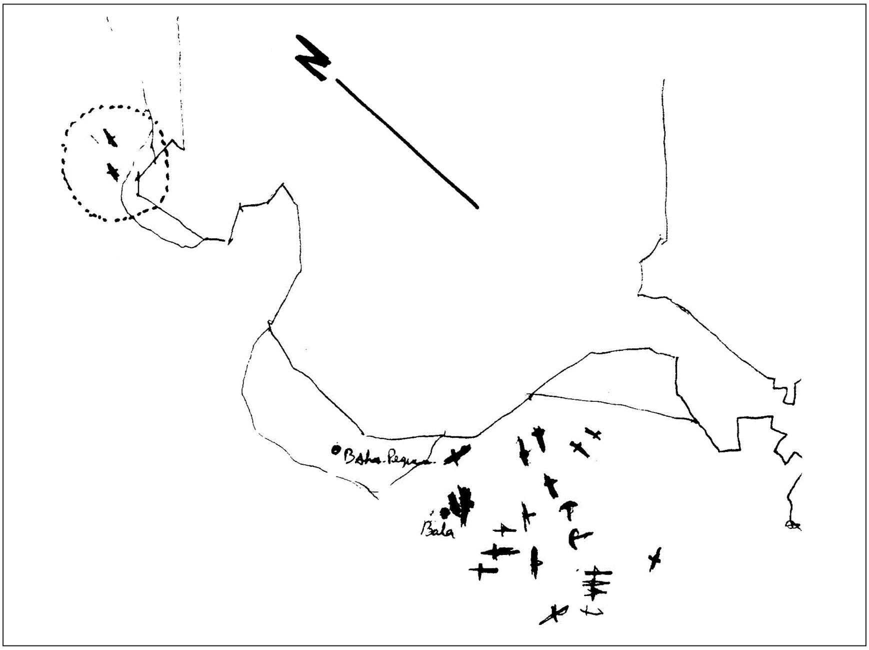



Fig. 5.8. Second map of the SJB1 area, drawn early 1980s by Guilherme Cardoso. (Map CNANS archives; used with permission of CNANS)

knowledge of the site that eventually led to the discovery of the wooden hull structure. Furthermore, their precious collection of artifacts, gathered during more than a decade, was very well conserved.

Due to its extent and accessibility, the site situated immediately to the south of the fortress, designated as SJB1, is the one that has yielded—to my knowledge—the largest and perhaps most interesting collection of artifacts. The site was partially covered in the early twentieth century by the construction of a swimming pool, and the shoreline is covered with debris from the countless portions of wall destroyed by the sea during winter storms. Divers who used to spearfish in that area report a pile of lead ingots that once lay near the swimming pool and extended beneath it. A small number of these ingots were recovered in the 1970s, but none have yet been dated (fig. 5.9). The officers in the fortress of São Julião da Barra have a bronze gun said to have been found in the area now occupied by the pool. The children who used to swim around the shoreline tell of countless silver coins once concreted to the rocks, that were recovered, melted, and sold in Lisbon.

In addition to these stories of troves of coins and jewels, a large number of artifacts dating from three distinct periods have been found. The first group, consisting mostly of porcelain shards, dates to around 1600, and is clearly as-

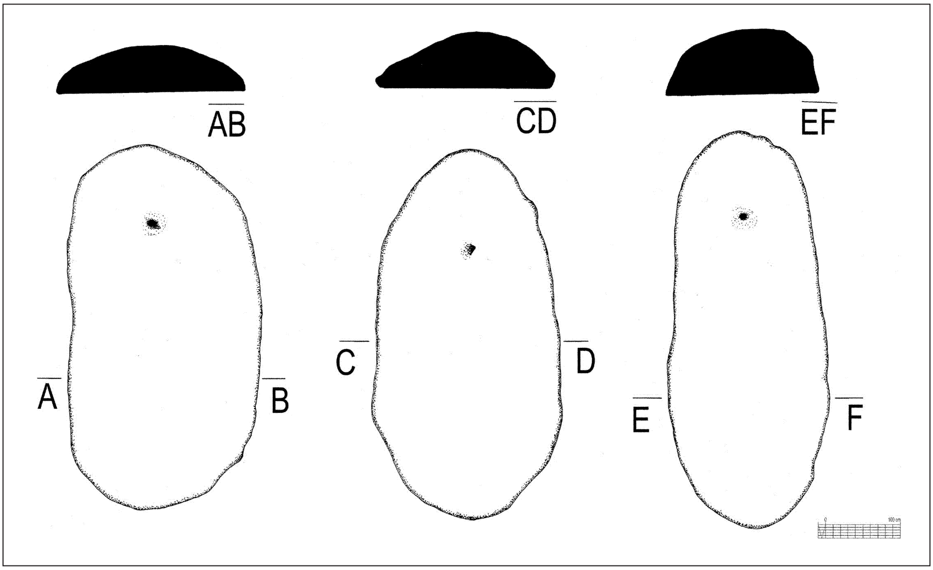



Fig. 5.9. Lead ingots from SJB1 (scale: 10 cm). (Drawing João Pedro Cardoso, CNANS; used with permission of CNANS)

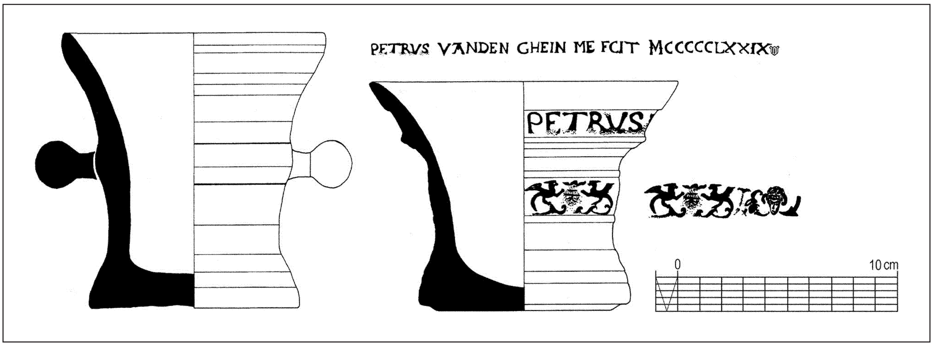



Fig. 5.10. Mortars from SJB1 recovered by a sport diver in the 1980s. (Drawing João Pedro Cardoso, CNANS; used with permission of CNANS)

sociated with the wreck of *Nossa Senhora dos Mártires.* Moreover, several pairs of dividers, similar to those found at SJB2 are said to have been found here, together with three interesting mortars. These artifacts are now in private collections, making some of them inaccessible for study (fig. 5.10).

The second group of artifacts dates to the second half of the seventeenth century. Several coins bearing the date of 1655 were found within a large concretion containing more than five hundred *realles de a ocho* (pieces of eight), evidence of a still-unidentified wreck that occurred after that date. Several sets of bronze nested weights also date from the second half of the seventeenth century. The existence of at least nineteen sets as well as twenty-two isolated pieces has been reported. Thus far the whereabouts of fourteen sets have been confirmed: six sets and twenty-two 22 isolated pieces are in the collections of CNANS; one set is in the Museum of Quinta das Cruzes, in Funchal, Madeira Island; and seven sets are known to be in private collections (fig. 5.11). Two sets were sold by an antique shop in Cascais to unknown private collectors, and three other sets could not be traced.

The third group of artifacts, far less interesting from an archaeological point of view, pertain to the loss of the fishing boat *Santa Mafalda* in 1966. Most artifacts retrieved from São Julião da Barra dating to the twentieth century are in private collections. The majority consist of brass scuttles, although a few nautical instruments were recovered.

During the summers of 1999 and 2000 I conducted an inquiry on the whereabouts of all artifacts from São Julião da Barra whose possible existence had been reported. Sport divers known to have frequented the area were interviewed, and the information they provided was later verified during dives at the site. As a result, a total of twenty-eight sites can be identified that yielded artifacts dating from the late sixteenth century and to the late twentieth century (fig. 5.12). Of these twenty-eight sites, only a few can be securely related

Fig. 5.11. Sets of nested weights from SJB1 in collection of CNANS. (Photo CNANS archives; used with permission of CNANS)

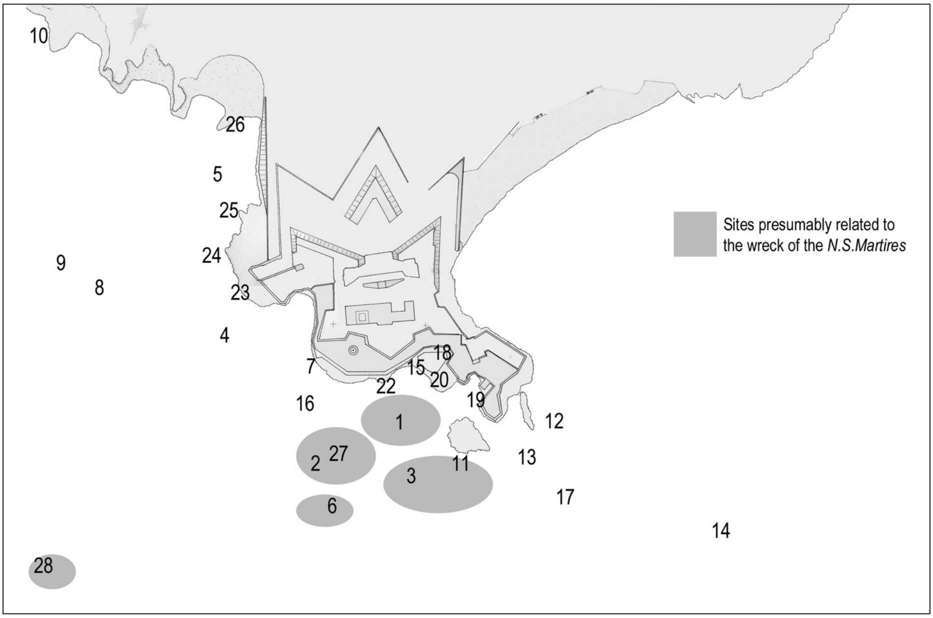



Fig. 5.12. Sites that have yielded artifacts in the area around fortress of São Julião da Barra.

1
Anchors, iron guns, and other artifacts including silver coins dating from the 1650s
2
Wreck site presumed to be the *Nossa Senhora dos Mártires*, 1606
3
Three iron guns and Wan-Li porcelain from the late 16th and early 17th centuries
4
Two large anchors, lead ingots, and a pewter plate
5
Muskets and pottery shards dated to 18th century
6
Large standing anchor with fluke stuck under the rocks and shank bent in the direction of the wreck
7
Iron hull of a steamship
8
Bronze object, presumably part of a bell
9
Wooden barrels
10
Pair of earrings dated to late 16th or early 17th century
11
Artifacts from a 20th-century wreck
12
Copper bolts and copper alloy pan handle
13
Small admiralty anchor
14
Section of the trawler *Santa Mafalda*, 1966
15
Pile of lead ingots
16
Large modern anchor, possibly from the trawler *Santa Mafalda*, 1966
17
Concretion with fruit pits
18
Bronze gun found during construction of swimming pool
19
Bronze gun trapped under wreckage of the *Santa Mafalda*
20
Gold and silver coins found during construction of swimming pool
21
Small bronze gun retrieved by sport divers in late 1970s. then lost
22
Recent iron gun
23
Small bronze gun retrieved by sport divers in late 1970s
24
Iron guns
25
Iron gun
26
Bronze gun buried in the sand
27
Large bronze gun retrieved by sport divers in early 1980s and sold for scrap
28
Hull timbers and peppercorns

to the SJB2 wreck, presumed to be *Nossa Senhora dos Mártires*. The sites designated as SJB10 and SJB17 may also be related to the wreck. The former site consists of a series of depressions in the rocky bottom from which several artifacts were retrieved, while a concretion containing fruit pits was found at the latter location. Only further study will tell us whether these impressions of fruits are related to the SJB2 wreck site.

A study of the artifacts related to the presumed wreck of *Nossa Senhora dos Mártires* was the subject of a master's thesis at Texas A&M University.[6] A complete catalog of the materials from the vicinity of São Julião da Barra sorted by sites and probable dates will certainly be undertaken in the next decade.

6

# Survey and Excavation

During the fall of 1993 and the spring of 1994, the Museu Nacional de Arqueologia and Arqueonáutica conducted a survey of the area below the fortress of São Julião da Barra under the direction of Francisco Alves. Two main areas of archaeological interest were identified. The first area—designated SJB1—consisted of a large concentration of anchors and iron guns, next to which many silver coins had been found during a previous survey conducted by amateur archaeologists in the late 1970s (fig. 6.1). The second area (SJB2) consisted of the remains of a wooden hull and associated shards of Ming porcelain and Chinese earthenware dating from the late sixteenth or early seventeenth century (fig. 6.2). Based on information from the Museu Nacional de Arqueologia's shipwreck archives, *Nossa Senhora dos Mártires* was identified as the most likely name for this wreck.

In 1993 the Portuguese government passed a law that allowed treasure hunting in Portuguese waters. Despite the scandal that arose almost immediately following the law's ratification—after the press made public a professional relationship between at least one adviser of the committee for the promotion of this decree and a known American treasure hunter—this law was not reversed until 1995, and was not repealed until 1997. All underwater archaeology projects were suspended during this period.

From 1993 to 1995 both the Museu Nacional de Arqueologia and Arqueonáutica spent significant time and energy promoting the cause of archaeology—mainly through courses offered around the country to sport divers, using the British Nautical Archaeology Society model—and attacking the

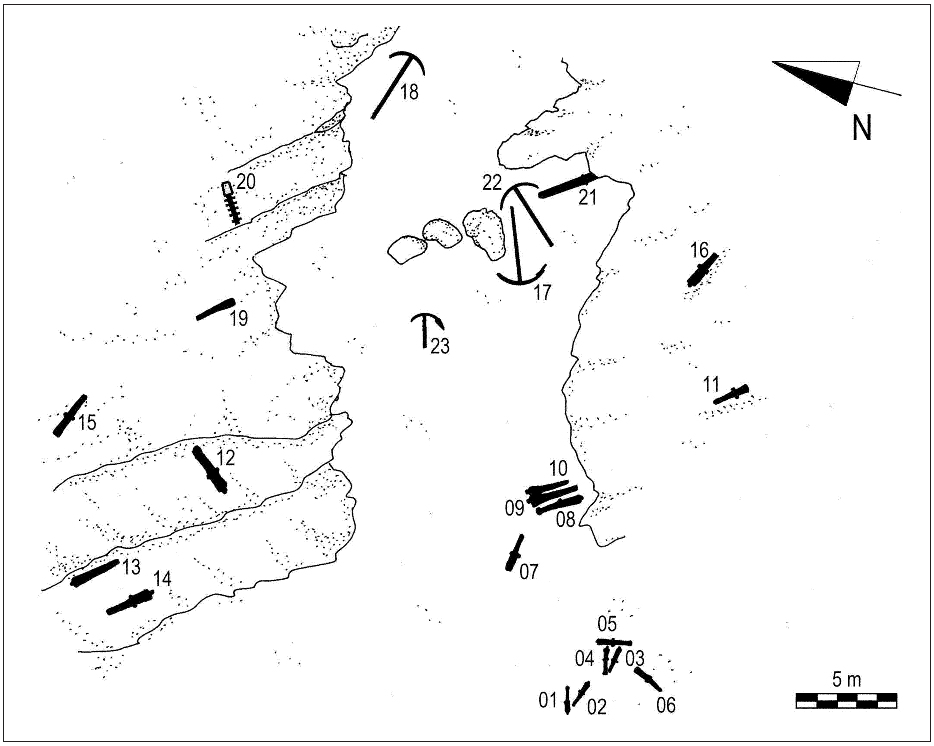



Fig. 6.1. Map of SJB1 after 2000 field season. (Drawing Filipe Castro, after 1994 F. Alves plan)

treasure hunting legislation through an information campaign in the press. As a result, this legislation was finally halted in 1995 before any permit was ever issued to the many treasure hunting companies that proposed to work in Portugal. The government decided to create an agency to deal with the problems of the underwater cultural heritage and the project of São Julião da Barra was selected as the anchor project for this agency. At EXPO '98, which was held in Lisbon, this project became the main subject of the Portuguese pavilion, making a clear statement from the Portuguese government against treasure hunting.

In 1996 and 1997 excavations were conducted on the SJB2 site under the direction of Francisco Alves and me, although I was hired only as a manager and an adviser to assist both the creation of the state agency for nautical archaeology and to manage the logistics. A manager was deemed necessary because the project was launched on a very tight schedule and in an environment of heavy bureaucracy with traditionally slow processing of information and documents.

The wooden hull was recorded, and an area of approximately 100 $m^2$ was

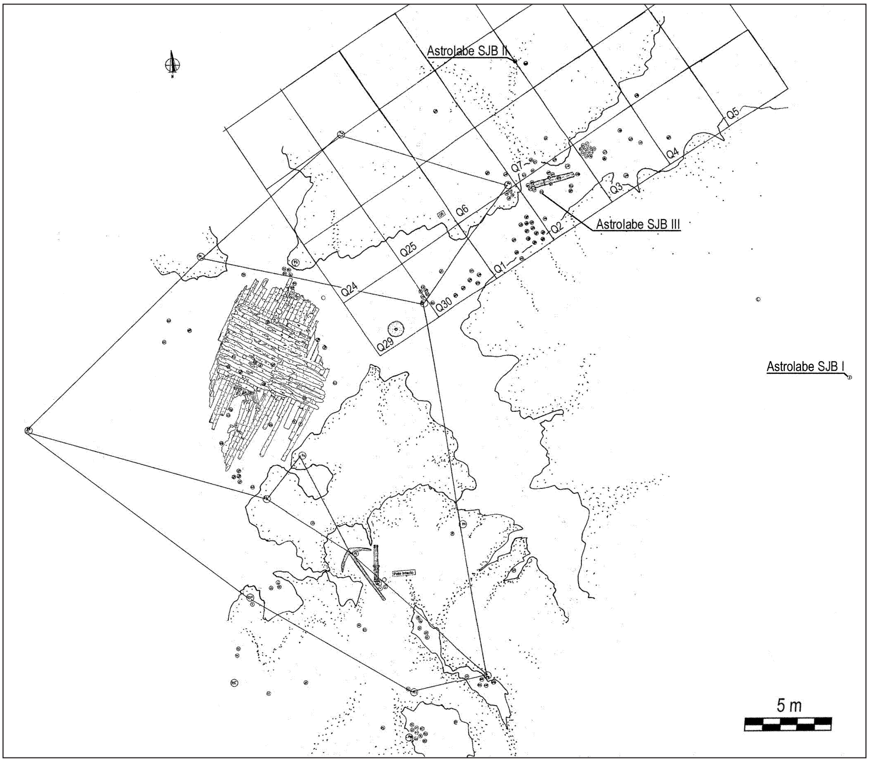



Fig. 6.2. Map of SJB2 after 2000 field season. (Drawing Filipe Castro, after 1998 CNANS plan)

excavated. Many artifacts were recovered from within an ubiquitous layer of peppercorns. These included three nautical astrolabes and two dividers, several sounding leads, as well as porcelain, stoneware, earthenware, brass, copper, pewter, silver, and gold objects. Among the organic materials many peach pits were recovered along with ropes, fabrics, leather and straw, the latter found between seven stacked porcelain dishes. Several of these artifacts were exhibited in the Portuguese pavilion at EXPO '98.

This archaeological site encompassed a large area strewn with lead straps and pottery shards over a layer of small pebbles and peppercorns. It was composed of the remains of a vessel—SJB2 or the Pepper Wreck—located approximately 200 m from the fortress of São Julião da Barra, at 9 m deep at high tide (fig. 6.3). The wooden structure was enclosed in a natural depression of the rocky bottom, sheltered by a small crest of rocks that extends north and west. A slight slope toward the south was filled by sediment. The remains of the hull rested on a layer of small pebbles with diameters between 8 and 15 cm and were

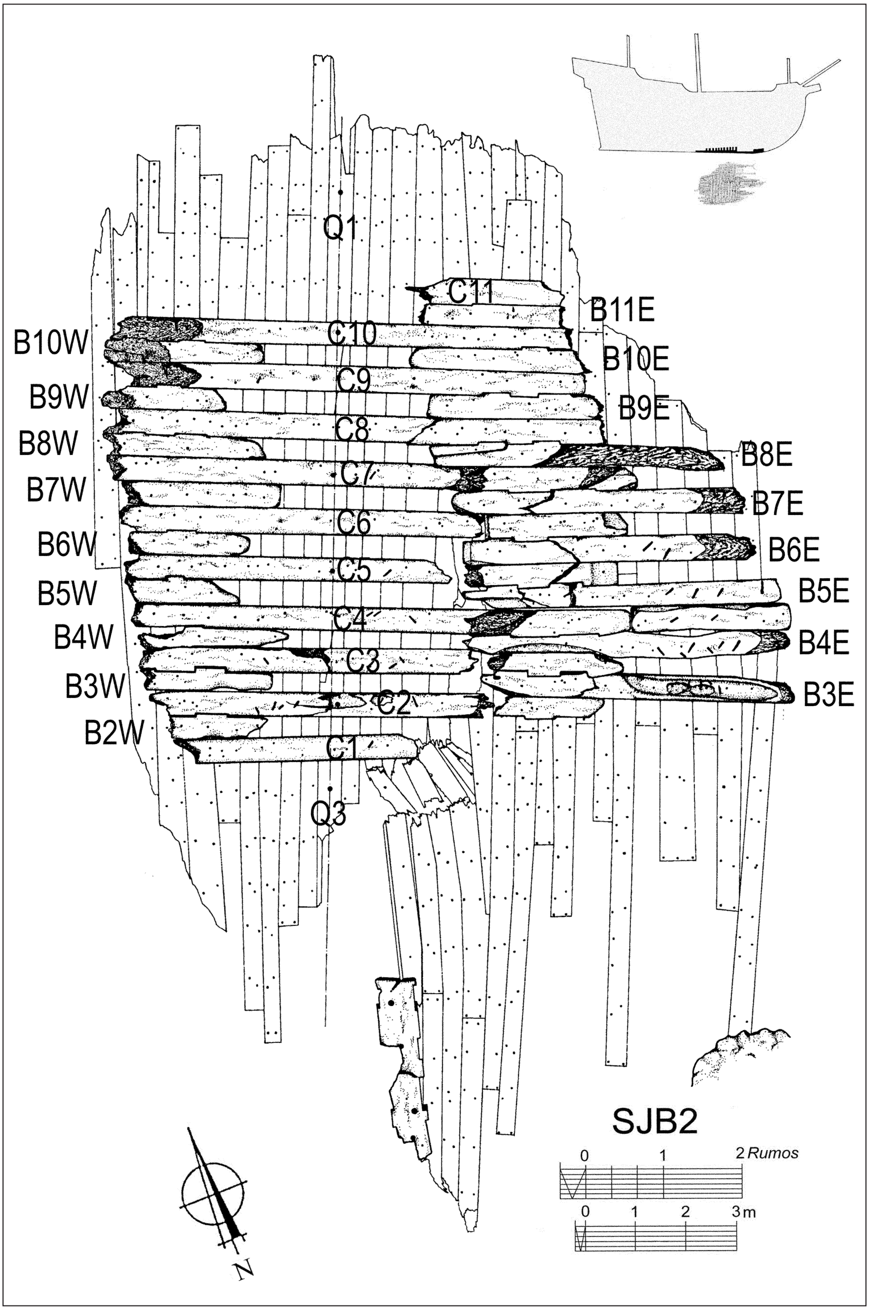



Fig. 6.3. Plan of the SJB2 hull after 1997 field season. (Drawing Filipe Castro, after CNANS plan)

embedded in a thick mire of peppercorns and pebbles with few artifacts. The planking was separated from the frames and rested on the bottom, molded to its shape rather than to the shape of the lower face of the frames, as we found when we took profiles of it.

In this zone the rocky bottom consists of highly fossiliferous limestone, dating from the Miocene. The surface of the rocky substratum shows abundant perforations due to small bivalves, whose shells are still preserved in most of the holes. This presumes that sometime before the wreck, this rocky outcrop was free from sediment long enough to allow the growth of colonies of barnacles and small bivalves, apparently of the same species that attacked the upper surface of the wreck's timbers. Above the rocky base there was a fairly constant and clear stratigraphy (table 6.1)

To the north of the hull a natural depression on the bottom followed the rocky outcrop that protected the wooden hull, and immediately suggested a perfect area for a trial excavation. The abundance of cultural materials found here determined the excavation of an area of around 100 $m^2$ that has produced an important collection of artifacts (fig. 6.4).

Among the most important were three astrolabes, of which two were found together with two dividers in an area of around 10 $m^2$. One of these astrolabes bore the date 1605 and the maker's mark of the famous Goes family workshop in Lisbon (see fig. 6.10). A stack of seven porcelain dishes, still with a layer of straw in between each, and an iron gun that accreted the shards missing from a large porcelain platter fragment found nearby, were among many

**TABLE 6.1. SJB2—STRATIGRAPHY**

| LAYER | THICKNESS | DESCRIPTION |
|---|---|---|
| A | Variable | Highly movable siliceous sand layer with variable thickness. Very rich in cultural materials but highly contaminated with garbage of several possible provenances, mostly related to sports and professional fishing: lines, hooks, lead weights, abandoned and lost traps, ropes, nets, bottles, cans, and so on. |
| B | 5–30 cm | Dark sediment with sand, littered with lead straps from the caulking of SJB2's hull. |
| C | 20–60 cm | Pebbles (mostly of limestone and basalt) with diameters between 4 and 15 cm, sometimes impregnated with peppercorns. In certain areas this layer was not contaminated and produced only shards dated from the time of the SJB2 wreck. |
| D | 5–30 cm | Coarse sand with organic materials, mostly pepper; reasonably stable and generally not contaminated with more recent cultural materials. This layer has produced some interesting and sometimes intact artifacts such as porcelain dishes. |
| E | 2–5 cm | Yellow sand, very fine and very compacted. Archaeologically sterile. |
| F | — | Rocky bottom of Miocene fossiliferous limestone, heavily altered in certain zones, presenting a clayish consistency. |

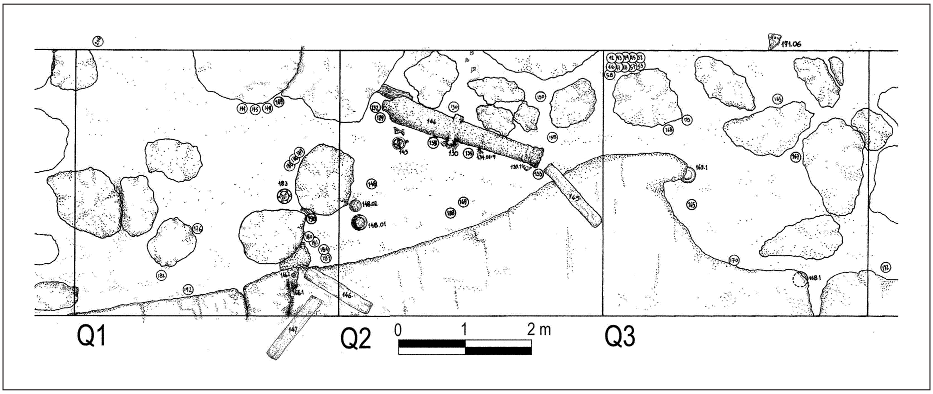



Fig. 6.4. Map of squares Q1 to Q3 from the SJB2 area excavated in 1996 and 1997. (Drawing Filipe Castro)

finds, including pewter plates, green and yellow Chinese glazed earthenware, Martaban stoneware, lead shot, and cannonballs.

To the south, the increasing thickness of the sediments also promised some interesting troves. However, a large number of grenades dating from between World War I and World War II were discovered concreted to the bedrock. The excavation of this area was suspended until a thorough investigation could be performed by navy divers. No one seemed to know how many, when, or why these grenades were deposited. At the end of the summer of 1997, a small number of grenades were detonated in situ by the navy. After the detonations a few "rocks" that had shown a metallic content when surveyed with a metal detector broke and proved to be large lumps of concretions, housing many artifacts, and possibly including rigging material. These were all left in situ, because we did not have the equipment to lift them properly or treat them in the laboratory. A curious piece of wood with an engraved monogram was found in the presumed area of the bow, where the deck boys would have lived and kept their meager possessions.

To the east was a rocky surface, slightly elevated, where Remigy de Halut's bronze gun had been found near a small anchor. A series of fissures crossing this outcrop were excavated to the depth of an arm, producing a considerable amount of pot shards, peppercorns, peach pits, and coconut shells. Here an interesting Japanese piece from the Momoyama period (1573–1603) was found, the *tsuba,* or hand guard, of a small saber made of a copper alloy (fig. 6.5)

To the west the very thin layer of sediments covering the rough terrain did not allow for many artifact finds. Under a thin covering of sand (layer A) was a layer of pebbles of unknown thickness (layer C) that was not excavated for lack of time. However, a small and thin strata of planking, heavily eaten by

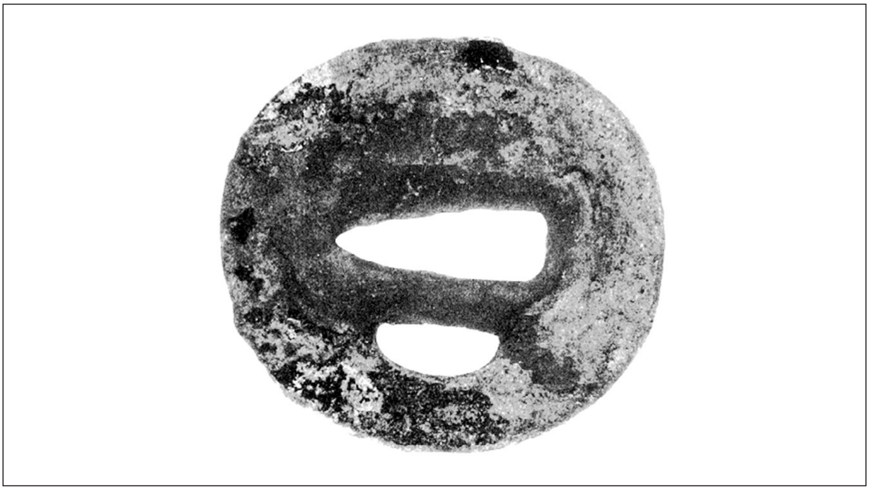


Fig. 6.5. Japanese *tsuba.* (Photo Pedro Gonçalves, CNANS; used with permission of CNANS)

wood worms, of 2.5 m by 1 m was atop layer C. Again, this section of the hull was not fully exposed for lack of time.

Altogether four areas were excavated during the 1996–97 field season. The wooden hull, covering around 80 $m^2$; the north area, covering around 100$m^2$; the east area fissures, covering another 100 $m^2$; and a small portion of the southern area, covering less than 50 $m^2$.

The conditions surrounding the project were quite complicated. The wreck site, situated at the entrance of the Lisbon harbor, is a military zone, requiring a permit from the harbor authority and another from the navy. Unfortunately, the permits were slow in coming and we began in late October, 1996, instead of early July.

Sea conditions are difficult in the winter, with low visibility and strong tides. Also, we could only work during the ebb tide periods because of the strong and dangerous currents. This meant we had to adjust the work schedule each day, many times getting out of bed early and out of the water late in the day. The team was quickly exhausted by the schedule and demanding conditions. The accessibility of the site was another problem. Every day we had to pack our equipment in one pickup truck and two or three private cars and drive to the navy dock in Paço d'Arcos, which took thirty and forty-five minutes in the winter and around one hour in the summer. Then we had to unload the equipment and pile all the tanks, pumps, and pipes into three small boats. Finally we had to sail down the Tagus to the wreck site, another thirty minutes, position our four large buoys in the corners of the working area, and

Fig. 6.6. The first days of work at São Julião da Barra in 1996. (Photo Francisco Alves, CNANS; used with permission of CNANS)

set all the water dredges and airlifts in place before we started working. No equipment could be left on the bottom, not only because of the swell and current but also because our buoys and cables, much coveted by fishermen and sport divers, would disappear overnight if left on site.

Although the team was given one or two days' rest every week, determined by the hours of the tides and the conditions of the sea, the directors had no choice but to work all week. In the summer of 1997 the conditions and the workload were improved as a result of the participation of many sport divers, some of whom were highly skilled and could be given tasks to perform with minimal supervision.

A grid of datum points was first established on the site using climbing spikes driven into the rocks. These points were then numbered and connected with cables. The positions of the hull and the artifacts were referenced to this grid by triangulation. Additional objects and topographic features were positioned in relation to at least two datum points. All artifacts and lots were numbered, photographed, positioned, and marked on a general plan at the end of each day of diving. As we analyze this information, we are finding many flaws, both because of the inexperience of the great majority of the team and because of the hectic pace required by time constraints imposed by the needs of the Portuguese pavilion at EXPO '98. In spite of a few small mistakes, the map of the site produced over these two years is quite accurate although incomplete in recording the details of certain bottom characteristics, such as the limits of the rocky outcrops, the depth of the crevices, or the thickness of the sediments on several points.

The hull was fully recorded at 1 : 1 scale on Plexiglas slates of 1 m by 50 cm and the drawings later transferred to plastic sheets and reduced in a photocopier to 1 : 10 scale. This was an intensive, complicated, and inaccurate process due to the many different projections obtained and the inevitable parallax errors involved. In addition, the violent surge tended to tear the Plexiglas slates and throw them around with the divers many times during every dive. However, many additional measurements were taken, and the plan was eventually corrected to a good standard of accuracy.

During the 1999 and 2000 field seasons some of the timbers were raised and drawn in a dry environment (fig. 6.7). This allowed us to verify a large part of the plan that proved to be accurate and reliable, with small mistakes and parallax of less than 1 percent of the overall dimensions. The only important deformations were due to the horizontal projection obtained in the drawing, in the longitudinal direction, the direction of the slope, where the planks were generally shorter than what would be expected. These errors were consistently found to be less than 2 percent.

The 1999 excavation season lasted two months. The first month entailed intense underwater work to record important construction details and to raise most of the remaining structure. Unfortunately since the 1997 excavation season the wood remains were heavily damaged by rough sea conditions. Most of the second month was spent recording the timbers and preparing an exhibition of the artifact collection for Lisbon's Naval Museum. The 2000 excavation season consisted primarily of the recovery of the planking that had been wrapped and stored the previous year. Then followed a period of recording all timbers at 1 : 10 scale and many at 1 : 1 scale. The last weeks of the 2000 season were spent surveying newly reported sites and inquiring about the location of artifacts known to exist in private collections. Finally, the remains of the hull were covered with sand bags and sand, and the raised timbers stored in the warehouse of the Centro Nacional de Arqueologia Náutica e Subaquática (CNANS) in Belém.

The SJB2 wreck site is located within an archaeological complex, a relatively small stretch of sea bottom containing several shipwrecks. The strong dynamics of the sea and annual shift of sediments have combined to mix the artifacts of several wrecks, making this site at once an interesting and rich ship graveyard and a true nightmare for archaeologists. The material culture represented in the collection of artifacts from this site encompasses a period of more than 350 years.

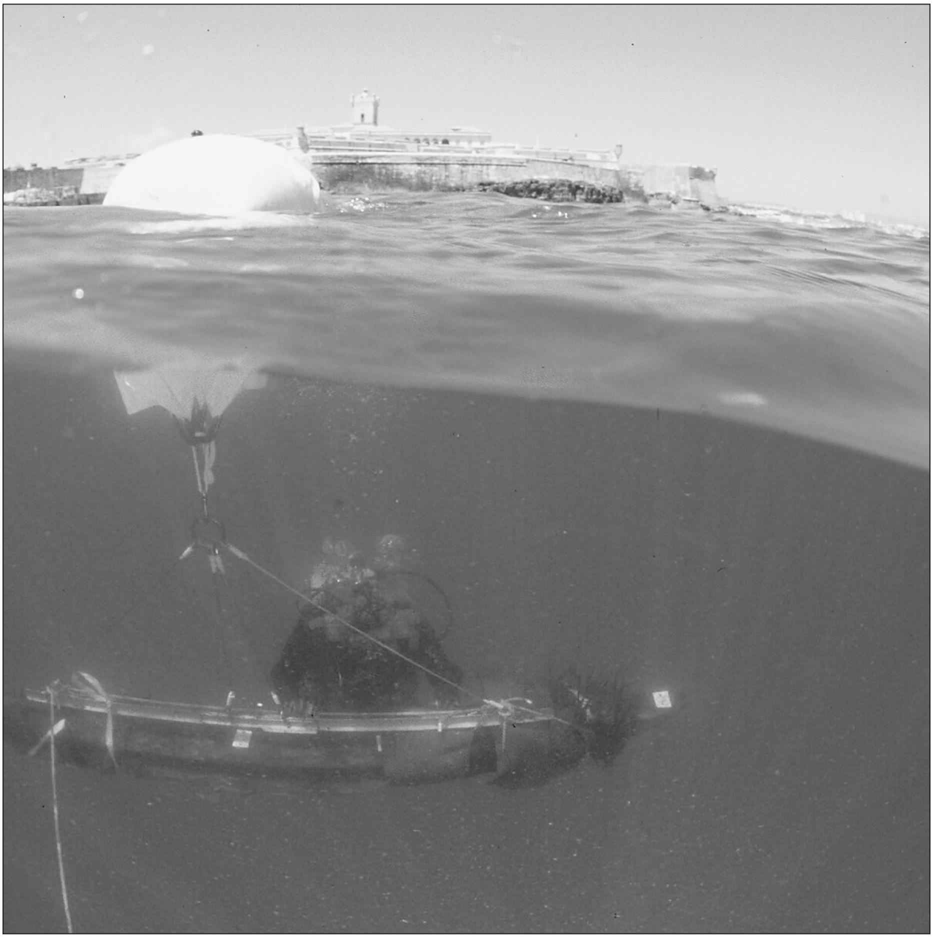


Fig. 6.7. Raising timbers during the 1999 field season. (Photo Guilherme Garcia, CNANS; used with permission of CNANS)

That the wreck at this site is undoubtedly the *Nossa Senhora dos Mártires* cannot be stated with complete confidence. However, there is no other record of an Indiaman wrecked against the rocks of the São Julião da Barra promontory, and it is hard to imagine that a ship so large and richly laden could be lost in such a prominent spot and recorded as being lost somewhere else.

According to a database generated by CNANS many wrecks were lost at the mouth of the Tagus, a general designation that encompasses an extensive area. Fortunately, the area of the fortress of São Julião da Barra is small, well defined, and has a precise toponymy; most vessels lost here are specifically referred to in official documents as being lost off the fort, rather than at another,

**TABLE 6.2. WRECKS IN SÃO JULIÃO DA BARRA**

| YEAR | SHIP | NATIONALITY | WRECK SITE |
|---|---|---|---|
| 1587 | *San Juan Baptista* | Spanish | Near the fortress |
| 1594 | Galleon | Portuguese | Near the fortress |
| 1606 | *Nossa Senhora dos Mártires* | Portuguese | Near the fortress |
| 1669 | *Saint Charles* | French | Near the fortress |
| 1733 | *Union* | French | Near the fortress |
| 1753 | Unknown merchantman | Dutch | Presumably east of the fortress |
| 1783 | *Nossa Senhora da Conceição Africana* | Portuguese | Beach of São Julião da Barra |
| 1802 | Unknown ship | English | Near the fortress |
| 1824 | Local craft | Portuguese | Near the fortress |
| 1867 | *Oletim* (brig) | Danish | Near the fortress |
| 1870 | *Aliança* (patacho) | Portuguese | Near the fortress |
| WWI | *Maria Eduarda* | Portuguese | Presumably west of the fortress |
| 1917 | *Porto Alexandre* (steamship) | Portuguese | Near the fortress |
| 1966 | *Santa Mafalda* | Portuguese | Near the fortress |

*Source:* CNANS Database.

less precise designation. The records often correspond with and explain the provenance of artifacts retrieved or located near São Julião da Barra.

These known wrecks date from the late sixteenth century to the middle twentieth century. But no database of shipwrecks is ever complete, and there are so many references to shipwrecks in the area of the Tagus mouth, that I have divided the collected data into two major groups.

The first group—with 15 references—encompasses all wrecks registered as having been lost around the fortress of São Julião da Barra. This is a small group, but references suggest that all these shipwrecks have a very strong probability of having occurred around the fortress (table 6.2). The second group—with 116 references—is referred to as having been lost in the area of the Tagus mouth, sometimes also referred to as the Cachopos, a vague designation that applies to the two rocky formations situated at the mouth of the river that create the two channels leading to Lisbon harbor. The small Cachopo Norte stands between the northern and southern channel, and the large and very silted Cachopo Sul limits the southern channel. The wrecks listed in this group have occurred in the wide area of the Tagus mouth, which may sometimes include the estuary, but have a small probability of having occurred close to São Julião da Barra. They are referred to in the documents as "leaving Lisbon," in the "Lisbon sandbar," in the "Tagus sandbar," or on the "coast of Cascais," which encompasses the stretch of coast from Cascais to São Julião da Barra, including the area around the fortress. For the more recent wrecks, I have also included other references to the local toponymy whenever mentioned, such as "Bugio," "Ponta da Rana," or others (table 6.3).

**TABLE 6.3. WRECKS IN OR NEAR THE TAGUS MOUTH (1147–1936)**

| YEAR | NAME OR TYPE OF VESSEL | PROVENENCE | WRECK SITE |
|---|---|---|---|
| 1147 | Various small local boats | Portuguese | Tagus |
| 1370 | Various local vessels | Portuguese | On the coast of Cascais |
| 1451 | Caravel | Portuguese | Cachopos |
| 1456 | Caravel of Luis de Faria | Portuguese | Cachopos |
| 1505 | Nau | Portuguese | Lisbon |
| 1519 | *Santo Antonio* | Portuguese | Tagus mouth |
| 1525 | *São Vicente* | Portuguese | Tagus mouth |
| 1526 | *Flor de la Mar* | Spanish | Tagus mouth |
| 1526 | *Paraíso* | Portuguese | Tagus mouth |
| 1550 | Ship | Spanish | Tagus mouth |
| 1561 | *Nuestra Señora de la Merced* | Spanish | Tagus mouth |
| 1564 | *San Juán* | Spanish | Tagus mouth / Cachopos |
| 1594 | Galleon | Spanish | Tagus mouth |
| 16?? | *Neptune Français* | French | Tagus mouth |
| 1603 | *N. S. de la Candelaria* | Spanish | Lisbon |
| 1604 | *S. Francisco* | Spanish | Lisbon |
| 1606 | *Nuestra Señora del Rosario* | Spanish | Tagus mouth / Cachopos |
| 1610 | *N.ª S.ª do Livramento* | Portuguese | Tagus mouth / Bugio |
| 1615 | Caravel | Portuguese | Tagus mouth |
| 1618 | *Las Angústias* | Spanish | Tagus mouth |
| 1620 | *São João Baptista* | Portuguese | Tagus mouth |
| 1625 | *São Francisco Xavier* | Portuguese | Tagus mouth / Bugio |
| 1633 | *Santo Inácio de Loiola* | Portuguese | Tagus mouth |
| 1667 | Caravel | Portuguese | On the coast of Cascais |
| 1673 | *Dauphin Couronné* | French | Tagus mouth |
| 1674 | Barca | Portuguese | Tagus mouth |
| 1691 | Merchantman | Portuguese | Tagus mouth |
| 1697 | *Le Chasseur* | French | Tagus mouth |
| 1697 | *St. Pierre* | French | Tagus mouth |
| 1699 | *La Hardie* | French | On the coast of Cascais |
| 17?? | *Marcelina* (muleta) | Portuguese | Tagus mouth |
| 1700 | *Le Marquis* | French | Tagus mouth |
| 1700 | Ship | Unknown | Tagus mouth / Cachopos |
| 1704 | *Santa Teresa* | Portuguese | Tagus mouth |
| 1708 | 2 naus | Portuguese | Tagus mouth |
| 1715 | Ship | English | Tagus mouth |
| 1716 | Ship | English | Tagus mouth / Cachopos |
| 1717 | Ship | English | Tagus mouth |
| 1719 | *English Crown* | English | Tagus mouth |
| 1720 | *A Chata* | Portuguese | Tagus mouth |
| 1720 | *Rio Real* | Portuguese | Tagus mouth |
| 1720 | *São Frutoso* | Portuguese | Tagus mouth |
| 1733 | Ship | Portuguese | Tagus mouth / Cachopos |
| 1733 | Ship | Portuguese | Tagus mouth / Cachopos |
| 1735 | *La Gaillarde* | French | Tagus mouth / Bugio |
| 1736 | *Toussaint* | French | Tagus mouth |
| 1742 | Merchantman | English | Tagus mouth |
| 1742 | *Saint Christophe* | French | Tagus mouth |
| 1747 | *L'Amitié* | French | Tagus mouth |
| 1747 | Paquebot | English | Tagus mouth |

**TABLE 6.3. (CONTINUED)**

| YEAR | NAME OR TYPE OF VESSEL | PROVENENCE | WRECK SITE |
|---|---|---|---|
| 1756 | *Gasparinho* | Portuguese | Tagus mouth |
| 1756 | *A Serrada* | Portuguese | Tagus mouth |
| 1772 | Ship | Danish | Tagus mouth |
| 1776 | *Aniceta* | Portuguese | Tagus mouth |
| 1779 | Ship | American | Tagus mouth / Cachopos |
| 1783 | Ship | Danish | On the rocks of Cascais |
| 1783 | Various vessels | Portuguese | On the rocks of Cascais |
| 1784 | Ship | Unknown | Tagus mouth |
| 1786 | Ship | English | Tagus mouth |
| 1786 | 2 muletas | Local craft | Tagus mouth |
| 1790 | Patacho | Local craft | Tagus mouth / Cachopos |
| 1796 | *Bombay Castle* | English | Tagus mouth / Bugio |
| 1796 | Ship | English | Tagus mouth |
| 1798 | *Kingfisher* | Unknown | Tagus mouth |
| 1800 | Various small lcoal vessels | Portuguese | Tagus mouth |
| 1800 | *Weymouth* | English | Tagus mouth |
| 1809 | Vessel | Portuguese | Coast of Cascais |
| 1814 | *Neptune* | English | Tagus mouth |
| 1815 | Ship | English | Tagus mouth |
| 1829 | *Jane* | English | Tagus mouth |
| 1834 | *Portuense* | Portuguese | Tagus mouth |
| 1854 | Brig | English | Tagus mouth |
| 1855 | *Bristol* (brig) | English | Tagus mouth / Cachopo Sul |
| 1855 | *Flor do Mar* | Portuguese | Tagus mouth / Ponta da Rana |
| 1856 | *Cruz Segunda* | Portuguese | Tagus mouth / Carcavelos |
| 1856 | Fishing boat | Portuguese | Tagus mouth |
| 1856 | *Howard Primerose* | English | Tagus mouth |
| 1856 | *Triumpho do Porto* | Portuguese | Tagus mouth |
| 1857 | *Herdel* | German | Tagus mouth / Cachopo Norte |
| 1858 | *British Queen* | English | Tagus mouth |
| 1858 | *Stéphanie* (brig) | French | Tagus mouth / Bugio |
| 1859 | *Alysa* | Portuguese | Tagus mouth / Carcavelos |
| 1860 | *Lady Suffolk* | American | Coast of Cascais |
| 1860 | 3 local fishing vessels | Portugeuse | Tagus mouth |
| 1860 | Local fishing vessel | Portugeuse | Tagus mouth |
| 1861 | *Almirante do Porto* | Portuguese | Tagus mouth |
| 1861 | *Nea Angélica* | Greek | Tagus mouth |
| 1861 | *Vricudshap* | Dutch | Tagus mouth / Cachopos |
| 1863 | *Alfredo* | Portuguese | Tagus mouth / Bugio |
| 1864 | *Else* | Swedish | Tagus mouth / Oeiras |
| 1866 | *Northcote* | Norwegian | Tagus mouth |
| 1868 | *Hamburgo* (steamship) | Spanish | Tagus mouth / Ponta da Rana |
| 1868 | *Margarida* | Portuguese | Tagus mouth |
| 1869 | *Boa Esperança* | Portuguese | Tagus mouth / Ponta da Rana |
| 1870 | Fishing vessel | Portuguese | Tagus mouth |
| 1870 | Local muleta | Portuguese | Tagus mouth / Ponta da Rana |
| 1872 | *Izolina* (schnooner) | Portuguese | Tagus mouth / Parede |
| 1872 | Schooner | English | Tagus mouth / Bugio |
| 1873 | *Bismark* | Portuguese | Tagus mouth |

(*continued*)

**TABLE 6.3. (CONTINUED)**

| YEAR | NAME OR TYPE OF VESSEL | PROVENENCE | WRECK SITE |
|---|---|---|---|
| 1876 | Steamship *Wodham* | English | Tagus mouth/Bugio |
| 1878 | Fishing vessel | Portuguese | Tagus mouth/Bugio |
| 1880 | *Marta Wilhelmine* (schooner) | German | Tagus mouth/Bugio |
| 1880 | *Ulysses* | English | Tagus mouth |
| 1881 | Local fishing vessel | Portuguese | Tagus mouth |
| 1885 | *Lusitânia* | Portuguese | Tagus mouth/Bugio |
| 1892 | *Guadiana* | Portuguese | Tagus mouth/S.J. do Estoril |
| 1904 | *Conseil Frères* (steamship) | French | Tagus mouth/Ponta da Rana |
| 1905 | *Lisboa* (steamship) | German | Tagus mouth |
| 1914 | *Arrábida* | Portuguese | Tagus mouth/Ponta da Rana |
| 1916 | *Novo Bonfim* | Portuguese | Tagus mouth/Bugio |
| 1918 | *David Mori* | English | Tagus mouth |
| 1918 | *Vila Franca* | Portuguese | Tagus mouth |
| 1924 | *Pacífico* | Portuguese | Tagus mouth/Parede |
| 1926 | *Maria Augusta* | Portuguese | Tagus mouth/Ponta da Rana |
| 1936 | *Patrão Lopes* | Portuguese | Tagus mouth/Bugio |
| 1936 | *Santa Clara* | Portuguese | Tagus mouth/Bugio |

*Source:* CNANS Database.

Based on the most probable dates of the artifacts it seems reasonable that the Pepper Wreck has only four possible candidates for its identity. The first is *Nossa Senhora dos Mártires* of 1606. The three other candidates are the Spanish nau *San Juan Baptista* wrecked in 1587, an unidentified Portuguese galleon wrecked in 1594, and the French vessel *Saint Charles* lost in 1669.

The clues leading to the tentative identification of the SJB2 wreck as the 1606 *Nossa Senhora dos Mártires* can be clustered in three main categories. First, the artifacts found on this site match the expected period, around the turn of the century and not before 1605. Second, the materials employed in the construction of this vessel match those expected for an India route nau.[1] Third, the relation between the dimensions of the timbers match both the units and the construction methods in use at the Portuguese shipyards around the turn of the sixteenth century.

The bronze culverin was founded by Remigy de Halut, head of the Flemish foundry at Malines, today's Mechelen, between 1536 and 1568 (fig. 6.8). These dates do not exclude any of the possibilities, from 1587 to 1669, for old bronze guns have been found in many wrecks. The porcelains belong to the Wan-Li period (1572–1620) and have been dated to 1595 to 1600 based on the typologies of the cartouches, rims, and cavettos displayed on the whole vessels and fragments (fig. 6.9).[2] These typologies were subject to changes in fashion and therefore allow a more exact dating interval, specifically around 1606.

The three astrolabes, two of which (São Julião da Barra II and III) were found together with two dividers, pottery, and pewter plates, proved to be


Fig. 6.8. Text incised on the base ring of bronze culverin. (Photo Pedro Gonçalves, CNANS; used with permission of CNANS)

quite interesting. Once we had identified which portion of the hull was preserved, they were found precisely abaft the ship's master frames, on the starboard side, the area where we would expect to find the quarters of the pilots on the gun deck. The third astrolabe to be found (São Julião da Barra III) bears the date 1605, the year *Nossa Senhora dos Mártires* left Lisbon (fig. 6.10).

Other, less precisely dated artifacts, agree with an Asian origin for the SJB2 vessel, excluding both the Spanish nau *San Juan Baptista* wrecked in 1587, as it was leaving Lisbon, and the unidentified Portuguese galleon wrecked in 1594, which was also lost on its way out. Three Chinese brown stoneware pots were found on the site, together with countless shards of the same kind (fig. 6.11). Also of Chinese origin were the green and yellow glazed earthenware shards (fig. 6.12) and the blue and white Wan-Li shards (fig. 6.13).

From Martaban, in today's Burma, came the many stoneware shards with the characteristic dots imitating the rivets of copper pots. Finally, some shards of Japanese pots were found among the wreckage. And we should not forget the Japanese saber *tsuba,* which is tempting to identify with Miguel, the young Japanese who was coming to Portugal in the company of Father Francisco Rodrigues (fig. 6.5).


Fig. 6.9. Porcelain dish from SJB2. (Photo Pedro Gonçalves, CNANS; used with permission of CNANS)

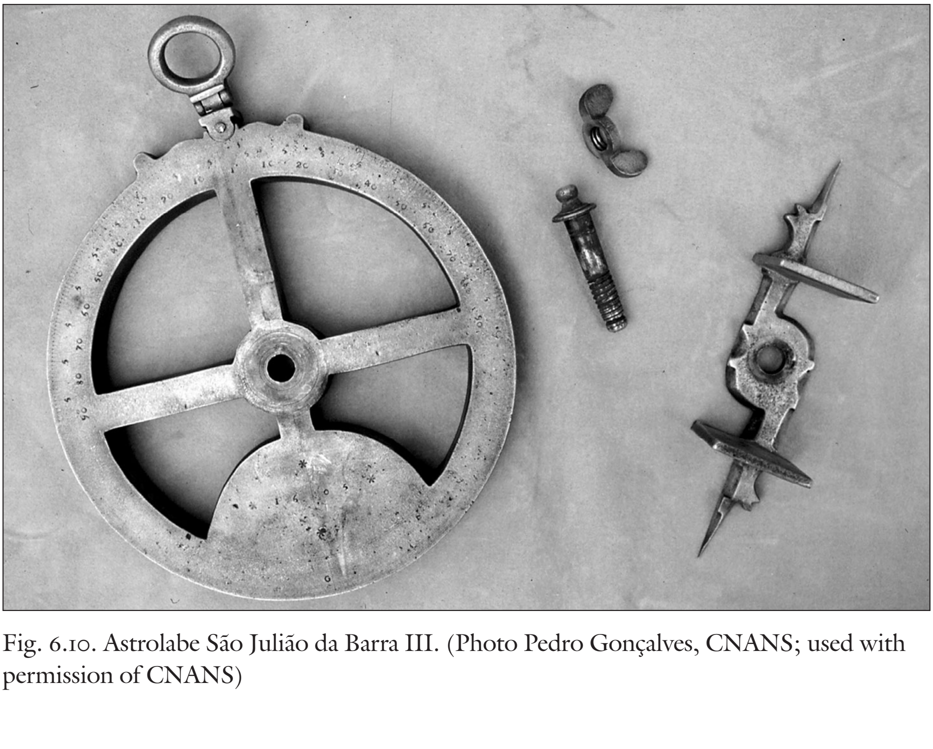


Fig. 6.10. Astrolabe São Julião da Barra III. (Photo Pedro Gonçalves, CNANS; used with permission of CNANS)

Fig. 6.11. Chinese stoneware pots from SJB2. (Photo José Pessoa, CNANS; used with permission of CNANS)

Fig. 6.12. Chinese glazed green and yellow earthenware pot from SJB2. (Photo José Pessoa, CNANS; used with permission of CNANS)

Fig. 6.13. Chinese porcelain from SJB2. (Photo Pedro Gonçalves, CNANS; used with permission of CNANS)

The remains of the ship itself suggest a Portuguese origin, ruling out both the Spanish nau *San Juan Baptista* and the French vessel *Saint Charles*. This nau was built of cork oak (*Quercus suber*) and umbrella pine (*Pinus pinea*), and fastened with iron nails, typical Portuguese materials of the time, and not of any other kinds of European oak, as would be expected from the Spanish and French vessels. Furthermore, it was caulked with a string of lead in each seam, a practice dupicated in the Portuguese Indiaman of the late sixteenth century found in the Seychelles and presumed to be the *Santo António* wrecked in 1589.[3]

More construction-related clues point in this direction, but these can only be fully understood when we analyze the remains of this hull in depth.

# 7

# Hull Description

Two features are immediately apparent when this hull is examined: the scantlings are impressively large, and the wood used is of poor quality. This large structure was built with timbers that were small for the needs of the shipwright. All structural pieces were cut from relatively small cork oaks (*Quercus suber*), the species believed by Portuguese shipwrights to be most suitable for the construction of large ships. In contrast, all the hull planks were cut from fairly large umbrella pines (*Pinus pinea*), likewise thought to be the best material for planking these vessels.

The preserved portion of the hull was essentially flat at its north end, and the frames—floors and futtocks—rose and narrowed gradually toward the south. For this reason, the remains seemed almost immediately to correspond to the central part of the bottom of the ship and are now believed to be situated immediately forward of the master frames. The ship was better preserved on one of its sides—the east, presumably portside—due to the morphology of the sea bottom (fig. 7.1).

A longitudinal fracture exists on this side, along a line inboard of the overlapping connections of the floors and futtocks, which were recessed down along the seabed and survived to an extent of several meters (fig. 7.2).

At the south (forward) end of the hull, the strakes were completely splintered along a fracture zone also related to the morphology of the bottom. No remains of the stem were found.

The wooden remains occupied an area of about 50 $m^2$, with a preserved length of 12 m in longitudinal axis and a maximum preserved breadth of about

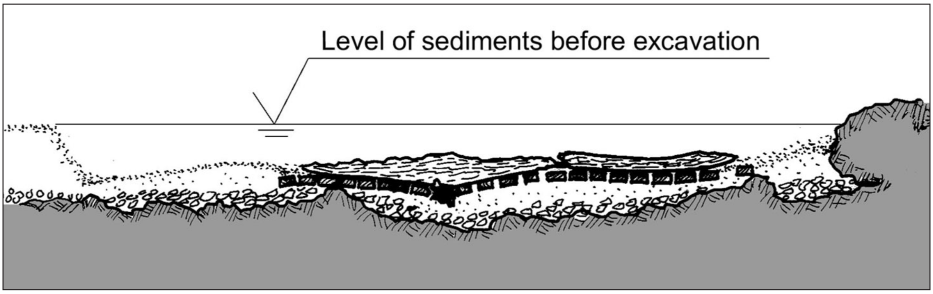



Fig. 7.1. Schematic section of the Pepper Wreck. (Drawing Filipe Castro)

**TABLE 7.1. TIMBERS AT SBJ2 FOUND IN SITU (1996)**

| DESIGNATION | SECTION | NUMBER AND REFERENCE OF TIMBERS | WOOD |
|---|---|---|---|
| Keel | Sided: 25 cm; molded: unknown | 4: Q0 and Q1–Q3[a] | Cork oak (*Quercus suber*) |
| Apron | Sided: 38 cm molded: 25 cm | 1: E1 | Cork oak (*Quercus suber*) |
| Floors | Sided: 23–25 cm Molded: 23–24 cm | 11: C1–C11 | Cork oak (*Quercus suber*) |
| Futtocks | Sided: 21–25 cm molded: 23–24 cm | 18: B2W–B10W; B3E–C11E | Cork oak (*Quercus suber*) |
| Reinforcement | Sided: 24 cm molded: 24 cm | 1: A4E | Cork oak (*Quercus suber*) |
| Planking | Sided: 15–35 cm molded: 11 cm | — | Umbrella pine (*Pinus pinea*) |

[a] Q0 is the first section of the keel.
Q1 is the second section of the keel.

7 m. This corresponds roughly to two-fifths of the estimated original length of the keel and approximately the width of the flat of the floors, plus one-third of the extension of the frames to the main deck. The excavated portion of the hull consisted only of the keel, an apron, eleven frames, and twenty-six strakes of hull planking (table 7.1). A dark-colored silt layer impregnated with peppercorns filled the spaces between the floor timbers and extended over a large area around the hull, constituting a well-defined archaeological layer with a thickness varying between 3–4 cm and 20–25 cm.

No traces of the keelson, footwales or ceiling were found on the site, undoubtedly due to the combined actions of the salvers, the shipworms, and the strong winter storms that occur annually. Our crew learned firsthand just how violent the dynamics of this bottom can be—even on relatively sheltered portions of the hull. Toward the end of the 1997 season, before the hull had been reburied, a southern gale covered the wreck with more than a meter of sand, making it impossible to reexpose the wreck and cover the structure with a

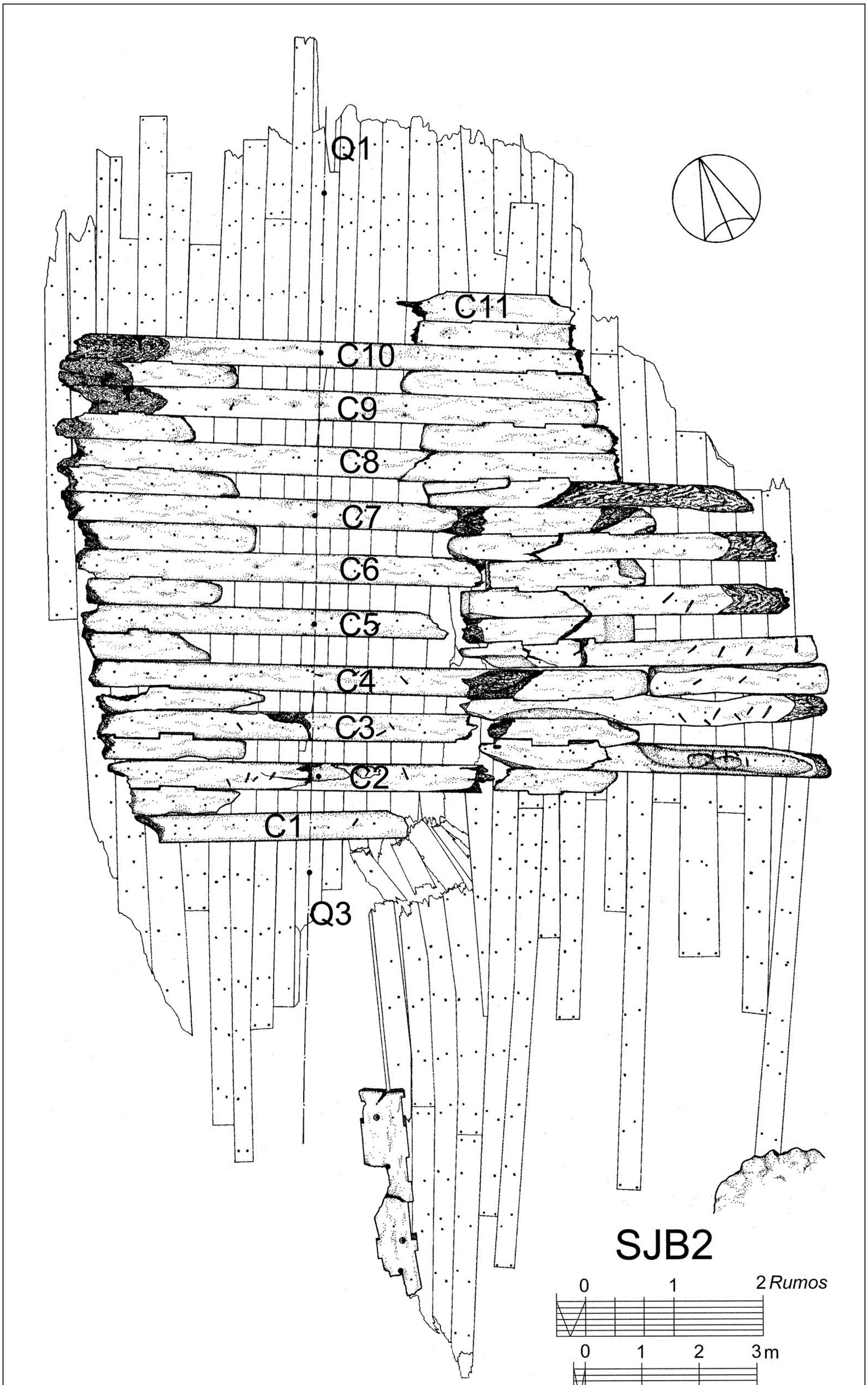



Fig. 7.2. Plan of the hull after 2000 field season. (Drawing Filipe Castro)

**TABLE 7.2. STATUS OF TIMBERS AT SBJ2 AFTER 2000 FIELD SEASON**

| DESIGNATION | STATUS |
|---|---|
| Keel | Q0 recovered in 1997 |
| | Q1, Q2, and Q3 recovered in 1999 |
| Apron | E1 recovered in 1997 |
| Floors | C1 lost during the field season of 1996 |
| | C2 and C3 recovered in 1997 |
| | East parts of C4, C5, C6, and C7 recovered in 1999 |
| | West parts of C4, C5, C6, and C7 lost between 1997 and 1999 |
| | C8, C9, C10, and C11 lost between 1997 and 1999 |
| Futtocks | B2W, B3W, and B3E recovered in 1997 |
| | B4E, B5E, B6E, B7E, and B8E recovered in 1999 |
| | B4W–B10W and B9E–B11E lost between 1997 and 1999 |
| Planking | 1 plank recovered in 1997 (T11W) |
| | 4 planks recovered in 1999 (T1W[1], T1W[2], T2W[2], and T8W) |
| | 2 planks lost between 1997 and 1999 (T9W and T10W) |
| | 6 planks recovered in 2000 (T1W[3], T2W[1], T3W, T4W, T5W, T6W) |
| | An undetermined number of planks remain in situ |

protective layer of sand bags, before reburying it. During inspection the following summer, the timbers were found to be stable and were still covered with a thick layer of sand. However, the following winter, strong currents exposed the timbers, and the winter swells destroyed part of them, tearing away several floors and depositing them several hundred yards away (table 7.2).

## Keel

The lower portions of the surviving keel timbers were badly eroded as a consequence of repeated abrasion against the rocky bottom during the wrecking. The keel's section measures 25 cm sided along the three portions preserved and shows a maximum molded dimension of 20 cm (fig. 7.3). The rabbets maintain a constant angle of 23° and an average depth of around 4.5 cm, occupying the upper part of the keel along 11 cm of its molded dimension.

As the keel shattered against the rocky bottom, two spikes and three of the bolts connecting the floors and the keelson to the keel were bent and preserved as imprints or concretions on the lower surface of the keel (fig. 7.4). Since these bolts exhibited different lengths as measured from the upper surface of the keel, they were presumably either pushed in or pulled out when the keel struck the bottom. It appears that two of the bolts were pushed inward, resulting in lengths of 19 and 29 cm (measured from the upper surface of the keel) and that the third bolt may have been pulled out after the keelson broke loose, as it has a length of 46 cm, too long in relation to the remaining scantlings (table 7.3). In any case it seems fair to assume that the keel's molded dimension was between 29 and 46 cm.

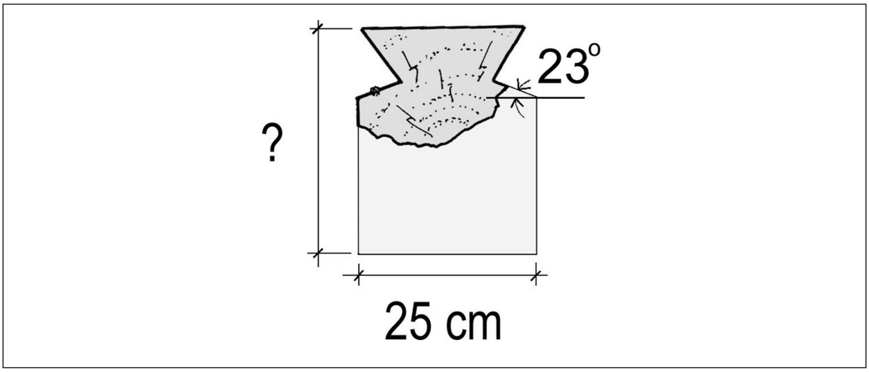



Fig. 7.3. Best preserved section of the keel. (Drawing Filipe Castro)


Fig. 7.4. Bolt linking keel to keelson at frame C7 (V). (Drawing Filipe Castro)

**TABLE 7.3. BOLTS CONNECTING KEEL TO KEELSON PRESERVED**

| KEEL TIMBER | FLOOR | LENGTH PRESERVED |
|---|---|---|
| Q1 | C10 (II) | 29 cm |
| Q2 | C7 (V) | 46 cm |
| Q3 | C0 (XII) | 19 cm |

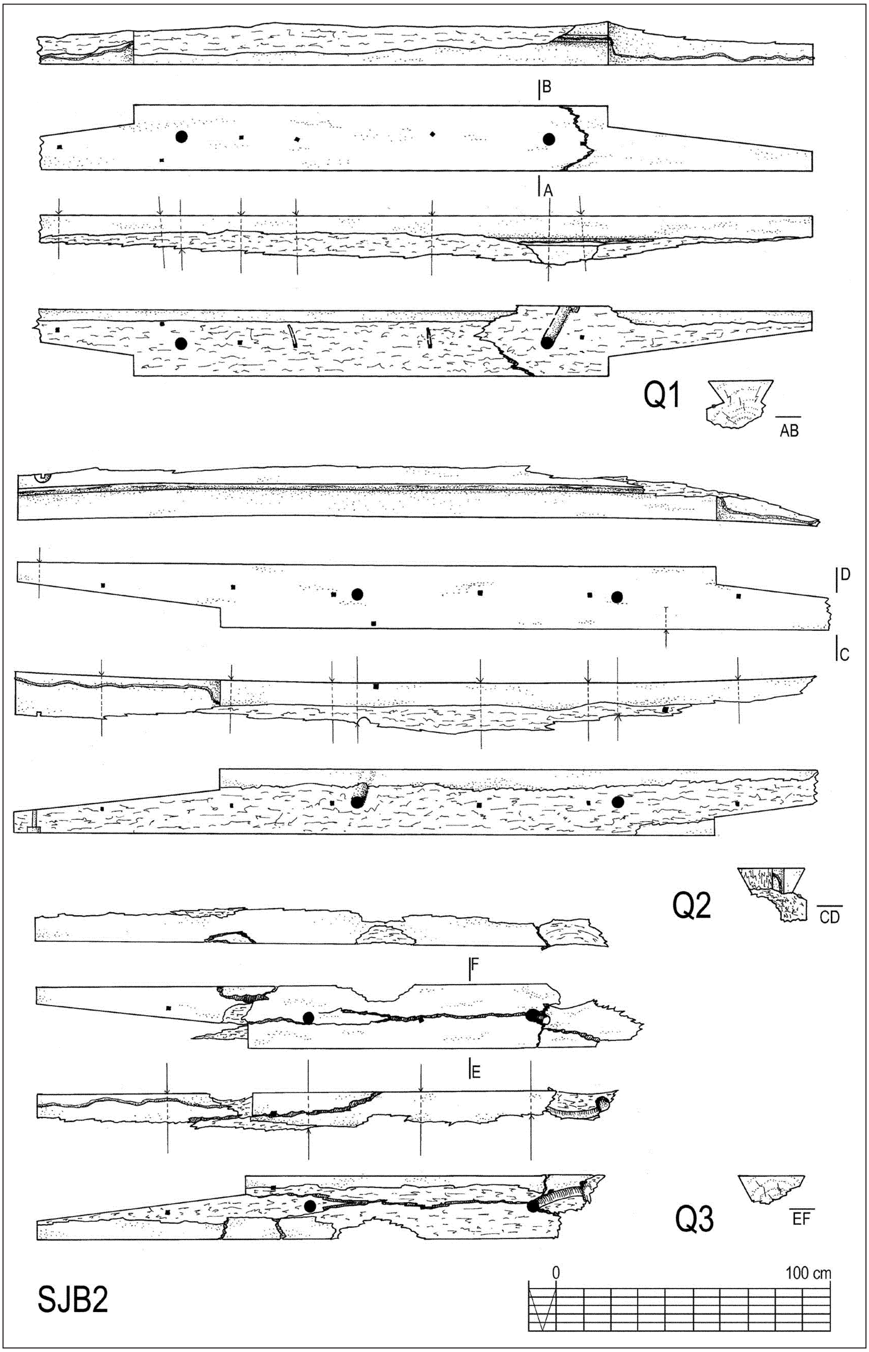



Fig. 7.5. Sections Q1, Q2, and Q3 of keel. (Drawing Filipe Castro)

**TABLE 7.4. KEEL—LENGTH OF SCARVES**

| SECTION | LENGTH PRESERVED ON NORTH SIDE | LENGTH OF KEEL BETWEEN SCARVES | LENGTH PRESERVED ON SOUTH SIDE | PERCENT OF TOTAL LENGTH TAKEN BY SCARVES |
|---|---|---|---|---|
| Q0 | — | — | 34 cm | — |
| Q1 | 35 cm | 176 cm | 75 cm | 46 |
| Q2 | 75 cm | 180 cm | 41 cm | 46 |
| Q3 | 76 cm | 157 cm | — | — |

All sections of the keel exhibited a slight rocker, possibly designed to counteract the predictable hogging of the ship during use (fig. 7.5). The three preserved sections of the keel are quite short and are linked to each other by long, flat, vertical scarves, supporting the assumption that large straight oak timbers were not available to the shipwright (table 7.4).

On each section two round holes were bored to receive the bolts that connected the keel and keelson, placed one before and one abaft each keel scarf. The fully preserved scarves presented tables around 75–76 cm long, a measure close to 3 *palmos de goa* (77 cm). Only one of these scarves was preserved well enough to show traces of a transverse spike, inserted from the port side, 15 cm below the upper surface of the keel and 10 cm from the end of the scarf. This position, very close to the end of the scarf, suggests the existence of at least two more spikes in this connection. As in the outer planking, there was a countersink hole to house the head of this spike. The table was caulked with a thin and highly dense vegetable felt.

## Apron

Situated at the south end of the site were the remains of an apron, still aligned with the axis of the keel and retaining the concretions of two iron bolts bent by the violence of the impact against the rocky bottom (fig. 7.6). The apron was cut from a single timber and measured 40 cm on its sided dimension and 23 cm on its molded dimension. It was preserved along its full length, measured 1.79 m, and was notched to receive four floors on its top face, spaced at uneven intervals.

The apron was designed to sit on top of the keel and stem, and was beveled to receive the lower planks, which made an angle of 135° with the top of the keel at this point. On its side faces this timber displayed notches to receive the four frames it supported (fig. 7.7). Apparently these frames were not placed at even intervals, given measures for the room-and-space between 40 and 53 cm (53, 40, 44, and 38+ cm). This represents a variation of more or less 6.5 cm around

Fig. 7.6. Apron in situ. (Photo Francisco Alves, CNANS; used with permission of CNANS)

the average room-and-space measured on the preserved structure, which was 46.2 cm.

The upper surface of the apron showed two round holes from bolts that almost certainly connected the keel and keelson through the frames and apron, two countersunk holes opened to receive the heads of two spikes connecting the apron to the keel, and four holes from the spikes connecting the frames to the apron. On its sides were holes left by the spikes used to fasten the garboards to the apron.

## Frames

Eleven floors, designated C1 to C11, were preserved over the keel (see fig. 7.2). Futtocks were partially preserved on both the port and starboard ends of the floors. The floors and futtocks were joined with double dovetail scarves and fastened with three or four iron spikes, all driven through preaugered holes from the after side of the floor. These spikes had square shanks more or less 60 cm long with sides 1.8 to 2.0 cm; the squared heads with round corners were lodged in circular countersink holes, with diameters ranging from 5 to 6 cm and depths around 1.5 cm. On the forward faces of the futtocks the spikes were clenched and embedded in grooves.

Limber holes were cut under each floor, with a semielliptic form, 7–8 cm

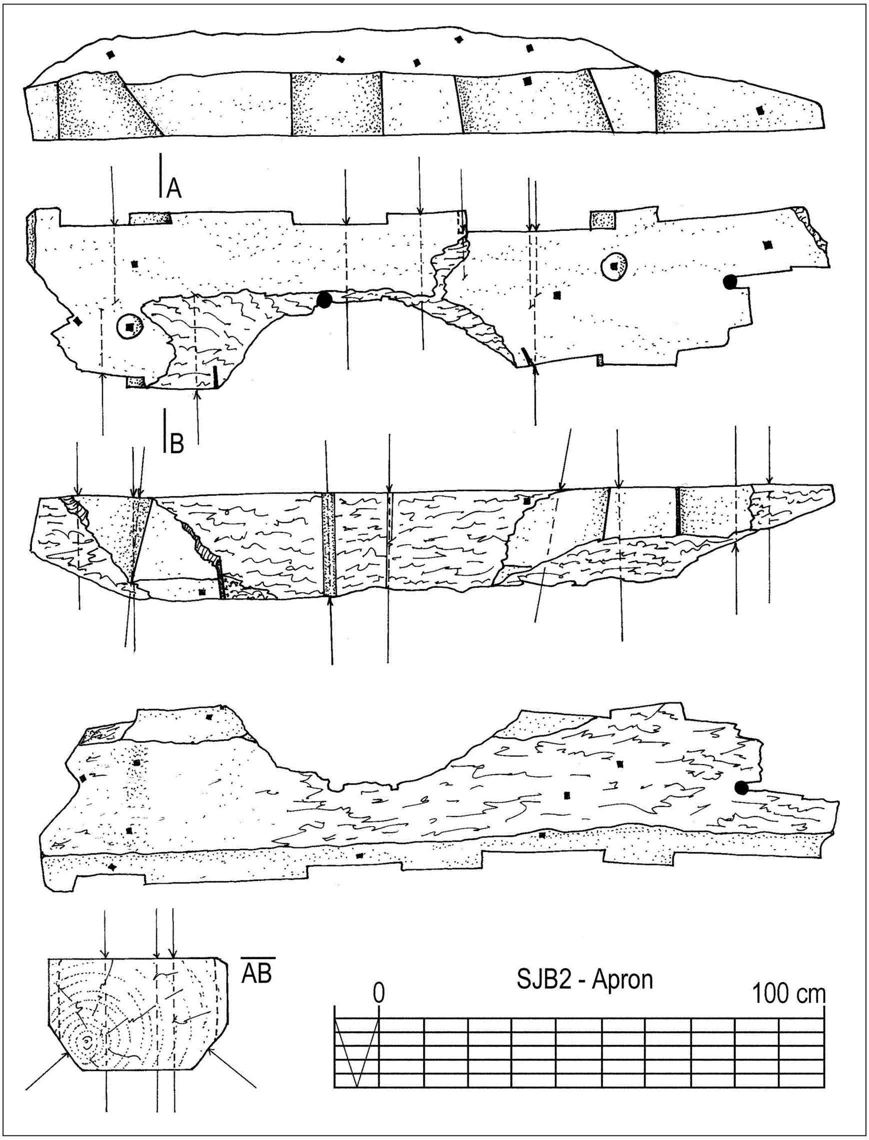



Fig. 7.7. The apron. (Drawing Filipe Castro)

wide and 5 cm high. They seem to have been cut with a curved blade less than 1 cm wide—something similar to a gouge—in what was apparently a labor-intensive manner.

Only six futtocks were preserved to a substantial extent, the rest being preserved only along the extent of the overlapping joints with the respective floors. All the futtocks were attached to the forward side of the floors. To the north, nail marks on the planking indicated the position of another four frames that were not preserved. These corresponded to floors C12, C13, C14, and C15. Of these, the first three were erected without any space between them (fig. 7.8). In the space between floors C14 and C15 nail marks on the port and starboard sides showed the position of the futtocks of floor C14. To the south (forward) end, the positions of another nine frames were clearly marked on the planking by the nail holes and butted joints of the planks (fig. 7.9).

While amidships the futtocks were attached to the floors at an average of 225 cm from the center of the keel, normally leaving three of four plank strakes exposed, the lower ends of the futtocks toward the bow gradually approach the keel axis (see table 7.9).

Due to the extremely degraded state of the upper surfaces of the floors and futtocks, and the large variation in depth and extension of the tenons, it is difficult to determine whether all the joints were attached with double dovetail scarves, or if in some cases a single dovetail was used.

A single filling timber (A4) extended floor C4 to the east, between futtocks B5E and B4E. It probably functioned as an isolated reinforcement of a particularly weak and irregular futtock as B4E proved to be. The sided dimensions of the floors, futtocks, and room-and-space measured in situ varied slightly, depending on the longitudinal section from which they were taken. This is ex-

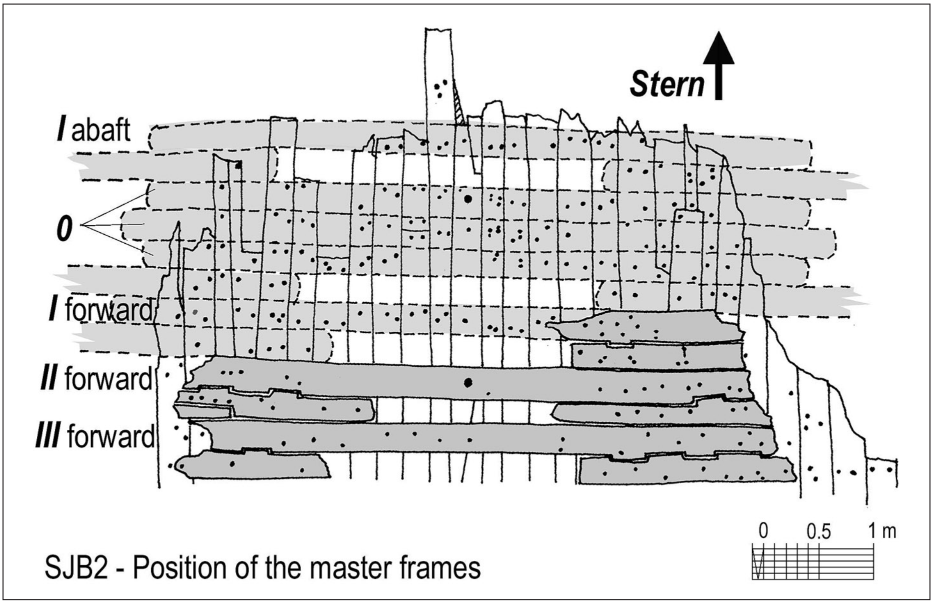



Fig. 7.8. Presumed position of the master frames. (Drawing Filipe Castro)

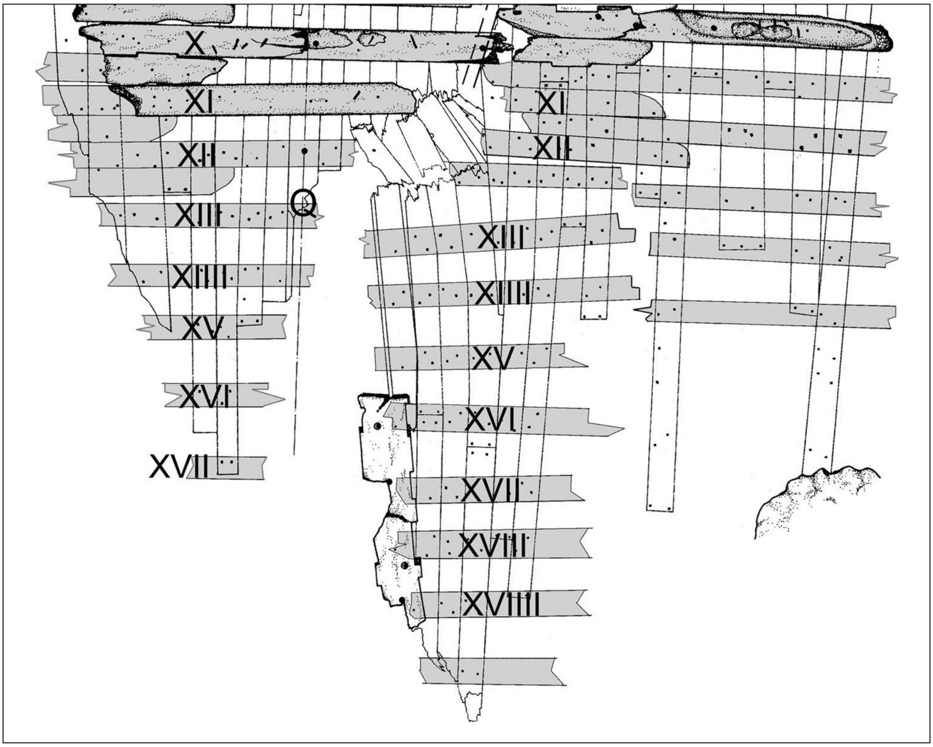



Fig. 7.9. Presumed position of nine frames to the south. (Drawing Filipe Castro)

**TABLE 7.5. PATCHES ON FUTTOCKS**

| FUTTOCK | PATCH |
|---|---|
| B3E | On its lower face, a patch with a length of 95 cm and a maximum thickness of 7 cm |
| B5E | On the zone of the first dovetail, a patch with the dimensions 47 × 15 × 10 cm |
| B7W | On the zone of the first dovetail, a patch with a preserved length of 12 cm and a preserved thickness of 12 cm that covered the full molded dimension of the timber |
| B8E | On the zone of the second dovetail, a patch with a preserved length of 77 cm and a preserved thickness of 10 cm that covered the full molded dimension of the timber |
| B10W | On the zone of the second dovetail, a patch with a preserved length of 39 cm and a preserved thickness of 10 cm that covered the full molded dimension of the timber |

plained by both the natural irregularity of the wood and by the distortions that occurred in the hull after the wreck, when the sides broke apart and collapsed to the bottom. In fact, many of these timbers were very crudely cut, and some even exhibited surfaces with preserved cork bark. To complete the full sections required for the frames, patches were extensively used. This was the case for futtocks B3E, B5E, and B8E on the east side, and B7W and B10W on the west side (table 7.5).

Marks from clenched nails were clearly visible on most of the top surfaces of both floors and futtocks. Only a small number of holes from nails driven from the frames upper faces were preserved—presumably corresponding to the footwale runs—leading to the conclusion that there was no ceiling in this central zone of the hull.

Some floors and futtocks had wooden plugs filling nail cavities on the lower, external, faces (table 7.6). Of these, some were only preserved on the frames (fig. 7.10); others were observed on the planking, after the removal of the floor (fig. 7.11).

The average sided dimension of the floors as measured in situ was 24.6 cm, roughly 4 percent shorter than 1 *palmo de goa* (25.67 cm). The median value was 25 cm, less than 3 percent shorter than 1 *palmo de goa* (table 7.7). The molded dimensions of the floors were very close to 25 cm at their extremities (between 24 and 26 cm), and grew in height toward the axis of the keel, where the concretions of the iron fastenings had preserved the sections almost in their entirety. This increase in height is significant, as it follows a curve that closely matches the curve proposed by Fernando Oliveira (see chap. 4) for the rising of the floors at the forward end of an India nau (table 7.8).

**TABLE 7.6. WOODEN PLUGS ON LOWER FACES OF FRAMES**

| LOCATION | DIMENSIONS | DESCRIPTION |
|---|---|---|
| Under floor C3 | ⍁ = 1 cm<br>h = 4.5 cm | Pyramidal; only preserved on the floor |
| Under floor C4 at T11E | ⍁ = 2 cm on the base<br>1 cm on the top<br>h = 7 cm (+11) | Frustum of pyramid; preserved on the planking (damaged during the raising of floor C7) |
| Under futtock B5E at T15E | ⍁ = 2–1 cm on the base<br>h = 3 cm (+11) | Frustum of pyramid; inserted at an angle |

Fig. 7.10. Plug under floor C3. (Photos Miguel Aleluia, CNANS; used with permission of CNANS)

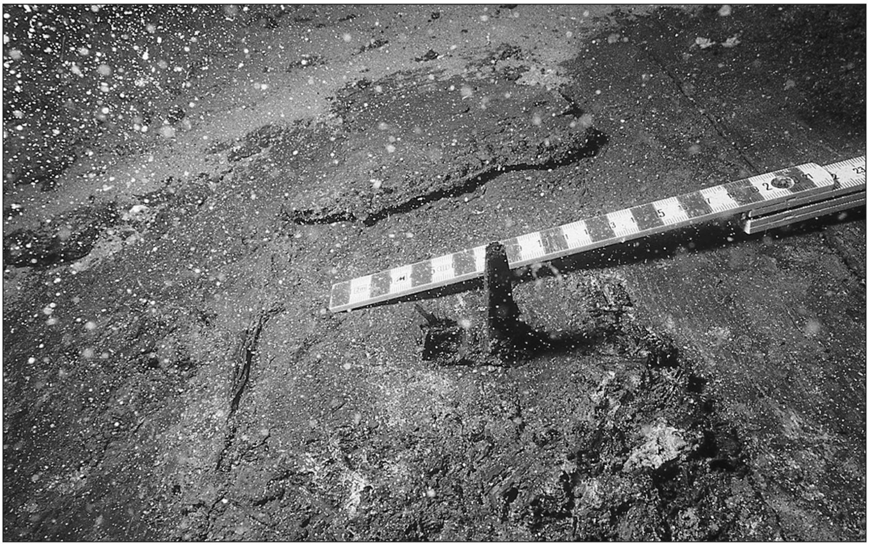


Fig. 7.11. Plug on plank T11E, under floor C4. (Photo Augusto Salgado, CNANS; used with permission of CNANS)

**TABLE 7.7. FRAMES—SIZE OF FLOORS, SPACE BETWEEN FLOORS AND ROOM-AND-SPACE**

| FLOOR | SIDED DIMENSION | DISTANCE BETWEEN FRAMES[a] | ROOM-AND-SPACE | DISTANCE BETWEEN FRAME AXES |
|---|---|---|---|---|
| C11 | 26 cm | 20 cm | 46 cm | 45.5 cm |
| C10 | 25 cm | 24 cm | 49 cm | 47.5 cm |
| C9 | 22 cm | 22 cm | 44 cm | 45.5 cm |
| C8 | 25 cm | 20 cm | 45 cm | 45.5 cm |
| C7 | 26 cm | 24 cm | 50 cm | 50.0 cm |
| C6 | 26 cm | 23 cm | 49 cm | 48.0 cm |
| C5 | 24 cm | 23 cm | 47 cm | 47.5 cm |
| C4 | 25 cm | 18 cm | 43 cm | 42.5 cm |
| C3 | 24 cm | 20 cm | 44 cm | 44.5 cm |
| C2 | 25 cm | 20 cm | 45 cm | 44.5 cm |
| C1 | 24 cm | — | — | — |

[a] Corresponding sided dimensions of the futtocks.

The futtocks exhibited sided dimensions slightly narrower than those of the floors with an average of 21.4 cm, again less than 3 percent smaller than 1 *palmo de vara,* with molded dimensions varying between 24 and 26 cm. All futtocks were evenly cut on their external, forward, and aft faces but were sometimes roughly finished on their internal faces. Another result of the irregularity of the wood used is the variation in the length of the overlap be-

**TABLE 7.8. RISING OF THE FLOOR (MOLDED DIMENSIONS)**

| FRAME | AFTER OLIVEIRA (CM) | *N.ª S.ª MÁRTIRES* (CM) |
|---|---|---|
| C11 (I) | 25.8 | — |
| C10 (II) | 26.4 | 31 |
| C9 (III) | 27.2 | 25 |
| C8 (IIII) | 28.5 | 27 |
| C7 (V) | 30.0 | 36 |
| C6 (VI) | 31.9 | 31 |
| C5 (VII) | 34.0 | 35 |
| C4 (VIII) | 36.5 | 37 |
| C3 (VIIII) | 39.2 | 39 |
| C2 (X) | 42.2 | 42 |
| C1 (XI) | 45.4 | 46 |
| XII | 48.8 | — |
| XIII | 52.3 | — |
| XIIII | 56.1 | — |
| XV | 59.9 | — |
| XVI | 63.8 | — |
| XVII | 67.8 | — |
| XVIII | 71.9 | — |

**TABLE 7.9. FLOORS—BREADTHS TAKEN FROM CENTRAL AXIS**

| FLOOR | DISTANCE TO EXTREMITY (WEST) | DISTANCE TO FIRST DOVETAIL (WEST) | DISTANCE TO FIRST DOVETAIL (EAST) | DISTANCE TO EXTREMITY (EAST) |
|---|---|---|---|---|
| C11 | — | — | 129 cm | 155 cm |
| C10 | 223 cm | 130 cm | 180 cm | 231 cm |
| C9 | 224 cm | 153 cm | 144 cm | 246 cm |
| C8 | 228 cm | 127 cm | 139 cm | 264 cm |
| C7 | 225 cm | Not visible | 165 cm[a] | 108 + 170 cm[a] |
| C6 | 206 cm | 132 cm | 140 cm[a] | 152 + 134 cm[a] |
| C5 | 206 cm | 145 cm | 148 cm[a] | 119 + 120 cm[a] |
| C4 | 197 cm | 129 cm | 164 cm[a] | 205 + 88 cm[a] |
| C3 | 188 cm | 115 cm | 150 cm[a] | 148 + 112 cm[a] |
| C2 | 175 cm | 98 cm | 163 cm[a] | 165 + 77 cm[a] |
| C1 | 150 cm | 97 cm | — | 89 cm |

[a] Estimated distance between the rupture surfaces discounted.

tween the floors and the futtocks. In fact, neither the dovetail scarves nor the spikes fastening them seem to have been positioned with any consideration of the location of the turn of the bilge (table 7.9).

## Construction Marks

Perhaps the most important feature presented by the frames is the collection of construction marks engraved on the faces of some of the floors. Although carefully recorded, the precise positions of the marks situated to portside of the keel were very difficult to establish because of the longitudinal fracture that split the hull in two.

This longitudinal fracture was carefully recorded in the 2000 field season, and although the seams along which the hull had split were often badly eroded, it has been possible to close the fracture and obtain corrected measures for the distances between some of these marks and the keel axis within a fair degree of accuracy (3 cm of maximum error).

The marks identified on the preserved timbers can be divided into five different types:

A sequential numbering of the frames using roman numerals (fig. 7.12; table 7.10)

Fig. 7.12. Roman numeral X on floor C2. (Photo Miguel Aleluia, CNANS; used with permission of CNANS)

**TABLE 7.10. CONSTRUCTION MARKS (NUMBERS) AT AFT SIDE, TO STARBOARD**

| FLOOR | MARK | NOTES |
|---|---|---|
| C2 | X | — |
| C3 | VIIII | Incomplete: . . . IIII |
| C7 | V | Inverted |
| C8 | IIII | — |
| C9 | III | — |

A series of vertical lines, marking the edges—in Portuguese *astilhas*—and the axis of the keel (fig. 7.13; table 7.11)
A series of lines marking the turn of the bilge (fig. 7.14; table 7.12)
A series of marks whose significance is not clear, presumably made during early stages of the construction (fig. 7.15; table 7.13)
A series of marks that seem to have no precise meaning, presumably resulting from gouging during the construction process, and mentioned here only because of their occurrence on the Angra D wreck[1] (fig. 7.16; table 7.14)

The inversion of the numeral V on floor C7 is paralleled by similarly inverted numerals on other wrecks, such as the fourteenth-century ship from Catalonia known as Culip VI, the fifteenth-century Ria de Aveiro A wreck, and the sixteenth-century Cais do Sodré ship (table 7.15). The first and most obvious conclusion to reach about the existence of these marks, which are typ-

Fig. 7.13. Marks of keel axis and edges on floor C10. (Photo Miguel Aleluia, CNANS; used with permission of CNANS)

**TABLE 7.11. CONSTRUCTION MARKS (VERTICAL GROOVES)—KEEL**

| FLOOR | POSITION |
|---|---|
| C2 (X) | Aft side, on axis and edges |
| C9 (IIII) | Aft side, on axis and edges |
| C10 (III) | Aft side, on axis and starboard edge |

Fig. 7.14. Mark indicating the turn of the bilge on floor C6 (VI). (Photo Filipe Castro)

**TABLE 7.12. CONSTRUCTION MARKS (VERTICAL GROOVES)—TURN OF THE BILGE**

| FLOOR | POSITION |
|---|---|
| C4 (VIII) | Aft side, to port side, 202 cm (in situ) from the keel axis, 189 cm after correction |
| C5 (VII) | Aft side, to port side, 202 cm (in situ) from the keel axis. 193 cm after correction |
| C6 (VI) | Aft side, to port side, 203 cm (in situ) from the keel axis. 197 cm after correction |
| C7 (V) | Aft side, to port side, 203 cm (in situ) from the keel axis. 200 cm after correction |

ical of, and well described in, the Portuguese shipbuilding treatises of the late sixteenth and early seventeenth centuries, is that the floors C12, C13, and C14, whose existence is known from nail holes, were the three master frames of this vessel and would not have borne roman numerals because they would have been the numeral zero (as shown on fig. 7.8).

The second conclusion that can be drawn is that because the numbers inscribed on the floors match the ones on the theoretical curve proposed by Oliveira (see table 7.8), these floors may have belonged to a sequence of eighteen predesigned floors, as proposed by this author.

The next logical step was to check whether the marks indicating the turn of the bilge match Oliveira's model. After the longitudinal fracture that separates the starboard ends of floors C4, C5, C6, and C7 was closed, these marks were found to correspond to Oliveira's design (see table 7.12).

A fourth archaeological parallel is currently under study: the late seven-

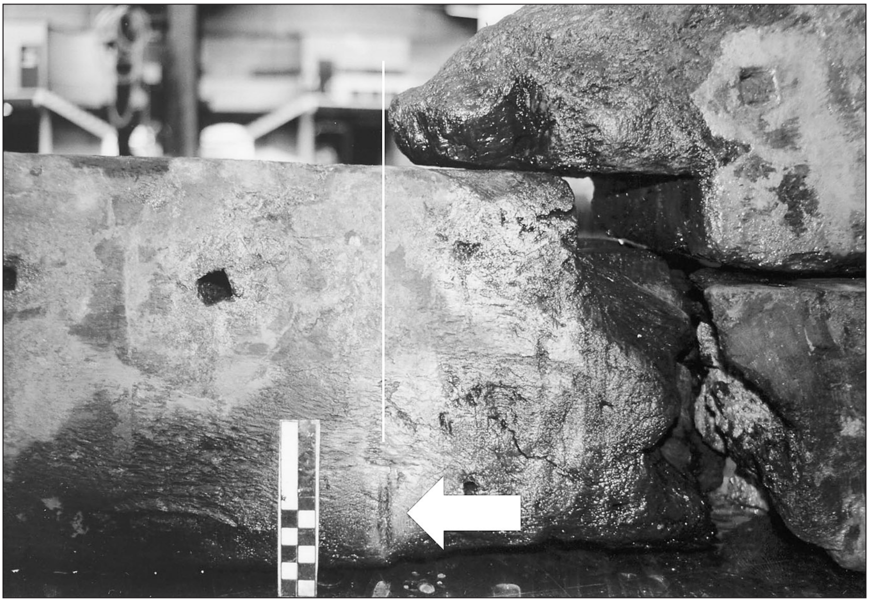


Fig. 7.15. Mark on base of floor C3, at precise point where futtock ends. (Photo Filipe Castro)

**TABLE 7.13. CONSTRUCTION MARKS (OTHER)**

| FLOOR | MARK | POSITION |
|---|---|---|
| C2 (X) | Vertical groove | Aft side, to port side, 63 cm from the keel axis |
| C3 (VIIII) | Vertical groove | Aft side, to port side, 159 cm from the keel axis |
| C3 (VIIII) | Vertical groove | Aft side, to starboard, 169 cm from the keel axis |
| C3 (VIIII) | Horizontal groove | Base, to port side, 108 cm from the keel axis |

teenth-century *Belle,* the vessel of Chevalier de La Salle's expedition to the Mississippi between 1682 and 1686. This ship also bears an impressive collection of construction marks. In the *Belle* all frames were numbered before and abaft the midship frame, which corresponded to the number zero.

As for the remaining marks, they undoubtedly had clear meanings for the shipwrights who built the *Nossa Senhora dos Mártires,* and some seem to mark construction features. For example, the shallow groove incised on the lower face of floor C3, exactly marks the position of the tip of the mating floor. However, the meaning of many of these carpenter's marks remains a mystery for the time being, especially in the case of the faded vertical grooves marked on each side of floor C3, located almost exactly 1 *palmo de goa* from the turn of the bilge (fig. 7.17).

Fig. 7.16. Groove on floor C3. (Photo Miguel Aleluia, CNANS; used with permission of CNANS)

**TABLE 7.14. CONSTRUCTION MARKS (CURVED GROOVES)**

| FLOOR | POSITION |
|---|---|
| C2 | Aft side, to port, coming out of countersink hole |
| C3 | Aft side, to port, coming out of countersink hole |

Of the eighteen futtocks preserved on the site, twelve were preserved only along the extent of their overlap with the floors, and these timbers did not yield much information pertaining to the extension and radius of the hull's curves. However, the remaining six futtocks—B3E, B4E, B5E, B6E, B7E, and B8E—were much better preserved, measuring around 3 m in length, allowing for the study of their curvatures (table 7.16).

The study of the curvature of these futtocks was difficult and somewhat inconclusive. Not only was the construction generally crude, with no smooth surfaces on any of the preserved futtocks, but the lower faces of the futtocks had undergone heavy dubbing during the construction of the vessel in order to bevel the outer face of the frames to receive the planking. The small number and poor preservation of the extant futtocks made their analysis even more difficult.

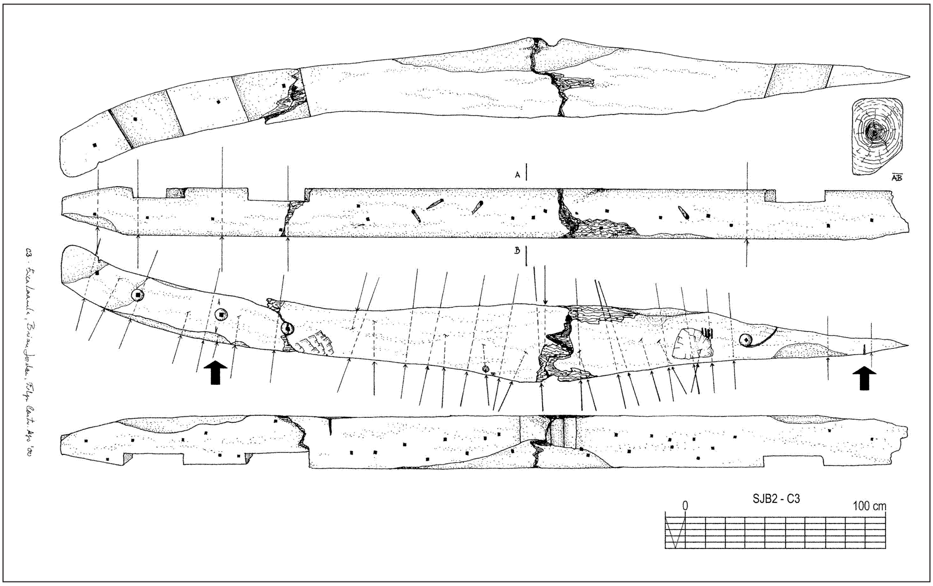



Fig. 7.17. Vertical marks (indicated by arrows) on floor C3. (Drawing Erika Laanela, Brian Jordan, Filipe Castro)

An attempt was made to determine the arcs of the futtocks with the best possible accuracy, resulting in interesting but puzzling results. The methodology adopted in the analysis of the futtocks was largely determined by the assumptions that the futtocks had one single arc, as indicated by Oliveira in his drawings, and that all the futtocks had the same radius. Both of these assumptions were proven to be faulty.[2]

To find the values of the arcs of these six futtocks, three different methods were used. The first, a simple geometric method, consisted of the graphic resolution of the center of the circle for a given group of three points (fig. 7.18). This technique was quickly dismissed after only a few tests, since the values obtained for the radius varied largely with the points chosen. These tests were made on 1:10 scale drawings obtained by reducing the full scale tracings with a computer-aided design program, and it is possible that any errors made during tracing were compounded during the scanning process.

The second method consisted of the use of templates with circular curves that were overlaid on the drawings of the futtocks to determine which curve fit best over each futtock. This method was also not very accurate, as the average preserved length of only 3 m allowed a wide number of arcs to fit equally well over the outline of each futtock.

**TABLE 7.15. CONSTRUCTION MARKS—KNOWN PARALLELS**

| NAME AND DATE OF SHIP | PRESERVED MARKS | MASTER FRAME | POSITION |
|---|---|---|---|
| *Nossa Senhora dos Mártires* (early 17th century) | Of 3 types: numbering the floors, the marks III, IIII, V, VIIII(?), and X | Probably 3 master frames<br>Probably numbered 0 | Side facing the master frames<br>Starboard side<br>at least one inverted |
| | Marking the keel, vertical lines on floors III, IIII, and X | Not preserved | Side facing the master frame |
| | Marking the turn of the bilge, vertical lines on floors V, VI, VII, and VIII | Not preserved | Side facing the master frame |
| *Cais do Sodré* (late 15th century) | Of 2 types: numbering the floors, the marks XVI, XVII and XVIII, to the bow, and a complete sequence from IIII to XVIII to the stern | Not preserved | Side facing the master frame<br>Both on port and starboard sides<br>Both inverted and straight |
| | For the marking of the keel, vertical lines on almost all 18 numbered floors (fore and aft) and on some of the others | Not preserved | Side facing the master frame |
| Ria de Aveiro A (mid-15th century) | Of the first type: numbering the floors, the marks V, II, and XV | 1 master frame numbered I | Number V facing the stern; number XII on the upper face; number XV facing master frame numbers V and XV on starboard, XII on portside; numbers V and XV inverted |
| *Culip VI* (early 14th century) | Of 3 types: numbering the floors, the marks I to X to the stern and I to XXVI to the bow | 2 master frames each one numbered I | Facing the master frame on port side to the bow and on starboard side to the stern<br>All inverted, some repeated on the upper face |
| | Marking the keel, vertical lines on all preserved central floors I to XXV and I to XI | On both master frames | Facing the master frame |
| | Marking the turn of the bilge, vertical lines on all preserved central floors I to XXV and I to XI | On both master frames | Facing the master frame |

**TABLE 7.16. DIMENSIONS OF FUTTOCKS (IN CM)**

| FUTTOCK | EXTENSION | SIDED | MOLDED | FUTTOCK | EXTENSION | SIDED | MOLDED |
|---|---|---|---|---|---|---|---|
| B2W | 108 | 21/20 | 24/26 | B2E | — | — | — |
| B3W | 129 | 24/22 | 24/26 | B3E | 316 | 24/19 | 24/26 |
| B4W | 147 | 22/18 | 24/26 | B4E | 315 | 25/18 | 24/26 |
| B5W | 113 | 25/22 | 24/26 | B5E | 315 | 25/23 | 24/26 |
| B6W | 119 | 22/21 | 24/26 | B6E | 286 | 24/22 | 24/26 |
| B7W | 157 | 24/22 | 24/26 | B7E | 287 | 25/22 | 24/26 |
| B8W | 160 | 24/21 | 24/26 | B8E | 289 | 27/24 | 24/26 |
| B9W | 123 | 24/23 | 24/26 | B9E | 168 | 25/20 | 24/26 |
| B10W | 157 | 24/20 | 24/26 | B10E | 171 | — | 24/26 |
| B11W | — | — | — | B11E | 132 | — | 24/26 |

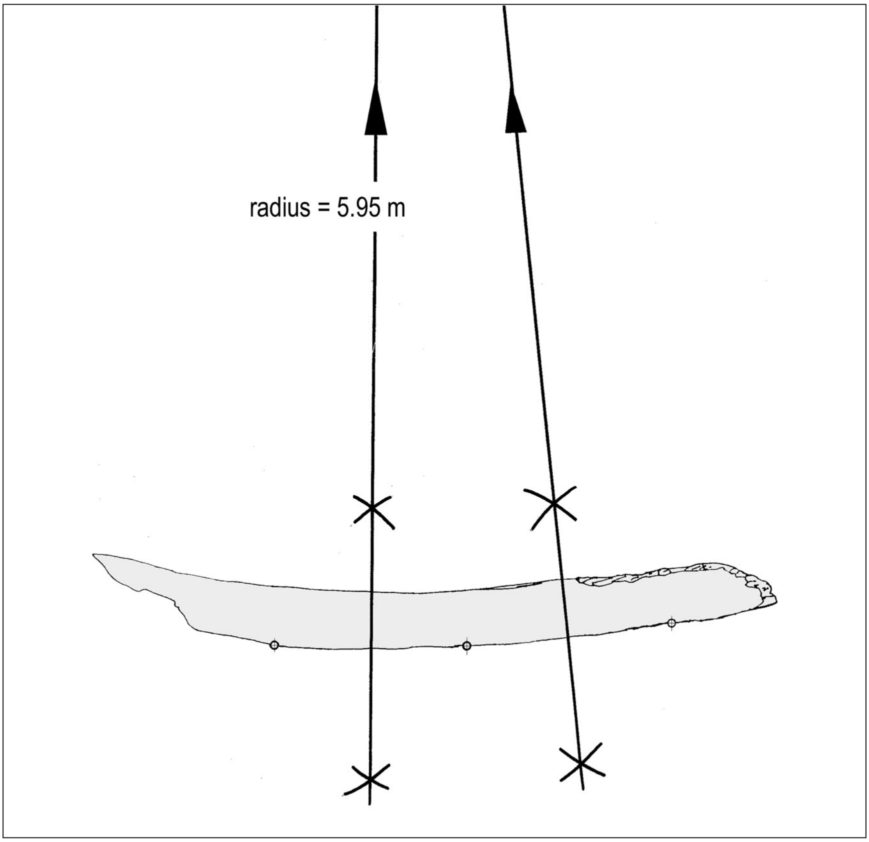



Fig 7.18. Graphic method used to find center of curvature of the futtocks. (Drawing Filipe Castro)

The third method consisted of a mathematical analysis of the lists of coordinates (*x*, *y*) that define each one of the lower surfaces of the futtocks at 10 cm intervals. This analysis was performed with the help of two computer programs developed by Thomas Vogel of Texas A&M University Mathematics Department, which run on a Maple V environment. The first of these programs finds the best fit circular curve for a given number of points. The second program finds the radius of each three consecutive points and lists the series of radii obtained.

The available data were run through the two programs with rather inconclusive results. The radii obtained using the first program clearly showed the existence of a turn of the bilge arc and a futtock arc, and suggested the existence of a tumble-home arc in the longer futtocks. However, the results varied too widely to allow for any further analysis, and thus the second program was employed. Because we were convinced that the *x* and *y* values taken at the extremities of the futtocks might create some form of noise in the computation of the values of the radii if there were three arcs, several combinations of points were tested. As a result, the radius of the best fit circular curve for each futtock was determined, for nine different combinations of points: for the whole extension of the futtocks every 10 cm and every 30 cm, and excluding 50 cm in each one of the extremities; for five points; and for five different combinations of three points. Table 7.17 shows all the values given by the computer program.

The computerized values were then compared with the ones obtained from the templates (table 7.18), using the two columns of table 7.17 that seem most reliable or relevant to this analysis, the values obtained for the central portion considering five points along the curve, and the average of the eight values. All futtocks displayed a clear bevel in the direction of the bow, fairly constant and varying from 15 to 25 mm between the aft and the forward faces, and therefore from 30 to 50 mm between the aft face of the floor and the forward face of the futtock.

**TABLE 7.17. FUTTOCK ARCS—RADII OF THE BEST FIT CIRCULAR CURVES**

| FUTTOCK | //*10 CM (1) | // 30 CM (2) | 5 POINTS (3) | 3 POINTS (4) | 3 POINTS (5) | 3 POINTS (6) | 3 POINTS (7) | 3 POINTS (8) | AVERAGE RADIUS |
|---|---|---|---|---|---|---|---|---|---|
| B3E | 4.08 | 4.30 | 4.70 | 5.02 | 4.87 | 4.77 | 4.68 | 5.43 | 4.73 |
| B4E | 3.48 | 3.63 | 3.77 | 3.83 | 3.51 | 4.03 | 3.80 | 3.75 | 3.73 |
| B5E | 5.17 | 5.25 | 4.81 | 4.71 | 4.58 | 5.14 | 4.80 | 4.71 | 4.90 |
| B6E | 4.39 | 4.43 | 4.85 | 4.96 | 5.04 | 4.65 | 4.76 | 4.92 | 4.75 |
| B7E | 4.44 | 4.36 | 5.22 | 5.45 | 4.65 | 5.87 | 4.74 | 5.54 | 5.03 |
| B8E | 5.95 | 6.20 | 6.05 | 6.02 | 6.77 | 6.06 | 5.91 | 6.40 | 6.17 |

*Note:* (1) and (2) calculated for the whole length; (3) to (7) for the central portion of the futtock in the following way: (4) $x = 50/150/250$; (5) $x = 60/160/260$; (6) $x = 40/140/240$; (7) $x = 40/150/260$; and (8) $x = 60/150/240$.

*// = spaced or at intervals of.

**TABLE 7.18. FUTTOCKS—CURVES**

| FUTTOCK | TEMPLATES | CENTRAL PORTION (5 POINTS) | AVERAGE OF BEST-FIT CURVES |
|---|---|---|---|
| B3E | 18–19 pg | 4.70 m = 18.3 pg | 4.73 m = 18.4 pg |
| B4E | 19 pg | 3.77 m = 14.7 pg | 3.73 m = 14.5 pg |
| B5E | 19 pg | 4.81 m = 18.7 pg | 4.90 m = 19.1 pg |
| B6E | 22 pg | 4.85 m = 18.9 pg | 4.75 m = 18.5 pg |
| B7E | 22 pg | 5.22 m = 20.3 pg | 5.03 m = 19.6 pg |
| B8E | 22–23 pg | 6.05 m = 23.6 pg | 6.17 m = 24 pg |

*Note:* pg = *palmos de goa.*

**TABLE 7.19. FRAMES**

| TIMBER | TREENAILS |
|---|---|
| Floor C3 | Ø 25 mm, octahedral, 12 mm from the lower edge and 0.15 m from the keel axis |
| Futtock B3E | Ø 32 mm, octahedral, 8 mm from the lower edge and 3.18 m from the keel axis |
| Futtock B4E | Ø 27 mm, 55 mm from the lower edge and 3.82 m from the keel axis |
| Futtock B6E | Ø 27 mm, 25 mm from the lower edge and 3.46 m from the keel axis |

A particularly interesting feature of these frames is that three futtocks and one floor exhibited a treenail on their aft faces, near the external face, cut flush with its surface (table 7.19). The treenail was extracted from futtock B3E, and a mold was cast of the hole in which it had been inserted in order to determine the type of auger used. The hole turned out to be fairly shallow, 8 cm deep at the center, and was done with an auger with a conical point. The treenail is octagonal and the wood is still under analysis for species identification (figs. 7.19 and 20).

It is not clear at this point if these treenails result from previous uses of the timbers or if they were used during some phases of the construction to fasten the futtocks to the ship's cradle or just to single poles used to secure the frames in place.

## Planking

The preserved planking was a major source of information, as a result of its relatively large extent when compared with the framing and the regular pattern of nail holes that it presented, which marked the position of thirteen missing frames.

With slight variations, each plank was attached to the framing with two spikes per frame, showing a clear pattern that indicated the positions of the frames that were not preserved, and thus enhancing our knowledge of the framing pattern.

Curiously, it seems that not much care was taken to position the plank butts precisely in the middle of a floor or a futtock, and in a few rare cases the

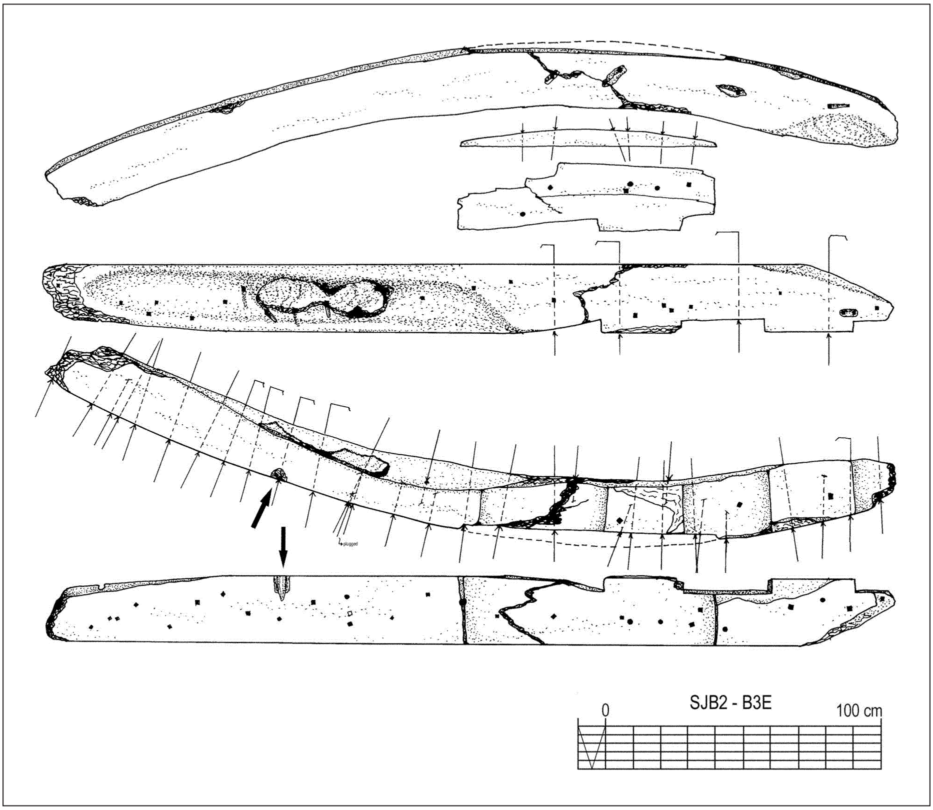



Fig. 7.19. Futtock B3E.C3. (Drawing Brian Jordan, Erika Laanela, Filipe Castro)

butt joints seem to have been positioned very close to the edge of a floor or a futtock. Another interesting feature was the careful and complex way in which the planks were cut and fitted together, more like a jigsaw puzzle than a straight wooden floor. Some planks displayed a number of notches and bevels along their seams that prevented them from sliding longitudinally—for instance when the hull suffered torsional stresses—giving extra strength to the already solid shell composed by these strakes.

In the field seasons of 1996 and 1997 the planking was drawn at a 1 : 1 scale, and a few nail holes were positioned with great precision in relation to each plank. In the field seasons of 1999 and 2000 these drawings were completed and corrected (fig. 7.21). The final plan elaborated in the winter of 2000 from the data obtained in the four excavation seasons showed a general agreement between the different sources in the central portion of the planking and some discrepancies toward the southern and northern extremities. Here there were differences of almost 10 cm in the position of some of the nail holes. All the

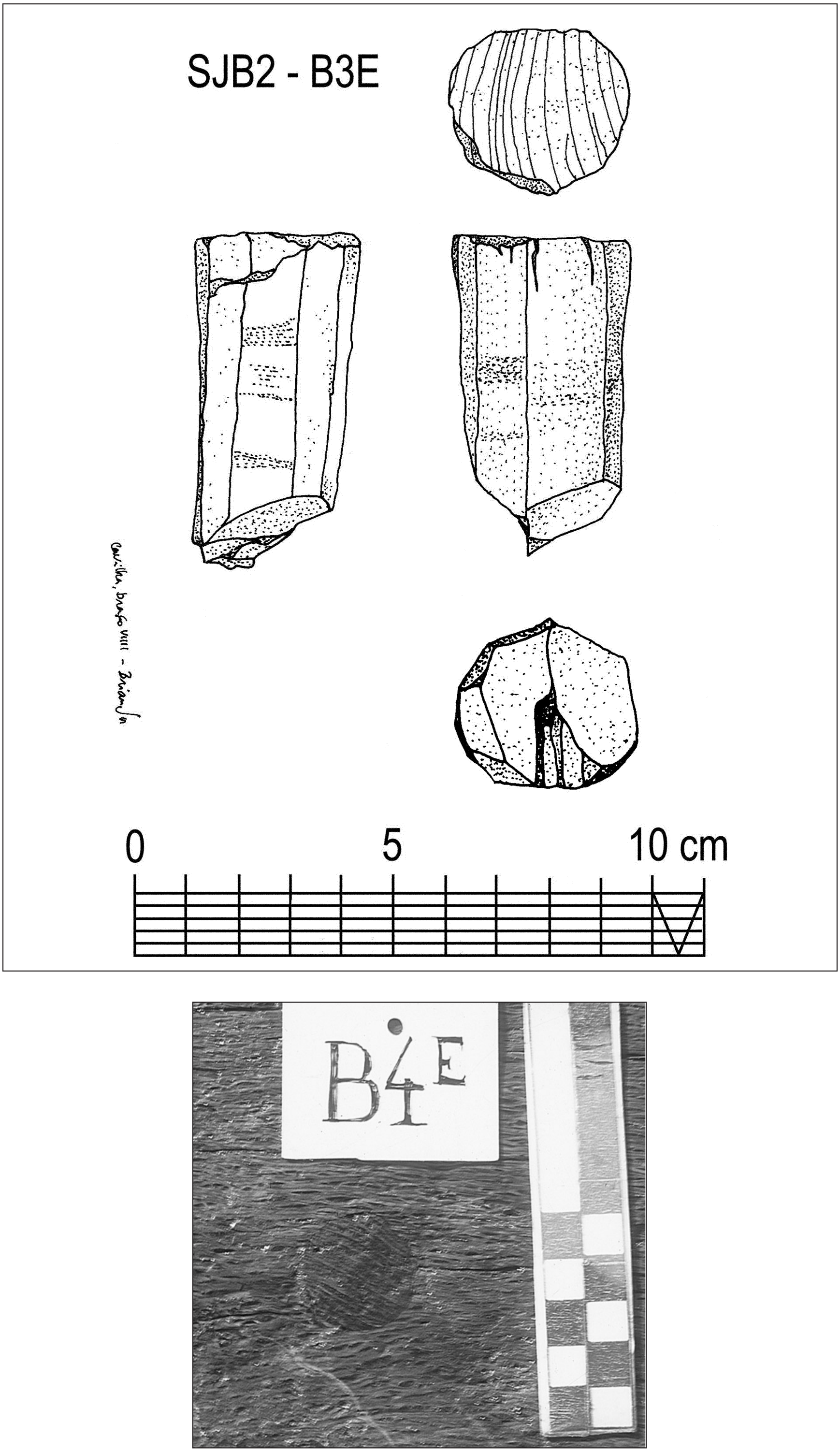



Fig. 7.20. Treenail extracted from futtock B3E (*left*) and treenail on B4E. (Drawing Brian Jordan)

**TABLE 7.20. PRESERVATION OF STRAKES AND PLANKS FOR THE PEPPER WRECK**

| STARBOARD | | | | PORT SIDE | | | |
|---|---|---|---|---|---|---|---|
| STRAKE | PLANK | LENGTH (IN M) | CONDITION | STRAKE | PLANK | LENGTH (IN M) | CONDITION |
| T1W | 1 | 4.14 | Broken | T1E | 1 | 2.16 | Broken |
| | 2 | 4.36 | Complete | | 2 | 4.70 | Complete |
| T2W | 1 | 0.82 | Broken | | 3 | 2.12 | Broken |
| | 2 | 3.53 | Complete | T2E | 1 | 2.97 | Broken |
| | 3 | 3.55 | Complete | | 2 | 3.95[a] | Broken |
| T3W | 1 | 5.48 | Complete | T3E | 1 | 4.93 | Broken |
| | 2 | 3.43 | Complete | | 2 | 3.28[b] | Broken |
| T4W | 1 | 4.64 | Broken | | 3 | 2.00 | Broken |
| | 2 | 3.87 | Complete | T4E | 1 | 2.54 | Broken |
| T5W | 1 | 5.82 | Complete | | 2 | 6.44[c] | Broken |
| T6W | 1 | 4.82 | Complete | | 3 | 2.14 | Broken |
| T7W | 1 | 5.31 | Complete | T5E | 1 | 1.51 | Broken |
| | 2 | 2.70 | Broken | | 2 | 5.10[d] | Broken |
| T8W | 1 | 3.38 | Complete | T6E | 1 | 4.37 | Broken |
| | 2 | 3.77 | Broken | | 2 | 3.24 | Broken |
| T9W | 1 | 2.34 | Broken | | 3 | 5.45 | Complete |
| | 2 | 5.83 | Broken | T7E | 1 | 1.02 | Broken |
| T10W | 1 | 3.58 | Broken | | 2 | 5.29 | Complete |
| | | | | | 3 | 4.00 | Complete |
| | | | | T8E | 1 | 0.61 | Broken |
| | | | | T9E | 1 | 2.68 | Broken |
| | | | | | 2 | 4.16 | Complete |
| | | | | T10E | 1 | 2.53 | Broken |
| | | | | | 2 | 4.96 | Complete |
| | | | | T11E | 1 | 1.58 | Broken |
| | | | | | 2 | 3.44 | Complete |
| | | | | T12E | 1 | 0.36 | Broken |
| | | | | | 2 | 4.85 | Complete |
| | | | | T13E | 1 | 2.43 | Broken |
| | | | | | 2 | 4.88 | Complete |
| | | | | T14E | 1 | 3.83 | Broken |
| | | | | T15E | 1 | 4.58 | Complete |
| | | | | T16E | 1 | 3.32 | Broken |
| | | | | T17E | 1 | 4.56 | Complete |
| | | | | T18E | 1 | 1.73 | Broken |
| | | | | | 2 | 3.98 | Incomplete |

[a] 3.40 + 0.55 m
[b] 1.50 + 1.78 m
[c] 3.57 + 0.65 + 2.22 m
[d] 4.50 + 0.60 m.

planks were cut from straight stone pines (*Pinus pinea*) of varying ages. Fifty-three planks were preserved along twenty-eight strakes (table 7.20).

The garboards exhibited the same thickness as the rest of the planking and were beveled to fit the rabbets. At two different points they were spiked to the keel from the outside. No pattern was found for these diagonal spikes, and it

**TABLE 7.21. PLANKING THICKNESS OF IBERIAN WRECKS**

| SHIP | NATIONALITY | ROUTE | DATE OF WRECK | ESTIMATED LENGTH OVERALL | PLANKING THICKNESS |
|---|---|---|---|---|---|
| *N.ª S.ª Mártires*[1] | Portugal | India Route | 1606 | ≈40 m | 11 cm |
| Cais do Sodré | Portugal (?) | — | ≈1500 | ≈40 m | 7 cm |
| *San Diego* | Spain | Manila | 1600 | ≈40 m | 6.5–7 cm |
| Seychelles | Portugal | India Route | ≈1600 | >30 m (?) | 9 cm |
| Emanuel Point | Spain | New World | ≈1550 | >30 m (?) | 5/8 cm |
| *San Esteban* | Spain | New World | 1554 | ≈20/21 m | 10 cm |
| Cattewater | England | — | 1500–1550 | >30 m (?) | 6–7 cm |
| *San Juan* | Spain | New World | 1565 | ≈22 m | 5/6 cm |
| Highborn Cay | Spain | New World | ≈1500 | >20 m (?) | 6 cm |
| Corpo Santo | Portugal (?) | — | ≈1400 | ≈15/16 m | 4–5 cm |
| Molasses Reef | Portugal (?) | New World | ≈1500 | ≈20 m | 4.5 cm |
| Ria de Aveiro A | Portugal | Coaster | ≈1450 | 15/16 m | 4 cm |
| Western Ledge Reef | Spain | New World | 1575–1600 | ≈20 m | 3.5 cm |
| *Nuestra Senhora de Atocha* | Spain | New World | 1622 | — | 10 cm |

*Note:* See appendix B for bibliography of Iberian wrecks.

seems that they were used to remedy weaknesses or imperfections perceived as dangerous during the building process (fig. 7.22).

All planks were placed without regard to the direction of the heartwood, some with the growth rings placed with their concave side to the interior; some to the exterior. This parallels the practice still in use today in Portuguese shipyards of placing the planks against the frames with consideration to their natural warping after seasoning, rather than the direction of the grain (fig. 7.23). The planking was 11 cm thick, among the highest values known for Iberian ships (see table 7.21). This value is only surpassed by the theoretical value of 12.5 cm indicated by Manoel Fernandez in the *Livro das traças de carpintaria* for the bottom planking of an Indiaman. The width of the planks varied between 15 and 35 cm.

The planking's interior surface was very well preserved under a layer of a resinous substance that is still being analyzed but that exuded a strong smell of pine. Under floor C6, plank T2E(2) showed the mark of a recessed spike head, suggesting that it had been reused or turned over, after being nailed to a few frames, for a better fit.

In contrast, the external faces of the planks are abraded and were destroyed over large sections due to the violence of collision against the rocky bottom during the wreck. Where original surfaces were preserved, they show a consistent thin charred layer (fig. 7.24). This practice was used in Portuguese shipyards before the first coating and between the first and second coatings of

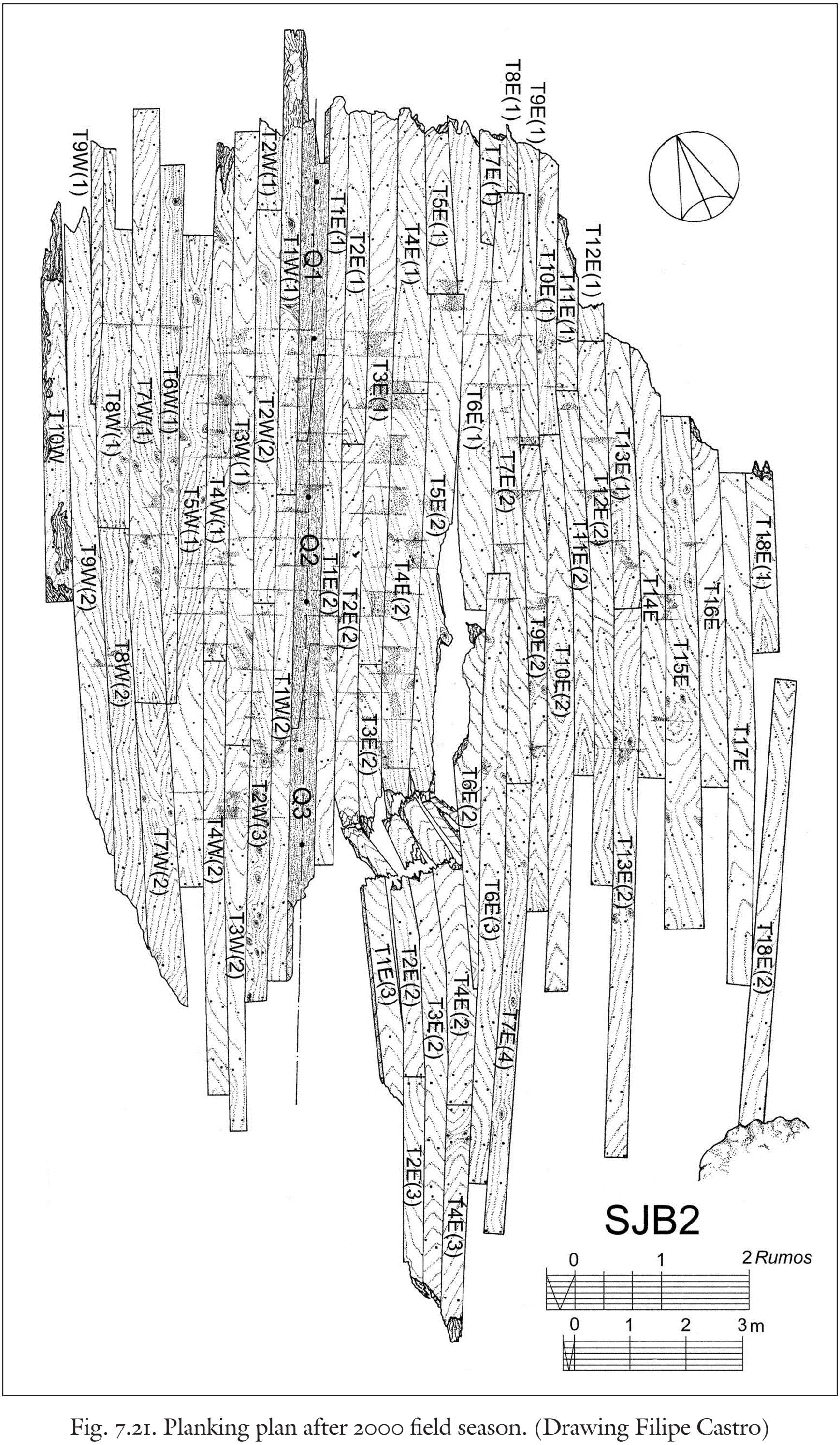
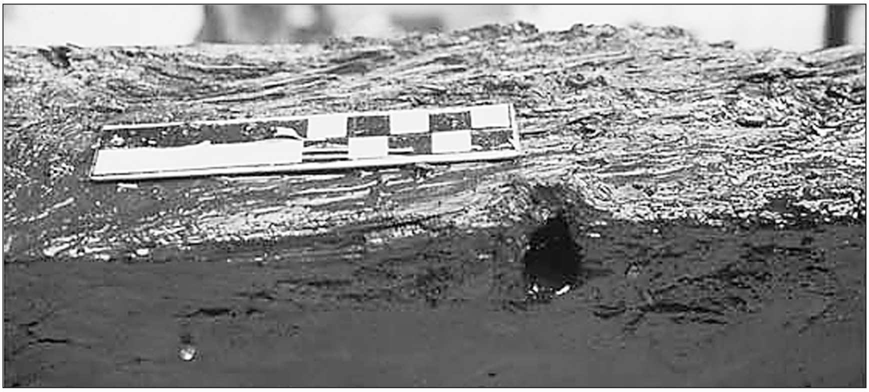



Fig. 7.21. Planking plan after 2000 field season. (Drawing Filipe Castro)



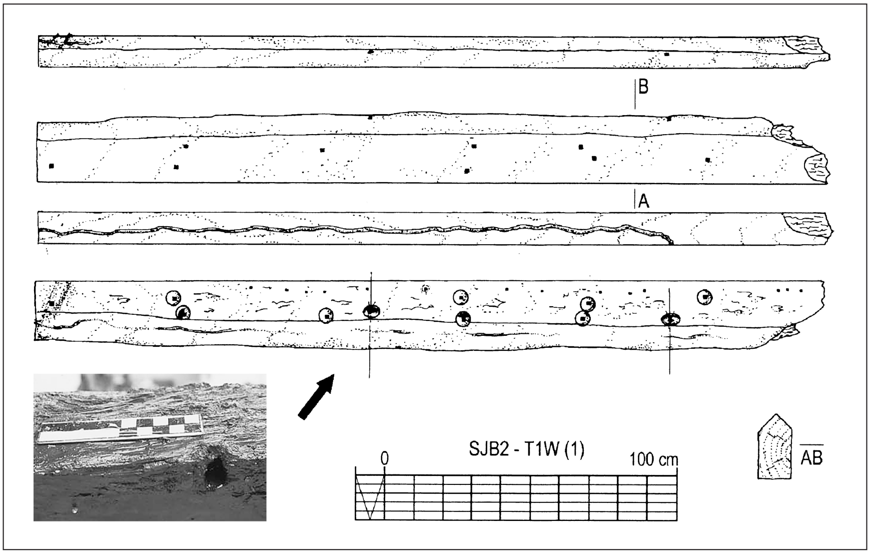



Fig. 7.22. Garboard T1W(1) showing diagonal spikes that reinforced fastening between the keel and garboard. (Drawing Filipe Castro)

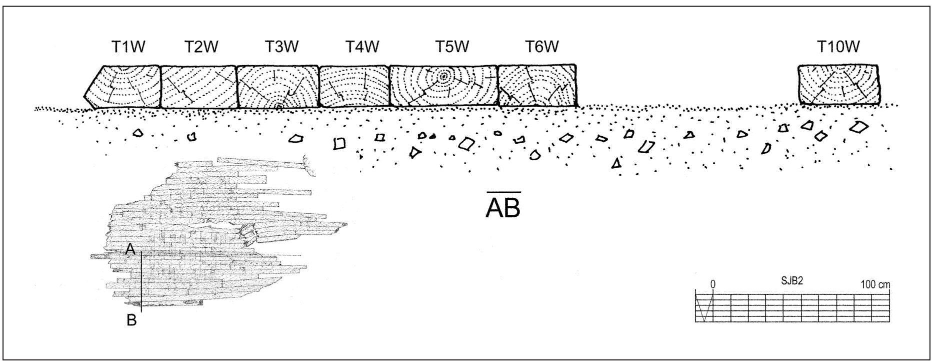



Fig. 7.23. Wood grain of a sample of planks. (Drawing Filipe Castro)

Fig. 7.24. Outer surface of plank T6W showing evidence of charring. (Photo Filipe Castro)

**TABLE 7.22. WOODEN PLUGS**

| LOCATION | DIMENSIONS | COMMENTS |
|---|---|---|
| Under floor C3 | ⌀ = 1 cm<br>h = 4 cm | Only preserved on floor |
| Under floor C4/T11E | ⌀ = 2 cm at base, 1 cm at top<br>h = 7.5 cm | Left in situ |
| Under futtock B5E/T15E | ⌀ = 1.5 cm at base<br>h = 3 cm | Inserted at 60° angle with planking |

pitch. This was said to help the first layer of pitch penetrate more deeply into the wood and the second to adhere better to the first. The interior of the hull was well preserved under a layer of a resinous substance that exuded a strong smell of pine.

With very few exceptions, all planks were spiked to the frames with two iron spikes per frame, and the heads of each spike were recessed into countersunk holes. The countersink holes varied in diameter from 4–7 cm, in depth from 1–3 cm, and in shape from perfectly circular holes to square holes with rounded corners.

In three different locations, wooden plugs were used to fill nail holes in the planking that were not in use (table 7.22). All these plugs were beveled into a pyramidal shape and tightly inserted into the planking and framing (see figs. 7.10 and 7.11).

## Fastenings

All fastenings found on the wreck were made of iron. Each timber exhibited spike holes of several dimensions, the majority having square sections. Impressions of the fastening heads were visible on the countersink holes, showing that they were square with rounded corners.

Some of the floors had round holes in addition to the square ones, corresponding to the bolts that linked the keel to the keelson. These round holes were also found in the apron. Two bolts were placed in each section of the keel, before and abaft of each scarf.

All fastening holes were bored with augers prior to driving the spikes and bolts. Spikes were manufactured with pyramidal shanks to facilitate their insertion—some spikes were 60 cm long—and to ensure a good sealing of the holes. Caulking—probably oakum—was found in the concretions around the heads. Similarly, the bolts had conical shanks that enlarged around 5 mm over their last 10 cm to plug the augured holes, but no caulking remains were found on either of the two concretions that preserved the shape of bolt heads.

The fastening pattern is clear and simple. Floors and futtocks were joined with spikes about 60 cm long, with square shanks 2–2.5 cm on a side and square heads with rounded corners. The same was true for fastening floors and keel. Planks and floors were fastened with spikes of two types: the first is about 25 cm long, with square shanks 1.8–2 cm on a side, and the second type is around 50 cm long, with square shanks 2–2.5 cm on a side. Both types had square heads with rounded corners. The longer spikes were clenched on the upper surfaces of the floors. Keel and keelson, as well as keel and apron, were joined with bolts more than 1 m long, with round shanks 3.5–4 cm in diameter and round heads 7 cm in diameter (table 7.23). Casts were taken from two fastener concretions: a bolt from keel section Q2 and garboard T1W (1) and a spike from floor C6 (figs. 7.25 and 7.26).

**TABLE 7.23. FASTENINGS (SPIKES AND BOLTS)**

| JOINERY | LENGTH | SECTION | HEAD | COUNTERSINK |
|---|---|---|---|---|
| Planking to frames | 25 cm | ⌷ = 1.6–1.8 cm | ⌷ = 4.0 cm, with round corners | [1] Ø = 4–6 cm 1–2 cm deep |
| Planking to frames | 50 cm | ⌷ = 2–2.5 cm | ⌷ = 5.0 cm, with round corners | Ø = 5–7 cm 1–3 cm deep |
| Floors to futtocks | 60 cm | ⌷ = 2–2.5 cm | ⌷ = 3.5 a 4.0 cm, with round corners | Ø = 6 cm 2.0 cm deep |
| Floors to keel | 60 cm | ⌷ = 2–2.5 cm | — | — |
| Keel to keelson | >1.00 m | Ø = 3.5–4 cm | Ø = 7 cm | — |
| Apron to keelson | >1.00 m | Ø = 3.5–4 cm | Ø = 7 cm | — |

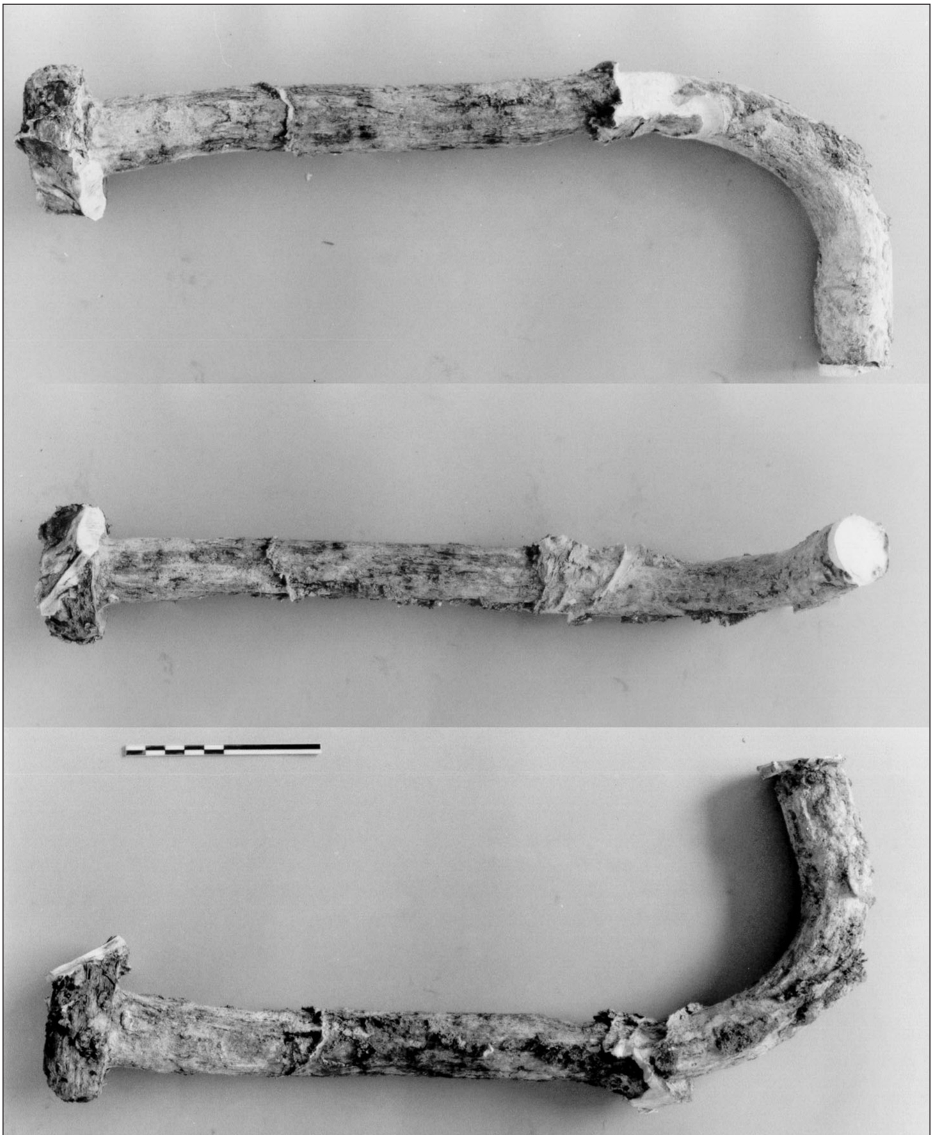


Fig. 7.25. Three views of cast of bolt Q2/C7(V) joining keel and keelson. (Photos Pedro Gonçalves, CNANS; used with permission of CNANS)


Fig. 7.26. Cast of spike on floor C6. (Photo Pedro Gonçalves, CNANS; used with permission of CNANS)

## Caulking

The caulking was performed with great care. Each plank seam, including the hood ends, was caulked with a strip of lead twisted into a 5–9 mm thick string (fig. 7.27), and two layers of oakum thread were then pressed against it from the outside (fig. 7.28). At many points, a thread of oakum was also found on the inside of the seam, presumably indicating that it was inserted in at least some of the seams before the lead string, creating a four-layer caulking protection between the planks.

All seams were then protected from the outside with long, narrow straps of lead 2–8 cm wide, some nailed along the plank seam's central axis, some along both edges. The lead straps were held with one or two lines of iron tacks, with shanks 4 mm on a side and round large heads 27–30 mm in diameter, spaced 4–8 cm apart (figs. 7.29 and 7.30).

Lead sheets of square or rectangular shape were also found on the site. These were pierced along their perimeters with the same 4-mm square holes, spaced from 4 to 8 cm apart. These sheets presented greatly varying dimensions, the smallest being 12 by 13.5 cm and the largest 40.5 by 23 cm, and may correspond to repairs made during the trip. All sheets and straps of lead presented thicknesses between 1–2 mm (fig. 7.31).

The seam between the keel and the garboard was also caulked with a string of lead, two layers of oakum, and a continuous lead strap (fig. 7.32). The tables of the keel scarves were caulked with a vegetable felt that has not yet been analyzed.

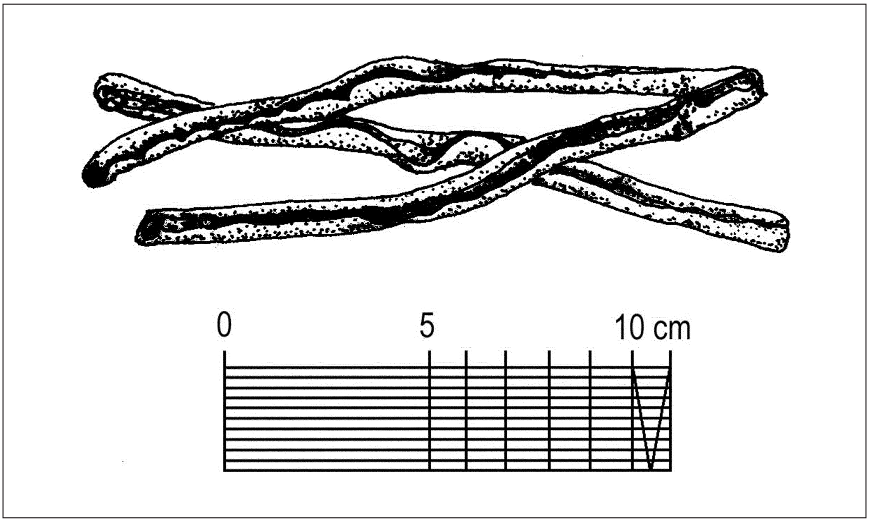



Fig. 7.27. Lead string inserted into seams. (Drawing Filipe Castro)

Fig. 7.28. Oakum inserted into seams. (Photo Pedro Gonçalves, CNANS; used with permission of CNANS)

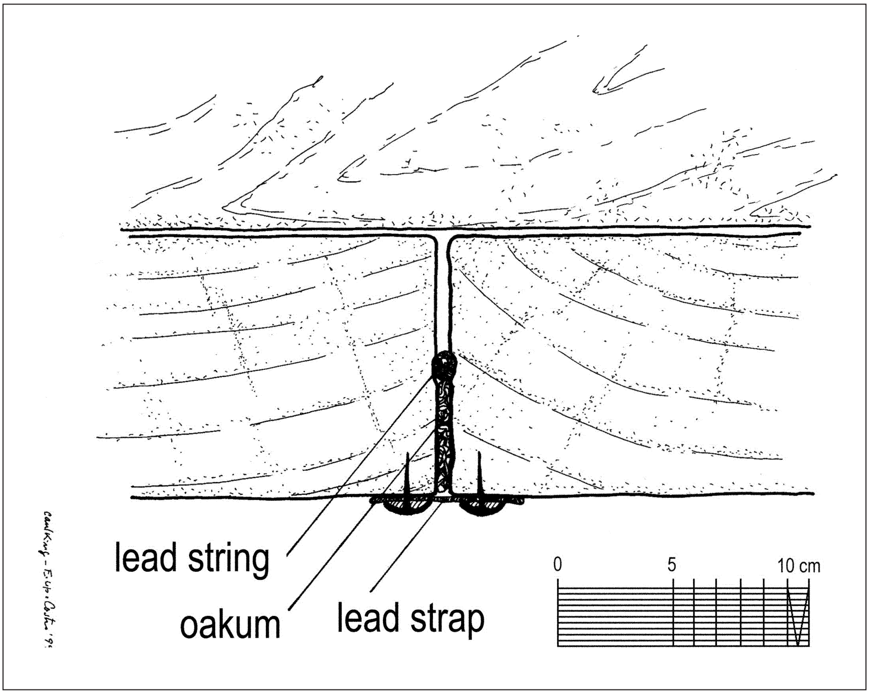



Fig. 7.29. Caulking arrangement. (Drawing Filipe Castro)

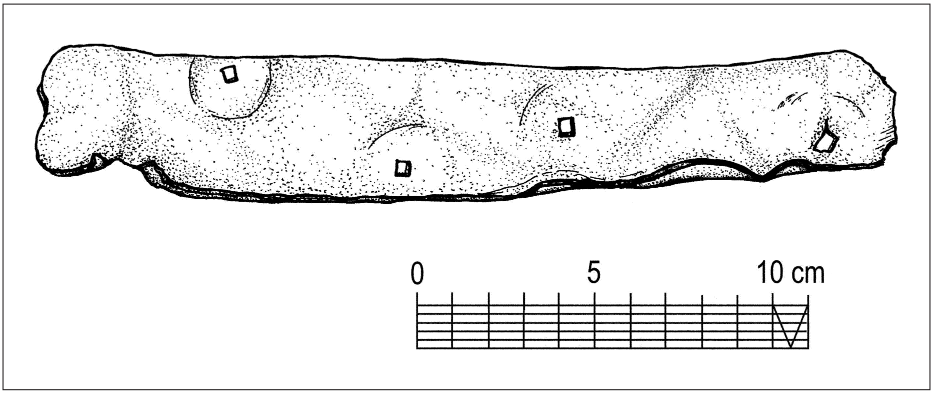



Fig. 7.30. Marks of heads of tacks on lead strap. (Drawing Filipe Castro)

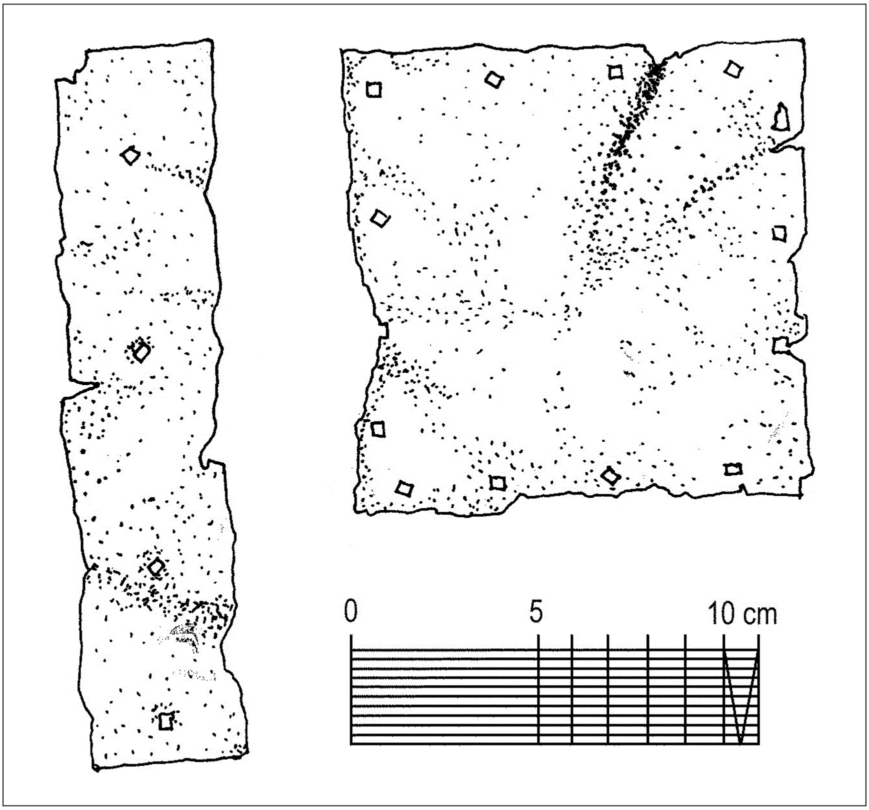



Fig. 7.31. Lead sheets. (Drawing Filipe Castro)

## Wood

At least two different species of wood were used in the construction of this vessel. In 1996, ten samples were taken and sent for analysis and species identification (fig. 7.33). The results indicate that the keel, apron, and frames were cut from cork oaks (*Quercus suber*), and the planks were made from umbrella (stone) pines (*Pinus pinea*) (fig. 7.34). These results came as no surprise, as these species are indicated in the late sixteenth- and early seventeenth-century literature as the proper trees with which to build ships.

It appears that the cork oaks used were relatively small considering the dimension required for the structural timbers—as suggested by the number of sections composing the keel and the number of patches on the futtocks. The planking was cut out of large and straight pine trees, with regular grain and very few knots.

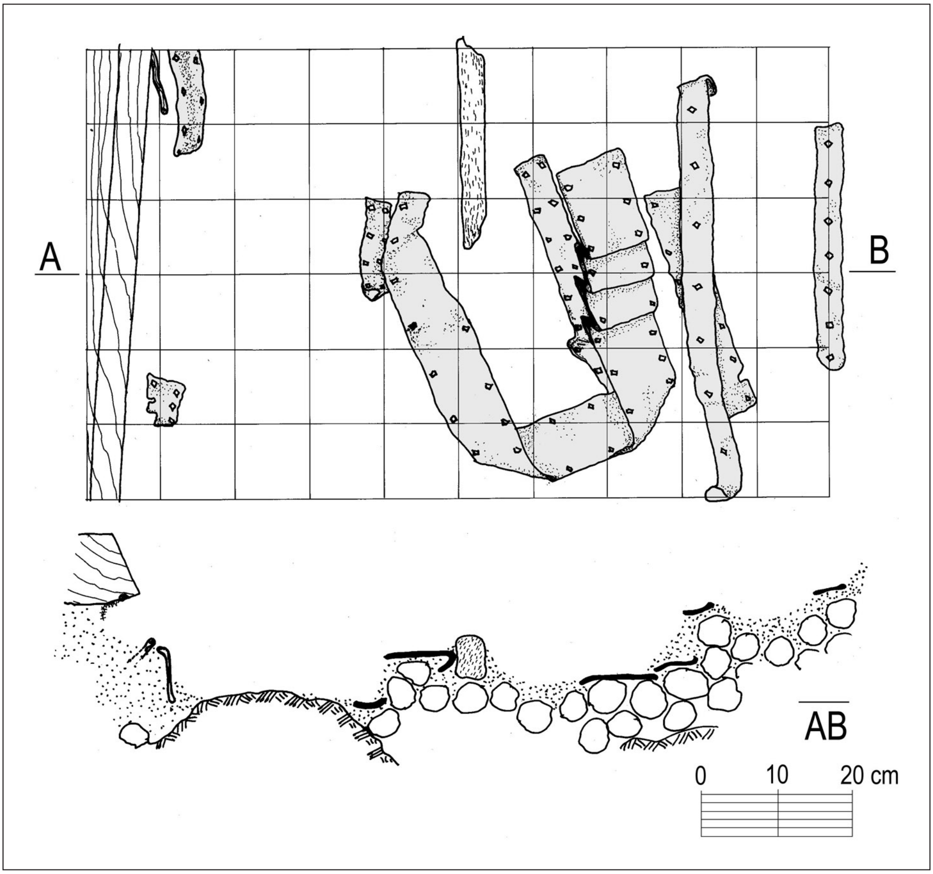



Fig. 7.32. Lead caulking strap found under seam of keel and garboard. (Drawing Filipe Castro)

Since there is no dendrochronological series for Portugal, no further analysis was conducted on the wood from this vessel. Dendrochronological analysis might help to determine the relative ages of the timbers found on the vessel and to investigate questions related to the management of the forests and timber supply problems, as well as times of seasoning, storage, and possible reuse. Nevertheless, the size of the oak timbers suggests a shortage of large trees and indicates that there was little or no forest management, pruning, or long time storing, at least for oaks.

## Tool Marks

Most timbers were badly preserved, showing rounded corners, eroded surfaces and, where exposed, extensive damage, mainly due to wood worms.

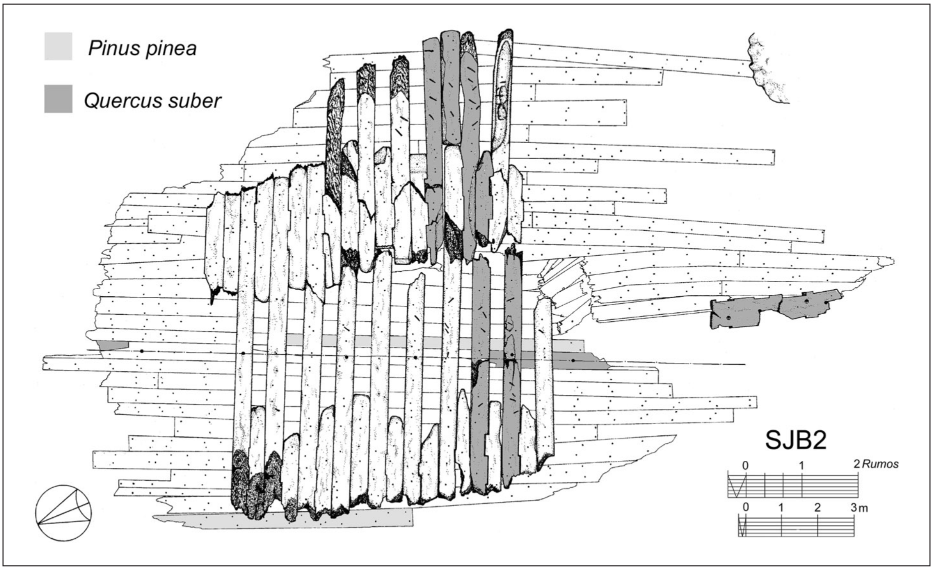



Fig. 7.33. Wood species identification, sampling plan and results. (Drawing Filipe Castro)

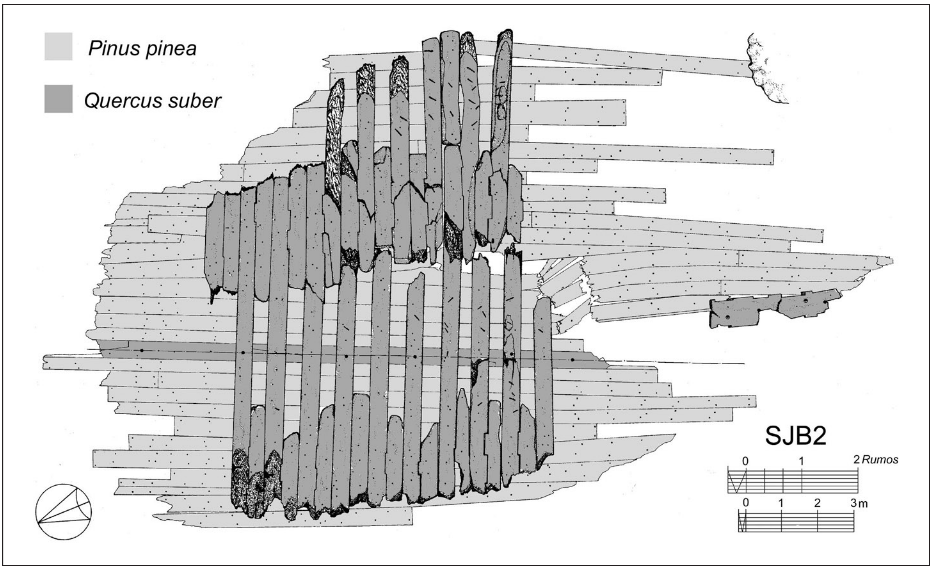



Fig. 7.34. Woods used in construction of the SJB2 vessel. (Drawing Filipe Castro)

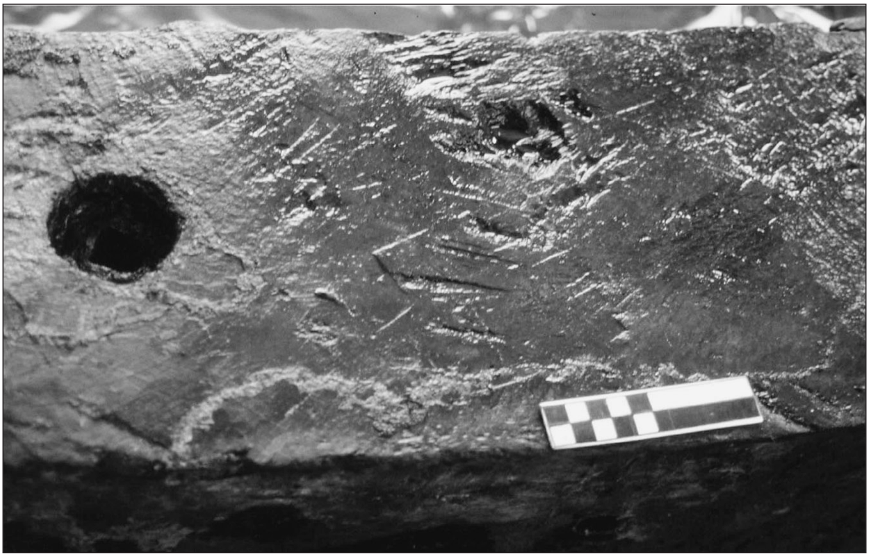


Fig. 7.35. Adze marks on floor C4. (Photo Filipe Castro)

However, a number of timbers showed tool marks in their preserved surfaces. Most floors and futtocks were clearly shaped and finished with adzes (fig. 7.35). Where they could be measured, the blades of the adzes seemed to be 7 to 10 cm wide (fig. 7.36). All surfaces that had not been deliberately smoothed still showed saw marks (fig. 7.37). The hole on futtock B3E from where the treenail was extracted had been opened with an auger with a conical tip.

## Ballast

Although no clear evidence of the ballast has been found, the hull lies above a thick layer (archaeological stratum C) of round pebbles of small diameter (5–15 cm) mostly from a Cretaceous limestone with Eocene basalt intrusions characteristic of the Lisbon region. These pebbles are abundant on the northern banks of the Tagus and are known to have been used as ballast in other ships, such as the Molasses Reef Wreck, although stones of larger dimension usually seem to have been preferred.[3] However, this site comprises the remains of many shipwrecks, and most wrecks that occurred here had violent impacts on the vessels' hulls. Neat, coherent ballast piles cannot be expected to exist in this area. Adding to the puzzle, the remains of several sections of the fortress walls destroyed by winter storms and reconstructed in the subsequent summers are scattered all around, including fairly recent concrete shards. Samples of some of the intrusive stones, such as granite, have been retrieved for analysis.

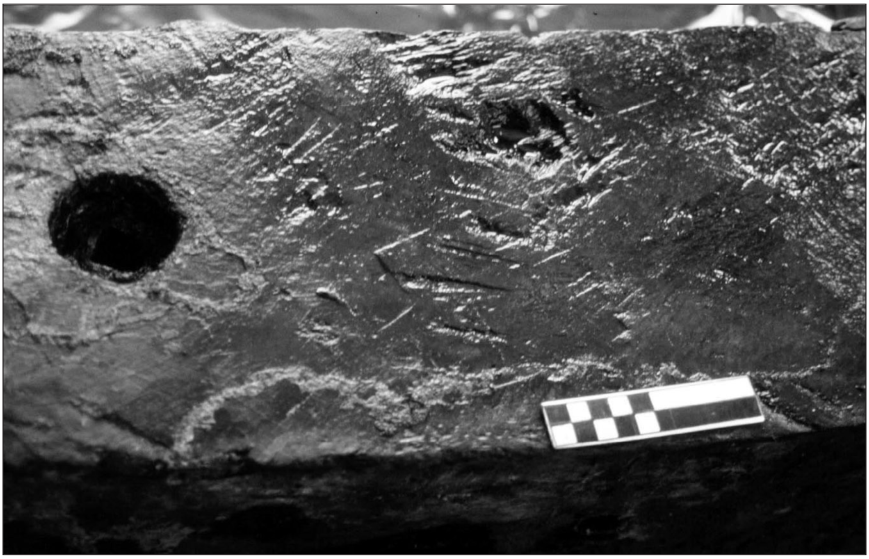


Fig. 7.36. Adze marks on floor C6. (Photo Filipe Castro)

Fig. 7.37. Saw marks on patch from futtock B5E. (Photo Filipe Castro)

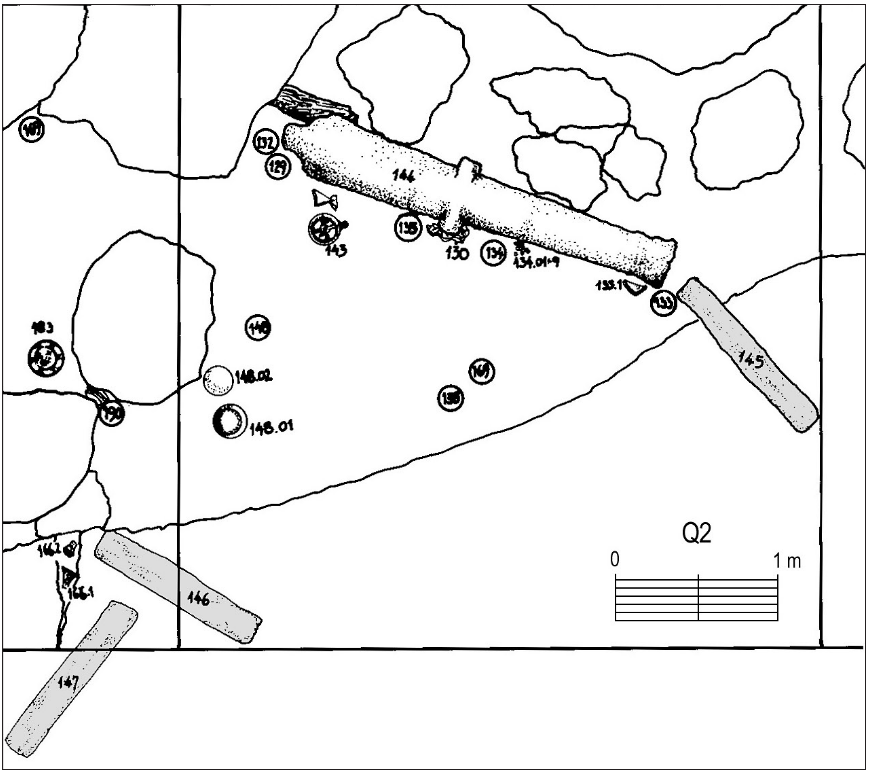



Fig. 7.38. Long stones, possibly carved, found north of wreck (Square Q2). (Drawing Filipe Castro)

Certain stones found near the hull deserve mention because of their weight and possible connection with the shipwreck under study (fig. 7.38). These are a grinding stone with a diameter of 83 cm; three long stones with roughly rectangular sections, around 10 cm thick and measuring 13 by 79 cm, 22 by 110 cm, and 15 by 119 cm; and one stone about 1.50 m long that may be an old anchor stock. The long stones with roughly rectangular sections were recorded in situ in 1997 but could not be relocated during the 1999 and 2000 field seasons due to heavy silting. A geological origin should not be excluded.

# 8

# Analysis and Reconstruction

THE RECONSTRUCTION of the hull of a seventeenth-century Portuguese nau proved to be a difficult task given the large gaps in the available data. The undertaking therefore involved much speculation and conjecture. Nevertheless, even the sparse remains of the *Nossa Senhora dos Mártires* provide enough data to justify such a study, particularly when combined with the important body of theoretical information available from this period.The three most important texts pertaining to Portuguese shipbuilding during the late sixteenth and early seventeenth century are Father Fernando Oliveira's *Liuro da fabrica das naus* (1580), João Baptista Lavanha's *Livro primeiro de arquitectura naval* (c. 1610), and Manoel Fernandez' *Livro de traças de carpintaria* (1616). To these treatises can be added the late sixteenth-century manuscript from the codex known as the *Livro náutico* and two early seventeenth-century manuscripts, the "Coriosidades de gonçallo de sousa" and the Harvard manuscript, containing the expenses of the construction of two India naus in the 1620s. Additional information can be retrieved from the *Livro de toda a fazenda* by Figueiredo Falcão (1607) and the contracts for the construction of the naus of Gonçalo Roiz and Sebastião Themudo (1598), transcribed by João Baptista Lavanha, to which should be added the comments of the commissions gathered in the 1620s to discuss the size of India naus.[1]

In the following pages each structural component of the *Mártires*'s hull is analyzed in view of the theories related in the texts on shipbuilding from the Habsburg period in Portugal (1580–1640).

## Size

East Indiamen, which averaged about 500 tons capacity—probably around 1,000 tons displacement—were said to be the largest vessels built at their time, and this may very well be true as no other route required larger vessels. Though larger vessels had been constructed in previous centuries, they were not built following a prototype, as a specialized type of working craft designed to perform a given task on a regular basis.

By the early seventeenth century many large round ships were sailing all seas. It is difficult to compare the sizes of various ships using historical sources, because the way in which tonnage was calculated changed from port to port and through time, and the relations between the numerous units given in the written sources are seldom clear or absolutely reliable. However, India naus were by no means the giants of all times. As early as the mid-thirteenth century, the galleys of Genoa failed to capture the Venetian ship *Roccaforte,* said to have had a capacity of around 500 tons.[2] In the early fifteenth century the Italian merchant Luca di Maso described the English lapstrake vessel *Grâce Dieu* as having a capacity of around 1,500 tons.[3] Although the *Grâce Dieu* was considered unfit to sail and can hardly be considered a success from the history of shipwrightry, it was astoundingly big for its time, and its tonnage was certainly not matched by many other vessels during the fifteenth century. There are references to some large vessels in Portugal in the late fifteenth and early sixteenth centuries, such as the large ship mentioned in Garcia de Resende's chronicle of John II (1455–95), or the *São João* from the 1530s, a ship said to have been one and a half times the size of an India nau.[4] However, like the *Grâce Dieu,* this vessel did not perform well at sea.

Large vessels were not very popular among English shipwrights before 1650. Only three ships are credited with keels of more than 30 m before 1600, and until 1649 only eight are mentioned in the English records, the largest being Phineas Pett's *Prince Royal* (1610), with 35.05 m of keel, and Peter Pett's *Sovereign of the Seas* (1637), with a keel of 38.71 m.[5]

However, the popular accounts that portray the India route naus as immense floating cities are exaggerated. François Pyrard de Laval and Jan Huigen van Linschoten wrote two of the most popular accounts of voyages to India aboard Portuguese naus. The first of these authors, traveling to India between 1601 and 1611, left us interesting, if at times exaggerated, descriptions of these ships: "These naus have commonly fifteen hundred to two thousand tons and more, being the largest vessels in the world, as far as I have seen, and cannot sail in less that ten braças [20.54 m] of water." He goes on to say that the vessels had four decks, and that in each one could fit a standing man, no matter how tall he might be, leaving still two feet above his head. According to Pyrard de Laval each of these naus carried thirty-five to forty large bronze guns to which were added other smaller guns, such as *esperas* and *pedreiros,* placed at the tops. He claims that the tops were large enough to accommodate ten or twelve men, and that all the masts were so enormous that there were no trees to make them, and they had to be assembled from several pieces: "All masts are commonly made of several pieces, and covered around by *chúmeas* which are thick timbers tightly inlaid on the required thickness. And these timbers, very well adjusted, are tightly fastened with ropery and iron bands very well tightened so that they don't collide with the raising and lowering of the yard, which is proportionately thick to the mast, and has got 20 braças [41.08 m] of length. It takes more than 200 men to raise one of these yards, and always two thick capstans."[6]

That the main yard measured close to 20 braças makes sense; the author of the *Livro Náutico* gives its length as being as many *braças* (2.048 m) in length as the keel had in *rumos* (1.54 m), claiming that this is equivalent to three-quarters of the length of the weather deck.[7] But the size of crews manning the India naus is fairly well documented, and it is hard to believe that it would take more than two hundred men to raise the main yard, for which we know there was a specific windlass on the gun deck. Distortions and exaggerations aside, the India naus were certainly large vessels specifically designed for long voyages. Many other nations also had large ships, and by the late sixteenth century there were several types of vessels with keels around 30 m long. Chances are that the keel of the *Nossa Senhora dos Mártires* was shorter than that.

Indiamen had to be large to sustain crews and passengers during the long voyages, and it seems that a larger than usual vessel was occasionally built in the Lisbon shipyards. Good examples of these are ships such as the *São João* of 1550–52 and the *São Bento* of 1551–54, both 900 tons; the *Garça* of 1556–59, 1,000 tons; and the *Madre de Deus,* captured by the British in 1592, and said to have been a three-decker of 1,600 tons burden.[8] However, the average India nau was smaller, with a keel length of around 27 m and a capacity of 500 or 600 tons. This trend is referred to by Father Fernando Oliveira in the late sixteenth century: "[I]n the time of King D. Manuel and King D. João, his son, when the voyage to India began and flourished, it was entrusted to men of singular understanding and knowledge, who did not neglect the profit: . . . From that time until now, that voyage has always been made in ships of more than 500 tons, and some 800 and 1000: and these have always been the ones that make the best and safest voyages: for they cope with the sea better. Which, on that track, is great and requires large ships to dominate it."[9]

The entry of the northern nations into the eastern trade, as well as the development of mathematics and engineering, brought about a trend toward larger vessels, and the size of merchantmen and war vessels increased steadily during the seventeenth century. Discussions regarding the size of the India route merchantmen were held in Portugal and Spain in the 1620s, following a letter from Admiral João Pereira Corte Real to the new king, Filipe IV of Spain and III of Portugal (1621–40). At least in those two countries an effort was made to impose reasonable limits on this growth. But apparently this was merely a political undertaking, for neither the shipwrights nor the theoreticians analyzed here seem to have been concerned with the increase in size of the India naus.

According to information in the Portuguese texts on shipbuilding, the India nau was evidently a standardized vessel. With rather small variations, they had a capacity between 500 and 600 tons, three or four decks, around 26–28 m of keel length, 39–41 m of overall length, 10 m of maximum breadth measured slightly below the weather deck, around 10 m of depth in hold, and a length to beam ratio around 3 : 1. They presented wide bows and full sterns, and had a characteristic flat midship section. Quite understandably, there exist many references to vessels that did not fit this standard. These were the giants that fascinated everybody, except perhaps the few who had to sail them. In addition to *Madre de Deus* (1592) and the large ships of the mid-sixteenth century—*São João* (1552), *São Bento* (1554), and *Garça* (1559)—there were others, such as the *Santa Catarina do Monte Sinai* built in Cochin in 1512 with a capacity of 800 tons and believed to be represented in the painting *Portuguese Carracks* in the National Maritime Museum in Greenwich.[10]

In order to understand the magnitude of this growth it is important to examine the standard size of vessels (table 8.1). In the *Liuro da fabrica das naus* (1580), Father Oliveira describes a nau with 3 decks, 18 *rumos* of keel (27.72 m), 39.04 m of length overall, a maximum beam of 12.32 m, a depth in hold of 9.24 m, and 600 tons of capacity. Its length to beam ratio is 3.17 : 1. In the *Livro náutico* of the 1590s, its author considers the proper size of an India nau to be 3 decks, a keel of 17 *rumos* (26.18m), 37.86 m of length overall, a beam of 12.83 m, a depth in hold around 8.19 m, and 600 tons of capacity. Its length to beam ratio is 2.95 : 1 In the *Livro primeiro de arquitectura naval* João Baptista Lavanha finds the best model around 1610 a 4-decker with a keel of 17.5 rumos (26.95m), 39.27 m of length overall, not considering the sterncastle extension over the transom, a beam of 13.86 m, and a depth in hold of 9.67 m. He does not indicate any capacity. Its length to beam ratio is 2.83 : 1 In the *Livro de traças de carpintaria* (1616) Manoel Fernandez proposes a 4-decker nau with a keel of 17.5 to 18 rumos (26.95 to 27.72 m), 40.04 to 40.82 m of length overall, a beam of 13.86 to 14.38 m, a depth in hold of around 10 m, and 600 tons of capacity. Its length to beam ratio is 2.83 or 2.89 : 1. Gonçallo de Sousa shares the same opinion, as he used the same original documents Fernandez used when he wrote his "Coriosidades."

The sets of measurements that survive today from the master builders

**TABLE 8.1. BASIC SHIP DIMENSIONS, AFTER 16TH- AND EARLY 17TH-CENTURY TEXTS**

| SHIPS AND SHIPS AS DESCRIBED BY AUTHORS | NUMBER OF DECKS | LENGTH OF KEEL (IN M) | OVERALL LENGTH (IN M) | BEAM (IN M) | DEPTH IN HOLD (IN M) | LENGTH TO BEAM RATIO |
|---|---|---|---|---|---|---|
| Oliveira, 1580 | 3 | 27.72 | 39.04 | 12.32 | 9.24 | 3.17 |
| *Livro Náutico,* 1590s | 3 | 26.18 | 37.86 | 12.83 | 8.21 | 2.95 |
| *Madre de Deus,* 1592 | 3 | 30.80 | 50.29 | 14.27 | — | 3.52 |
| V. Themudo, 1598 | 3 | 26.95 | 38.95/39.86 | 13.61 | ≈10 | 2.86/2.93 |
| Gonçalo Roiz, 1598 | 3 | 26.95 | 38.95/39.86 | 13.61 | ≈10 | 2.86/.93 |
| Lavanha, 1610 | 4 | 26.95 | 39.27 | 13.86 | 9.67 | 2.83 |
| Fernandez, 1616 | 4 | 26.95/27.72 | 40.04/40.82 | 13.86/14.38 | ≈10 | 2.89/.83 |
| *S. Bartolomeu,* 1625 | 3 | 30.03 | 43.98 | — | — | — |

Gonçalo Roiz and Sebastião Themudo (1598) are similar, with 3 decks and very bulky hulls. The keel length is still of 26.95 m (17.5 *rumos*); the overall length remains between 38.95 and 39.86 m, depending on the rake of the sternpost, and the beam is equal to one-third of the overall length. Gonçalo Roiz gives 13.61 m for his maximum beam, on the gun deck, and the depth of hold is estimated at around 10 m, for no measurements are given for the thickness of the deck timbers:

*3.58 m (hold) + 1.79 m (3d deck) + 1.79 m (2d deck) + 1.79 m (main deck) = 8.96 m*

When the larger vessels of the seventeenth century are considered, it is evident that they are a continuation of designs that had already been developed, rather than a new type of vessel. The description of the nau *Madre de Deus* captured by the British in 1592 mentions 3 decks and an overall length of 50.29 m (165 feet), from the beak head to the stern. Its maximum breadth, measured on the second closed deck, was 14.27 m and its length of keel is said to have been 30.48 m, but it seems more likely that it was 30.80 m, the equivalent of 20 *rumos.* The draft seems exaggerated no matter what the conditions of load may have been: "She drew in water 31 feet at her departure from Cochim in India, but not above 26 at her arrival in Dartmouth, she being lightened in her voyage by diverse means."[11]

It is a fact that these ships could not sail with only light cargoes in the hold—such as pepper—and heavy artillery on the decks. As a result, they had to load as much as 9 *palmos de goa* (2.31 m) of ballast in the hold, leaving very little space for the pepper lockers. But it is difficult to imagine how a vessel with slightly more than 30 m of keel could draw 9.45 m of water (see table 8.1).[12]

The best insight into these larger vessels is given by the reports of a committee created by the king to analyze the claims of Admiral Corte Real regarding the allegedly poor performance of the naus built in Lisbon in the 1620s. In 1624 the king ordered two naus for the armada of 1625, with 3 decks and 20 *rumos* (30.80 m) of keel.[13] These were the *São Bartolomeu* and *Santa Helena,* inspected by a committee of experts in the Ribeira das Naus, Lisbon's shipyards, in order to inform the king about their quality.

These two vessels were meant to be equal in size and had a length of keel of 30.03 m (19.5 *rumos*), an overall length of 43.89 m, a beam of 14.76 m, and a depth in hold of 9.63 m. Their length to beam ratio was 2.97 : 1. Their stern castles were each 1.97 m high, the first extending to the main mast, and the forecastle was 2.31 m high.

Master shipwright Valentim Themudo, one of the members of this committee, found these ships unsuitable for the India route. In his opinion, they were too wide at the bow; their scantlings were too heavy; and the hull was too bulky amidships. In his experience, ships should not have length to beam ratios out of the range 3 to 4 : 1. Valentim Themudo thought the ideal keel length was 30.80 m (20 *rumos*), for an overall length of 41.70 m and a beam of 13.35 m on the second deck. The length to beam ratio should therefore be 3.12 : 1 and not 2.97 : 1, which he considered unacceptable. Another criticism put forth by Valentim Themudo was that the stern castle should not extend too far abaft of the sternpost to avoid the enemy putting fire underneath it. Finally he thought that additional gun ports should be opened at the bow and stern, to allow four cannon in the stern and at least two culverins in the bow.

The committee met again in 1627 and the question of the best model for the India route was once more raised. Curiously, this time Valentim Themudo argued that the best ships for the voyage should have 600 *toneladas* of capacity and 18 *rumos* (27.72 m) of keel, disagreeing on this point with all the other members of the committee, who voted for a 700 to 800 *toneladas* vessel, with 19 to 20 *rumos* of keel (29.26 to 30.80 m).[14]

One of the problems evoked when trying to determine an ideal model was related to the helmsman's position on the 4-deckers. It was difficult to place the whipstaff at a point that allowed the helmsman to see the rig and the sails, which were therefore frequently at risk of being torn apart during maneuvers. Also, by now there was a problem with the loading of even the smallest ships, because more than a century of dumping ballast at the anchorage of Goa had made it so shallow in some areas that ships sometimes hit bottom in rough seas. Perhaps the only tendency that attained a degree of consensus among all the experts was the necessity of lowering the castles. Other aspects were discussed, and a recommendation was formed about not cutting any gun ports before the ship was ready, rigged, and floating, and those responsible for the defense of the ship were consulted.

The last documents from these discussions date from 1629 and contain a recommendation, which was refused, for the construction of three-decked ships of very large dimensions: a keel of 32.34 m (21 *rumos*), an overall length of 47.48 m, a beam of 14.89, and a depth in hold of 9.63 m, giving a length to beam ratio of 3.2 : 1.

Whatever the political circumstances, large ships continued to be built throughout the seventeenth century, some being praised for their characteristics like the *Bom Jesus,* about which the German traveler Johan Albrecht von Mandelslo said in 1639 that it was the noblest vessel he ever saw, or the great galleon *Santíssimo Sacramento,* lost in 1647 on the first trip from India to the kingdom, but said to have been one of the best naus ever built.[15]

## Keel

The keel of the SJB2 wreck was 25 cm sided and was not preserved in its complete molded dimension. However, the sizes of the three bolts that linked the keel to the keelson, preserved in the concretions under the keel, suggest the possibility that it may have been as much as 46 cm molded. Obviously the keel splintered in many places after hitting the rocky bottom, and some of the bolts were pushed in and bent to port side, as were the spikes that linked the floors to the keel. In addition, the bolt preserved under floor C7 (V) may have been pulled out as the keelson broke (see fig. 7.4). It is much more difficult to pull a bolt out than to push it in under these circumstances; therefore the possibility that this keel was 46 cm molded must be considered.

The keel was assembled from sections of less than 3 m, each roughly a tenth of its total length. If no larger pieces than these were used and the keel was close to 27 m in length, it can be assumed that it was assembled from seven small straight pieces and two *couces,* the stem and stern knees.

The texts considered in the analysis and reconstruction of this nau describe keels between 17 and 18 *rumos* long (26.18 and 27.72 m). Measurements given in contemporary written sources are summarized in table 8.2. As for the scant-

**TABLE 8.2. KEEL LENGTHS, AFTER 16TH AND EARLY 17TH-CENTURY TEXTS**

| AUTHOR | KEEL LENGTH | BIBLIOGRAPHIC REFERENCE[a] |
|---|---|---|
| Fernando Oliveira | 18 *rumos* = 27.72 m | Oliveira, 86, 165 |
| *Livro Náutico* | 17 *rumos* = 26.18 m | *Livro Náutico*, fl. 1 |
| Sebastião Themudo | 17.5 *rumos* = 26.95 m | Lavanha, 115 and 237 |
| Gonçalo Roiz | 17.5 *rumos* = 26.95 m | Lavanha,117 and 240 |
| João Baptista Lavanha | 17.5 *rumos* = 26.95 m | Lavanha, 34–35, 148, fl. 56 |
| Manoel Fernandez | 17.5–18 *rumos* = 26.95–27.72 m | Fernandez, 23 |

[a] See appendix B for bibliography of Iberian wrecks.

**TABLE 8.3. KEEL SECTIONS, AFTER 16TH AND EARLY 17TH-CENTURY TEXTS**

| AUTHOR | KEEL SECTION | BIBLIOGRAPHIC REFERENCE[a] |
|---|---|---|
| Fernando Oliveira | "heavier than the ribs" | Oliveira, 116, 197 |
| *Livro Náutico* | Sided: 1 pg; molded: 1 pg + 2 *dedos* | *Livro Náutico,* fl. 1 |
| João Baptista Lavanha | Sided: 1 pg; molded: 1 pg plus rabbet molded | Lavanha, 44, 154, fl. 62 v |

*Note:* pg = *palmos de goa; dedo* = unit of length, approx. 1.83 cm.
[a] See appendix B for bibliography of Iberian wrecks.

lings, apparently all agreed that the keels should be 25 cm (1 *palmo de goa*) sided and between 30 and 36 cm molded (table 8.3).

There was no consensus on the question of whether a keel should be carved out of a single piece of timber or made of assembled sections. Oliveira asserts that the optimal solution is to carve the keel from a single piece of wood, and if that were not possible, its sections should be very well joined together. However, Lavanha states that this is a poor solution as long timbers tend to warp, and therefore all keels should be assembled from several sections. The author of the *Livro Náutico* states that a keel takes five timbers plus the *couces,* with no further comments.[16] A scarf between the keel and the posts does not seem to have been an acceptable option for any of the authors. The solution that best accommodated the need for strength at these two important points of the hull was the use of the knees on both the extremities of the keel called *couces,* and linking them with flat scarves to the keel and posts. It is understandable that care was taken to ensure great strength at the extremities of the keel, as all kinks are points of concentration of stress in any structure. Furthermore, the stem was generally designed as a circular arc tangential to the keel at its base, creating a smooth transition and thereby avoiding the accumulation of stress at that particular point. All connections between the keel and posts were accomplished by flat scarves, vertical over the keel and horizontal on the posts (fig. 8.1).[17]

These discussions of the assembly of keels cannot be separated from the important question of timber availability. Comparison of the Portuguese and southern Spanish shipbuilding traditions in the sixteenth century with the northern European traditions makes evident the much greater quantity of wood used in northern hull construction and the larger dimension of the scantlings. Good timber for shipbuilding was quite scarce in Portugal and Spain by this time, and in spite of legislation issued by Filipe II to protect oaks and straight trees, the problem may have been beyond solution. These preoccupations are passionately expressed in 1580 by Father Oliveira: "this timber [cork oak] is so appropriate for the work and is necessary on this earth, and as, furthermore, we have no other that is equal for this use, it should be saved and

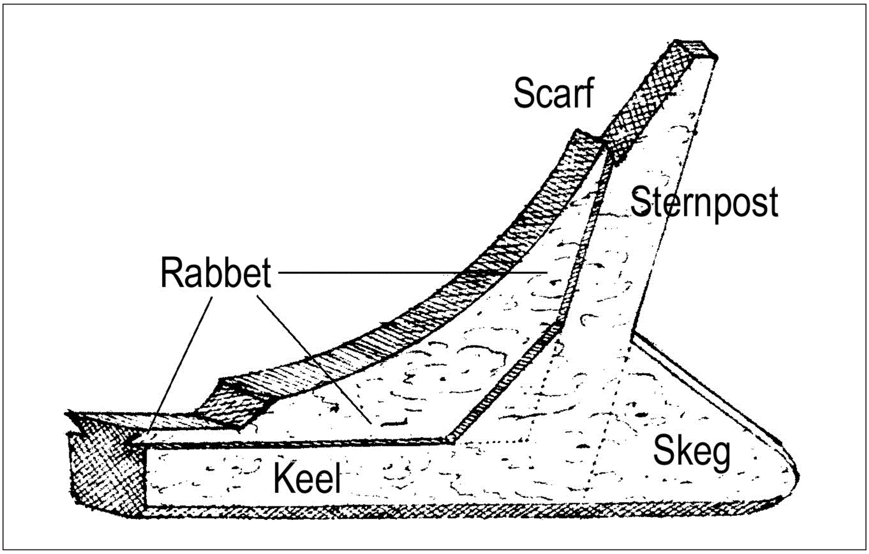



Fig. 8.1. Stern *couce,* after Lavanha, fl.63.

the felling of cork-oak trees for charcoal or tanning bark, or any other purpose less necessary than our naval construction, should be proscribed." And later, in 1628, by the shipwright Manuel Galego: "the cork oak timbers that are felled today are not anymore long enough to be fastened and connected together as they were in the past . . . and what can be found today is so little that in a few years there will be no more timber to build naus."[18]

Cork oaks are not straight trees, and building keels out of such crooked trees does not seem an easy task. Nonetheless several contemporary authors consider cork oak the best timber for building the keels, posts, and frames of India naus. Oliveira says: "the cork oak is very hard and does not rot in water, but freshens, rather, and is revigorated: for it is naturally dry and is preserved by humidity. In addition to this, its branches are twisted and the crooks have forms that are suitably shaped for bow and stern timbers, and knees, and other parts of this assemblage, being of such shapes that they seem, without any alteration, to have been born for this."[19]

In view of the shortage of timber and the large scantlings required in the construction of these ships, the short sections forming the building blocks of the SJB2 keel make sense. Since no full section was preserved and only a partial spike hole exists (fig. 8.2), it is not even possible to state how many spikes were used in each flat vertical scarf connection. However, Lavanha provides a detailed drawing of a flat vertical scarf with three spikes that can be assumed to be a plausible solution (fig. 8.3). Another reinforcing measure used by the

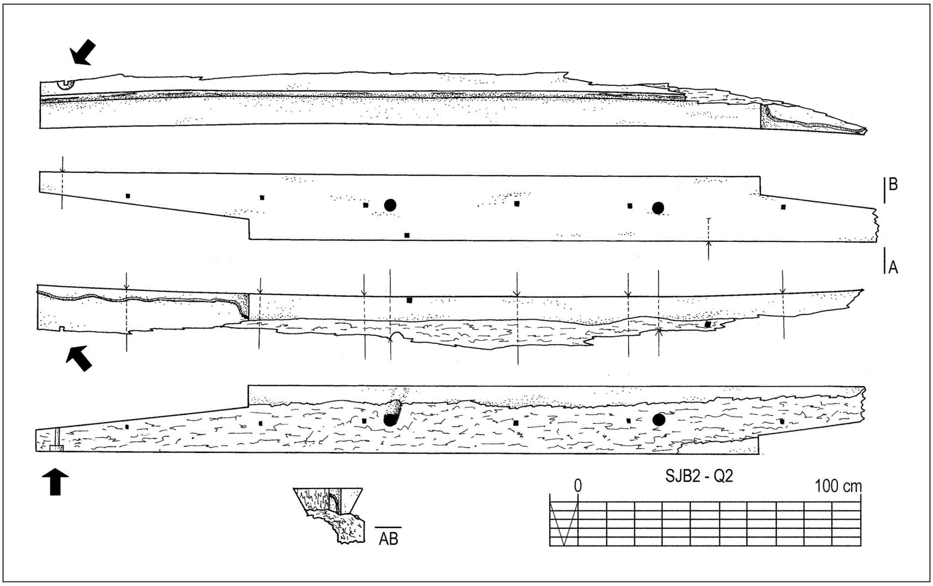



Fig. 8.2. Keel section Q2, the best preserved of the three sections of keel found. (Drawing Filipe Castro)

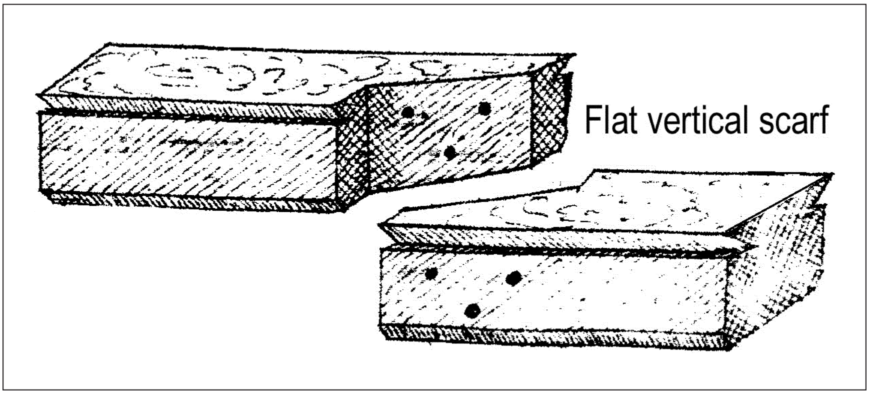



Fig. 8.3. Flat vertical scarf, after Lavanha, fl.62v. (Drawing Filipe Castro)

shipwright was to fasten each section of keel to the keelson with two strong iron bolts, placed before and abaft each of the scarves.

The rabbets have a constant angle that does not change along the preserved portion of the keel. This shows only that the curvature of the floors must match the angle of the garboards, and therefore will have a slightly concave curve near the keel axis toward the extremities of the keel.

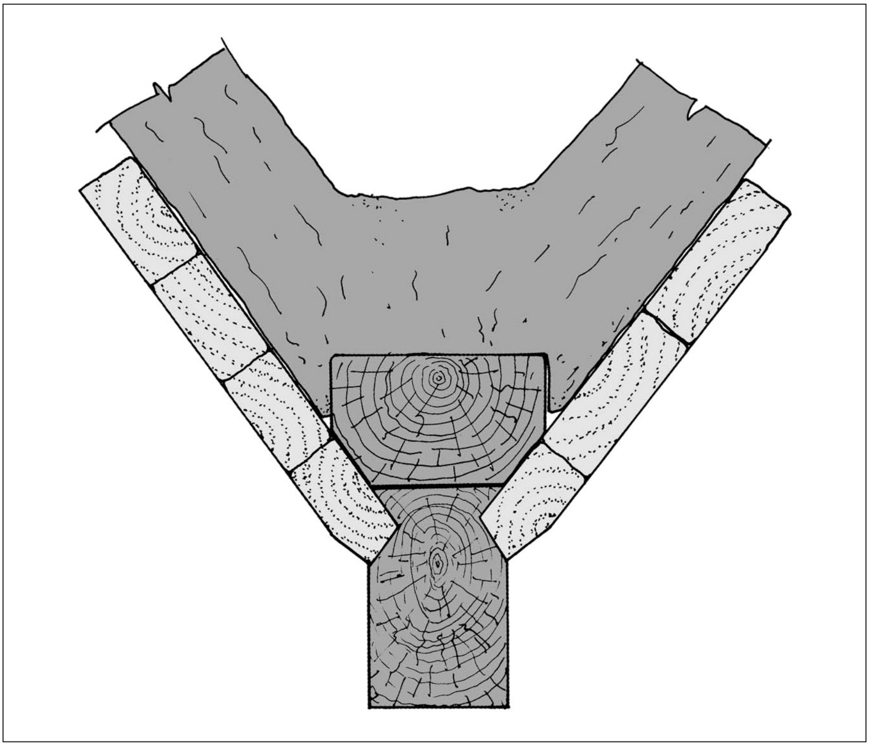


Fig. 8.4. Section of apron and reconstructed arrangement of keel, floor, and planking. (Drawing Filipe Castro)

## Apron

The apron is basically a large cork oak timber in which notches were cut to fit the foot of the floors. There was no preserved keel under the apron but a fair reconstruction of the arrangement used can be made employing the angles on the lower sides of the apron, to which was attached the planking (fig. 8.4). Based on the pattern established by the nail holes in the planking, the apron evidently received floors XVI, XVII, and XVIII.

## Frames

The frames yielded many important clues for the reconstruction of the hull. All futtocks were fastened to the floors with three or four spikes and a pair of dovetail scarves with rectangular tables. This method is well described by Lavanha for the central, predesigned floors: "all the eleven floors of account are joined with their *braços* [futtocks] on the ground . . . with great care, and have to come one on another very precisely, and account has to be taken only of these lines of the wrongheads [the surmarks] in the joining together of the floors with the futtocks, and in ones, and in others, mortises are made, with which they are adjusted." However, there were other ways to build a frame-first hull. Manoel Fernandez claims that predesigned frames should be erected every two *rumos:* "To the bow and to the stern you will set frames every two *rumos.*[20]

The mating surface between the floors and futtocks was always the face that looked toward the extremity of the vessel, a hallmark of the Mediterranean frame-first shipbuilding tradition. In other words, the futtocks of the Pepper Wreck are attached to the floors from the side of the posts. This practice may have resulted from two main factors. The first relates to the bevels required to fit the planks over the frames. If the design surface was the closest face to the master frame(s) the shipwrights always had to cut timber to get the appropriate bevels. If the frames were designed from the other side, the mating surface, the bevels would have to be cut on the futtocks and added on the floors (fig. 8.5).

The second factor pertains to the building sequence. Because the master floor and its fore and aft futtocks were spiked over the keel before the other

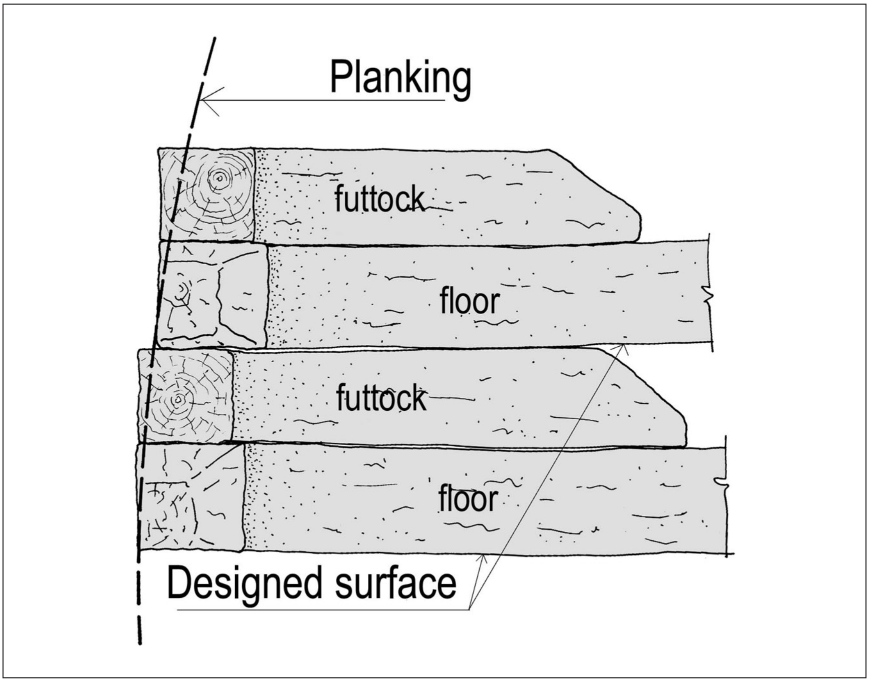



Fig. 8.5. Pairs floors/futtocks and respective bevels. (Drawing Filipe Castro)

frames, it seems reasonable that the next frames added would have had the floor placed against the futtocks to obtain a sequence of alternate floors and futtocks with a regular room-and-space.

## Design

It has been suggested that these frames were predesigned and preassembled according to the rules expressed by the Portuguese treatises and texts of shipbuilding of their time. That they were preassembled is obvious. All spikes were clenched on the side of the futtocks and encased in recessed cavities. Their heads were encased in countersink holes on the floors, at the side of the heads, and grooves were adzed on the futtocks to house the clenched points of the spikes. The floors leaned against the futtocks of the previous frame without any space between them. This arrangement would have been impossible if the floors were not already attached to the futtocks.

The evidence for the predesign of the frames is redundant, since it is impossible to cut and assemble frames without designing them first. Though some clues indicate how they were predesigned, many doubts remain. Different authors suggest various ways to design the frames to obtain a good hull shape, with fair runs and smooth ends, that could cut through the water without plunging the bow and steer efficiently without sinking the stern. Table 8.4 lists several different arrangements described in the historical sources. Other authors present different solutions. For example, in Spain, Diego Garcia de Palacio mentions nine predesigned floors to the bow and six to the stern, and Tomé Cano prescribes fourteen predesigned floors on each side of the master frame.[21]

The clues left on the structure of the Pepper Wreck are scarce yet eloquent. Only eleven floors were partially preserved, and of these only a few were not badly broken. The floors that were not broken were lost between 1997 and 1999 due to lack of means to expose and protect the structure after it was covered by several meters of sand during storms in the winter of 1997.

**TABLE 8.4. PREDESIGNED FRAMES, AFTER 16TH AND EARLY 17TH-CENTURY TEXTS**

| AUTHOR | MASTER FRAMES | PREDESIGNED FRAMES | BIBLIOGRAPHIC REFERENCE[a] |
|---|---|---|---|
| Fernando Oliveira | 3 | 18 before; 18 abaft[b] | Fernando Oliveira, 94, 174 |
| *Livro Náutico* | 1 | 17 before; 17 abaft[b] | *Livro Náutico* fl. 2 |
| Sebastião Themudo | 1 | 5 before; 5 abaft | Lavanha, 115, 238 |
| Gonçalo Roiz | 1 | 15 before; 15 abaft | Lavanha, 117, 240 |
| João Baptista Lavanha | 1 | 5 before; 5 abaft | Lavanha, 57, 163, fl. 72 |
| Manoel Fernandez | 3 | 15 before; 15 abaft | Fernandez: fl.1 v. |

[a] See appendix B for bibliography of Iberian wrecks
[b] As many predesigned floors as the number of *rumos* in the keel.

Profiles recorded in 1996 and 1997 using an electronic goniometer revealed the position of the planking, rather than the curves of the lower face of the floors, and are not very useful for the analysis of the shape of the frames. Moreover, many construction marks could not be observed in situ, as the timbers required thorough cleaning before most of the marks could be exposed.

However, the available evidence allows a tentative reconstruction of the process followed by the shipwrights of the Pepper Wreck. The most important clues for understanding the construction process are the numbers engraved on the floors, the rate at which the height of the floors grows over the keel, the surmarks that suggest the position of the turn of the bilge, and the curves of the futtocks.

The construction features exhibited by the hull's remains appear to represent the signature of a particular shipbuilding tradition. The Iberian-Atlantic tradition is documented by João Baptista Lavanha, who wrote perhaps the first treatise on shipbuilding where the theoretical role is clearly ascribed to an architect and not to a shipwright. His remarks on the building sequence include several references to the surmarks as part of the common construction routine: "then the straight line MS, the middle of the floor, may be marked with a scribe, and two others that terminate the *astilha,* set off from MS half a *palmo* each side, which make the breadth of the keel, and thus with the same *escopro* the straight line OP of the wronghead may be marked too."[22]

Lavanha also explains the necessity of numbering the floors during construction: "And at each floor with the same scribe its number may be marked on it, first, second or third, etc, whatever it may be, so that it may be known where it has to be set, and what its place is." He goes on to make an interesting reference to the insufficiency of the sections of the timbers, which may not allow the mold to touch the whole perimeter to be drawn. Such care must have applied to the design of the Pepper Wreck, for many of the large timbers clearly show the difficulties of obtaining adequate compass wood for the construction of large ships. When the mold floats above the surface of the timber to be cut, Lavanha recommends the use of a prismatic weight: "And when on the frames of the said timbers there may be wany edge (which often happens). . . . [A] small stick may be used, with four faces, ending in a point, called in this Art *chincho,* hung along the template."[23]

In the case of the Pepper Wreck there was evidence for three master frames and an undetermined number of predesigned frames of which only eleven were preserved, numbered with roman numerals, and preassembled before being mounted on the keel. Each frame was numbered counting from the master frames, which bore no numbers, since they were the number zero. The height of each floor over the keel rose as distance from the master frames increased, and the values of this rising closely match the rule defined by Father Oliveira for the rising of the turn of the bilge points (see table 8.6).

It follows that the four turns of the bilge surmarks should match the predicted narrowing of the floor timbers described in Oliveira's model. If this is the case, it will be interesting to analyze the design of the floors and futtocks preserved and recorded over the templates built after Oliveira's theoretical model.

## Rising of the Bottom

Both Fernando Oliveira and João Baptista Lavanha state that the floors should be 1 *palmo de goa* molded (table 8.5). This is an important measurement, not only because the floors of the Pepper Wreck were in fact 1 *palmo de goa* square but also because when this value is subtracted from the total height of the floors measured over the keel, a series of values are produced that follow closely a sequence of numbers obtained through a mathematical algorithm called *graminho* and clearly defined by Fernando Oliveira. "[O]ur carpenters call *graminho* . . . the distribution of increments by which the bottom, and the waist and the beam, of the ship are raised and narrowed. Which distribution is marked on a board, following the art that is indicated now. This art results in the making of an instrument which is also called *graminho:* for it indicates the apportionment by lines of certain fractions of the *compartida,* or length that is divided."[24]

The *graminho,* a gauge with a series of incised grooves, was used in the design of the floors through a system that is today known as whole-molding. Using a single straight half mold and two gauges, one for the rising and another for the narrowing, each floor was designed and sent to the sawyers in the manner shown in figure 8.6.

Each floor was plotted from the original flat mold, which corresponded to the master frames. Then the first floor before the master frames was designed using the master frame's mold by narrowing one point and rising one point, the second by narrowing two points and rising two points, continuing to the last predesigned frames which were called the tail frames, or in Portuguese *almogamas* (see fig. 3.2).

**TABLE 8.5. FRAME'S SECTION, AFTER 16TH AND EARLY 17TH-CENTURY TEXTS**

| AUTHOR | KEEL LENGTH | BIBLIOGRAPHIC REFERENCE[a] |
|---|---|---|
| Fernando Oliveira | Sided: 1 pg; molded: 1 pg | Oliveira, 116, 197 |
| Sebastião Themudo | — | Lavanha, 115, 237 |
| Gonçalo Roiz | — | Lavanha, 117, 240 |
| João Baptista Lavanha | Sided: 1 pg; molded: 1 pg | Lavanha, 38, 150, fl. 58 v |

*Note:* pg = *palmos de goa.*
[a] See appendix B for bibliography of Iberian wrecks.

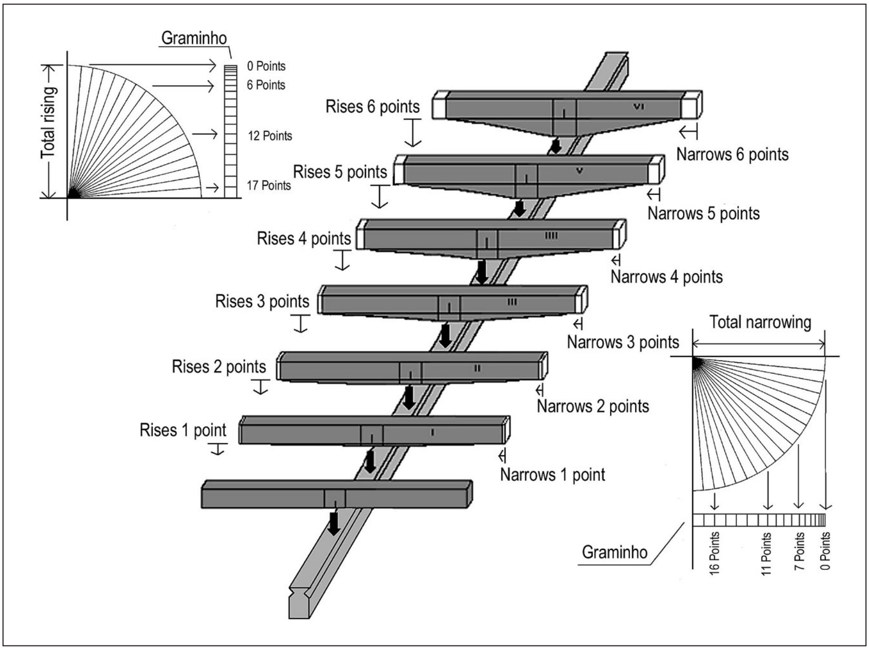



Fig. 8.6. Rising and narrowing of the bottom of a vessel using the whole-molding system. (Drawing Filipe Castro)

The two rising scales and the single narrowing scale were designed through a series of possible methods that had already been explained by Zorzi Timbotta in the mid-fifteenth century. In his book Oliveira uses the old Italian *mezza-luna,* called *besta* or *meia lua* in Portuguese, a word that means crossbow (see fig. 3.3). The values for the total rising to the stern and to the bow, and for the respective total narrowing, varied from author to author. Designating the value of the total rising or narrowing as *compartida,* Oliveira proposes the following: "Each of the scales related to the rise of the bottom has its own *compartida:* one for the stern and another for the bow, and they are different: one more and the other less: that of the stern more, and of the bow less. . . . The after scale usually rises one-twelfth part of the length which, with eighteen pairs [floor and futtock], gives us one 'pair and a half': and the one for the bow rises one-half or one-third less, resulting in almost a single 'pair.'"[25]

In other words, the bottoms should rise 1.5 times the value of room-and-space to the stern, and 1 time the room-and-space to the bow. Further on Oliveira proposes that the narrowing be a sixth of the flat amidships. These values were tested and a very close match was obtained (see table 7.8). The procedure is quite simple. The *besta* method consists of dividing half a circumference in two, and then in dividing each half into equal parts, as many as the number of floors over which one wants to spread the rising and the narrowing of the bottom. Under the symmetrical axis is placed the wooden gauge used to mark the horizontal grooves corresponding to the increments to be applied on each floor (see fig. 3.3). The total rising or narrowing is the radius of the circumference (see figs. 8.6 and 3.3). When each division of the circle, on each side of the half circumference, is united with its equivalent over the wooden gauge, a new point is marked on the sequence. Moving down the arc of the circumference, starting from the center, at 90°, larger increments are produced. The last division is equal to the base line, and the angle is 0°. Using *H* to represent the total rising or narrowing, and *n* the number of predesigned frames, the distance between each incremental line and the top of the gauge, $h_i$, will be given by the equation:

$$h_i = 1 - SIN\ (90/n_i)\ x\ H$$

The required values from this equation can be easily generated by computer, which I did using an Excel spreadsheet. The values obtained are given in table 8.6. It was necessary to test the other formulas for the design of ship's bottoms, as proposed by the other authors, in order to determine whether the rising of the bottom of the Pepper Wreck followed Oliveira's rule.

João Baptista Lavanha presented two different solutions for the rising of

**TABLE 8.6. VALUES FOR THE RISING OF FLOORS (AFTER OLIVEIRA)**

| FRAME NUMBER | *BESTA*—1.5 *PARES* (IN CM) | *BESTA*—1 PAR (IN CM) | PEPPER WRECK (IN CM) |
|---|---|---|---|
| I | 25.9 | 25.8 | — |
| II | 26.7 | 26.4 | 31 |
| III | 28.0 | 27.2 | 25 |
| IIII | 29.8 | 28.5 | 27 |
| V | 32.2 | 30.0 | 36 |
| VI | 35.0 | 31.9 | 31 |
| VII | 38.2 | 34.0 | 35 |
| VIII | 41.9 | 36.5 | 37 |
| VIIII | 46.0 | 39.2 | 39 |
| X | 50.4 | 42.2 | 42 |
| XI | 55.2 | 45.4 | 46 |
| XII | 60.3 | 48.8 | — |
| XIII | 65.7 | 52.3 | — |
| XIIII | 71.3 | 56.1 | — |
| XV | 77.0 | 59.9 | — |
| XVI | 82.9 | 63.8 | — |
| XVII | 88.9 | 67.8 | — |
| XVIII | 95.0 | 71.9 | — |

the bottom of an India nau. Both these methods have one thing in common: the master frame is not flat. In fact, Lavanha can be excluded from the list of candidates who might have written down the rules describing the building of the bottom of the Pepper Wreck by stating that the master frames should have a foot, in Portuguese *pé,* of one *dedo.* I have estimated 1 *dedo* as ⅔ of a common *polegada,* or 1.83 cm, a value substantially larger than the Spanish *dedo* in use in Seville at the time, which was equal to 1.74 cm.[26]

Since the planking preserved under the master frames of the Pepper Wreck was perfectly flat, and the garboards make an angle of 180° with the upper face of the keel, clearly whoever built this ship made the master frames flat. Nevertheless, Lavanha's rules were tested, and interesting results for both his methods were obtained (tables 8.7 and 8.8).

The first is presented by Lavanha and appears in his transcription of a document with the rules for an India nau by Sebastião Themudo in 1598. It implies a foot of 2.5 *dedos* (4.575 cm) and a rising of five *dedos* before and abaft a single master frame, distributed over five predesigned frames to each side. The second appears in Lavanha's transcription of the rules for the making of the nau *Conceição* in 1598 by the master shipwright Gonçalo Roiz, and considers a foot of 1 *polegada* (3.67 cm) on the master frame, and a rising of 2 *palmos de vara* (44 cm) forward and 3.5 *palmos de goa* (89.83 cm) abaft the three master frames, distributed over fifteen to seventeen predesigned frames to each side. The results show clearly that both these solutions contain a much sharper dead rise than the one recorded on the remains of the Pepper Wreck (see tables 8.7 and 8.8). When plotted graphically, clearly only Oliveira's rule approximates the values of the Pepper Wreck (figs. 8.7 and 8.8).

**TABLE 8.7. VALUES FOR THE RISING OF FLOORS (AFTER LAVANHA AND THEMUDO)**

| FLOORS | RISING TO BOW AND STERN | RISING ON PEPPER WRECK |
|---|---|---|
| Main floor | 30.2 | — |
| I | 30.6 | — |
| II | 31.9 | 31 |
| III | 33.9 | 25 |
| IIII | 36.5 | 27 |
| V | 39.3 | 36 |
| — | — | 31 |
| — | — | 35 |
| — | — | 37 |
| — | — | 39 |
| — | — | 42 |
| — | — | 46 |

**TABLE 8.8. VALUES FOR THE RISING OF FLOORS (AFTER GONÇALLO ROIZ)**

| FLOORS | RISING TO BOW | RISING TO STERN | RISING ON PEPPER WRECK |
|---|---|---|---|
| Main floor | 29.3 | 29.3 | — |
| I | 29.5 | 29.8 | — |
| II | 30.2 | 31.2 | 31 |
| III | 31.4 | 33.6 | 25 |
| IIII | 33.1 | 37.0 | 27 |
| V | 35.2 | 41.3 | 36 |
| VI | 37.7 | 46.4 | 31 |
| VII | 40.6 | 52.3 | 35 |
| VIII | 43.8 | 58.9 | 37 |
| VIIII | 47.4 | 66.2 | 39 |
| X | 51.3 | 74.1 | 42 |
| XI | 55.4 | 82.4 | 46 |
| XII | 59.7 | 91.2 | — |
| XIII | 64.1 | 100.2 | — |
| XIIII | 68.7 | 109.5 | — |
| XV | 73.3 | 118.9 | — |

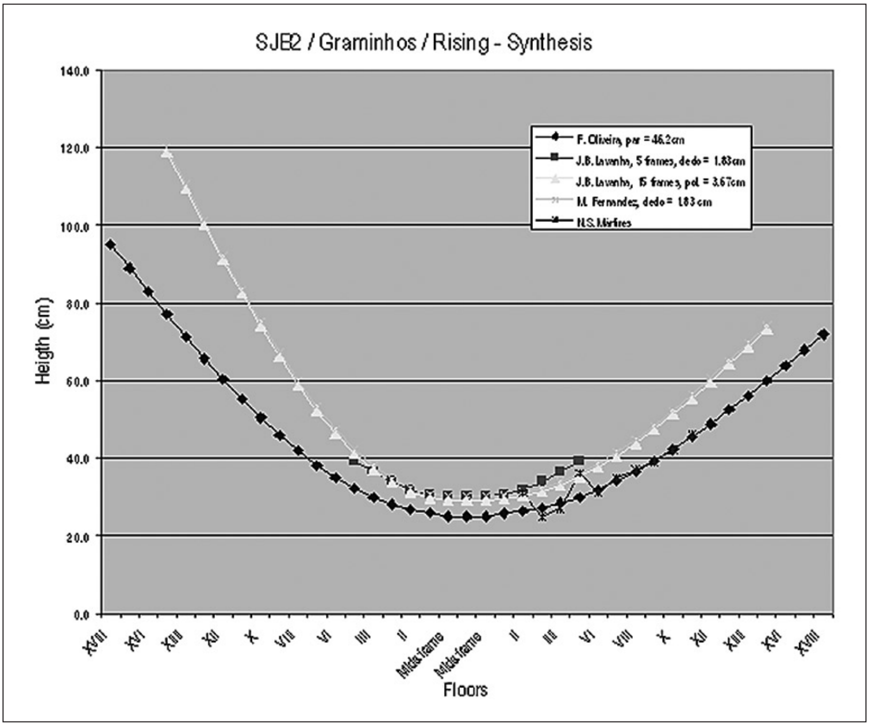



Fig. 8.7. Rising of the bottom after authors shown. (Graphic Filipe Castro)

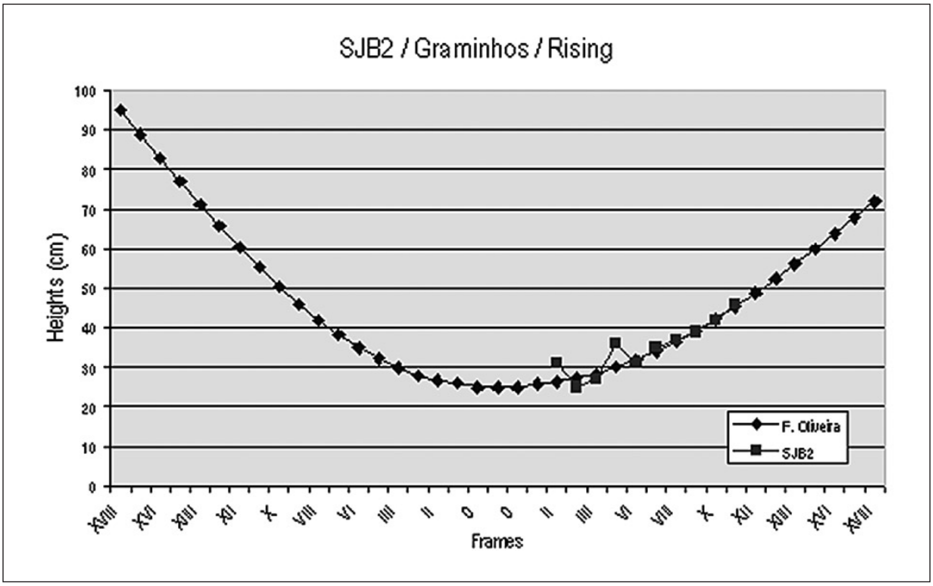



Fig. 8.8. Rising of the bottom, after Oliveira, compared with Pepper Wreck values. (Graphic Filipe Castro)

By the early seventeenth century, when the *Nossa Senhora dos Mártires* sank at São Julião da Barra, this was already an old rule for building vessels, as Oliveira had presented it first in 1570 in his Latin manuscript *Ars Nautica*.[27] However, although it seems that there may have been a trend toward reducing the number of predesigned frames during the first half of the seventeenth century, Manoel Fernandez still proposed fifteen predesigned frames in 1616.

## Narrowing of the Bottom

If the rising of the bottom seems so clearly to follow Oliveira's rule, how does the narrowing behave, according to the data available? The answer is not so clear, although it seems close to the values predicted by Father Oliveira.

Fortunately, the remains of eleven floors were preserved, of which ten still had the full section, over the keel, preserved by the concretions of thick bolts that once linked the keel to the keelson. The positions of the surmarks along the turn of the bilge could not be observed prior to the dismantling of the hull, as they were obscured by the adjacent futtocks. After the partial breakup of the hull remains in the winter of 1997, only four of these marks could be retrieved, and each was separated from the keel by the longitudinal fracture that runs along the hull. It is therefore harder to relate them properly to the keel axis and much harder to build or test a theory using four of the thirty-nine frames believed to have been predesigned. Nevertheless, an attempt was made to reconstruct their design.

The first task consisted of closing the fracture to try to get an accurate measurement of the distance between the surmarks and the keel axis. This was done in several different ways, and all produced slightly different values primarily due to two major problems. First, the seams of this fracture are eroded along several meters and do not allow a good drawing. Second, the eastern sections of the floors that still carry the turn of the bilge surmarks were separated from the planking with the exception of one (C4), which was kept in place by a wooden plug (see table 7.22).

The values obtained for the distances from the turn of the bilge marks to the keel axis are therefore fairly accurate before correction (see table 7.12) and highly conjectural after correction (table 8.9). The seams were closed in three different ways. The first method consisted of measuring the width of the seam in situ, under each of the floors C4 to C7, and then subtracting the values obtained from the total distance between the mark and the keel axis before correction. The second method consisted of rotating the planking in a paper model in order to close the seam and again subtracting the values obtained from the distances between the marks and the keel axis before correction. The third way consisted of rotating the planking and sliding the floors over the planking in order to align the two portions separated by the fracture (except number C4 [VIII], which was kept in place on the planking by a wooden dowel). The different values are presented in table 8.9 and compared to the expected values obtained from the model proposed by Oliveira.

Oliveira proposes a narrowing that is a sixth of the flat of the master frame, which should measure between a third and a half of the maximum beam, and a maximum beam that should measure between a third and a half of the keel length. He defines the ideal beam as being between 8 and 9 *rumos* and the flat as a third of the maximum beam, that is, 16 to 18 *palmos de goa*. The two possible values were plotted for the flat and compared to the values from the four series of measures presented above (see table 8.9). The results were quite

**TABLE 8.9. POSITION OF TURN OF THE BILGE MARKS AFTER CORRECTION (IN CM)**

| FLOOR | VALUES BEFORE CORRECTION | CORRECTED VALUES, 1 | CORRECTED VALUES, 2 | CORRECTED VALUES, 3 | VALUES AFTER OLIVEIRA |
|---|---|---|---|---|---|
| C4 | 202 | 189 | 182 | 189[a] | 189 |
| C5 | 202 | 193 | 188 | 188 | 193 |
| C6 | 203 | 196 | 194 | 195 | 196 |
| C7 | 203 | 199 | 198 | 198 | 199 |

[a] Fixed

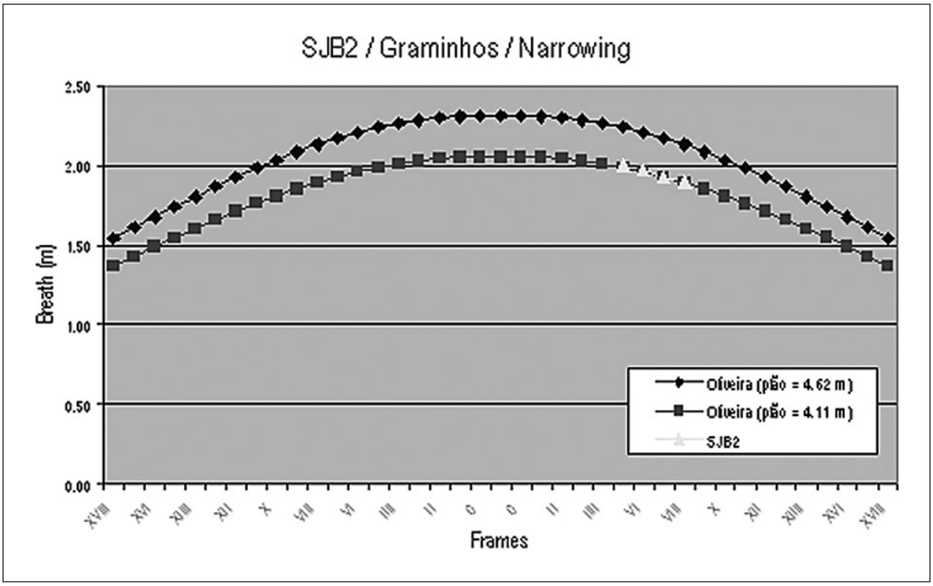



Fig. 8.9. Narrowing of the bottom. Comparison of values predicted by Oliveira and those obtained for SJB2. (Graphic Filipe Castro)

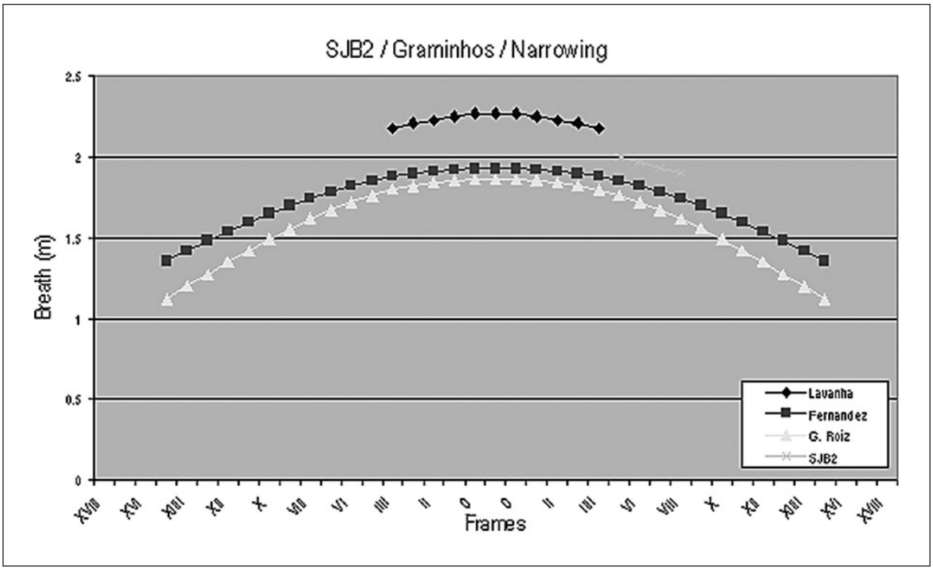



Fig. 8.10. Narrowing of the bottom. Comparison of values predicted by Lavanha, Fernandez, and Ruiz and those obtained for SJB2. (Graphic Filipe Castro)

**TABLE 8.10. VALUES FOR THE CALCULATION OF THE NARROWING**

| AUTHOR | MAXIMUM BEAM | FLAT AMIDSHIPS | TOTAL NARROWING | PREDESIGNED FRAMES |
|---|---|---|---|---|
| Oliveira | 54 pg = 13.86 m | 1/3 = 18 pg = 4.62 m | 1/6 = 77 cm | 18 |
| Oliveira | 48 pg = 12.32 m | 1/3 = 16 pg = 4.11 m | 1/6 = 68 cm | 18 |
| Gonçalo Roiz | 52 pg = 13.35 m | 14.5 pg = 3.72 m | 2/5 = 74 cm | 15 |
| Lavanha | 54 pg = 13.86 m | 2/5 = 21.6 pg = 5.54 m | 5 *dedos* = 9.15 cm | 5 |
| Fernandez | 48 pg = 12.32 m | 1/3 = 18 pg = 4.62 m | 1/6 = 68 cm | 15 |

*Note:* pg = *palmos de goa; dedo* = unit of length, approx. 1.83 cm.

exciting (see fig. 8.9). These sets of values were then tested against the models of Lavanha, Fernandez, and Gonçalo Roiz. The values involved in these calculations are summarized for each of the authors considered (table 8.10).

The results obtained for the narrowing were consistent with the ones obtained in the analysis of the rising. The values that match the measures from the Pepper Wreck are again those obtained by Oliveira's rule (fig. 8.9). Seemingly both the rising and the narrowing of the bottom of the Pepper Wreck follow Oliveira's rule quite closely.

## Futtock Arcs

The analysis of the futtocks was certainly the most frustrating task in this tentative reconstruction. Not only do the arcs not seem to be constant, but they do not even seem to follow a clear rule as they decrease toward the bow.

There is plenty of evidence for the construction of ships through the whole-molding system using futtocks with just one circular arc. This system was much easier from the point of view of the timber suppliers, who could go to the woods with only one template and fell all the trees necessary to fulfill a given request, but above all it was much easier for the contractor, who could handle the timbers with much more freedom, in terms of storing and moving them around in the shipyard. If the futtocks of a particular vessel were cut from compass timbers with too many different arcs, the management of the stocks would have been much more difficult.

Many authors mention a fairly simple and widespread method used to vary the breadth of the frames according to the needs of the shipwright along the sequences of frames before and abaft the master frame. This method was already implicit in Matthew Baker's *Fragments of Ancient Shipwrightry* and in Fernando Oliveira's *Liuro da Fabrica das Naus,* and is still in use in the Mediterranean's traditional shipyards.[28] It consists mainly in sliding the mold of the futtock down over the mold of the floor in order to open the breadth of the

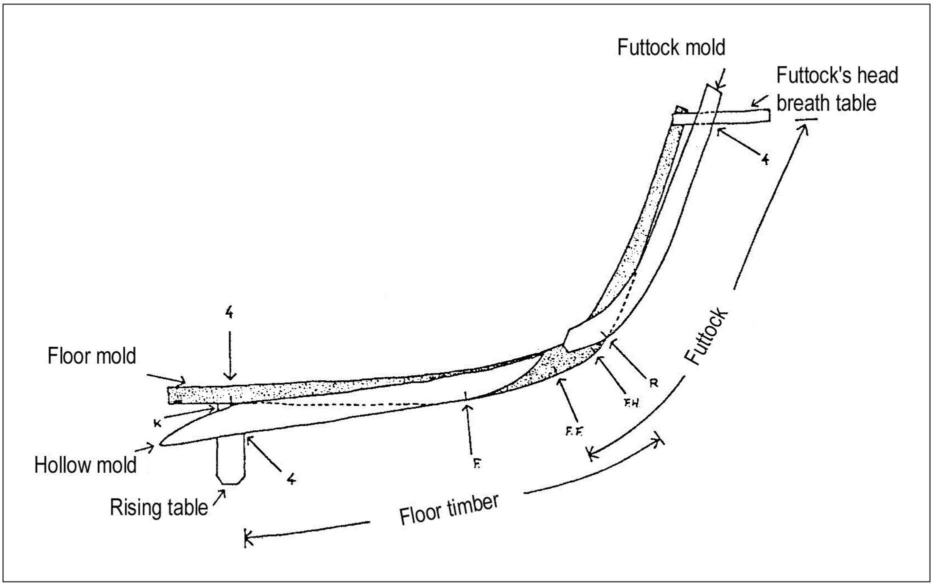



Fig. 8.11. Whole-molding, after Kostas Damianidis, "Methods Used to Control the Form of the Vessels in the Greek Traditional Boatyards." (Drawing Filipe Castro)

frame at its upper end (fig. 8.11). Another way to achieve this consists of rotating the mold of the futtock around the turn of the bilge. If this widening of the upper tip of the first futtocks is not performed, the narrowing of the bottom is reflected upward, generally narrowing the decks more than required. For this reason it was common to draw the main deck before assembling the frames, and to fix the breadth at several levels for each station to determine the overture of the first futtocks that would guarantee these predetermined measures.

This practice is probably much older than the whole molding tradition and has been documented by Zorzi Timbotta. Both Fernando Oliveira and Matthew Baker mention this technique, the first by referring to the drawing of the main deck, and the second by showing three curves on one of his best-known diagrams: the first for the rising of the bottom, the second for its narrowing, and the third for the narrowing of the weather deck.[29] However, a puzzling aspect of Oliveira's work is that in one of his drawings he defines a system that implies a different radius for each futtock (fig. 8.12).

I had always thought that this was a misunderstanding by Father Oliveira, who despite his knowledge about shipbuilding had never built a ship. However, the futtocks of the Pepper Wreck do decrease their radius as they move away from the master frame, even considering the odd results obtained for futtock B4E. It seems that in this section of the vessel, two sizes of futtocks were

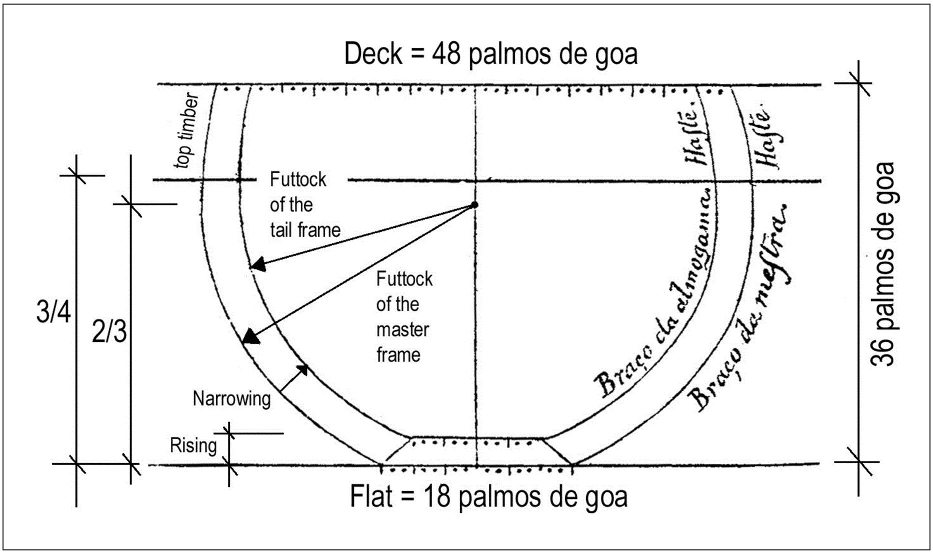



Fig. 8.12. Design of the hull, after Oliveira. (Drawing Filipe Castro)

used, the ones with larger radii closer to the midships frame and those with smaller radii toward the bow. Although this practice is not documented to my knowledge anywhere except in Oliveira's *Liuro da Fabrica das Naus,* it seems possible that the frames were assembled with futtocks with radii that vary gradually toward the extremities by steps rather than continuously, as Oliveira seems to suggest. This solution would be a compromise between his system, which suggests a different radius for each futtock in all the predesigned frames, and the normal way, which implies the use of different extensions of a set of futtocks with the same radii. It is unfortunate that insufficient data exist for this wreck, precluding a clear understanding of the method used to cut the first futtocks of this vessel.

## A Proposed Reconstruction

A lines drawing of an India nau was produced based on Fernando Oliveira's data and on the six floors and futtocks preserved in situ. The first task consisted of putting floors and futtocks together over the keel and then fairing the lines obtained. The results were fairly good, discounting some minor discrepancies that may have resulted from the degradation of the remains and the recording process (fig. 8.13).

It was fairly easy to put the frames over a predesigned set of rising and narrowing lines determined for the working hypothesis described before, which

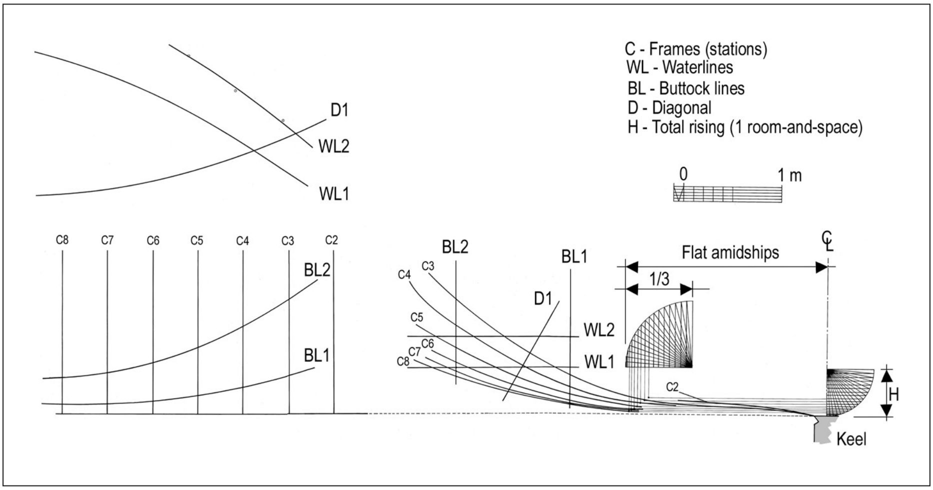



Fig. 8.13. Lines drawing of the stations preserved. (Drawing Filipe Castro)

implied a total narrowing of ⅙ of the flat amidships on each side, and a total rising of 1 room-and-space, both distributed over eighteen floors. However, a few discrepancies deserve mention:

The turn of the bilge marks of floor C5 (VII) and C6 (VI) are clearly below their theoretical position, which should be on a straight line between C8 (III) and C2 (X).

It was not possible to fair the waterline WL2. It would be possible to run a line parallel to WL1 over the intersection points from the stations C2 (X) and C4 (VIII) but the futtock C3 (VIII) would be 3 to 4 cm centimeters short of the planking.

The small arc on the outer extremity of futtock C5 (VII) stands too low and does not match the curvature of the remaining futtocks.

Some of these discrepancies can be explained by the fact that oak timber can distort over time.

The second task consisted of an attempt to create a set of lines for the complete vessel, following Oliveira's instructions. I have considered the basic measures presented by him for the nau of 18 *rumos* of keel (table 8.11). The final drawing shows a consistent, plausible hull with a transom plunging very low in the water, as frequently shown in the illustrations of the treatises and in most of the iconography of this period (fig. 8.14).

The quarterdeck hangs far abaft the transom, reminiscent of Valentim Themudo's remarks on the danger of the enemy placing a boat under the stern to try to set the vessel on fire. And finally the load waterline, whose position is

**TABLE 8.11. BASIC MEASURES FOR CONSTRUCTION OF OLIVEIRA'S INDIA NAU**

| ELEMENT | RULE OF PROPORTION | VALUE (IN M) |
|---|---|---|
| A. Keel | 18 *rumos* for 600 *tonéis* | 27.72 |
| B. Spring of the stem post | 1/3 of A | 9.24 |
| C. Height of the stem post | 1/3 of A | 9.24 |
| D. Rake of the stern post | 1/4 of A/3 | 2.31 |
| E. Height of the transom | 1/3 of A | 9.24 |
| F. Maximum breadth | 1/3 to 1/2 of A | 12.32 |
| G. Flat amidships | 1/3 to 1/2 of F | 4.10 |
| H. Room-and-space | 1 *palmo de goa* + 1 *palmo de vara* | 0.48 |
| I. Rising of the bottom | Forward: H; aft: 1.5 H | 0.48/0.72 |
| J. Narrowing of the bottom | 1/6 of G | 0.68 |
| K. Height of the fashion pieces | Start at 1/3 of E | 3.08 |
| L. Breadth of the transom | 1/2 of F | 6.16 |
| M. Maximum breadth on main deck | F—(≈1 + 1 *palmos de goa*) | 11.81 |
| N. Depth of the hold | 14 *palmos de goa* | 3.59 |
| O. Depth of the second deck | 9 *palmos de goa* | 2.31 |
| P. Depth of the gun deck | 9 *palmos de goa* | 2.31 |
| Q. Length of the quarter deck | 1/2 of length of deck (D + A + B) | 20.46 |
| R. Height of the quarter deck | 8 *palmos de goa* | 2.05 |
| S. Length of the poop deck | 1/2 of Q | 13.86 |
| T. Height of the poop deck | 7 *palmos de goa* | 1.80 |
| U. Length of the forecastle | 1/2 of M | 5.90 |
| W. Height of the forecastle | 1/3 of M | 3.94 |
| V. Height of bulwarks on the deck | 1 *rumo* | 1.54 |
| X. Height of bulwarks on the castles | 3 *palmos de goa* | 0.77 |
| Y. Length overall | A + B + D | 39.27 |

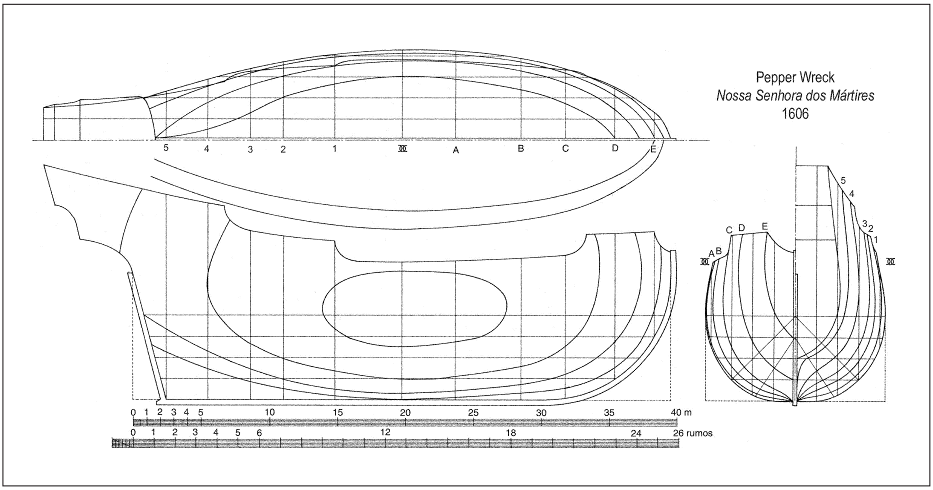



Fig. 8.14. Tentative reconstruction of an India nau, after Fernando Oliveira and the Pepper Wreck remains. (Drawing Filipe Castro)

suggested around the level of the lower deck by the placement of the stringers and wales, seemed quite low and unstable, and certainly did not fit the accounts of the overloaded *Madre de Deus,* allegedly drawing 31 feet. I chose to put the load waterline at the level of waterline number 3 in figure 8.14, 4.62 m above the bearding line amidships, and got a displacement of 1,096 tons. For a load waterline at the level of waterline 4, running 6.16 m above the bearding line amidships, I got a displacement of 1,684 tons. The volumes before and abaft the midship section are more or less the same for both theoretical load waterlines, the after part displacing 49 percent of the total volume below the theoretical load waterlines. This suggests that this vessel sat almost flat on the keel, with a minor drag, the true load waterline running almost horizontal.

Fairing the lines proved quite difficult, and in the end a set of lines was produced where the futtocks have more or less the same radii, contradicting both the theoretical data supplied by Father Oliveira and the archaeological data retrieved from the seabed off São Julião da Barra.

## Planking

All planking was cut from stone pines (*Pinus pinea*) as was to be expected from contemporary accounts:

> For planking, we use pine, because it is flexible and close grained, free of fissures and does not crack: furthermore, its sap is resinous and resists the humor of water, which does not penetrate it, And it is also contrary to the shipworm: which it does not create in itself, nor admits from the outside: Vitruvius says that this wood becomes bitter and will not consent the penetration of the shipworm, nor support it. The pine of which he speaks is the stone pine, which provides the seeds that we eat: and by this, we must understand that it is good for the planking of ships, contrary to the cluster pine, which has long cones without seeds of any use: because the wood of this cluster pine is dry and without the resin that resists the humor of the water: which penetrates it and causes it to rot: this why it is useless except for upper works which are situated above the water.[30]

The planking was preserved over a relatively large extent but was not attached to the frames since the iron spikes had long decayed. Several profiles were taken of the interior planking surface with a goniometer, but these show instead the profile of the bottom underneath, and even if some of the planks did retain part of their original curvature it was not possible to use this curvature in the reconstruction of buttock lines. The maximum widths of the planks

**TABLE 8.12. ANGLE OF THE GARBOARD/ KEEL OF PEPPER WRECK**

| SECTION | DEGREE OF ANGLE |
|---|---|
| C10 (II) | 180 |
| C1 (XI) | 175.5 |
| Apron (XVI) | 136 |

varied from 15 to 35 cm. The lengths varied between 3.38 (T8W[1]) and 5.83 m (T9W[2], broken).

The angle formed between the upper face of the garboard and the upper face of the keel varied along the preserved section of the hull, and it was clear that the angles to the surface of the keel narrowed toward the bow. The values taken in situ are presented in table 8.12. At the apron, this angle was 136°, but since the apron could not be accurately positioned along the keel axis, this information does not give definitive clues for the design of the bow. The indication XVI means only a presumption that the first floor sits on the apron. (See table 8.12.)

All the planking was elaborately carved and carefully fitted to the frames. Because of its thickness (11 cm) and the design of its seams, which were at times joggled by the introduction of notches and bevels, it conveys a sense of strength and rigidity (8.15; see also fig. 7.21).

Since only the portion of the planking situated amidships was preserved, where the runs are generally smooth and many times almost flat, it is difficult to reconstruct the building sequence. The construction of such planking may have entailed some defining runs or, in other words, planks that were placed before the others, running from post to post at certain predefined heights. This procedure is described by João Baptista Lavanha in the last pages of his unfinished manuscript and consists of the placement of two wales that have fixed paths over the eleven predesigned frames to the sternpost and stem.[31] However, no wales were found on the hull of the Pepper Wreck. This may be explained by Father Oliveira's assertion that wales should not be placed below the water line, the longitudinal strength being provided by stringers.

The care taken to keep the surface of the hull as smooth as possible makes sense if one considers that it must have been fairly well understood by shipwrights and officers that at low speeds the shape of the hull had almost no importance in determining the drag during long trips and that the most important factor for better performance under full sail was the smoothness of the immersed surface. Perhaps for this reason all nail heads were lodged in counter sink holes, although there was no evidence for any protection or covering of these.

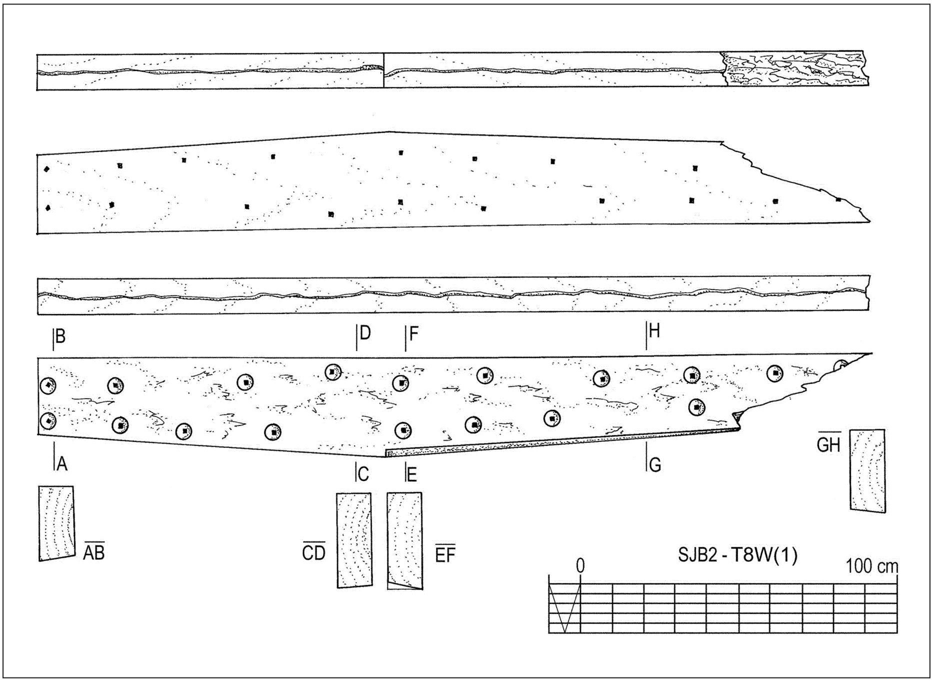



Fig. 8.15. Plank T8W(1) showing beveled and notched seam. (Drawing Filipe Castro)

An attempt was made to find symmetrical planking strakes that looked regular enough to be used to define these runs. No clear longitudinal runs could be identified, and it seems that the bottom of this hull was designed transversally, at least in this central part, and faired only at the ends, after the placement of the ribbands, or *armadouras* (see fig. 7.21).

## Fastenings

All fastenings consisted of iron spikes and bolts. This practice was advised by all the authors who address this issue, since treenails were believed to be easily eaten by shipworms. Oliveira claimed that treenails were a good solution for smaller craft, the best being of chestnut, but should not be employed on these vessels, for the lengths required implied impractical thickness. Lavanha agreed with these observations and added that since the shipworms eat the wood along the grain, and the grain of the treenails runs perpendicularly to the planking, these large treenails could easily become preferential paths for water leaks.[32]

The list of expenses for the construction of two India naus in 1624–25 contains no mention of treenails whereas the "assorted nails and bolts" category

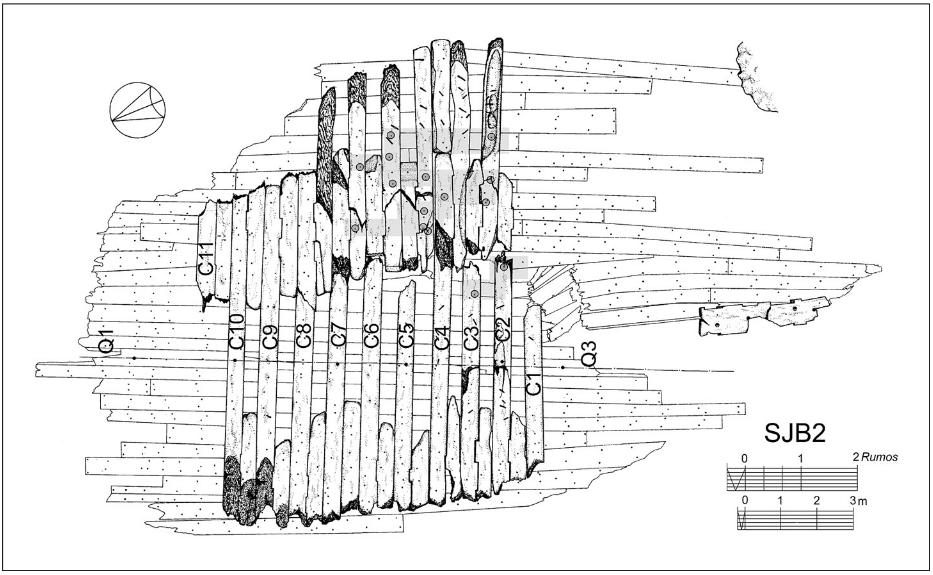



Fig. 8.16. Spikes clearly driven into the timbers from the upper surface down. (Drawing Filipe Castro)

accounted for several tons.[33] Although Oliveira advised against the use of spikes completely punched through the timbers, many were clenched over the insides of floors and futtocks.

Marks left on the Pepper Wreck by the fastening indicated the positions of several floors and futtocks that had already disappeared. Similarly, several spike holes on the upper surface of the preserved floors and futtocks suggest that although there was no ceiling in the central portion of the bilge of this vessel, more or less 1 m to each side of the keel, beyond that line there was a ceiling loosely fastened to the frames (fig. 8.16).

It was not possible to guess where the footwales ran from the positions of these spike holes, although there is no doubt that somewhere in the overlapping zone of the floors and futtocks there were one or two footwales spiked to the frames. Here again, the existence of through holes on these timbers does not allow a clear understanding of the direction from which the spikes were driven in.

## Caulking

The caulking arrangement seen on the Pepper Wreck is not mentioned by any author or list of materials and prices consulted, except for Pyrard de Laval, who wonders why the Portuguese only cover the seams with lead straps instead of fully sheeting the hull "as we [the French] do." However, he mentions a second layer of planking on Portuguese ships that did not exist on this wreck.[34]

Oliveira supports the practice of placing a second layer of planking over the first, thereby alluding to the famous *galagala* (a caulking paste made of oil and chalk also mentioned by Pyrard and accounted for in the Harvard manuscript) and recommends that warships and vessels destined for transcontinental trips have hulls thicker than 4 *dedos* (7.32 cm).[35]

According to Fernando Oliveira, caulking was a very delicate operation, to be undertaken with care. The caulkers were obliged to check all the seams and parts of the ship where water could penetrate or seep in, and had to caulk them with oakum and paint them with pitch. After caulking as many times as necessary to fill the seams with highly compressed oakum strings, the surface was burned to soften the pitch that had already been applied and to prepare the surface for another coat of pitch or tar. Then the oakum that had been burned by this phase of the caulking operation was replaced and the whole surface painted again with another pitch coating. Finally, a layer of lead plates was nailed over the pitch and the oakum, covering the seams, or cracks, of the planking to protect them.[36]

Building contracts stated frequently that the ship should be delivered ready and "black, in the water," which meant that the final caulking was performed by painting layers of pine resin, the *breu,* obtained by a process that consisted of burning the wood in a furnace. This resin was then mixed with charcoal and vinegar and melted again for a complete hot coating of all the timbers.[37]

Lavanha and Fernandez do not mention caulking. A short allusion to lead is made by Lavanha, who explains that among the materials for shipbuilding were "nails, linen, tow, tar, pitch, grease and lead."[38]

## Wood

Wood was naturally the most important material used in the construction of any vessel and it is logical that much was written about which timbers to use, how to choose them, and where and how to cut them. Father Oliveira is clear in stating that in Portugal two kinds of wood were suitable for shipbuilding: "In this, our land, there are two kinds of woods that are appropriated for these two parts of ships, respectively: they are the woods of cork-oak and of pine. The cork-oak for the frames and the pine for the planking." Lavanha is of the same opinion, as are other authors consulted. References exist to the use of small quantities of other woods, such as European oak for some beams and cluster pine for the planking of the upper decks, above the water line, as suggested by Fernando Oliveira.[39]

## Ballast

At this point no data support any speculation regarding the nature or extent of the ballast pile. The most likely hypothesis is that the layer of pebbles found over and around the hull remains was part of the ship's ballast. However, since the ballast may have been loaded on one of the nearby beaches, estimating the size and weight of the ballast carried on the Pepper Wreck will be impossible.

# 9

# Conclusion

Despite the relatively limited extent of the hull remains available, this study attempts to provide a working hypothesis regarding the size and shape of the Pepper Wreck. The ship was almost certainly the *Nossa Senhora dos Mártires,* lost on September, 1606, off São Julião da Barra.

The collection of artifacts found in and around the wreck consistently matches both the type of assemblage one would expect to find on a homebound Portuguese India nau and the time frame of this particular shipwreck. The cargo of pepper, the porcelain dishes, the Chinese stoneware, and the green and yellow glazed earthenware, all typical of the late sixteenth century, as well as the date 1605 on the third astrolabe (see figs. 6.10 and 9.1), leave no doubt that this ship was returning from Asia and could not have left Lisbon earlier than 1605, the year the *Nossa Senhora dos Mártires* departed. In addition, no other India nau wrecked near the fortress of São Julião da Barra between 1606 and 1783 (see table 6.2). An in-depth study of the artifacts, the subject of a master's thesis at Texas A&M University, will likely reinforce the assumptions made above.[1]

The most important aspects of wreck site SJB2 are related to the portion of the hull preserved, which after study reinforced the assumption that this is the wreck of the *Nossa Senhora dos Mártires.* The types of timbers used in its construction, cork oak and stone pine (see figs. 7.33 and 7.34), are typically Portuguese and very probably exclusively Portuguese. The size and shape of the timbers also matched our expectations of a late sixteenth- or early seventeenth-century ship, built when the scarcity of large suitable trees and good


Fig. 9.1. Date engraved on astrolabe São Julião da Barra III. (Photo Pedro Gonçalves, CNANS; used with permission of CNANS)

compass timber, mentioned by several authors (see chap. 8), forced shipwrights to build such large vessels as a patchwork of small logs.

The design, too, matches the guidelines expressed by Father Fernando Oliveira in his *Liuro da fabrica das naus* (1580), the building procedures expressed by João Baptista Lavanha in his *Livro primeiro de arquitectura naval* (c. 1610), and the rules of Manoel Fernandez' *Livro de traças de carpintaria* (1616). Though many questions remain unanswered, these timbers seem to have been designed following the methods in use in Portugal in the late sixteenth and early seventeenth century.

A series of marks engraved by the shipwrights on the floors not only mirrored the set of construction rules and prescriptions presented by Lavanha in his book (see tables 7.10, 7.11, 7.12, and 7.13) but also showed a logical pattern of design, with three master frames, just as Oliveira and Fernandez recommended for a standard India nau of 26.95–27.72 m of keel (see tables 8.2 and 8.3). I have tested the rising and narrowing of the bottom found in situ with the theoretical values expressed in Oliveira, Lavanha, and Fernandez' works.

The rising of the bottom was clearly designed following an arithmetical algorithm that is known from many written sources to have been common in Portugal at the time (see fig. 8.8). The narrowing also matches a similar arithmetical algorithm, although the conditions under which the data pertaining to this feature were retrieved were far from perfect—implying a tentative match of a very broken and distorted seam (see fig. 8.9).

The study of the shape of the few preserved futtocks yielded the most disappointing results. Only six futtocks were preserved to any extent (see fig. 6.3), and no futtock was preserved in its entirety. Many of these timbers had large gaps in their sections and some had patches filling the larger gaps (see table 7.5), showing again the difficult situation the shipwrights faced when building a large vessel with such a small stock of suitable timber. When analyzed, the futtock curvatures did not match any of the expectations. Although they clearly show a turn of the bilge arc and a futtock arc, the radii found through the several methods of analysis used did not follow any particular pattern, at least in the way in which these timbers are believed to have been cut. (see table 7.17).

Instead of a regular design obtained by the application of a standard mold that would slide or tilt to allow the shipwright to obtain a fair set of longitudinal runs while rising and narrowing the bottom of the vessel (see fig. 8.12), futtock's radii seemingly diminish toward the bow, as Oliveira indicates in his book (see fig. 8.12). The irregularity of the values obtained is far from the unlikely precision implied in Oliveira's drawing. This scheme has often been interpreted as the result of a poor understanding of the building technique, because cutting each pair of futtocks with a particular radius from a particular compass timber for all the thirty-nine predesigned frames required seems quite labor intensive. This practice would create some problems with regard to provisioning, stocking, and handling of compass wood in any shipyard, should the process be applied with the precision implied in Oliveira's drawing.

However, when we look at the values obtained from the six futtocks that were analyzed, there seems to be a trend toward the reduction of the futtock's arcs as we move away from the master frames (see table 7.17). The irregularity of the values obtained suggests that the frames were assembled on the ground—as the fastening pattern between floors and futtocks shows without any doubt—over a template where the maximum beam and the beam on the main deck were marked with precision for each station, and the futtocks were chosen "by eye" from the pile of timber stock. The larger radii were naturally used on the frames that are closer to the midships, and the smaller radii in the extremities.

A pile of timber probably buried in the sand after the 1755 earthquake was found in 1996 on the site of Lisbon's sixteenth- and seventeenth-century shipyard by a contractor who was building a large underground park on Praça do Município.[2] Still under study, it encompasses a few keel sections with the rabbets already opened, stored next to a number of roughly cut flat, V- and Y-shaped timbers, obviously meant for the construction of floor timbers. No curved timbers were found anywhere nearby, suggesting that perhaps these were stored separately and reinforcing the idea that the futtocks were chosen from a pile of more or less equally curved timbers, the bigger radii used to assemble wider frames, the smaller radii for the frames to be placed closer to the extremities.

The planking, cut from straight stone pines of several ages, from fairly young trees to some larger logs, was laid regardless of the grain, sometimes the heart to the interior, sometimes to the exterior, certainly profiting from the natural warp of each plank, as is still done in Portuguese shipyards today (see fig. 7.23). No continuous runs were identified at any distance from the keel on the preserved area of the planking. We know that ribbands (*armadouras*) were used both to achieve a smooth longitudinal overall shape of the hull and in shaping the portions of the hull before and abaft the predesigned central portion of the hull, as mentioned by Oliveira and Lavanha. The absence of continuous strakes suggests that either the ribbands were removed after the framing was completely fastened in place, or that the defining strakes ran above the preserved area of the bottom. The thickness of the planks, the general irregularity of the disposition of the seams, the existence of joggled seams, and the caulking solution adopted are little known. The caulking arrangement matches the only other archaeological information available about India naus, from the presumed wreck of the *Santo António* (1598), inspected in the Seychelles by Warren Blake and Jeremy Green in the 1970s. Similar lead strings, which showed clear marks of having been wrapped in some type of fabric, were found in the 1980s in sediment dredged from the mouth of the Arade River, on the southern coast of Portugal.[3]

A reconstruction of the hull shape was proposed based on the shape of the timbers recorded on this wreck and the extrapolations made from shipbuilding treatises and texts (see chap. 3). The reconstruction is shown in figures 8.14. and 8.15.

Regarding the central portion of the hull where I considered the supposed thirty-nine predesigned frames, I have followed the general scheme proposed by Father Oliveira, of three master frames and eighteen predesigned frames, before and abaft these midship frames.

The general dimensions were also defined according to Oliveira's proportions (see table 8.11). I obtained a displacement of around 1,100 tons for a draft of 4.62 m amidships, the water line running about 75 cm above the lower wale at that point, which was supposed to run at the level of the lower deck. I varied the draft above the projected load water line and obtained a maximum of 1,684 metric tons of displacement for a draft amidships of 6.16 m. These values are not very far from the 1,200 tons displacement expected for a vessel of 600 tons burden. The coefficients calculated for the projected load water line

**TABLE 9.1. COEFFICIENTS OF HULL OF PEPPER WRECK AS RECONSTRUCTED**

| | |
|---|---|
| Water plane | Cw = 0.74 |
| Midships | Cm = 0.71 |
| Block | Cb = 0.49 |
| Prismatic | Cp = 0.69 |

are indicated in table 9.1. The length to beam ratio obtained was 39.27/12.32 = 3.19 : 1, again within the values proposed in the literature of the late sixteenth and early seventeenth centuries. The coefficients indicate some of the characteristics of this tubby hull, but how fine were its entries? For a water plane coefficient of 0.74, which shows the low transom and the round bow, it has a block coefficient of barely 0.50. Although its lower midship section is almost a perfect half circle and the central portion of the lower hull shows a slight deadrise before and abaft the tailframes, the hull quickly develops a wineglass shape forward and aft, already suggested on frames C10 and C11.

I conclude with a final word regarding the recent theoretical works pertaining to the definition of a possible Iberian shipbuilding tradition and the place of this wreck within this tradition. All written sources considered in this study point to the existence of a standard India nau. Although varying in size and presenting a general tendency to grow during the sixteenth and seventeenth centuries, all India naus seem to have been built according to a well-defined standard. These vessels undoubtedly belong to the well-established Mediterranean skeleton-based shipbuilding tradition. The question now under analysis is whether this India nau standard belongs to the Iberian Atlantic family of water craft, supposing that such a thing exists and can be defined.

What were the traits common to all Iberian Atlantic vessels, and how were these traits expressed in the context of the postmedieval European shipbuilding tradition?

Eric Rieth introduced the concept of "architectural signatures." He defined these signatures as secondary technological characteristics that are not decisive for the definition of an architectural system but may indicate common practices or traditional techniques specific to a certain place and time.[4] According to Rieth these architectural signatures are the equivalent of what Ole Crumlin-Pederson had already proposed as "fingerprints" on Scandinavian medieval craft.[5] It was Thomas Oertling who first addressed the question of defining a certain number of traits that characterized the west Atlantic postmedieval craft in Europe. In 1989 he proposed a series of twelve distinct traits shared by seven vessels that showed an Iberian association in a defined time period, the sixteenth century. His analysis was solely based on the archaeological record and did not consider iconographic, ethnographic, or historical data, namely the treatises and other contemporary texts related to shipbuilding in the Iberian world. The twelve common traits proposed by Oertling are nevertheless a very interesting set of construction features, understandably related to the bottoms of vessels. They emphasize mainly the existence of a central portion of the hull built skeleton first with predesigned frames, the fastening process of the carvel planking over the frames, the arrangement of the connection between keel and sternpost, the keelson and maststep arrangement, the ceiling layout, a characteristic detail related to the attachment of the shrouds to the hull, the existence of a flat transom with a proud sternpost, and the shape of the garboard (table 9.2).[6]

Seven vessels were analyzed in 1989 by Thomas Oertling: the Rye A vessel, the Cattewater wreck, and the Studland Bay wreck, all found in English waters; the Basque whaler *San Juan* found in Newfoundland, Canada; the Caribbean wreck of the *San Esteban;* the Highborn Cay wreck; and the Molasses Reef wreck.[7] In spite of the great variety of types of vessels considered, and their different sailing routes, many similarities were found when analyzed with regard to the twelve traits presented in table 9.2. In spite of the scarcity of available data, which is expressed in the many empty spaces, most of the traits are consistent within the group of vessels considered.

The Rye A wreck was dated to the mid-sixteenth century. It was found by a machine digging a pit for a new drainage system in Saint Mary's Marsh, at Rye, Sussex, England, and was not excavated. Some timbers were abandoned near the site; other broken timbers were kept in the local school and analyzed later. The Cattewater wreck was clearly ballasted in south England, and although it may have been purchased somewhere in the Iberian Peninsula (it was built of oak and pine) or built in England by Iberian or Italian shipwrights, it is presumed to have been sailing in English hands. The other vessels considered in this study are certainly Iberian. The Studland Bay wreck was a Spanish trader that sank in the early sixteenth century in Poole Bay, Dorset, England; the *San Juan* was a Basque whaler that sank in 1565; the *San Esteban,* a large nau, sank in the New World in 1554; and the Molasses Reef and Highborn Cay wrecks were two small, early sixteenth-century vessels engaged in exploration of the New World. The Molasses Reef wreck is thought to have been ballasted in Lisbon.

A decade later Thomas Oertling revised this study in light of the number of Iberian vessels that had been found and excavated at that time, more than doubling the sample under analysis.[8] The eight vessels added to this study were the Caribbean wrecks of Emanuel Point, Western Ledge reef, or IMHA3,

**TABLE 9.2. CHARACTERISTICS OF IBERIAN ATLANTIC VESSELS AS PROPOSED BY OERTLING IN 1989**

**1** A given number of preassembled central frames bearing dovetail joints
**2** Carvel planking fastened with a combination of nails and treenails
**3** A knee joining the after end of the keel and the sternpost (*couce*)
**4** A single piece deadwood knee over the *couce* upon which sit the Y-frames (*coral*)
**5** Y-frames tabbed into the deadwood knee
**6** Keelson notched over the floors
**7** Maststep is an expanded portion of the keelson, part of which is cut to seat the ship's pump
**8** Buttresses supporting the maststep against the footwale
**9** Ceiling extending only over the floors, the last strake notched to receive filler planks
**10** Teardrop-shaped iron strop accepting a deadeye attached to 2 or 3 lengths of chain, the last link through an eyebolt
**11** Flat transom with proud sternpost
**12** Garboard carved from an extra thick plank

| WRECK | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Rye A* vessel | — | — | — | — | — | Y | Y | Y | Y | — | — | — |
| *San Juan* | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | N |
| Cattewater wreck | Y | Y | — | — | — | Y | Y | N | Y | — | — | Y |
| *San Esteban* | — | Y | Y | Y | Y | — | — | — | — | Y | Y | Y |
| Highborn Cay wreck | Y | — | — | — | — | Y | Y | Y | Y | Y | N | — |
| Molasses Reef wreck | Y | Y | — | — | — | — | — | — | Y | Y | Y | — |
| Studland Bay wreck | Y | Y | Y | Y | N | — | — | — | — | — | Y | — |

and Saint John's Bahamas; the presumably Spanish Angra D wreck, found in Angra Bay, Terceira, Azores; and the Portuguese wrecks of Ria de Aveiro A, Cais do Sodré, Corpo Santo, and *Nossa Senhora dos Mártires*.[9]

The Caribbean wrecks present themselves as a fairly homogeneous sample: the Emanuel Point wreck presumed to have been lost on Tristan de Luna's expedition to Florida in 1559, the Western Ledge reef wreck being a small Spanish vessel dated to the last quarter of the sixteenth century, and the Saint John's Bahamas also a fairly small Spanish ship dated to the sixteenth century. As to the Portuguese wrecks, size and tentative dating indicate fairly different craft. The Aveiro A wreck is a small trader lost in the mid-fifteenth century; the Corpo Santo wreck, which consists only of a fragment of a stern, has been dated to the late fourteenth century; and the Cais do Sodré wreck is a large derelict from the late fifteenth or early sixteenth century.

Again, in spite of the diversity of origins, the wider time frame considered, and the diverse sizes and purposes of the ships under analysis, Oertling concluded that this larger group still had many features in common. Only the last point of his list of common traits, the existence of a garboard carved from an extra thick plank, could not be considered because of lack of support in the ar-

**TABLE 9.3. CHARACTERISTICS OF IBERIAN ATLANTIC VESSELS AS PROPOSED BY OERTLING IN 1998**

| WRECK | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *Rye A* vessel | — | N | — | — | — | Y | Y | Y | Y | — | — |
| *San Juan* | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Cattewater wreck | Y | Y | — | — | — | Y | Y | N | Y | — | — |
| *San Esteban* | — | N | Y | Y | Y | — | — | — | — | Y | Y |
| Highborn Cay wreck | Y | — | — | — | — | Y | Y | Y | Y | Y | — |
| Molasses Reef wreck | Y | Y | — | — | — | — | — | — | Y | Y | Y |
| Studland Bay wreck | Y | Y | Y | Y | N | | | | | | Y |
| Emanuel Point wreck | Y | Y | N | Y | Y | Y | Y | Y | Y | | N |
| Western Ledge wreck | Y | | Y | Y | Y | Y | Y | Y | Y | | Y |
| St. John's Bahamas wreck | — | Y | — | — | — | — | — | — | — | Y | — |
| Ria de Aveiro A wreck | Y | Y | Y | Y | — | Y | N | Y | — | — | — |
| Angra D wreck | Y | — | Y | Y | Y | Y | Y | Y | — | — | — |
| *Nossa Senhora dos Mártires* | Y | N | — | — | — | — | — | — | — | — | — |
| Cais do Sodré wreck | Y | N | — | — | Y | Y | — | — | — | — | — |
| Corpo Santo wreck | — | Y | Y | Y | Y | — | — | — | — | — | — |

**1** A given number of preassembled central frames bearing dovetail joints
**2** Carvel planking fastened with a combination of nails and treenails
**3** A knee joining the after end of the keel and the sternpost (*couce*)
**4** A single piece deadwood knee over the *couce* upon which sit the Y-frames (*coral*)
**5** Y-frames tabbed into the deadwood knee
**6** Keelson notched over the floors
**7** Maststep is an expanded portion of the keelson, part of which is cut to seat the ship's pump
**8** Buttresses supporting the maststep against the footwale
**9** Ceiling extending only over the floors, the last strake notched to receive filler planks
**10** Teardrop-shaped iron strop accepting a deadeye attached to 2 or 3 lengths of chain, the last link through an eyebolt
**11** Flat transom with proud sternpost

chaeological data. Oertling's new list of fifteen wrecks is shown in table 9.3 with reference to the eleven common traits observed.

However incomplete the information presented in the table above may be it seems fair to accept the existence of these eleven common traits in the Iberian Atlantic vessels, even when we consider the differences between the Basque, the Portuguese, and the Andalusian cultural universes in the sixteenth century. Furthermore, we know that in the early seventeenth century the Hapsburg kings of Portugal and Spain issued legislation in an attempt to unify and harmonize many aspects of the Iberian shipbuilding industry regarding the types of vessels, and their sizes, proportions, and construction features (see chap. 3).

When we analyze these features in light of the historical texts, a certain *air de famille* becomes evident in all these Iberian vessels, and a few common traits are undoubtedly shared by all Iberian Atlantic vessels. Nonetheless, we need a larger sample and an in-depth analysis of the treatises, contracts, accounts of voyages and shipwrecks, iconography, and ethnography in order to get a clear picture.

The preserved portion of the hull of the *Nossa Senhora dos Mártires* does not yield many clues as to whether this ship belongs to this family (see table 9.3). No keelson, maststep arrangement, sternpost arrangement, or transom were found; no rigging details were preserved; and all fastenings were made of iron, no treenails being employed anywhere. For the time being we can only state that the central portion of the hull was undoubtedly predesigned and pre-assembled, affiliating this ship with the Mediterranean skeleton-based ship-building tradition represented in a number of well-preserved wrecks in the Mediterranean and in the Atlantic, as well as in the smaller and more precisely defined standard of the India route naus.

## Appendix A
# Tonnage and Systems of Units

What systems were in use to find the tonnage of seagoing vessels in different countries and harbors in the late sixteenth century is by no means fully understood. And comparing sizes of vessels, especially if we only have their estimated tonnages, remains a difficult task.

In sixteenth-century Portugal one *tonelada* was the measure of volume equivalent to the space occupied by a barrel (*tonel*). One *rumo* was the measure of the height of the standard barrel, the *tonel*. This meant that along each *rumo* of any vessel's keel, one could store a number of barrels that only depended on the breadth and depth in hold. It is generally believed that in Portugal the hull's capacity was established after completion by a commission of experts with a set of arcs with the diameters of a *tonel,* a *pipa* and a *quarto*. The experts determined how many *tonéis, pipas,* and *quartos* would fit in each rumo. Tables of equivalence were used for heavier merchandise or materials that could not be stored in containers. In the early sixteenth century, 1 *tonelada* was the equivalent of 750 roof tiles, 500 sugar *formas,* 14 *quintais* of metal, or half of an animal and its feed.[1]

There is an indication that estimated tonnage could be obtained by multiplying the number of *rumos* of a keel by the number of *tonéis* that could be stored on the *rumo* situated on the midship section, and by a coefficient, but Father Oliveira's explanation clearly indicates that he did not fully understand the formula.[2]

In Spain, where commerce with the world was based on a system of freights of private ships, the use of formulas was already common in the early sixteenth century. And in 1570s England, Matthew Baker presented a formula that remained in use until the 1620s.[3] Despite the void in our knowledge of tonnage calculations, we have good estimates of the value of most units of measure used in Portuguese shipyards in the late sixteenth and early seventeenth centuries.

Weights and measures were always a royal matter, generally delegated to the municipalities and checked by civil officials elected by the citizens, as established by a law of King Afonso III dated December 26, 1253. The consolidation of the state's power entailed standardizing the weights and measures used throughout the country. This decision was announced in 1361, at the legislative state assembly of the three classes (clergy, nobility, and commoner)—the *Cortes*—which took place in Elvas.

In 1488, during the reign of João II, a law established the Köln mark as the standard unit of weight in Portugal. In 1499 King Manuel I placed new standards in the city halls, copied from the royal ones deposited in the king's palace. The supervision and calibration of all the weights and scales in the city of Lisbon resided with the Brotherhood of Saint Eloy, from August 7, 1460, to the adoption of the metric system in 1814.

King Sebastian decreed another reform of the system of weights and measures in 1575, in the Edict of Almeirim, which established one system of measures for dry products and a separate one for liquids. This law also defined the jurisdictions of the inspectors. Its success was overwhelming, as all municipalities received a full set of standards copied from the royal ones. France adopted a decimal system based on the meter in 1791, and Portugal adopted the same system in 1814 as part of a profound agricultural reform decreed by King João VI.[4]

In the shipyards, the most important unit was undoubtedly the *tonelada,* the measure of capacity of every ship, on which taxes and freight prices were fixed and charged. The word *tonelada* derives from *tonel,* the standard barrel with 6 *palmos de goa,* or 1 *rumo* (1.54 m) in height, and 4 *palmos de goa* (1.027 m) of *párea,* the designation in use for its maximum diameter. Each *tonel* contained two *pipas,* and each *pipa* two *quartos.* The volume occupied by a *tonel* would vary between the space taken by the cylinder obtained by the expression:

$$0.513^{2} \text{ x } ( \text{ x } 1.54 = 1.275 \text{ m}^{3}$$

and the prism obtained by the expression:

$$1.027^{2} \text{ x } 1.54 = 1.624 \text{ m}^{3}$$

The basic unit in use in the Portuguese shipyards was the *palmo de goa* (1 *pg* = 25.67 cm), which contained 7 *polegadas* (1 *pol* = 3.67 cm) and 14 dedos (1 *d* = 1.83 cm). The height of a barrel—6 *palmos de goa*—was called *rumo* (1 *r* = 1.54 m), and half a *rumo* was called *goa* (1 *g* = 77 cm). There were also *palmos de vara* (1 *pv* = 22 cm), each of which contained 6 *polegadas* and 12 *dedos,* and *varas* (1 *v* = 1.10 m), containing 5 *palmos de vara* each.

Many other units were also in use in Portugal in the late sixteenth and early seventeenth centuries, designating lengths, surfaces, volumes of solids, volumes of liquids, and weights. These all varied somewhat in time and space in

**TABLE A.1. UNITS OF MEASURE IN 16TH- AND 17TH-CENTURY PORTUGAL**

| UNIT: LENGTH | GENERAL EQUIVALENT | METRIC EQUIVALENT |
|---|---|---|
| *Vara* | 5 *palmos de vara* | 110 cm |
| *Palmo de vara*[a] | 1/5 of a *vara* | 22 cm |
| *Rumo* | 7 *palmos de vara;* 6 *palmos de goa* | 154 cm |
| *Palmo de goa* | 1/6 of a *rumo* | 25.67 cm |
| *Goa* | 3 *palmos de goa* | 77 cm |
| *Côvado real* | 1 *goa* | 77 cm |
| *Braça comum* | 10 *palmos de vara* | 220 cm |
| *Braça marítima* | 8 *palmos de goa* | 204.8 cm |
| *Polegada comum* | 1/8 of a *palmo de vara* | 2.75 cm |
| *Polegada de goa* | 1/7 of a *palmo de vara* | 3.67 cm |
| *Ângula* | 1/10 of a *palmo de goa;* English inch | 2.56 cm |
| *Dedo* | 1/2 of a *polegada de goa* | 1.83 cm |
| *Légua* | 3 *milhas* | 5.556 m |
| *Milha* | 1/3 of a *légua* | 1.852 m |
| UNIT: AREA | GENERAL EQUIVALENT | METRIC EQUIVALENT |
| *Alqueire* | 15,625 square *palmos* | 756.25 $m^2$ |
| UNIT: VOLUME | GENERAL EQUIVALENT | METRIC EQUIVALENT |
| *Almude* | 12 *canadas;* 48 *quartilhos* | 25 liters |
| *Canada* | 4 *quartilhos* | 2.083 liters |
| *Quartilho* | 1/4 of a *canada* | 0.5 liter |
| *Moio* | 60 *alqueires* | 780 liters (cereals) |
| *Saco* | 6 *alqueires* | 78 liters (cereals) |
| *Alqueire* | 1/60 of a *moio* | 8 liters (liquids)<br>13 liters (cereals) |
| *Moio* | 60 *alqueires* | 780 liters (cereals) |
| *Tonel* | 2 *pipas* | 1,050–1,250 liters |
| *Pipa* | 1/2 *tonel;* 21–25 *almudes* | 525–625 liters |
| *Quarto* | 1/2 *pipa* | 262.53–312.5 liters |
| UNIT: WEIGHT | GENERAL EQUIVALENT | METRIC EQUIVALENT |
| *Quintal* | 4 *arrobas* | 58.754 kg |
| *Arroba* | 1/4 of a *quintal;* 32 *arratéis* | 14.690 kg |
| *Arratel* | 16 *onças* | 459 g |
| *Onça* | 1/16 of a *arratel* | 28.69 g |
| *Oitava* | 3 *escrópulos* | 3.027 g |
| *Escrópulo* | 24 *grãos;* 1/3 of an *oitava* | 1.009 g |

[a] Also known as *palmo, palmo craveiro, palmo comum, palmo ordinário, palmo redondo,* or *palmo singelo.*

spite of the reforms, and sometimes there is no accurate way to determine exact values—as likely often happened to the people who handled them—and estimates must be relied on.

In his comments on Lavanha's *Livro Primeiro de Arquitectura Naval,* Pimentel Barata presents a table with the measures of the units in use in late sixteenth-century Portuguese shipyards based on a fairly accurate measure of

**TABLE A.2. 16TH- AND 17TH-CENTURY CURRENCY**

| UNIT | PORTUGUESE EQUIVALENTS (IN *REIS*) |
|---|---|
| *Cruzado* | 400 |
| *Escudo* | 100 |
| *Xerafim* | 300 |
| *Ducado* | ≈345 to 360 |
| *Peso* | ≈320 |

the *vara,* a value of length he relates afterward to the other units mentioned in the contemporary literature. An early nineteenth-century study presented by a commission from the Portuguese Academia Real das Sciencias on the introduction of the metric system in Portugal shows how the best-preserved unit template in the country was the *vara* given by King Sebastian to the village of Tomar, and that this standard gauge measured exactly 110 cm. Based on this value, Pimentel Barata related the *vara* with the other units in use in Portugal, as they were described in the literature in relation to each other.[5] See tables A.1 and A.2 for equivalencies useful in understanding the late sixteenth- and early seventeenth-century texts.

These values were by no means precise or constant through time. Nor were they the only tables of equivalents in use contemporaneously around the commercial ports, and converting values was part of the bargaining process. A merchant needed a quick and well-trained mind if he wanted to survive in the India trade of the sixteenth and seventeenth centuries, especially considering that even the relation between the prices of gold and silver varied from port to port.[6] The India route trade depended to a large extent on those merchants whose trained minds could quickly evaluate the quality of merchandise, determine its value in several distant ports, add the costs of transport to each of them, and determine the taxes and fees due in every scale. Only large profits could justify the risks taken on such a long voyage, whose success depended on good seamen, skilled officers, competent soldiers, and astute politicians. If we consider all the problems that could arise during these fifteen-month-long round-trips, the India route represents a monumental undertaking.

Appendix B

# Bibliography of Iberian Wrecks

This is a basic bibliography of the Iberian and similar wrecks found, excavated, published, or made public in any way.


### Angra B Wreck

Crisman, Kevin. "Angra B: The Lead-sheathed Wreck at Porto Novo (Angra do Heroísmo, Terceira Island, Azores-Portugal)." *Revista Portuguesa de Arqueologia* 2 (1999):1.

### Angra D Wreck

Monteiro, Paulo. *Relatório da campanha arqueológica subaquática, desenvolvida pelo Centro Nacional de Arqueologia Náutica e Subaquática, do Instituto Português de Arqueologia, e pela Direcção Regional da Cultura, do Governo Regional dos Açores, na baía de Angra do Heroísmo.* Angra do Heroísmo, Açores: 1998.

———. "Um naufrágio na Carreira das Índias." *Mundo Náutico* 4, no. 34 (1997): 70–72.

Monteiro, Paulo, and Catarina Garcia. "Angra D: A Shipwreck from Angra Bay, Azores." *Pre- Proceedings of the International Symposium,* Archaeology of Medieval and Modern Ships of Iberian-Atlantic Tradition. Lisbon: IPA/CNANS, September, 1998, forthcoming.

### Bahia Mujeres Wreck

Keith, Donald H., and Roger Smith. *An Archaeology Survey of an Early Sixteenth-Century Shipwreck Site in Bahia Mujeres, Quintana Roo, Cancun, Mexico.* Report in the INA archive, 1984, College Station, Tex.

Smith, Roger. "Treasure Ships of the Spanish Main: The Iberian-American Maritime Empires." In *Ships and Shipwrecks of the Americas,* ed. George Bass. London: Thames and Hudson, 1988.

### Caio Nuevo Wreck

Smith, Roger. "Treasure Ships of the Spanish Main: The Iberian-American Maritime Empires." In *Ships and Shipwrecks of the Americas,* ed. George Bass. London: Thames and Hudson, 1988.

### Cais do Sodré Wreck

Rodrigues, Paulo J. P. *Relatório preliminar dos trabalhos de desobstrução e registo arqueográfico dos restos do navio encontrado no Cais do Sodré, nas obras do Metropolitano de Lisboa.* Lisboa: Instituto Português do Património Arqueológico e Arquitectónico, 1995.

Rodrigues, Paulo, Francisco Alves, Eric Rieth, and Filipe Castro. "Os destroços do navio da 2ª metade do século XV/inícios do séc XVI do Cais do Sodré (Lisboa). Notícia preliminar." *Cadernos de Arqueonáutica* 1. Lisboa: Centro Nacional de Arqueologia Náutica e Subaquática, forthcoming.

### *Capitana de Ivella*

Bueno, Martin. *Costa da Morte: Atopamo—La historia.* Vigo, España: Xunta de Galícia, Conselleria de Cultura e Deportes, 1990.

### Cattewater Wreck

Mortlock, Berit, and Mark Redknap. "The Cattewater Wreck, Plymouth, Devon. Preliminary Results of Recent Work." *International Journal of Nautical Archaeology* 7, no. 3 (1978): :195–204.

Redknap, M. *The Cattewater Wreck: The Investigation of an Armed Vessel of the Early Sixteenth-Century.* Oxford: BAR, 1984.

### Corpo Santo Wreck

Alves, Francisco J. S., Paulo J. P. Rodrigues, and Eric Rieth, "O navio do século XIV do Corpo Santo (Lisboa)." *Cadernos de Arqueonáutica,* (1998) 1. Lisboa: Centro Nacional de Arqueologia Náutica e Subaquática. In press.

Alves, Francisco J. S., Paulo Rodrigues, and Eric Rieth. "O navio do século XIV do Corpo Santo (Lisboa)." In *Proceedings of the International Symposium "Archaeology of Medieval and Modern Ships of Iberian-Atlantic Tradition,"* ed. Francisco Alves. Lisbon: IPA, 2001.

### Dry Tortugas Deep Water Wreck. No information published

Salvaged by a Southern Florida company named Seahawk, this wreck lay around 500 m deep and had extensive hull remains.

### Emanuel Point Wreck

Smith, Roger C., John R. Bratten, J. Cozzi, and Keith Plaskett. *The Emanuel Point Ship: Archaeological Investigations, 1997–1998.* Preliminary Report. Pensacola: Florida Bureau of Archaeological Research, 1998.

Smith, Roger C., James Spirek, John Bratten, and Della Scott-Ireton. *The Emanuel Point Ship: Archaeological Investigations, 1992–1995.* Preliminary Report. Pensacola: Florida Bureau of Archaeological Research, 1995.

### *Espiritu Santo* (South Africa). Not yet positively identified

Bell-Cross, G. "A Brief Maritime History of the Coast between the Kei and Fish Rivers, Part 1." *Coelacanth* 20, no. 2 (1982).

———. "A Brief Maritime History of the Coast between the Kei and Fish Rivers, Part 2." *Coelacanth* 21, no. 1 (1983).

### *Espiritu Santo* (Texas)

Arnold, J. Barto, III, and Robert Weddle. *The Nautical Archaeology of Padre Island: The Spanish Shipwrecks of 1554.* London: Academic Press, 1978.

### Fuxa Wreck

Lopez Perez, Alessandro, and Cesar Alonso Sanson. *1590: La nao Nuestra Señora del Rosario. Estudio de su estructura.* La Habana, Cuba: Carisub–Departamiento de Arqueologia, 1993.

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### Green Cabin Wreck

Smith, Roger. "New World Shipwrecks, 1500–1800: A Compendium of Sites Salvaged or Excavated." Report on file at the Texas A&M University Nautical Archaeology program library, 1978.

Moore, David, and Bill Muirl. "Archaeology of the *San Martin*." *Seafarers* 1: (1987)

### Highborn Cay Wreck

Oertling, Thomas J. "The Highborn Cay Wreck: The 1986 Field Season." *International Journal of Nautical Archaeology* 18, no. 3 (1989): 244–53.

Peterson, Mendel. "Buried Treasure beneath the Spanish Main." *Unesco Courier* (1972) 23–27.

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Smith, Roger, Donald H. Keith, and Denise Lakey. "The Highborn Cay Wreck: Further Exploration of a Sixteenth-Century Bahaman Shipwreck." *International Journal of Nautical Archaeology* 14, no. 1 (1985): 63–72.

### Inês de Soto

*Naufragio de Inês de Soto: Un hallasgo de cuatro siglos.* La Habana, Cuba: Carisub, SA, 1998.

### *Jesús M.ª de la Limpia Concepción.* No information published

A galleon from the Pacific silver route (from Callao, the port of Lima in Peru, to Panama City) it was lost in 1654 off Shanduy, Ecuador; it has not yet been excavated.

### Molasses Reef Wreck

Keith, Donald H. "The Molasses Reef Wreck." Ph.D. diss., Texas A&M University, 1987.

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Keith, Donald H., J. A. Duff, S. R. James, T. Oertling, and J. J. Simmons. "The Molasses Reef Wreck, Turks and Caicos Islands, B. W. I.: A Preliminary Report." *International Journal of Nautical Archaeology* 13, no. 1 (1984): 45–63.

Keith, Donald H., and J. J. Simmons. "An Analysis of Hull Remains, Ballast and Artifact Distribution of a Sixteenth-Century Shipwreck: Toward a Better Understanding of Wrecking and Reconstruction" *Journal of Field Archaeology* 12, no. 4 (1985): 411–24.

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### Mystery Wreck of MAREX

Marx, Robert F. *Quest for Treasure*. Dallas: Ram Books, 1982.

Papers privately published by the company MAREX, Memphis, Tennessee. Personal communication, John de Bry, 1998.

### *Nossa Senhora da Atalaia*

Allen, Geoffrey, and David Allen. *The Guns of Sacramento*. London: Robin Garton, 1978.

Esparteiro, Comandante António Marques. *Três séculos no mar (1640–1910)*. 32 vols. Lisboa: Colecção Estudos, Ministério da Marinha, 1974–87.

### *Nossa Senhora da Luz*

Monteiro, Paulo. *O naufrágio da nau da Carreira da India Nossa Senhora da Luz*. Lisboa: Centro Nacional de Arqueologia Náutica e Subaquática, 1999.

———. "Um naufrágio na Carreira das Índias." *Mundo Náutico* 4, no. 34 (1997): 70–72.

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Afonso, Simonetta Luz, ed. *Nossa Senhora dos Mártires: The Last Voyage*. Lisbon: Verbo/EXPO '98, 1998.

Brigadier, Sara, "The Artifacts from São Julião da Barra." INA Quarterly 27, no. 4 (Winter, 2000): 10–12.

Castro, Filipe. "The Last Field Season on the Pepper Wreck. A Preliminary Analysis of the Hull." *INA Quarterly* 27, no. 4 (Winter, 2000): 3–9.

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*Nuestra Señora de Atocha*

Lyon, Eugene. "The Trouble with Treasure." *National Geographic Magazine* 149, no. 6 (1976): 787–809.

Mathewson, Duncan. *Treasure of the Atocha.* New York: Pisces Books, 1986.

Smith, Roger. "New World Shipwrecks, 1500–1800: A Compendium of Sites Salvaged or Excavated." Report on file at the Texas A&M University Nautical Archaeology program library, 1978.

*Nuestra Señora de la Concepción* (Dominican Republic)

Bowden, Tracy. "Gleaming Treasure from the Silver Bank." *National Geographic Magazine* 1, no. 90 (1996): 90–105.

Peterson, Mendel. *Treasure of the Concepción.* Boston: New England Aquarium, 1980.

*Nuestra Señora de la Conceptión* (Guam)

Mathers, William M. "Nuestra Señora de la Conceptión." *National Geographic Magazine* 178, no. 3 (1990): 38–53.

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Marx, Robert F. *Quest for Treasure.* Dallas: Ram Books, 1982.

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Alves, Francisco J. S. "Ponta do Altar B—Arqueologia de um naufrágio no Algarve nos alvores do século XVII." *O Arqueólogo Português* 4, nos. 8 and 10 (1990–92): 357–424.

Ria de Aveiro A Wreck

Alves, Francisco J. S. *Os destroços do navio do século XV Ria de Aveiro A—Campanha de 1996. Estudo interdisciplinar e comparativo de duas jazidas arqueológicas subaquáticas.* Preliminary Report for the Junta Nacional de Investigação Científica e Tecnológica, Lisboa: Centro Nacional de Arqueologia Náutica e Subaquática, 1997.

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### Rye A Wreck

Lovegrove, Capt. H. "Remains of Two Old Vessels Found at Rye, Sussex." *Mariner's Mirror* 52, no . 2 (1964): 115–22.

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### Saint Honorat I

L'Hour, Michel, and Florence Richez. "Sondage sur un site submarin de la baie de Cannes, Saint Honorat I, l'Epave d'un galleon espanhol incendié en 1637?" *Cahiers d'Archéologie Subaquatique* 11 (1993): 125–40.

### Saint John's Bahamas Wreck

Malcom, Corey. "St. John Bahamas Wreck." In *Encyclopedia of Underwater and Maritime Archaeology*. London: Yale University Press, 1997.

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### *San Agustin*

Aker, Raymond. *The Cermeno Expedition at Drakes Bay, 1595.* Typed Report. Copy at Nautical Archaeology Program Liabrary, Texas A&M University, College Station. Palo Alto, Calif., 1965.

Delgado, James P., ed. *Encyclopedia of Underwater and Maritime Archaeology*. New Haven, Connecticut: Yale University Press, 1997.

### *San Antonio*

Smith, Roger. "New World Shipwrecks, 1500–1800: A Compendium of Sites Salvaged or Excavated." Report on file at the Texas A&M University Nautical Archaeology program library, 1978.

### *San Diego*

L'Hour, Michel. "Construction navale." In *Le San Diego—Un Trésor sous la mer.* Catalog of the exposition *On a retrouvé le trésor du* San Diego. Paris: Association Française d'Action Artistique–Réunion de Musées Nationaux, 1994.

### *San Esteban*

Arnold, J. Barto, III, and Robert Weddle. *The Nautical Archaeology of Padre Island: The Spanish Shipwrecks of 1554*. London: Academic Press, 1978.

Rosloff, Jay, and Barto Arnold III. "The Keel of the *San Esteban* (1554): Continued Analysis." *International Journal of Nautical Archaeology* 13, no. 4 (1984): 287–96.

### *San Juan*

Grenier, Robert. “Basque Whalers in the New World: The Red Bay Wrecks.” *Ships and Shipwrecks of the Americas,* ed. George F. Bass. London: Thames and Hudson, 1988.

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Bernier, Marc-André. *Les archéologues aux pieds palmés.* Saint-Lambert, Canada: Editions Héritage, 1996.

Waddell, P. J. A. “The Disassembly of a Sixteenth-Century Galleon.” *International Journal of Nautical Archaeology* 15, no. 2 (1986): 137–48.

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Smith, Roger. “Treasure Ships of the Spanish Main: The Iberian-American Maritime Empires.” In *Ships and Shipwrecks of the Americas,* ed. George Bass. London: Thames and Hudson, 1988.

### *Santa Catarina de Ribamar*

Esparteiro, Comandante António Marques. *A peça do cabo da Roca.* Lisboa: Instituto Português de Arqueologia, História e Etnografia, 1966.

### *Santa Margarita* (Florida)

Lyon, Eugene. “*Santa Margarita:* Treasure from the Ghost Galleon.” *National Geographic Magazine* 161, no. 2 (1982): 228–43.

### *Santa Margarita* (Guam). No information published

Allegedly a Manila galleon wrecked in the seventeenth century in the Mariana Islands, salvaging of this ship began in 1998.

### *Santa Maria de la Rosa*

Martin, Colin. *Full Fathom Five,* New York: Viking Press, 1975.

Wignall, Sydney “The Spanish Armada Salvage Expedition.” Typescript, Dublin, 1968.

### *Santa Maria Madre de Deus.* Not yet positively identified

Vernon, Gillian. “A Portuguese Shipwreck site at Bonza Bay: Is It the *Santa Maria Madre de Deus* of 1643?” *Coelacanth* 32, no. 1 (June, 1994): 28–33.

### *Santa Maria de Yciar*

Arnold, J. Barto, III, and Robert Weddle. *The Nautical Archaeology of Padre Island: The Spanish Shipwrecks of 1554.* London: Academic Press, 1978.

### *Santiago*

Stuckemberg, Brian. *The Story of the Wreck of the Santiago.* East London, So. Afr.: Natal Museum, 1987.

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Allen, Geoffrey, and David Allen. *The Guns of Sacramento.* London: Robin Garton, 1978.

Esparteiro, Comandante António Marques. *Três séculos no mar (1640–1910).* 32 vols. Lisboa: Colecção Estudos, Ministério da Marinha, 1974–87.

### *Santíssimo Sacramento B*

Mello, Ulysses P. de. "O galeão *Sacramento* (1668): Um naufrágio do século XVII e os resultados de uma pesquisa de arqueologia submarina na Bahia (Brasil)." *Navigator* 13 (1977): 7–40.

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# Appendix C
# Artifact List

| ID | DATE | ARTIFACT NUMBER | MATERIAL | DESCRIPTION |
|---|---|---|---|---|
| 1 | Unknown | 001 | Lead | Weight |
| 2 | Unknown | 002 | Cupreous | Astrolabe |
| 3 | Unknown | 003 | Ceramic | Martaban jar |
| 4 | 10/22/1996 | 004.01.01 | Stoneware | Buff-bodied fragments with brown glaze |
| 5 | 10/22/1996 | 004.01.02 | Stoneware | Buff-bodied fragments with brown glaze |
| 6 | 10/22/1996 | 004.01.03 | Stoneware | Buff-bodied fragments with brown glaze |
| 7 | 10/22/1996 | 004.01.04 | Stoneware | Buff-bodied fragments with brown glaze |
| 8 | 10/22/1996 | 004.01.05 | Stoneware | Buff-bodied fragments with brown glaze |
| 9 | 10/22/1996 | 004.01.06 | Stoneware | Buff-bodied fragments with brown glaze |
| 10 | 10/22/1996 | 004.01.07 | Stoneware | Buff-bodied fragments with brown glaze |
| 11 | 10/22/1996 | 004.01.08 | Stoneware | Buff-bodied fragments with brown glaze |
| 12 | 10/22/1996 | 004.01.09 | Stoneware | Buff-bodied fragments with brown glaze |
| 13 | 10/22/1996 | 004.01.10 | Stoneware | Buff-bodied fragments with brown glaze |
| 14 | 10/22/1996 | 004.01.11 | Stoneware | Buff-bodied fragments with brown glaze |
| 15 | 10/22/1996 | 004.01.12 | Stoneware | Buff-bodied fragments with brown glaze |
| 16 | 10/22/1996 | 004.01.13 | Stoneware | Buff-bodied fragments with brown glaze |
| 17 | 10/22/1996 | 004.01.14 | Stoneware | Buff-bodied fragments with brown glaze |
| 18 | 10/22/1996 | 004.01.15 | Stoneware | Buff-bodied fragments with brown glaze |
| 19 | 10/22/1996 | 004.01.16 | Stoneware | Buff-bodied fragments with brown glaze |
| 20 | 10/22/1996 | 004.02.01 | Possibly ferrous | Unidentified |
| 21 | 10/22/1996 | 004.02.02 | Possibly ferrous | Unidentified |
| 22 | 10/22/1996 | 004.02.03 | Possibly ferrous | Unidentified |
| 23 | 10/22/1996 | 004.02.04 | Possibly ferrous | Unidentified |
| 24 | 10/22/1996 | 004.02.05 | Possibly ferrous | Unidentified |
| 25 | 10/22/1996 | 004.02.06 | Possibly ferrous | Unidentified |
| 26 | 10/22/1996 | 004.02.07 | Possibly ferrous | Unidentified |
| 27 | 10/22/1996 | 004.02.08 | Possibly ferrous | Unidentified |
| 28 | 10/22/1996 | 004.03.01 | Lead | Sheathing and Caulking fragment |
| 29 | 10/22/1996 | 004.03.02 | Lead | Sheathing and Caulking fragment |
| 30 | 10/22/1996 | 004.03.03 | Lead | Sheathing and Caulking fragment |
| 31 | 10/22/1996 | 004.03.04 | Lead | Sheathing and Caulking fragment |
| 32 | 10/22/1996 | 004.03.05 | Lead | Sheathing and Caulking fragment |
| 33 | 10/22/1996 | 004.04 | Organic | Long bone fragment with proximal epiphysis |
| 34 | 10/22/1996 | 004.05.01 | Earthenware | Red-bodied coarse tempered sherd |
| 35 | 10/22/1996 | 004.05.02 | Earthenware | Red-bodied coarse tempered sherd |

| ID | DATE | ARTIFACT NUMBER | MATERIAL | DESCRIPTION |
|---|---|---|---|---|
| 36 | 10/22/1996 | 004.05.03 | Earthenware | Red-bodied coarse tempered sherd |
| 37 | 10/22/1996 | 004.05.04 | Earthenware | Red-bodied coarse tempered sherd |
| 38 | 10/22/1996 | 004.05.05 | Earthenware | Red-bodied coarse tempered sherd |
| 39 | 10/22/1996 | 004.05.06 | Earthenware | Red-bodied coarse tempered sherd |
| 40 | 10/22/1996 | 004.06.01 | Organic | Wood fragment |
| 41 | 10/22/1996 | 004.06.02 | Organic | Wood fragment |
| 42 | 10/22/1996 | 004.06.03 | Organic | Wood fragment |
| 43 | 10/22/1996 | 004.06.04 | Organic | Wood fragment |
| 44 | 10/22/1996 | 004.06.05 | Organic | Wood fragment |
| 45 | 10/22/1996 | 004.06.06 | Organic | Wood fragment |
| 46 | 10/22/1996 | 004.06.07 | Organic | Wood fragment |
| 47 | 10/22/1996 | 004.06.08 | Organic | Wood fragment |
| 48 | 10/22/1996 | 004.06.09 | Organic | Wood fragment |
| 50 | 10/22/1996 | 004.07.01 | Earthenware | White-glazed fragment |
| 51 | 10/22/1996 | 004.07.02 | Earthenware | Aqua-glazed fragment |
| 52 | 10/22/1996 | 004.07.03 | Stoneware | Brown-glazed fragment |
| 53 | 10/22/1996 | 004.08 | Earthenware | Coarse gravel-tempered sherd with attached handle |
| 54 | 10/22/1996 | 004.09 | Ceramic | Sherd |
| 55 | 10/22/1996 | 004.01 | Stoneware | Red-bodied fragment buff interior and green exterior glaze |
| 56 | 10/22/1996 | 004.11 | Unknown | Unknown |
| 57 | 10/22/1996 | 004.12 | Unknown | Possible pipe stem |
| 58 | 10/22/1996 | 004.13 | Ferrous | Wrought iron tool possible punch stylus or bar fragment |
| 59 | 10/22/1996 | 005.01.01 | Silver | Coin |
| 60 | 10/22/1996 | 005.01.02 | Silver | Coin |
| 61 | 10/22/1996 | 005.01.03 | Silver | Coin |
| 62 | 10/22/1996 | 005.02 | Stoneware | Buff-bodied fragment with green glaze possible Dragon jar |
| 63 | 10/27/1996 | 005.03 | Ferrous | Wrought iron fastener |
| 64 | 11/01/1996 | 006.02 | Organic | Coconut shell |
| 65 | 11/01/1996 | 006.02.01 | Lead | Sheathing or caulking fragment |
| 66 | 11/01/1996 | 006.02.02 | Lead | Sheathing or caulking fragment |
| 67 | 11/01/1996 | 006.02.03 | Lead | Sheathing or caulking fragment |
| 68 | 11/01/1996 | 006.02.04 | Lead | Sheathing or caulking fragment |
| 69 | 11/01/1996 | 006.02.05 | Lead | Sheathing or caulking fragment |
| 70 | 11/01/1996 | 006.02.06 | Lead | Sheathing or caulking fragment |
| 71 | 11/01/1996 | 006.02.07 | Lead | Sheathing or caulking fragment |
| 72 | 11/01/1996 | 006.02.08 | Lead | Sheathing or caulking fragment |
| 73 | 11/01/1996 | 006.02.09 | Lead | Sheathing or caulking fragment |
| 74 | 11/01/1996 | 006.02.10 | Lead | Sheathing or caulking fragment |
| 75 | 11/01/1996 | 006.02.11 | Lead | Sheathing or caulking fragment |
| 76 | 11/01/1996 | 006.02.12 | Lead | Sheathing or caulking fragment |
| 77 | 11/01/1996 | 006.02.13 | Lead | Sheathing or caulking fragment |
| 78 | 11/01/1996 | 006.02.14 | Lead | Sheathing or caulking fragment |
| 79 | 11/01/1996 | 006.03.01 | Earthenware | Fragment with brown interior glaze |
| 80 | 11/01/1996 | 006.03.02 | Earthenware | Fragment with brown interior glaze |
| 81 | 11/02/1996 | 007.01.01 | Organic | Rope fragment |

| ID | DATE | ARTIFACT NUMBER | MATERIAL | DESCRIPTION |
|---|---|---|---|---|
| 82 | 11/02/1996 | 007.01.02 | Organic | Badly deteriorated wood fragment |
| 83 | 11/02/1996 | 007.01.03 | Organic | Leather fragment with stitch holes |
| 84 | 11/02/1996 | 007.02.01 | Lead | Sheathing fragments |
| 85 | 11/02/1996 | 007.02.02 | Lead | Sheathing fragments |
| 86 | 11/02/1996 | 007.02.03 | Lead | Sheathing fragments |
| 87 | 11/02/1996 | 007.02.04 | Lead | Sheathing fragments |
| 88 | 11/02/1996 | 007.02.05 | Lead | Sheathing fragments |
| 89 | 11/02/1996 | 007.02.06 | Lead | Sheathing fragments |
| 90 | 11/02/1996 | 007.03 | Ceramic | Likely pipe fragment |
| 91 | 11/02/1996 | 007.04 | Porcelain | Blue and white plate rim sherd |
| 92 | Unknown | 008.01 | Organic | Mammalian bone fragment possibly scapular or pelvic |
| 93 | Unknown | 010.01 | Cupreous | Mortar |
| 94 | 11/09/1996 | 011.01 | Porcelain | Sherd with deer motif |
| 95 | 11/09/1996 | 011.02 | Unknown | Concretion |
| 96 | 11/05/1996 | 012.02.01 | Stoneware | Thin-walled fragment |
| 97 | 11/05/1996 | 012.02.02 | Stoneware | Thin-walled fragment |
| 98 | 11/05/1996 | 012.02.03 | Stoneware | Thin-walled fragment |
| 99 | 11/05/1996 | 012.02.04 | Stoneware | Thin-walled fragment |
| 100 | 11/05/1996 | 013.01.01 | Earthenware | Fragment dark brown exterior glaze likely Martaban jar |
| 101 | 11/05/1996 | 013.01.02 | Earthenware | Fragment dark brown exterior glaze likely Martaban jar |
| 102 | 11/05/1996 | 013.01.03 | Earthenware | Fragment dark brown exterior glaze likely Martaban jar |
| 103 | 11/05/1996 | 013.01.04 | Earthenware | Fragment dark brown exterior glaze likely Martaban jar |
| 104 | 11/05/1996 | 013.01.05 | Earthenware | Fragment dark brown exterior glaze likely Martaban jar |
| 105 | 11/05/1996 | 013.01.06 | Earthenware | Fragment dark brown exterior glaze likely Martaban jar |
| 106 | 11/05/1996 | 013.01.07 | Earthenware | Fragment dark brown exterior glaze likely Martaban jar |
| 107 | 11/05/1996 | 013.01.08 | Earthenware | Fragment dark brown exterior glaze likely Martaban jar |
| 108 | 11/05/1996 | 013.01.09 | Earthenware | Fragment dark brown exterior glaze likely Martaban jar |
| 109 | 11/05/1996 | 013.01.10 | Earthenware | Fragment dark brown exterior glaze likely Martaban jar |
| 110 | Unknown | 014.01 | Likely ferrous | Ring with latch—possible barrel/cask hoop |
| 111 | 11/01/1996 | 015.01.01 | Lead | Caulking or sheathing fragment |
| 112 | 11/01/1996 | 015.01.02 | Lead | Caulking or sheathing fragment |
| 113 | 11/01/1996 | 015.01.03 | Lead | Caulking or sheathing fragment |
| 114 | 11/01/1996 | 015.01.04 | Lead | Caulking or sheathing fragment |
| 115 | 11/01/1996 | 015.01.05 | Lead | Caulking or sheathing fragment |
| 116 | 11/01/1996 | 015.01.06 | Lead | Caulking or sheathing fragment |
| 117 | 11/01/1996 | 015.01.07 | Lead | Caulking or sheathing fragment |
| 118 | 11/01/1996 | 015.01.08 | Lead | Caulking or sheathing fragment |

| ID | DATE | ARTIFACT NUMBER | MATERIAL | DESCRIPTION |
|---|---|---|---|---|
| 119 | 11/01/1996 | 015.01.09 | Lead | Caulking or sheathing fragment |
| 120 | 11/01/1996 | 015.01.10 | Lead | Caulking or sheathing fragment |
| 121 | 11/01/1996 | 015.01.11 | Lead | Caulking or sheathing fragment |
| 122 | 11/01/1996 | 015.01.12 | Lead | Caulking or sheathing fragment |
| 123 | 11/01/1996 | 015.01.13 | Lead | Caulking or sheathing fragment |
| 124 | 11/01/1996 | 015.01.14 | Lead | Caulking or sheathing fragment |
| 125 | 11/01/1996 | 015.01.15 | Lead | Caulking or sheathing fragment |
| 126 | 11/01/1996 | 015.01.16 | Lead | Caulking or sheathing fragment |
| 127 | 11/01/1996 | 015.01.17 | Lead | Caulking or sheathing fragment |
| 128 | 11/01/1996 | 015.01.18 | Lead | Caulking or sheathing fragment |
| 129 | 11/01/1996 | 015.01.19 | Lead | Caulking or sheathing fragment |
| 130 | 11/01/1996 | 015.01.20 | Lead | Caulking or sheathing fragment |
| 131 | 11/01/1996 | 015.01.21 | Lead | Caulking or sheathing fragment |
| 132 | 11/01/1996 | 015.01.22 | Lead | Caulking or sheathing fragment |
| 133 | 11/01/1996 | 015.01.23 | Lead | Caulking or sheathing fragment |
| 134 | 11/01/1996 | 015.01.24 | Lead | Caulking or sheathing fragment |
| 135 | 11/01/1996 | 015.01.25 | Lead | Caulking or sheathing fragment |
| 136 | 11/01/1996 | 015.02.01 | Organic | Unknown |
| 137 | 11/01/1996 | 015.02.02 | Organic | Unknown |
| 138 | 11/01/1996 | 015.02.03 | Organic | Unknown |
| 139 | 11/01/1996 | 015.02.04 | Organic | Unknown |
| 140 | 11/01/1996 | 015.02.05 | Organic | Unknown |
| 141 | 11/01/1996 | 015.02.06 | Organic | Unknown |
| 142 | 11/01/1996 | 015.02.07 | Organic | Unknown |
| 142 | 11/01/1996 | 015.02.08 | Organic | Unknown |
| 143 | 11/01/1996 | 015.02.09 | Organic | Unknown |
| 144 | 11/01/1996 | 015.02.10 | Organic | Unknown |
| 145 | 11/01/1996 | 015.02.11 | Organic | Unknown |
| 146 | 11/01/1996 | 015.02.12 | Organic | Unknown |
| 147 | 11/01/1996 | 015.02.13 | Organic | Unknown |
| 148 | 11/01/1996 | 015.02.14 | Organic | Unknown |
| 149 | 11/01/1996 | 015.02.15 | Organic | Unknown |
| 150 | 11/01/1996 | 015.02.16 | Organic | Unknown |
| 151 | 11/01/1996 | 015.03.01 | Likely ferrous | Unidentified |
| 152 | 11/01/1996 | 015.03.02 | Likely ferrous | Unidentified |
| 153 | 11/01/1996 | 015.03.03 | Likely ferrous | Unidentified |
| 154 | 11/01/1996 | 015.03.04 | Likely ferrous | Unidentified |
| 155 | 11/01/1996 | 015.03.05 | Likely ferrous | Unidentified |
| 156 | 11/01/1996 | 015.03.06 | Likely ferrous | Unidentified |
| 157 | 11/01/1996 | 015.03.07 | Likely ferrous | Unidentified |
| 158 | 11/01/1996 | 015.04.01 | Miscellaneous | Rocks slag encrustations organic fragments |
| 159 | 11/01/1996 | 015.04.02 | Miscellaneous | Rocks slag encrustations organic fragments |
| 160 | 11/01/1996 | 015.04.03 | Miscellaneous | Rocks slag encrustations organic fragments |
| 161 | 11/01/1996 | 015.04.04 | Miscellaneous | Rocks slag encrustations organic fragments |
| 162 | 11/01/1996 | 015.04.05 | Miscellaneous | Rocks slag encrustations organic fragments |

| ID | DATE | ARTIFACT NUMBER | MATERIAL | DESCRIPTION |
|---|---|---|---|---|
| 163 | 11/01/1996 | 015.04.06 | Miscellaneous | Rocks slag encrustations organic fragments |
| 164 | 11/01/1996 | 015.04.07 | Miscellaneous | Rocks slag encrustations organic fragments |
| 165 | 11/01/1996 | 015.04.08 | Miscellaneous | Rocks slag encrustations organic fragments |
| 166 | 11/01/1996 | 015.04.09 | Miscellaneous | Rocks slag encrustations organic fragments |
| 167 | 11/01/1996 | 015.04.10 | Miscellaneous | Rocks slag encrustations organic fragments |
| 168 | 11/01/1996 | 015.04.11 | Miscellaneous | Rocks slag encrustations organic fragments |
| 169 | 11/01/1996 | 015.04.12 | Miscellaneous | Rocks slag encrustations organic fragments |
| 170 | 11/01/1996 | 015.05.01 | Organic | Unknown |
| 171 | 11/01/1996 | 015.05.02 | Organic | Seed pod |
| 172 | 11/01/1996 | 015.05.03 | Organic | Seed pod |
| 173 | 11/01/1996 | 015.05.04 | Organic | Seed pod |
| 174 | 11/01/1996 | 015.06 | Organic | Fruit pit of unidentified species |
| 175 | 11/09/1996 | 016.01 | Earthenware | Red-bodied handle fragment |
| 176 | 11/09/1996 | 016.02.01 | Organic | Wood fragments |
| 177 | 11/09/1996 | 016.02.02 | Organic | Wood fragments |
| 178 | 11/09/1996 | 016.02.03 | Organic | Wood fragments |
| 179 | 11/09/1996 | 016.02.04 | Organic | Wood fragments |
| 180 | 11/09/1996 | 016.02.05 | Organic | Wood fragments |
| 181 | 11/09/1996 | 016.02.06 | Organic | Wood fragments |
| 182 | 11/09/1996 | 016.02.07 | Organic | Wood fragments |
| 183 | 11/09/1996 | 016.02.08 | Organic | Wood fragments |
| 184 | 11/09/1996 | 016.02.09 | Organic | Wood fragments |
| 185 | 11/09/1996 | 016.02.10 | Organic | Wood fragments |
| 186 | 11/09/1996 | 016.02.11 | Organic | Wood fragments |
| 187 | 11/09/1996 | 016.03.01 | Ceramic | White crazed tile |
| 188 | 11/09/1996 | 016.03.02 | Ceramic | Aqua-glazed white-pasted fragment |
| 189 | 11/09/1996 | 016.03.03 | Earthenware | Gray-bodied tin-glazed fragment |
| 190 | 11/09/1996 | 016.04 | Unknown | Unidentified |
| 191 | Unknown | 017 | Porcelain | Blue and white fragment |
| 192 | 11/16/1996 | 018.01 | Earthenware | Coarse red-bodied gravel-tempered fragment |
| 193 | 11/16/1996 | 018.02 | Ceramic | Fragment with brown interior glaze |
| 194 | 11/16/1996 | 018.03.01 | Earthenware | Redware fragment |
| 195 | 11/16/1996 | 018.03.02 | Earthenware | Redware fragment |
| 196 | 11/16/1996 | 018.03.03 | Earthenware | Redware fragment |
| 197 | 11/16/1996 | 018.04 | Earthenware | Highly fired fragment |
| 198 | 11/16/1996 | 018.05 | Rock | Rock |
| 199 | 11/16/1996 | 018.06 | Earthenware | Buff-bodied white-glazed Delftware fragment |
| 200 | 11/16/1996 | 018.07 | Rock | Rock |
| 201 | 11/16/1996 | 018.08 | Earthenware | Red-bodied coarse-tempered fragment |
| 202 | 11/16/1996 | 018.09 | Stoneware | Dragon jar rim sherd |
| 203 | 11/16/1996 | 018.10.01 | Earthenware | Coarse gravel-tempered sherd |

| ID | DATE | ARTIFACT NUMBER | MATERIAL | DESCRIPTION |
|---|---|---|---|---|
| 204 | 11/16/1996 | 018.10.02 | Earthenware | Coarse gravel-tempered sherd |
| 205 | 11/16/1996 | 018.10.03 | Earthenware | Coarse gravel-tempered sherd |
| 206 | 11/16/1996 | 018.10.04 | Earthenware | Coarse gravel-tempered sherd |
| 207 | 11/16/1996 | 018.11.01 | Stoneware | Dragon jar fragment |
| 208 | 11/16/1996 | 018.11.02 | Stoneware | Dragon jar fragment |
| 209 | 11/16/1996 | 018.11.03 | Stoneware | Dragon jar fragment |
| 210 | 11/16/1996 | 018.11.04 | Stoneware | Dragon jar fragment |
| 211 | 11/16/1996 | 018.11.05 | Stoneware | Dragon jar fragment |
| 212 | 11/16/1996 | 018.11.06 | Stoneware | Dragon jar fragment |
| 213 | 11/16/1996 | 018.11.07 | Stoneware | Dragon jar fragment |
| 214 | 11/16/1996 | 018.11.08 | Stoneware | Dragon jar fragment |
| 215 | 11/16/1996 | 018.11.09 | Stoneware | Dragon jar fragment |
| 216 | 11/16/1996 | 018.11.10 | Stoneware | Dragon jar fragment |
| 217 | 11/16/1996 | 018.11.11 | Stoneware | Dragon jar fragment |
| 218 | 11/16/1996 | 018.12.01 | Stoneware | Buff-bodied brown-glazed fragment |
| 219 | 11/16/1996 | 018.12.02 | Stoneware | Buff-bodied brown-glazed fragment |
| 220 | 11/16/1996 | 018.12.03 | Stoneware | Buff-bodied brown-glazed fragment |
| 221 | 11/16/1996 | 018.12.04 | Stoneware | Buff-bodied brown-glazed fragment |
| 222 | 11/16/1996 | 018.12.05 | Stoneware | Buff-bodied brown-glazed fragment |
| 223 | 11/16/1996 | 018.12.06 | Stoneware | Buff-bodied brown-glazed fragment |
| 224 | 11/16/1996 | 018.12.07 | Stoneware | Buff-bodied brown-glazed fragment |
| 225 | 11/16/1996 | 018.12.08 | Stoneware | Buff-bodied brown-glazed fragment |
| 226 | 11/16/1996 | 018.12.09 | Stoneware | Buff-bodied brown-glazed fragment |
| 227 | 11/16/1996 | 018.12.10 | Stoneware | Buff-bodied brown-glazed fragment |
| 228 | 11/16/1996 | 018.12.11 | Stoneware | Buff-bodied brown-glazed fragment |
| 229 | 11/16/1996 | 018.12.12 | Stoneware | Buff-bodied brown-glazed fragment |
| 230 | 11/16/1996 | 018.12.13 | Stoneware | Buff-bodied brown-glazed fragment |
| 231 | 11/16/1996 | 018.12.14 | Stoneware | Buff-bodied brown-glazed fragment |
| 232 | 11/16/1996 | 018.12.15 | Stoneware | Buff-bodied brown-glazed fragment |
| 233 | 11/16/1996 | 018.12.16 | Stoneware | Buff-bodied brown-glazed fragment |
| 234 | 11/16/1996 | 018.12.17 | Stoneware | Buff-bodied brown-glazed fragment |
| 235 | 11/16/1996 | 018.12.18 | Stoneware | Buff-bodied brown-glazed fragment |
| 236 | 11/16/1996 | 018.12.19 | Stoneware | Buff-bodied brown-glazed fragment |
| 237 | 11/16/1996 | 018.12.20 | Stoneware | Buff-bodied brown-glazed fragment |
| 238 | 11/16/1996 | 018.12.21 | Stoneware | Buff-bodied brown-glazed fragment |
| 239 | 11/16/1996 | 018.12.22 | Stoneware | Buff-bodied brown-glazed fragment |
| 240 | 11/16/1996 | 018.12.23 | Stoneware | Buff-bodied brown-glazed fragment |
| 241 | 11/16/1996 | 018.12.24 | Stoneware | Buff-bodied brown-glazed fragment |
| 242 | 11/16/1996 | 018.13.01 | Ceramic | Unknown |
| 243 | 11/16/1996 | 018.13.02 | Ceramic | Unknown |
| 244 | 11/16/1996 | 018.13.03 | Ceramic | Unknown |
| 245 | 11/16/1996 | 018.14.01 | Ceramic | Brown-glazed fragment |
| 246 | 11/16/1996 | 018.14.02 | Ceramic | Brown-glazed fragment |
| 247 | 11/16/1996 | 018.14.03 | Ceramic | Brown-glazed fragment |
| 248 | 11/16/1996 | 018.14.04 | Ceramic | Brown-glazed fragment |
| 249 | 11/16/1996 | 018.14.05 | Ceramic | Brown-glazed fragment |
| 250 | 11/16/1996 | 018.14.06 | Ceramic | Brown-glazed fragment |
| 251 | 11/16/1996 | 018.14.07 | Ceramic | Brown-glazed fragment |
| 252 | 11/16/1996 | 018.14.08 | Ceramic | Brown-glazed fragment |
| 253 | 11/16/1996 | 018.14.09 | Ceramic | Brown-glazed fragment |

| ID | DATE | ARTIFACT NUMBER | MATERIAL | DESCRIPTION |
|---|---|---|---|---|
| 254 | 11/16/1996 | 018.14.10 | Ceramic | Brown-glazed fragment |
| 255 | 11/16/1996 | 018.14.11 | Ceramic | Brown-glazed fragment |
| 256 | 11/16/1996 | 018.14.12 | Ceramic | Brown-glazed fragment |
| 257 | 11/16/1996 | 018.14.13 | Ceramic | Brown-glazed fragment |
| 258 | 11/16/1996 | 018.16.01 | Porcelain | Blue and white fragment |
| 259 | 11/16/1996 | 018.16.02 | Porcelain | Blue and white fragment |
| 260 | 11/16/1996 | 018.16.03 | Porcelain | Blue and white fragment |
| 261 | 11/16/1996 | 018.16.04 | Porcelain | Blue and white fragment |
| 262 | 11/16/1996 | 018.16.05 | Porcelain | Blue and white fragment |
| 263 | 11/16/1996 | 018.16.06 | Porcelain | Blue and white fragment |
| 264 | 11/16/1996 | 018.16.07 | Porcelain | Blue and white fragment |
| 265 | 11/16/1996 | 018.17 | Cupreous | Japanese tsuba |
| 266 | 11/16/1996 | 018.18 | Ferrous | Unidentified concretion |
| 267 | 11/16/1996 | 018.19.01 | Lead | Sheathing fragment |
| 268 | 11/16/1996 | 018.19.02 | Lead | Sheathing fragment |
| 268 | 11/16/1996 | 018.19.03 | Lead | Sheathing fragment |
| 270 | 11/16/1996 | 018.19.04 | Lead | Sheathing fragment |
| 271 | 11/16/1996 | 018.20.01 | Organic | Wood fragment |
| 272 | 11/16/1996 | 018.20.02 | Organic | Wood fragment |
| 273 | 11/16/1996 | 018.21 | Unknown | Possibly Organic concretion |
| 274 | 11/16/1996 | 019.01 | Silver | Coin |
| 275 | 11/16/1996 | 019.02 | Silver | Coin |
| 276 | 11/16/1996 | 019.03 | Silver | Coin |
| 277 | 11/16/1996 | 019.04 | Silver | Coin |
| 278 | 11/16/1996 | 019.05 | Silver | Coin |
| 279 | 11/16/1996 | 019.06 | Silver | Coin |
| 280 | 11/16/1996 | 019.07 | Silver | Coin |
| 281 | 11/16/1996 | 019.08 | Silver | Coin |
| 282 | 11/16/1996 | 019.09 | Silver | Coin |
| 283 | 11/16/1996 | 019.10 | Silver | Coin |
| 284 | 11/16/1996 | 019.11 | Silver | Coin |
| 285 | 11/16/1996 | 019.12 | Silver | Coin |
| 286 | 11/16/1996 | 019.13 | Silver | Coin |
| 287 | 11/16/1996 | 019.14 | Silver | Coin |
| 288 | 11/16/1996 | 019.15 | Silver | Coin |
| 289 | 11/16/1996 | 019.16 | Silver | Coin |
| 290 | 11/17/1996 | 020.01 | Ceramic | Fragment with dark brown exterior |
| 291 | 11/17/1996 | 020.02 | Ceramic | Fragment with dark brown exterior |
| 292 | 11/17/1996 | 020.03.01 | Earthenware | Buff-bodied black slip brown-glazed sherd |
| 293 | 11/17/1996 | 020.03.02 | Earthenware | Coarse-tempered black sherd |
| 294 | 11/17/1996 | 020.03.03 | Earthenware | Coarse-tempered black sherd |
| 295 | 11/17/1996 | 020.03.04 | Earthenware | Coarse-tempered black sherd |
| 296 | 11/17/1996 | 020.03.05 | Earthenware | Coarse-tempered black sherd |
| 297 | 11/1996 | 021.01 | Earthenware | Coarse gravel-tempered fragment |
| 298 | 11/17/1996 | 021.02.01 | Porcelain | Blue and white fragment |
| 299 | 11/17/1996 | 021.02.02 | Porcelain | Blue and white fragment |
| 300 | 11/17/1996 | 021.03.01 | Organic | Fruit pit likely peach |
| 301 | 11/17/1996 | 021.03.02 | Organic | Fruit pit likely peach |
| 302 | 11/17/1996 | 021.03.03 | Organic | Fruit pit likely peach |

| ID | DATE | ARTIFACT NUMBER | MATERIAL | DESCRIPTION |
|---|---|---|---|---|
| 303 | 11/17/1996 | 021.03.04 | Organic | Fruit pit likely peach |
| 304 | 11/17/1996 | 021.05 | Earthenware | light-pasted fragment with brown glaze |
| 305 | 11/17/1996 | 021.06 | Ceramic | Redware fragment |
| 306 | 11/17/1996 | 021.07 | Earthenware | Buff-bodied fragment with crazed white tin glaze |
| 307 | 11/17/1996 | 021.08 | Ceramic | Chinaware—Earthenware fragment |
| 308 | 11/17/1996 | 022.02.01 | Possibly ferrous | Unidentified concretion |
| 309 | 11/17/1996 | 022.02.02 | Possibly ferrous | Unidentified concretion |
| 310 | 11/17/1996 | 022.03.01 | Metal | Unidentified |
| 311 | 11/17/1996 | 022.03.02 | Metal | Unidentified |
| 312 | 11/17/1996 | 022.03.03 | Metal | Unidentified |
| 313 | 11/17/1996 | 022.04 | Cupreous | Candelabra fragment |
| 314 | 11/17/1996 | 022.05 | Lead | Cast lead ornamentation |
| 315 | 11/17/1996 | 023.01 | Organic | Mammalian long bone possibly juvenile |
| 316 | 11/17/1996 | 023.02 | Ceramic | Fragment |
| 317 | 11/17/1996 | 023.03.01 | Organic | Fruit pit likely peach |
| 318 | 11/17/1996 | 023.03.02 | Organic | Fruit pit likely peach |
| 319 | 11/17/1996 | 023.03.03 | Organic | Fruit pit likely peach |
| 320 | 11/17/1996 | 023.03.04 | Organic | Fruit pit likely peach |
| 321 | 11/17/1996 | 023.03.05 | Organic | Fruit pit likely peach |
| 322 | 11/17/1996 | 023.03.06 | Organic | Fruit pit likely peach |
| 323 | 11/17/1996 | 023.03.07 | Organic | Fruit pit likely peach |
| 324 | 11/17/1996 | 023.04 | Stoneware | Buff-bodied fragment with interior and exterior glaze |
| 325 | 11/17/1996 | 023.05 | Porcelain | Blue and white fragment |
| 326 | 11/17/1996 | 023.06 | Likely Lead | Unidentified fragment |
| 327 | 11/17/1996 | 023.07 | Stoneware | Poorly-fired red-bodied fragment |
| 328 | 11/17/1996 | 023.08.01 | Earthenware | Red-bodied gravel-tempered fragment |
| 329 | 11/17/1996 | 023.08.02 | Earthenware | Red-bodied gravel-tempered fragment |
| 330 | 11/17/1996 | 023.09 | Earthenware | Coarse red-bodied gravel-tempered base sherd |
| 331 | 11/17/1996 | 023.10 | Possibly ferrous | Unidentified |
| 332 | 11/17/1996 | 023.11 | Glass | Olive green bottle glass |
| 333 | 11/17/1996 | 024.01 | Ceramic | Green-glazed fragment |
| 334 | 11/17/1996 | 024.02 | Stoneware | Buff-bodied fragment with brown glaze |
| 335 | 11/17/1996 | 024.03 | Stoneware | Buff/gray-bodied fragment with dark brown glaze |
| 336 | 11/17/1996 | 024.04 | Stoneware | Coarse-tempered reddish body sherd |
| 337 | 11/17/1996 | 024.05 | Earthenware | Badly deteriorated red fragment |
| 338 | 11/17/1996 | 024.06 | Earthenware | Buff-bodied sherd with green glaze |
| 339 | 11/17/1996 | 024.07 | Earthenware | Coarse buff-bodied gravel-tempered sherd |
| 340 | 11/17/1996 | 024.08 | Ceramic | Brown-glazed sherd |
| 341 | 11/17/1996 | 024.09 | Porcelain | Blue and white fragment |
| 342 | 11/17/1996 | 024.10 | Stoneware | Buff-bodied dragon jar fragment |
| 343 | 11/17/1996 | 024.11.01 | Unknown | Unidentified concretions |
| 344 | 11/17/1996 | 024.11.02 | Unknown | Unidentified concretions |
| 345 | 11/17/1996 | 024.11.03 | Unknown | Unidentified concretions |
| 346 | 11/17/1996 | 024.11.04 | Unknown | Unidentified concretions |
| 347 | 11/17/1996 | 024.11.05 | Unknown | Unidentified concretions |

| ID | DATE | ARTIFACT NUMBER | MATERIAL | DESCRIPTION |
|---|---|---|---|---|
| 348 | 11/17/1996 | 024.12 | Stoneware | Reddish body sherd |
| 349 | Unknown | 025 | Organic | Coconut shell fragment |
| 350 | Unknown | 026.01 | Organic | Fruit pit likely peach or plum |
| 351 | Unknown | 026.02 | Organic | Fruit pit likely peach or plum |
| 352 | 11/18/1996 | 027.01.01 | Organic | Fruit pit likely peach |
| 353 | 11/18/1996 | 027.01.02 | Organic | Fruit pit likely peach |
| 354 | 11/18/1996 | 027.01.03 | Organic | Fruit pit likely peach |
| 355 | 11/18/1996 | 027.01.04 | Organic | Fruit pit likely peach |
| 356 | 11/18/1996 | 027.02.01 | Metal | Possible lead fragment |
| 357 | 11/18/1996 | 027.02.02 | Metal | Possible lead fragment |
| 358 | 11/18/1996 | 027.03 | Porcelain | Blue and white fragment |
| 359 | 11/17/1996 | 028.01.01 | Organic | Fruit pit likely peach |
| 360 | 11/17/1996 | 028.01.02 | Organic | Fruit pit likely peach |
| 361 | 11/17/1996 | 028.01.03 | Organic | Fruit pit likely peach |
| 362 | 11/17/1996 | 028.01.04 | Organic | Fruit pit likely peach |
| 363 | 11/17/1996 | 028.02 | Porcelain | Blue and white fragment possible plate rim |
| 363 | 11/17/1996 | 029.01 | Porcelain | Blue and white vase base |
| 364 | 11/17/1996 | 029.02 | Porcelain | Blue and white plate rim sherd |
| 365 | 11/17/1996 | 030.01.01 | Silver | Coin |
| 366 | 11/17/1996 | 030.01.02 | Silver | Coin |
| 367 | 11/17/1996 | 030.01.03 | Silver | Coin |
| 368 | 11/17/1996 | 030.01.04 | Silver | Coin |
| 369 | 11/17/1996 | 030.01.05 | Silver | Coin |
| 370 | 11/17/1996 | 030.01.06 | Silver | Coin |
| 371 | 11/17/1996 | 030.01.07 | Silver | Coin |
| 372 | 11/17/1996 | 030.01.08 | Silver | Coin |
| 373 | 11/17/1996 | 030.01.09 | Silver | Coin |
| 374 | 11/17/1996 | 030.01.10 | Silver | Coin |
| 375 | 11/17/1996 | 030.01.11 | Silver | Coin |
| 376 | 11/17/1996 | 030.01.12 | Silver | Coin |
| 377 | 11/17/1996 | 030.01.13 | Silver | Coin |
| 378 | 11/17/1996 | 030.01.14 | Silver | Coin |
| 379 | 11/17/1996 | 030.01.15 | Silver | Coin |
| 380 | 11/17/1996 | 030.01.16 | Silver | Coin |
| 381 | 11/17/1996 | 030.01.17 | Silver | Coin |
| 382 | 11/17/1996 | 031.01 | Porcelain | Blue and white fragment |
| 383 | 10/21/1996 | 033.02 | Earthenware | Buff-bodied coarse-tempered base sherd |
| 384 | 10/21/1996 | 033.03 | Stoneware | Buff-bodied sherd with crizzled brown glaze |
| 385 | 10/21/1996 | 033.04.01 | Ceramic | Red-bodied sherd |
| 386 | 10/21/1996 | 033.04.02 | Ceramic | Red-bodied sherd |
| 387 | 10/21/1996 | 033.04.03 | Ceramic | Red-bodied sherd |
| 388 | 10/21/1996 | 033.04.04 | Ceramic | Red-bodied sherd |
| 389 | 10/21/1996 | 033.04.05 | Ceramic | Red-bodied sherd |
| 390 | 10/21/1996 | 034.01 | Possibly organic | Possible leather fragment |
| 391 | 10/21/1996 | 034.02.01 | Stoneware | Buff-bodied fragment with brown glaze |
| 392 | 10/21/1996 | 034.02.02 | Stoneware | Buff-bodied fragment with brown glaze |
| 393 | 10/21/1996 | 034.03 | Stoneware | Dragon jar rim fragment |
| 394 | 10/21/1996 | 034.04.01 | Ceramic | Redware Earthenware handle |
| 395 | 10/21/1996 | 034.04.02 | Ceramic | Salt-glazed stoneware sherd |

| ID | DATE | ARTIFACT NUMBER | MATERIAL | DESCRIPTION |
|---|---|---|---|---|
| 396 | 10/21/1996 | 035.01.01 | Organic | Fruit pit likely peach or plum |
| 397 | 10/21/1996 | 035.01.02 | Organic | Fruit pit likely peach or plum |
| 398 | 10/21/1996 | 035.01.03 | Organic | Fruit pit likely peach or plum |
| 399 | 10/21/1996 | 035.01.04 | Organic | Fruit pit likely peach or plum |
| 400 | 10/21/1996 | 035.01.05 | Organic | Fruit pit likely peach or plum |
| 401 | 10/21/1996 | 035.01.06 | Organic | Fruit pit likely peach or plum |
| 402 | 10/21/1996 | 035.01.07 | Organic | Fruit pit likely peach or plum |
| 403 | 10/21/1996 | 035.01.08 | Organic | Fruit pit likely peach or plum |
| 404 | 10/21/1996 | 035.01.09 | Organic | Fruit pit likely peach or plum |
| 405 | 10/21/1996 | 035.01.10 | Organic | Fruit pit likely peach or plum |
| 406 | 10/21/1996 | 035.01.11 | Organic | Fruit pit likely peach or plum |
| 407 | 10/21/1996 | 035.01.12 | Organic | Fruit pit likely peach or plum |
| 408 | 10/21/1996 | 035.01.13 | Organic | Fruit pit likely peach or plum |
| 409 | 10/21/1996 | 035.02.01 | Earthenware | Gravel-tempered red-bodied fragment |
| 410 | 10/21/1996 | 035.02.02 | Earthenware | Gravel-tempered red-bodied fragment |
| 411 | 10/21/1996 | 035.02.03 | Earthenware | Gravel-tempered red-bodied fragment |
| 412 | 10/21/1996 | 035.02.04 | Earthenware | Gravel-tempered red-bodied fragment |
| 413 | 10/21/1996 | 035.02.05 | Earthenware | Gravel-tempered red-bodied fragment |
| 414 | 10/21/1996 | 035.02.06 | Earthenware | Gravel-tempered red-bodied fragment |
| 415 | 10/21/1996 | 035.02.07 | Earthenware | Gravel-tempered red-bodied fragment |
| 416 | 10/21/1996 | 035.02.08 | Earthenware | Gravel-tempered red-bodied fragment |
| 417 | 10/21/1996 | 035.02.09 | Earthenware | Gravel-tempered red-bodied fragment |
| 418 | 10/21/1996 | 035.02.10 | Earthenware | Gravel-tempered red-bodied fragment |
| 419 | 10/21/1996 | 035.02.11 | Earthenware | Gravel-tempered red-bodied fragment |
| 420 | 10/21/1996 | 035.02.12 | Earthenware | Gravel-tempered red-bodied fragment |
| 421 | 10/21/1996 | 035.03 | Organic | Rope |
| 422 | 10/24/1996 | 036.01 | Organic | Pepper kernels |
| 423 | 10/24/1996 | 036.02 | Unknown | Unidentified |
| 424 | 10/24/1996 | 036.03.01 | Lead | Sheathing or caulking fragment |
| 425 | 10/24/1996 | 036.03.02 | Lead | Sheathing or caulking fragment |
| 426 | 10/24/1996 | 036.03.03 | Lead | Sheathing or caulking fragment |
| 427 | 10/24/1996 | 036.03.04 | Lead | Sheathing or caulking fragment |
| 428 | 10/24/1996 | 036.03.05 | Lead | Sheathing or caulking fragment |
| 429 | 10/24/1996 | 036.03.06 | Lead | Sheathing or caulking fragment |
| 430 | 10/24/1996 | 036.03.07 | Lead | Sheathing or caulking fragment |
| 431 | 10/24/1996 | 036.03.08 | Lead | Sheathing or caulking fragment |
| 432 | 10/24/1996 | 036.03.09 | Lead | Sheathing or caulking fragment |
| 433 | 10/24/1996 | 036.03.10 | Lead | Sheathing or caulking fragment |
| 434 | 10/24/1996 | 036.03.11 | Lead | Sheathing or caulking fragment |
| 435 | 10/24/1996 | 036.03.12 | Lead | Sheathing or caulking fragment |
| 436 | 10/24/1996 | 036.03.13 | Lead | Sheathing or caulking fragment |
| 437 | 10/24/1996 | 036.03.14 | Lead | Sheathing or caulking fragment |
| 438 | 10/24/1996 | 036.03.15 | Lead | Sheathing or caulking fragment |
| 439 | 10/24/1996 | 036.04.01 | Glass | Modern clear base sherd |
| 440 | 10/24/1996 | 036.04.02 | Glass | Modern green sherd |
| 441 | 10/24/1996 | 036.05 | Earthenware | Buff-bodied sherd with white glaze—intrusive |
| 442 | 10/24/1996 | 036.06.01 | Organic | Wood fragment |
| 443 | 10/24/1996 | 036.06.02 | Organic | Wood fragment |
| 444 | 10/24/1996 | 036.06.03 | Organic | Wood fragment |
| 445 | 10/24/1996 | 036.06.04 | Organic | Wood fragment |

| ID | DATE | ARTIFACT NUMBER | MATERIAL | DESCRIPTION |
|---|---|---|---|---|
| 446 | 10/24/1996 | 036.06.05 | Organic | Wood fragment |
| 447 | 10/24/1996 | 036.06.06 | Organic | Wood fragment |
| 448 | 10/24/1996 | 036.06.07 | Organic | Wood fragment |
| 449 | 10/24/1996 | 036.06.08 | Organic | Wood fragment |
| 450 | 10/24/1996 | 036.06.09 | Organic | Wood fragment |
| 451 | 10/24/1996 | 036.06.10 | Organic | Wood fragment |
| 452 | 10/24/1996 | 036.06.11 | Organic | Wood fragment |
| 453 | 10/24/1996 | 036.06.12 | Organic | Wood fragment |
| 454 | 10/24/1996 | 036.06.13 | Organic | Wood fragment |
| 455 | 10/24/1996 | 036.06.14 | Organic | Wood fragment |
| 456 | 10/24/1996 | 036.06.15 | Organic | Wood fragment |
| 457 | 10/24/1996 | 036.06.16 | Organic | Wood fragment |
| 458 | 10/24/1996 | 036.06.17 | Organic | Wood fragment |
| 459 | 10/24/1996 | 036.06.18 | Organic | Wood fragment |
| 460 | 10/24/1996 | 036.06.19 | Organic | Wood fragment |
| 461 | 10/24/1996 | 036.06.20 | Organic | Wood fragment |
| 442 | 10/24/1996 | 036.06.21 | Organic | Wood fragment |
| 463 | 10/24/1996 | 036.06.22 | Organic | Wood fragment |
| 464 | 10/24/1996 | 036.06.23 | Organic | Wood fragment |
| 465 | 10/24/1996 | 036.06.24 | Organic | Wood fragment |
| 466 | 10/24/1996 | 036.06.25 | Organic | Wood fragment |
| 467 | 10/24/1996 | 036.06.26 | Organic | Wood fragment |
| 468 | 10/24/1996 | 036.06.27 | Organic | Wood fragment |
| 469 | 10/24/1996 | 036.06.28 | Organic | Wood fragment |
| 470 | 10/24/1996 | 036.06.29 | Organic | Wood fragment |
| 471 | 10/24/1996 | 036.06.30 | Organic | Wood fragment |
| 472 | 10/24/1996 | 036.06.31 | Organic | Wood fragment |
| 473 | 10/24/1996 | 036.06.32 | Organic | Wood fragment |
| 474 | 10/24/1996 | 036.06.33 | Organic | Wood fragment |
| 475 | 10/24/1996 | 036.06.34 | Organic | Wood fragment |
| 476 | 10/24/1996 | 036.06.35 | Organic | Wood fragment |
| 477 | 10/24/1996 | 036.06.36 | Organic | Wood fragment |
| 478 | 10/24/1996 | 036.06.37 | Organic | Wood fragment |
| 479 | 10/24/1996 | 036.06.38 | Organic | Wood fragment |
| 480 | 10/24/1996 | 036.06.39 | Organic | Wood fragment |
| 481 | 10/24/1996 | 036.06.40 | Organic | Wood fragment |
| 482 | 10/24/1996 | 036.06.41 | Organic | Wood fragment |
| 483 | 10/24/1996 | 036.06.42 | Organic | Wood fragment |
| 484 | 10/24/1996 | 036.06.43 | Organic | Wood fragment |
| 485 | 10/24/1996 | 036.06.44 | Organic | Wood fragment |
| 486 | 10/24/1996 | 036.06.45 | Organic | Wood fragment |
| 487 | 10/24/1996 | 036.06.46 | Organic | Wood fragment |
| 488 | 10/24/1996 | 036.06.47 | Organic | Wood fragment |
| 489 | 10/24/1996 | 036.06.48 | Organic | Wood fragment |
| 490 | 10/24/1996 | 036.06.49 | Organic | Wood fragment |
| 491 | 10/24/1996 | 036.06.50 | Organic | Wood fragment |
| 492 | 10/24/1996 | 036.06.51 | Organic | Wood fragment |
| 493 | 10/24/1996 | 036.06.52 | Organic | Wood fragment |
| 494 | 10/24/1996 | 036.06.53 | Organic | Wood fragment |
| 495 | 10/24/1996 | 036.06.54 | Organic | Wood fragment |
| 496 | 10/24/1996 | 036.06.55 | Organic | Wood fragment |

| ID | DATE | ARTIFACT NUMBER | MATERIAL | DESCRIPTION |
|---|---|---|---|---|
| 497 | 10/24/1996 | 036.06.56 | Organic | Wood fragment |
| 498 | 10/24/1996 | 036.06.57 | Organic | Wood fragment |
| 499 | 10/24/1996 | 036.06.58 | Organic | Wood fragment |
| 500 | 10/24/1996 | 036.06.59 | Organic | Wood fragment |
| 501 | 10/24/1996 | 036.06.60 | Organic | Wood fragment |
| 502 | 10/24/1996 | 036.06.61 | Organic | Wood fragment |
| 503 | 10/24/1996 | 036.06.62 | Organic | Wood fragment |
| 504 | 10/24/1996 | 036.06.63 | Organic | Wood fragment |
| 505 | 10/24/1996 | 036.06.64 | Organic | Wood fragment |
| 506 | 10/24/1996 | 036.06.65 | Organic | Wood fragment |
| 507 | 10/24/1996 | 036.06.66 | Organic | Wood fragment |
| 508 | 10/24/1996 | 036.06.67 | Organic | Wood fragment |
| 509 | 10/24/1996 | 036.06.68 | Organic | Wood fragment |
| 510 | 10/24/1996 | 036.06.69 | Organic | Wood fragment |
| 511 | 10/24/1996 | 036.06.70 | Organic | Wood fragment |
| 512 | 10/24/1996 | 036.06.71 | Organic | Wood fragment |
| 513 | 10/24/1996 | 036.06.72 | Organic | Wood fragment |
| 514 | 10/24/1996 | 036.06.73 | Organic | Wood fragment |
| 515 | 10/24/1996 | 036.06.74 | Organic | Wood fragment |
| 516 | 10/24/1996 | 036.06.75 | Organic | Wood fragment |
| 517 | 10/24/1996 | 036.06.76 | Organic | Wood fragment |
| 518 | 10/24/1996 | 036.06.77 | Organic | Wood fragment |
| 519 | 10/24/1996 | 036.06.78 | Organic | Wood fragment |
| 520 | 10/24/1996 | 036.06.79 | Organic | Wood fragment |
| 521 | 10/24/1996 | 036.06.80 | Organic | Wood fragment |
| 522 | 10/24/1996 | 036.06.81 | Organic | Wood fragment |
| 523 | 10/24/1996 | 036.06.82 | Organic | Wood fragment |
| 524 | 10/24/1996 | 036.06.83 | Organic | Wood fragment |
| 525 | 10/24/1996 | 036.06.84 | Organic | Wood fragment |
| 526 | 10/24/1996 | 036.06.85 | Organic | Wood fragment |
| 527 | 10/24/1996 | 036.06.86 | Organic | Wood fragment |
| 528 | 10/24/1996 | 036.06.87 | Organic | Wood fragment |
| 529 | 10/24/1996 | 036.06.88 | Organic | Wood fragment |
| 530 | 10/24/1996 | 036.06.89 | Organic | Wood fragment |
| 531 | 10/24/1996 | 036.06.90 | Organic | Wood fragment |
| 532 | 10/24/1996 | 036.06.91 | Organic | Wood fragment |
| 533 | 10/24/1996 | 036.06.92 | Organic | Wood fragment |
| 534 | 10/24/1996 | 036.06.93 | Organic | Wood fragment |
| 535 | 10/24/1996 | 036.06.94 | Organic | Wood fragment |
| 536 | 10/24/1996 | 036.06.95 | Organic | Wood fragment |
| 537 | 10/24/1996 | 036.06.96 | Organic | Wood fragment |
| 538 | 10/24/1996 | 036.06.97 | Organic | Wood fragment |
| 539 | 10/24/1996 | 036.06.98 | Organic | Wood fragment |
| 540 | 10/24/1996 | 036.06.99 | Organic | Wood fragment |
| 541 | 10/24/1996 | 037.01.01 | Lead | Sheathing or caulking fragment |
| 542 | 10/24/1996 | 037.01.02 | Lead | Sheathing or caulking fragment |
| 543 | 10/24/1996 | 037.01.03 | Lead | Sheathing or caulking fragment |
| 544 | 10/24/1996 | 037.01.04 | Lead | Sheathing or caulking fragment |
| 545 | 10/24/1996 | 037.01.05 | Lead | Sheathing or caulking fragment |
| 546 | 10/24/1996 | 037.01.06 | Lead | Sheathing or caulking fragment |
| 547 | 10/24/1996 | 037.01.07 | Lead | Sheathing or caulking fragment |

| ID | DATE | ARTIFACT NUMBER | MATERIAL | DESCRIPTION |
|---|---|---|---|---|
| 548 | 10/24/1996 | 037.01.08 | Lead | Sheathing or caulking fragment |
| 549 | 10/24/1996 | 037.01.09 | Lead | Sheathing or caulking fragment |
| 550 | 10/24/1996 | 037.01.10 | Lead | Sheathing or caulking fragment |
| 551 | 10/24/1996 | 037.01.11 | Lead | Sheathing or caulking fragment |
| 552 | 10/24/1996 | 037.01.12 | Lead | Sheathing or caulking fragment |
| 553 | 10/24/1996 | 037.01.13 | Lead | Sheathing or caulking fragment |
| 554 | 10/24/1996 | 037.01.14 | Lead | Sheathing or caulking fragment |
| 555 | Unknown | 038.01 | Possible organic concretion | Possible wood fragment with iron fastener |
| 556 | 11/25/1996 | 039.01.01 | Lead | Sheathing or caulking fragment |
| 557 | 11/25/1996 | 039.01.02 | Lead | Sheathing or caulking fragment |
| 558 | 11/25/1996 | 039.01.03 | Lead | Sheathing or caulking fragment |
| 559 | 11/25/1996 | 039.01.04 | Lead | Sheathing or caulking fragment |
| 560 | 11/25/1996 | 039.01.05 | Lead | Sheathing or caulking fragment |
| 561 | 11/25/1996 | 039.01.06 | Lead | Sheathing or caulking fragment |
| 562 | 11/25/1996 | 039.01.07 | Lead | Sheathing or caulking fragment |
| 563 | 11/25/1996 | 039.01.08 | Lead | Sheathing or caulking fragment |
| 564 | 11/25/1996 | 039.01.09 | Lead | Sheathing or caulking fragment |
| 565 | 11/25/1996 | 039.01.10 | Lead | Sheathing or caulking fragment |
| 566 | 11/25/1996 | 039.01.11 | Lead | Sheathing or caulking fragment |
| 567 | 11/25/1996 | 039.01.12 | Lead | Sheathing or caulking fragment |
| 568 | 11/25/1996 | 039.01.13 | Lead | Sheathing or caulking fragment |
| 569 | 11/26/1996 | 40.01.01 | Organic | Fruit pit likely peach |
| 570 | 11/26/1996 | 40.01.02 | Organic | Fruit pit likely peach |
| 571 | 11/26/1996 | 040.02 | Unknown | Unidentified |
| 572 | 11/26/1996 | 040.03.01 | Glass | Modern clear sherd |
| 573 | 11/26/1996 | 040.03.02 | Glass | Modern clear sherd |
| 574 | 11/26/1996 | 040.04 | Glass | Clear sherd |
| 575 | 11/26/1996 | 040.05 | Earthenware | Coarse red-bodied gravel-tempered sherd |
| 576 | 02/04/1997 | 041.01 | Cupreous | Astrolabe |
| 577 | 02/14/1997 | 042.01 | Porcelain | Blue and white fragment |
| 578 | 02/04/1997 | 043.02.01 | Lead | Sheathing fragment |
| 579 | 02/04/1997 | 043.02.02 | Lead | Sheathing fragment |
| 580 | 02/04/1997 | 043.02.03 | Lead | Sheathing fragment |
| 581 | 02/04/1997 | 043.02.04 | Lead | Sheathing fragment |
| 582 | 02/04/1997 | 043.02.05 | Lead | Sheathing fragment |
| 583 | 02/04/1997 | 044.01 | Stoneware | Martaban jar handle fragment |
| 584 | 02/04/1997 | 045.01 | Lead | Sounding weight with basal indentations |
| 585 | 02/04/1997 | 046.01 | Organic | Mammal bone with epiphysis |
| 586 | 02/04/1997 | 047.01.01 | Earthenware | Creamware fragment |
| 587 | 02/04/1997 | 047.01.02 | Earthenware | Creamware fragment |
| 588 | 02/04/1997 | 048.01.01 | Organic | Fruit pit likely peach |
| 589 | 02/04/1997 | 048.01.02 | Organic | Fruit pit likely peach |
| 590 | 02/04/1997 | 048.01.03 | Organic | Fruit pit likely peach |
| 591 | 02/06/1997 | 049.01 | Silver | Coin |
| 592 | 02/06/1997 | 050.01 | Earthenware | Red-bodied coarse-tempered sherd |
| 593 | 02/06/1997 | 050.02.01 | Stoneware | Gray-bodied sherd with exterior molding |
| 594 | 02/06/1997 | 050.02.02 | Stoneware | Buff-bodied sherd |
| 595 | 02/04/1997 | 050.04 | Porcelain | Blue and white base fragment |

| ID | DATE | ARTIFACT NUMBER | MATERIAL | DESCRIPTION |
|---|---|---|---|---|
| 596 | 12/04/1996 | 051.01.01 | Lead | Sheathing or caulking fragment |
| 597 | 12/04/1996 | 051.01.02 | Lead | Sheathing or caulking fragment |
| 598 | 12/04/1996 | 051.01.03 | Lead | Sheathing or caulking fragment |
| 599 | 12/04/1996 | 051.01.04 | Lead | Sheathing or caulking fragment |
| 600 | 12/04/1996 | 051.01.05 | Lead | Sheathing or caulking fragment |
| 601 | 12/04/1996 | 051.01.06 | Lead | Sheathing or caulking fragment |
| 602 | 12/04/1996 | 051.01.07 | Lead | Sheathing or caulking fragment |
| 603 | 12/04/1996 | 051.01.08 | Lead | Sheathing or caulking fragment |
| 604 | 12/04/1996 | 051.01.09 | Lead | Sheathing or caulking fragment |
| 605 | 12/04/1996 | 051.01.10 | Lead | Sheathing or caulking fragment |
| 606 | 12/04/1996 | 051.01.11 | Lead | Sheathing or caulking fragment |
| 607 | 12/04/1996 | 051.01.12 | Lead | Sheathing or caulking fragment |
| 608 | 12/04/1996 | 051.01.13 | Lead | Sheathing or caulking fragment |
| 609 | 12/04/1996 | 051.01.14 | Lead | Sheathing or caulking fragment |
| 610 | 12/04/1996 | 051.01.15 | Lead | Sheathing or caulking fragment |
| 612 | 12/04/1996 | 051.01.16 | Lead | Sheathing or caulking fragment |
| 613 | 12/04/1996 | 051.01.17 | Lead | Sheathing or caulking fragment |
| 614 | 12/04/1996 | 051.02 | Earthenware | Red-bodied coarse-tempered fragment |
| 615 | 12/04/1996 | 051.03.01 | Organic | Fruit pit likely peach |
| 616 | 12/04/1996 | 051.03.02 | Organic | Fruit pit likely peach |
| 617 | 12/04/1996 | 051.04.01 | Organic | Wood fragment |
| 618 | 12/04/1996 | 051.04.02 | Organic | Wood fragment |
| 619 | 12/04/1996 | 051.04.03 | Organic | Wood fragment |
| 620 | 12/04/1996 | 051.04.04 | Organic | Wood fragment |
| 621 | 12/04/1996 | 051.04.05 | Organic | Wood fragment |
| 622 | 12/04/1996 | 051.04.06 | Organic | Wood fragment |
| 623 | 12/04/1996 | 051.04.07 | Organic | Wood fragment |
| 624 | 12/04/1996 | 051.04.08 | Organic | Wood fragment |
| 625 | 12/04/1996 | 051.04.09 | Organic | Wood fragment |
| 626 | 12/04/1996 | 051.04.10 | Organic | Wood fragment |
| 627 | 12/04/1996 | 051.04.11 | Organic | Wood fragment |
| 628 | 12/04/1996 | 051.04.12 | Organic | Wood fragment |
| 629 | 12/04/1996 | 051.04.13 | Organic | Wood fragment |
| 630 | 12/04/1996 | 051.04.14 | Organic | Wood fragment |
| 631 | 12/04/1996 | 051.04.15 | Organic | Wood fragment |
| 632 | 12/04/1996 | 051.04.16 | Organic | Wood fragment |
| 633 | 12/04/1996 | 051.04.17 | Organic | Wood fragment |
| 634 | 12/04/1996 | 051.04.18 | Organic | Wood fragment |
| 635 | 12/04/1996 | 051.04.19 | Organic | Wood fragment |
| 636 | 12/04/1996 | 051.04.20 | Organic | Wood fragment |
| 637 | 12/04/1996 | 051.04.21 | Organic | Wood fragment |
| 638 | 12/04/1996 | 051.04.22 | Organic | Wood fragment |
| 639 | 12/04/1996 | 051.05 | Organic | Fruit pit possible olive or cherry |
| 640 | 12/04/1996 | 051.06 | Organic | Fruit pit possible olive or cherry |
| 641 | 02/05/1997 | 052.01.01 | Ceramic | Buff-bodied fragment with brown glaze |
| 642 | 02/05/1997 | 052.01.01 | Ceramic | Buff-bodied fragment with brown glaze |
| 643 | 02/06/1997 | 053.01 | Organic | Coconut shell |
| 644 | 02/06/1997 | 054.01 | Stoneware | Dragon jar fragment |
| 645 | 02/06/1997 | 054.02 | Porcelain | Blue and white base sherd |
| 646 | 02/05/1997 | 055.01.01 | Likely lead | Possible sheathing or caulking fragment |
| 647 | 02/05/1997 | 055.01.02 | Likely lead | Possible sheathing or caulking fragment |

| ID | DATE | ARTIFACT NUMBER | MATERIAL | DESCRIPTION |
|---|---|---|---|---|
| 648 | 02/05/1997 | 055.01.03 | Likely lead | Possible sheathing or caulking fragment |
| 649 | 02/05/1997 | 055.01.04 | Likely lead | Possible sheathing or caulking fragment |
| 650 | 02/05/1997 | 055.01.05 | Likely lead | Possible sheathing or caulking fragment |
| 651 | 02/05/1997 | 055.01.06 | Likely lead | Possible sheathing or caulking fragment |
| 652 | 02/05/1997 | 055.01.07 | Likely lead | Possible sheathing or caulking fragment |
| 653 | 02/05/1997 | 058.01 | Porcelain | Blue and white rim sherd |
| 654 | 02/05/1997 | 058.02 | Lead | Likely sheathing fragment |
| 655 | 02/07/1997 | 059.01 | Ceramic | Stoneware—Martaban jar fragment |
| 656 | 02/07/1997 | 059.02 | Ceramic | Fragment |
| 657 | 02/07/1997 | 059.03 | Organic | Bone with epiphysis |
| 658 | 02/07/1997 | 060.01.01 | Ceramic | Fragment |
| 659 | 02/07/1997 | 060.01.02 | Ceramic | Fragment |
| 660 | 02/07/1997 | 061.01.01 | Ceramic | Fragment with brown glaze |
| 661 | 02/07/1997 | 061.01.02 | Ceramic | Fragment with brown glaze |
| 662 | 02/07/1997 | 061.01.03 | Ceramic | Fragment with brown glaze |
| 663 | 02/07/1997 | 061.01.04 | Ceramic | Fragment with brown glaze |
| 664 | 02/07/1997 | 061.01.05 | Ceramic | Fragment with brown glaze |
| 665 | 02/07/1997 | 061.01.06 | Ceramic | Fragment with brown glaze |
| 666 | 02/07/1997 | 061.02 | Ferrous | Unidentified concretion |
| 667 | 02/07/1997 | 062.01 | Possibly cupreous | Unidentified |
| 668 | 02/07/1997 | 062.02.01 | Organic | Wood fragment |
| 669 | 02/07/1997 | 062.02.02 | Organic | Wood fragment |
| 670 | 02/07/1997 | 062.03 | Likely organic | Unidentified |
| 671 | 01/30/1997 | 063.01 | Lead | Weight |
| 672 | 01/30/1997 | 063.02 | Lead | Weight |
| 673 | 01/30/1997 | 063.03 | Lead | Weight |
| 674 | 01/30/1997 | 063.04 | Pewter | Plate |
| 675 | 03/21/1997 | 064.01.01 | Cupreous | Fastener—Nail or tack |
| 676 | 03/21/1997 | 064.01.02 | Cupreous | Fastener—Nail or tack |
| 677 | 03/21/1997 | 064.01.03 | Cupreous | Fastener—Nail or tack |
| 678 | 03/21/1997 | 064.01.04 | Cupreous | Fastener—Nail or tack |
| 679 | 03/21/1997 | 064.01.05 | Cupreous | Fastener—Nail or tack |
| 680 | 03/21/1997 | 064.01.06 | Cupreous | Fastener—Nail or tack |
| 681 | 03/21/1997 | 064.01.07 | Cupreous | Fastener—Nail or tack |
| 682 | 03/21/1997 | 064.01.08 | Cupreous | Fastener—Nail or tack |
| 683 | 03/21/1997 | 064.01.09 | Cupreous | Fastener—Nail or tack |
| 684 | 03/21/1997 | 064.01.10 | Cupreous | Fastener—Nail or tack |
| 685 | 03/21/1997 | 064.02.01 | Cupreous | Large metal fastener |
| 686 | 03/21/1997 | 064.02.02 | Cupreous | Large metal fastener |
| 687 | 03/21/1997 | 064.02.03 | Cupreous | Large metal fastener |
| 688 | 03/21/1997 | 064.02.04 | Cupreous | Large metal fastener |
| 689 | 03/21/1997 | 064.02.05 | Cupreous | Large metal fastener |
| 690 | 03/21/1997 | 064.02.06 | Cupreous | Large metal fastener |
| 691 | 03/21/1997 | 064.02.07 | Cupreous | Large metal fastener |
| 692 | 03/21/1997 | 064.02.08 | Cupreous | Large metal fastener |
| 693 | 03/21/1997 | 064.03 | Cupreous | Unidentified |
| 694 | 03/30/1997 | 065.01 | Stone | Shot |
| 695 | 03/30/1997 | 065.02 | Lead | Shot |
| 696 | 03/30/1997 | 065.03 | Lead | Shot |
| 697 | 03/30/1997 | 065.04 | Lead | Shot |
| 698 | 03/13/1997 | 071.01 | Likely organic | Probable wooden gaming piece |

| ID | DATE | ARTIFACT NUMBER | MATERIAL | DESCRIPTION |
|---|---|---|---|---|
| 699 | 03/13/1997 | 071.02 | Stoneware | Buff-bodied fragment greenish glaze |
| 700 | Unknown | 081.01 | Likely ferrous | Concretion |
| 701 | 03/24/1997 | 092.01 | Earthenware | Chinaware fragment |
| 702 | 03/24/1997 | 095.01 | Cupreous | Bronze cannon |
| 703 | 04/13/1997 | 101.01 | Cupreous | Decorative element possibly furniture trim |
| 704 | 04/13/1997 | 101.02 | Stoneware | Dragon jar fragment |
| 705 | 04/13/1997 | 101.03 | Cupreous | Fastening bolt fragments |
| 706 | 04/13/1997 | 101.04 | Cupreous | Flat beaten hoop with joint |
| 707 | 04/13/1997 | 102.01.01 | Organic | Fruit pit likely peach |
| 708 | 04/13/1997 | 102.01.02 | Organic | Fruit pit likely peach |
| 709 | 04/13/1997 | 102.01.03 | Organic | Fruit pit likely peach |
| 710 | 04/13/1997 | 102.01.04 | Organic | Fruit pit likely peach |
| 711 | 04/13/1997 | 102.01.05 | Organic | Fruit pit likely peach |
| 712 | 04/13/1997 | 102.01.06 | Organic | Fruit pit likely peach |
| 713 | 04/13/1997 | 102.02 | Organic | Probable wood fragment |
| 714 | 04/13/1997 | 102.03 | Porcelain | Blue and white sherd |
| 715 | 04/04/1997 | 103.01 | Organic | Basket fragment |
| 716 | 04/17/1997 | 104.01 | Earthenware | Dark brown glazed sherd |
| 717 | 04/27/1997 | 104.02 | Earthenware | Whiteware with black transfer print |
| 718 | 04/29/1997 | 105.01.01 | Organic | Fruit pit likely peach |
| 719 | 04/29/1997 | 105.01.02 | Organic | Fruit pit likely peach |
| 720 | 04/29/1997 | 105.01.03 | Organic | Fruit pit likely peach |
| 721 | 04/29/1997 | 105.02.01 | Earthenware | Lavender European ware |
| 722 | 04/29/1997 | 105.02.02 | Earthenware | Chinaware |
| 723 | 05/01/1997 | 106.01 | Gold | Small bead |
| 724 | Unknown | 120.01 | Likely cupreous | Fastener |
| 725 | 05/10/1997 | 121.01 | Organic | Wooden parquet fragment |
| 726 | 05/10/1997 | 121.05 | Cupreous | Twisted fastener |
| 727 | 05/11/1997 | 122.01 | Organic | Coconut shell |
| 728 | 05/12/1997 | 124.01 | Porcelain | Blue and white fragment |
| 729 | 05/16/1997 | 125.01 | Stoneware | Buff-bodied fragment with black slip and brown glaze |
| 730 | 05/16/1997 | 126.01 | Porcelain | Blue and white fragment |
| 731 | 05/16/1997 | 127.01 | Porcelain | Blue and white fragment |
| 732 | 05/17/1997 | 129.01.01 | Lead | Shot |
| 733 | 05/17/1997 | 129.01.02 | Lead | Shot |
| 734 | 05/17/1997 | 129.02.01 | Metal | Encrusted fragment |
| 735 | 05/17/1997 | 129.02.02 | Metal | Encrusted fragment |
| 736 | 05/17/1997 | 129.02.03 | Metal | Encrusted fragment |
| 737 | 05/17/1997 | 129.04 | Stoneware | Red-bodied coarse-tempered fragment |
| 738 | 05/17/1997 | 129.05 | Earthenware | Buff-bodied tin-glazed adorno |
| 739 | 05/17/1997 | 129.06 | Stoneware | Buff-bodied dark brown glazed fragment |
| 740 | 05/17/1997 | 129.07 | Earthenware | Creamware base sherd |
| 741 | 05/17/1997 | 129.08 | Earthenware | Gray-bodied coarse-tempered sherd |
| 742 | 05/17/1997 | 129.09 | Stoneware | Martaban jar fragment |
| 743 | 05/17/1997 | 129.10 | Earthenware | Sand-tempered fragment |
| 744 | 05/17/1997 | 129.11 | Organic | Wooden parquet fragment |
| 745 | 06/15/1997 | 130.01 | Porcelain | Blue and white fragment |
| 746 | 06/15/1997 | 130.02 | Porcelain | Blue and white fragment |
| 747 | 06/15/1997 | 130.03 | Porcelain | Blue and white fragment |

| ID | DATE | ARTIFACT NUMBER | MATERIAL | DESCRIPTION |
|---|---|---|---|---|
| 748 | 06/15/1997 | 130.04 | Porcelain | Blue and white fragment |
| 749 | 06/15/1997 | 130.05 | Porcelain | Blue and white fragment |
| 750 | 06/15/1997 | 130.06 | Ceramic | Possible Redware fragment |
| 751 | 06/15/1997 | 131.01 | Ceramic | Gray-bodied gravel-tempered fragment |
| 752 | 06/15/1997 | 132.01.01 | Ceramic | Buff-pasted fragment |
| 753 | 06/15/1997 | 132.01.02 | Ceramic | Redware sherd |
| 754 | 06/15/1997 | 132.01.03 | Stoneware | Sherd |
| 755 | 06/15/1997 | 132.02.01 | Stoneware | Dragon jar sherd |
| 756 | 06/15/1997 | 132.02.02 | Ceramic | Red-bodied sherd |
| 757 | 06/15/1997 | 133.01.01 | Stoneware | Martaban jar fragment |
| 758 | 06/15/1997 | 133.01.02 | Stoneware | Martaban jar fragment |
| 759 | 06/15/1997 | 133.01.03 | Stoneware | Martaban jar fragment |
| 760 | 06/15/1997 | 133.01.04 | Stoneware | Martaban jar fragment |
| 761 | 06/15/1997 | 134.01.01 | Lead | Shot with sprue and casting seam |
| 762 | 06/15/1997 | 134.01.02 | Lead | Shot with sprue and casting seam |
| 763 | 06/15/1997 | 134.01.03 | Lead | Shot with sprue and casting seam |
| 764 | 06/15/1997 | 134.01.04 | Lead | Shot with sprue and casting seam |
| 765 | 06/15/1997 | 134.01.05 | Lead | Shot with sprue and casting seam |
| 766 | 06/15/1997 | 134.01.06 | Lead | Shot with sprue and casting seam |
| 767 | 06/15/1997 | 134.01.07 | Lead | Shot with sprue and casting seam |
| 768 | 06/15/1997 | 134.01.08 | Lead | Shot with sprue and casting seam |
| 769 | 06/15/1997 | 134.01.09 | Lead | Shot with sprue and casting seam |
| 770 | 06/15/1997 | 134.02.01 | Organic | Unidentified fruit pit |
| 771 | 06/15/1997 | 134.02.02 | Organic | Unidentified fruit pit |
| 772 | 06/15/1997 | 134.03 | Organic | Long bone fragment |
| 773 | 06/15/1997 | 134.04 | Organic | Probable bone fragment |
| 774 | 06/15/1997 | 134.05.01 | Unknown | Unidentified |
| 775 | 06/15/1997 | 134.05.02 | Unknown | Unidentified |
| 776 | 06/15/1997 | 134.05.03 | Unknown | Unidentified |
| 777 | 06/15/1997 | 135.03.01 | Ceramic | Sherd |
| 778 | 06/15/1997 | 135.03.02 | Earthenware | Buff-pasted sherd |
| 779 | 06/15/1997 | 135.03.03 | Stoneware | Dragon jar sherd |
| 780 | 06/15/1997 | 135.04 | Stoneware | Gray-bodied coarse-tempered fragment |
| 781 | 06/15/1997 | 135.05 | Earthenware | Coarse-tempered sherd |
| 782 | 06/15/1997 | 135.06 | Ceramic | Sherd |
| 783 | 06/15/1997 | 135.07.01 | Glass | Intrusive sherd |
| 784 | 06/15/1997 | 135.07.02 | Glass | Intrusive sherd |
| 785 | 06/15/1997 | 135.07.03 | Glass | Intrusive sherd |
| 786 | 06/15/1997 | 135.08 | Organic | Fruit pit likely peach |
| 787 | 06/15/1997 | 135.09.01 | Ceramic | Creamware sherd |
| 788 | 06/15/1997 | 135.09.02 | Ceramic | Modern sherd |
| 789 | 06/15/1997 | 136.01.01 | Porcelain | Blue and white fragment |
| 790 | 06/15/1997 | 136.01.02 | Porcelain | Blue and white fragment |
| 791 | 06/15/1997 | 137.01 | Ceramic | Unknown |
| 792 | 06/15/1997 | 138.01 | Cupreous | Sheet fragment with fastener holes |
| 793 | 06/15/1997 | 139.01 | Ceramic | Buff-pasted fragment |
| 794 | 06/14/1997 | 139.02 | Earthenware | Buff-pasted fragment |
| 795 | 06/14/1997 | 139.03 | Stoneware | Buff-pasted fragment |
| 796 | 06/14/1997 | 139.04 | Earthenware | Buff-pasted fragment |
| 797 | 06/14/1997 | 139.05 | Earthenware | Buff-bodied fragment |
| 798 | 06/14/1997 | 140.01 | Unknown | Unidentified |

| ID | DATE | ARTIFACT NUMBER | MATERIAL | DESCRIPTION |
|---|---|---|---|---|
| 799 | 06/14/1997 | 140.02.01 | Organic | Fruit pit likely peach |
| 800 | 06/14/1997 | 140.02.02 | Organic | Fruit pit likely peach |
| 801 | 06/14/1997 | 140.02.03 | Organic | Fruit pit likely peach |
| 802 | 06/14/1997 | 140.02.04 | Organic | Fruit pit likely peach |
| 803 | 06/14/1997 | 140.02.05 | Organic | Fruit pit likely peach |
| 804 | 06/14/1997 | 140.02.06 | Organic | Fruit pit likely peach |
| 805 | 06/14/1997 | 140.02.07 | Organic | Fruit pit likely peach |
| 806 | 06/14/1997 | 140.02.08 | Organic | Fruit pit likely peach |
| 807 | 06/14/1997 | 140.02.09 | Organic | Fruit pit likely peach |
| 808 | 06/14/1997 | 140.02.10 | Organic | Fruit pit likely peach |
| 809 | 06/14/1997 | 140.02.11 | Organic | Fruit pit likely peach |
| 810 | 06/14/1997 | 140.02.12 | Organic | Fruit pit likely peach |
| 811 | 06/14/1997 | 140.02.13 | Organic | Fruit pit likely peach |
| 812 | 06/14/1997 | 140.02.14 | Organic | Fruit pit likely peach |
| 813 | 06/14/1997 | 140.02.15 | Organic | Fruit pit likely peach |
| 814 | 06/14/1997 | 140.02.16 | Organic | Fruit pit likely peach |
| 815 | 06/14/1997 | 140.02.17 | Organic | Fruit pit likely peach |
| 816 | 06/14/1997 | 140.03 | Porcelain | Blue and white fragment |
| 817 | 06/14/1997 | 140.04 | Earthenware | Red-bodied fragment greenish glaze |
| 818 | 06/14/1997 | 140.05 | Stoneware | Martaban jar fragment |
| 819 | 06/14/1997 | 140.06.01 | Stoneware | Red-bodied fragment |
| 820 | 06/14/1997 | 140.06.02 | Stoneware | Buff-bodied fragment |
| 821 | 06/14/1997 | 140.07.01 | Earthenware | Whiteware sherd |
| 822 | 06/14/1997 | 140.07.02 | Earthenware | Creamware sherd |
| 823 | 06/14/1997 | 140.08.01 | Glass | Olive green bottle glass |
| 824 | 06/14/1997 | 140.08.02 | Glass | Olive green bottle glass |
| 825 | 06/14/1997 | 140.09.01 | Earthenware | Red-bodied fragment |
| 826 | 06/14/1997 | 140.09.02 | Earthenware | Red-bodied fragment |
| 827 | 06/14/1997 | 140.09.03 | Earthenware | Red-bodied fragment |
| 828 | 06/14/0997 | 140.01.01 | Cupreous | Oblong tool-like object |
| 829 | 06/14/1997 | 141.01.02 | Cupreous | Likely bolt |
| 830 | 06/14/1997 | 141.01.03 | Cupreous | Likely bolt |
| 831 | 06/14/1997 | 141.02.01 | Cupreous | Fastener—Nail or tack |
| 832 | 06/14/1997 | 141.02.02 | Cupreous | Fastener—Nail or tack |
| 833 | 06/14/1997 | 141.02.03 | Cupreous | Fastener—Nail or tack |
| 834 | 06/14/1997 | 141.02.04 | Cupreous | Fastener—Nail or tack |
| 835 | 06/14/1997 | 141.02.05 | Cupreous | Fastener—Nail or tack |
| 836 | 06/14/1997 | 141.02.06 | Cupreous | Fastener—Nail or tack |
| 837 | 06/14/1997 | 141.02.07 | Cupreous | Fastener—Nail or tack |
| 838 | 06/14/1997 | 141.03 | Porcelain | Blue and white sherd |
| 839 | 06/14/1997 | 141.04 | Lead | Four-sided weight |
| 840 | 06/14/1997 | 141.05.01 | Cupreous | Possible broken tip |
| 841 | 06/14/1997 | 141.05.02 | Cupreous | Possible broken tip |
| 842 | 06/14/1997 | 142 | Cupreous | Strap possibly from barrel /cask |
| 843 | 06/15/1997 | 143 | Cupreous | Astrolabe |
| 844 | 06/21/1997 | 148.01 | Pewter | Plate |
| 845 | 06/21/1997 | 148.02 | Stone | Cannon ball |
| 846 | 06/21/1997 | 148.03.01 | Earthenware | Red fragment |
| 847 | 06/21/1997 | 148.03.02 | Earthenware | Red fragment |
| 848 | 06/21/1997 | 148.03.03 | Earthenware | Red fragment |
| 849 | 06/21/1997 | 148.05 | Stoneware | Dragon jar sherd |

| ID | DATE | ARTIFACT NUMBER | MATERIAL | DESCRIPTION |
|---|---|---|---|---|
| 850 | 06/21/1997 | 148.06 | Porcelain | Blue and white fragment |
| 851 | 06/21/1997 | 148.07.01 | Earthenware | Whiteware sherd |
| 852 | 06/21/1997 | 148.07.02 | Earthenware | Creamware sherd |
| 853 | 06/21/1997 | 148.08.01 | Ceramic | Gray-bodied coarse-tempered fragment |
| 854 | 06/21/1997 | 148.08.02 | Ceramic | Gray-bodied coarse-tempered fragment |
| 855 | 06/21/1997 | 148.09 | Ceramic | Red-bodied sherd |
| 856 | 06/22/1997 | 149.01 | Ferrous | Unidentified concretion |
| 857 | 06/22/1997 | 149.02 | Stoneware | Gray-bodied fragment with black glaze |
| 858 | 06/22/1997 | 149.03 | Porcelain | Blue and white sherd |
| 859 | 06/22/1997 | 149.04 | Lead | Sounding weight |
| 860 | 06/22/1997 | 149.05.01 | Organic | Fruit pit likely peach |
| 861 | 06/22/1997 | 149.05.02 | Organic | Fruit pit likely peach |
| 862 | 06/22/1997 | 149.05.03 | Organic | Fruit pit likely peach |
| 863 | 06/22/1997 | 149.05.04 | Organic | Fruit pit likely peach |
| 864 | 06/22/1997 | 149.05.05 | Organic | Fruit pit likely peach |
| 865 | 06/22/1997 | 149.05.06 | Organic | Fruit pit likely peach |
| 866 | 06/22/1997 | 149.05.07 | Organic | Fruit pit likely peach |
| 867 | 06/22/1997 | 149.05.08 | Organic | Fruit pit likely peach |
| 868 | 06/22/1997 | 149.05.09 | Organic | Fruit pit likely peach |
| 869 | 06/22/1997 | 149.05.10 | Organic | Fruit pit likely peach |
| 870 | 06/22/1997 | 149.05.11 | Organic | Fruit pit likely peach |
| 871 | 06/22/1997 | 149.05.12 | Organic | Fruit pit likely peach |
| 872 | 06/22/1997 | 149.05.13 | Organic | Fruit pit likely peach |
| 873 | 06/30/1997 | 153.01 | Cupreous | length of decoration |
| 874 | 06/30/1997 | 154.01 | Porcelain | Blue and white sherd |
| 875 | 07/04/1997 | 158.01 | Stoneware | Poorly fired gray-bodied fragment |
| 876 | 07/04/1997 | 158.02 | Stoneware | Martaban jar fragment |
| 877 | 07/04/1997 | 158.03.01 | Organic | Fruit pit likely peach |
| 878 | 07/04/1997 | 158.03.02 | Organic | Fruit pit likely peach |
| 879 | 07/04/1997 | 158.03.03 | Organic | Fruit pit likely peach |
| 880 | 07/04/1997 | 158.03.04 | Organic | Fruit pit likely peach |
| 881 | 07/04/1997 | 158.03.05 | Organic | Fruit pit likely peach |
| 882 | 07/04/1997 | 158.03.06 | Organic | Fruit pit likely peach |
| 883 | 07/04/1997 | 158.03.07 | Organic | Fruit pit likely peach |
| 884 | 07/04/1997 | 158.03.08 | Organic | Fruit pit likely peach |
| 885 | 07/04/1997 | 158.03.09 | Organic | Fruit pit likely peach |
| 886 | 07/04/1997 | 158.03.10 | Organic | Fruit pit likely peach |
| 887 | 07/04/1997 | 158.03.11 | Organic | Fruit pit likely peach |
| 888 | 07/04/1997 | 158.04 | Porcelain | Blue and white sherd |
| 889 | 07/05/1997 | 159.01.01 | Stoneware | Dragon jar sherd |
| 890 | 07/05/1997 | 159.01.02 | Stoneware | Dragon jar sherd |
| 891 | 07/05/1997 | 159.02 | Metal | Possible coin |
| 892 | 07/05/1997 | 160.01.01 | Silver or Cupreous | Possible coin or seal |
| 893 | 07/05/1997 | 160.01.02 | Silver or Cupreous | Possible coin or seal |
| 894 | 07/05/1997 | 160.01.03 | Silver or Cupreous | Possible coin or seal |
| 895 | 07/05/1997 | 160.01.04 | Silver or Cupreous | Possible coin or seal |
| 896 | 07/05/1997 | 160.01.05 | Silver or Cupreous | Possible coin or seal |
| 897 | 07/05/1997 | 160.01.06 | Silver or Cupreous | Possible coin or seal |
| 898 | 07/05/1997 | 160.01.07 | Silver or Cupreous | Possible coin or seal |
| 899 | 07/05/1997 | 160.01.08 | Silver or Cupreous | Possible coin or seal |
| 900 | 07/05/1997 | 160.01.09 | Silver or Cupreous | Possible coin or seal |

| ID | DATE | ARTIFACT NUMBER | MATERIAL | DESCRIPTION |
|---|---|---|---|---|
| 901 | 07/05/1997 | 160.01.10 | Silver or Cupreous | Possible coin or seal |
| 902 | 07/05/1997 | 160.01.11 | Silver or Cupreous | Possible coin or seal |
| 903 | 07/05/1997 | 160.01.12 | Silver or Cupreous | Possible coin or seal |
| 904 | 07/05/1997 | 160.01.13 | Silver or Cupreous | Possible coin or seal |
| 905 | 07/05/1997 | 160.01.14 | Silver or Cupreous | Possible coin or seal |
| 906 | 07/05/1997 | 160.01.15 | Silver or Cupreous | Possible coin or seal |
| 907 | 07/05/1997 | 160.01.16 | Silver or Cupreous | Possible coin or seal |
| 908 | 07/05/1997 | 160.01.17 | Silver or Cupreous | Possible coin or seal |
| 909 | 07/05/1997 | 160.01.18 | Silver or Cupreous | Possible coin or seal |
| 910 | 07/05/1997 | 160.01.19 | Silver or Cupreous | Possible coin or seal |
| 911 | 07/05/1997 | 160.02.01A | Cupreous | Fragment with escalloped distal portion |
| 912 | 07/05/1997 | 160.02.01 | Cupreous | Nail or tack |
| 913 | 07/05/1997 | 160.02.02 | Cupreous | Nail or tack |
| 914 | 07/05/1997 | 160.02.03 | Cupreous | Nail or tack |
| 915 | 07/05/1997 | 160.02.04 | Cupreous | Nail or tack |
| 916 | 07/05/1997 | 160.02.05 | Cupreous | Nail or tack |
| 917 | 07/05/1997 | 160.02.06 | Cupreous | Nail or tack |
| 918 | 07/05/1997 | 160.02.07 | Cupreous | Nail or tack |
| 919 | 07/05/1997 | 160.02.08 | Cupreous | Nail or tack |
| 920 | 07/05/1997 | 160.02.09 | Cupreous | Nail or tack |
| 921 | 07/05/1997 | 160.02.10 | Cupreous | Nail or tack |
| 922 | 07/05/1997 | 160.02.11 | Cupreous | Nail or tack |
| 923 | 07/05/1997 | 160.02.12 | Cupreous | Nail or tack |
| 924 | 07/05/1997 | 160.02.13 | Cupreous | Nail or tack |
| 925 | 07/05/1997 | 160.02.14 | Cupreous | Nail or tack |
| 926 | 07/05/1997 | 160.02.15 | Cupreous | Nail or tack |
| 927 | 07/05/1997 | 160.02.16 | Cupreous | Nail or tack |
| 928 | 07/05/1997 | 160.02.17 | Cupreous | Nail or tack |
| 929 | 07/05/1997 | 160.02.18 | Cupreous | Nail or tack |
| 930 | 07/05/1997 | 160.03.01 | Cupreous | Button |
| 931 | 07/05/1997 | 160.03.02 | Cupreous | Button |
| 932 | 07/05/1997 | 160.03.03 | Cupreous | Button |
| 933 | 07/05/1997 | 160.03.04 | Cupreous | Button |
| 934 | 07/05/1997 | 160.03.05 | Cupreous | Button |
| 935 | 07/05/1997 | 160.04.01 | Cupreous | Fragment or finial |
| 936 | 07/05/1997 | 160.04.02 | Cupreous | Fragment or finial |
| 937 | 07/05/1997 | 160.04.03 | Cupreous | Fragment or finial |
| 938 | 07/05/1997 | 160.04.04 | Cupreous | Fragment or finial |
| 939 | 07/05/1997 | 160.04.05 | Cupreous | Fragment or finial |
| 940 | 07/05/1997 | 160.05.01 | Lead | Probable bale seal |
| 941 | 07/05/1997 | 160.05.02 | Lead | Probable bale seal |
| 942 | 07/05/1997 | 160.05.03 | Lead | Probable bale seal |
| 943 | 07/05/1997 | 160.05.04 | Lead | Probable bale seal |
| 944 | 07/05/1997 | 160.05.05 | Lead | Probable bale seal |
| 945 | 07/05/1997 | 160.05.06 | Lead | Probable bale seal |
| 946 | 07/05/1997 | 160.05.07 | Lead | Probable bale seal |
| 947 | 07/05/1997 | 160.05.08 | Lead | Probable bale seal |
| 948 | 07/05/1997 | 160.05.09 | Lead | Probable bale seal |
| 949 | 07/05/1997 | 160.05.10 | Lead | Probable bale seal |
| 950 | 07/05/1997 | 160.05.11 | Lead | Probable bale seal |
| 951 | 07/05/1997 | 160.05.12 | Lead | Probable bale seal |

| ID | DATE | ARTIFACT NUMBER | MATERIAL | DESCRIPTION |
|---|---|---|---|---|
| 952 | 07/05/1997 | 160.05.13 | Lead | Probable bale seal |
| 953 | 07/05/1997 | 160.07.01 | Lead | Shot |
| 954 | 07/05/1997 | 160.07.02 | Lead | Shot |
| 955 | 07/05/1997 | 160.07.03 | Lead | Shot |
| 956 | 07/05/1997 | 160.07.04 | Lead | Shot |
| 957 | 07/05/1997 | 160.07.05 | Lead | Shot |
| 958 | 07/05/1997 | 160.07.06 | Lead | Shot |
| 959 | 07/05/1997 | 160.07.07 | Lead | Shot |
| 960 | 07/05/1997 | 160.07.08 | Lead | Shot |
| 961 | 07/05/1997 | 160.07.09 | Lead | Shot |
| 962 | 07/05/1997 | 160.07.10 | Lead | Shot |
| 963 | 07/05/1997 | 160.07.11 | Lead | Shot |
| 964 | 07/05/1997 | 160.07.12 | Lead | Shot |
| 965 | 07/05/1997 | 160.07.13 | Lead | Shot |
| 966 | 07/05/1997 | 160.07.14 | Lead | Shot |
| 967 | 07/05/1997 | 160.07.15 | Lead | Shot |
| 968 | 07/05/1997 | 160.07.16 | Lead | Shot |
| 969 | 07/05/1997 | 160.07.17 | Lead | Shot |
| 970 | 07/05/1997 | 160.07.18 | Lead | Shot |
| 971 | 07/05/1997 | 160.07.19 | Lead | Shot |
| 972 | 07/05/1997 | 160.07.20 | Lead | Shot |
| 973 | 07/05/1997 | 160.07.21 | Lead | Shot |
| 974 | 07/05/1997 | 160.07.22 | Lead | Shot |
| 975 | 07/05/1997 | 160.07.23 | Lead | Shot |
| 976 | 07/05/1997 | 160.07.24 | Lead | Shot |
| 977 | 07/05/1997 | 160.07.25 | Lead | Shot |
| 978 | 07/05/1997 | 160.07.26 | Lead | Shot |
| 979 | 07/05/1997 | 160.07.27 | Lead | Shot |
| 980 | 07/05/1997 | 160.07.28 | Lead | Shot |
| 981 | 07/05/1997 | 160.07.29 | Lead | Shot |
| 982 | 07/05/1997 | 160.07.30 | Lead | Shot |
| 983 | 07/05/1997 | 160.07.31 | Lead | Shot |
| 984 | 07/05/1997 | 160.07.32 | Lead | Shot |
| 985 | 07/05/1997 | 160.07.33 | Lead | Shot |
| 986 | 07/05/1997 | 160.07.34 | Lead | Shot |
| 987 | 07/05/1997 | 160.07.35 | Lead | Shot |
| 988 | 07/05/1997 | 160.07.36 | Lead | Shot |
| 989 | 07/05/1997 | 160.07.37 | Lead | Shot |
| 990 | 07/05/1997 | 160.07.38 | Lead | Shot |
| 991 | 07/05/1997 | 160.07.39 | Lead | Shot |
| 992 | 07/05/1997 | 160.07.40 | Lead | Shot |
| 993 | 07/05/1997 | 160.09 | Porcelain | Blue and white fragment |
| 994 | 07/05/1997 | 160.10.01 | Lead | Encrusted object |
| 995 | 07/05/1997 | 160.10.02 | Lead | Encrusted object |
| 996 | 07/05/1997 | 160.10.03 | Lead | Encrusted object |
| 997 | 07/05/1997 | 160.10.04 | Lead | Encrusted object |
| 998 | 07/06/1997 | 161.01.01 | Lead | Shot |
| 999 | 07/06/1997 | 161.01.02 | Lead | Shot |
| 1000 | 07/06/1997 | 161.01.03 | Lead | Shot |
| 1001 | 07/06/1997 | 161.01.04 | Lead | Shot |
| 1002 | 07/06/1997 | 161.01.05 | Lead | Shot |

| ID | DATE | ARTIFACT NUMBER | MATERIAL | DESCRIPTION |
|---|---|---|---|---|
| 1003 | 07/06/1997 | 161.01.06 | Lead | Shot |
| 1004 | 07/06/1997 | 161.01.07 | Lead | Shot |
| 1005 | 07/06/1997 | 161.01.08 | Lead | Shot |
| 1006 | 07/06/1997 | 161.01.09 | Lead | Shot |
| 1007 | 07/06/1997 | 161.01.10 | Lead | Shot |
| 1008 | 07/06/1997 | 161.01.11 | Lead | Shot |
| 1009 | 07/06/1997 | 161.01.12 | Lead | Shot |
| 1010 | 07/06/1997 | 161.01.13 | Lead | Shot |
| 1011 | 07/06/1997 | 161.01.14 | Lead | Shot |
| 1012 | 07/06/1997 | 161.01.15 | Lead | Shot |
| 1013 | 07/06/1997 | 161.01.16 | Lead | Shot |
| 1014 | 07/06/1997 | 161.01.17 | Lead | Shot |
| 1015 | 07/06/1997 | 161.01.18 | Lead | Shot |
| 1016 | 07/06/1997 | 161.03.01 | Lead | Shot |
| 1017 | 07/06/1997 | 161.03.02 | Lead | Shot |
| 1018 | 07/06/1997 | 161.03.03 | Lead | Shot |
| 1019 | 07/06/1997 | 161.04.01 | Lead | Fishing weights |
| 1020 | 07/06/1997 | 161.04.02 | Lead | Fishing weights |
| 1021 | 07/06/1997 | 161.04.03 | Lead | Fishing weights |
| 1022 | 07/06/1997 | 161.04.04 | Lead | Fishing weights |
| 1023 | 07/06/1997 | 161.05.01 | Lead | Probable bale seal |
| 1024 | 07/06/1997 | 161.05.02 | Lead | Probable bale seal |
| 1025 | 07/06/1997 | 161.05.03 | Lead | Probable bale seal |
| 1026 | 07/06/1997 | 161.05.04 | Lead | Probable bale seal |
| 1027 | 07/06/1997 | 161.06.01 | Glass | Bead |
| 1028 | 07/06/1997 | 161.06.02 | Glass | Bead |
| 1029 | 07/06/1997 | 161.06.03 | Glass | Bead |
| 1030 | 07/06/1997 | 161.07.01 | Cupreous | Nail or tack |
| 1031 | 07/06/1997 | 161.07.02 | Cupreous | Nail or tack |
| 1032 | 07/06/1997 | 161.07.03 | Cupreous | Nail or tack |
| 1033 | 07/06/1997 | 161.07.04 | Cupreous | Nail or tack |
| 1034 | 07/06/1997 | 161.07.05 | Cupreous | Nail or tack |
| 1035 | 07/06/1997 | 161.07.06 | Cupreous | Nail or tack |
| 1036 | 07/06/1997 | 161.07.07 | Cupreous | Nail or tack |
| 1037 | 07/06/1997 | 161.07.08 | Cupreous | Nail or tack |
| 1038 | 07/06/1997 | 161.07.09 | Cupreous | Nail or tack |
| 1039 | 07/06/1997 | 161.07.10 | Cupreous | Nail or tack |
| 1030 | 07/06/1997 | 161.07.11 | Cupreous | Nail or tack |
| 1031 | 07/06/1997 | 161.07.12 | Cupreous | Nail or tack |
| 1032 | 07/06/1997 | 161.07.13 | Cupreous | Nail or tack |
| 1033 | 07/06/1997 | 161.07.14 | Cupreous | Nail or tack |
| 1034 | 07/06/1997 | 161.07.15 | Cupreous | Nail or tack |
| 1035 | 07/06/1997 | 161.07.16 | Cupreous | Nail or tack |
| 1036 | 07/06/1997 | 161.07.17 | Cupreous | Nail or tack |
| 1037 | 07/06/1997 | 161.07.18 | Cupreous | Nail or tack |
| 1038 | 07/06/1997 | 161.07.19 | Cupreous | Nail or tack |
| 1039 | 07/06/1997 | 161.07.20 | Cupreous | Nail or tack |
| 1030 | 07/06/1997 | 161.07.21 | Cupreous | Nail or tack |
| 1031 | 07/06/1997 | 161.07.22 | Cupreous | Nail or tack |
| 1032 | 07/06/1997 | 161.07.23 | Cupreous | Nail or tack |
| 1033 | 07/06/1997 | 161.07.24 | Cupreous | Nail or tack |

| ID | DATE | ARTIFACT NUMBER | MATERIAL | DESCRIPTION |
|---|---|---|---|---|
| 1034 | 07/06/1997 | 161.07.25 | Cupreous | Nail or tack |
| 1035 | 07/06/1997 | 161.07.26 | Cupreous | Nail or tack |
| 1036 | 07/06/1997 | 161.07.27 | Cupreous | Nail or tack |
| 1037 | 07/06/1997 | 161.07.28 | Cupreous | Nail or tack |
| 1038 | 07/06/1997 | 161.08 | Lead | Sheathing |
| 1039 | 07/06/1997 | 161.09.01 | Pewter | Plate |
| 1040 | 07/06/1997 | 161.09.02 | Pewter | Plate |
| 1041 | 07/06/1997 | 161.09.03 | Pewter | Plate |
| 1042 | 07/06/1997 | 161.09.04 | Pewter | Plate |
| 1043 | 07/06/1997 | 161.09.05 | Pewter | Plate |
| 1044 | 07/06/1997 | 161.09.06 | Pewter | Plate |
| 1045 | 07/06/1997 | 161.09.07 | Pewter | Plate |
| 1046 | 07/06/1997 | 161.09.08 | Pewter | Plate |
| 1047 | 07/06/1997 | 161.09.09 | Pewter | Plate |
| 1048 | 07/06/1997 | 161.09.10 | Pewter | Plate |
| 1049 | 07/06/1997 | 161.10.01 | Ceramic | Red-bodied sherd green glaze |
| 1050 | 07/06/1997 | 161.10.02 | Ceramic | Brown-bodied sherd |
| 1051 | 07/06/1997 | 161.10.03 | Ceramic | Redware brown glaze |
| 1052 | 07/06/1997 | 161.10.04 | Ceramic | Buff sherd with incised lines |
| 1053 | 07/06/1997 | 161.11.01 | Lead | Unidentified |
| 1054 | 07/06/1997 | 161.11.02 | Lead | Unidentified |
| 1055 | 07/06/1997 | 161.012.01 | Cupreous | Discs possible seals |
| 1056 | 07/06/1997 | 161.012.02 | Cupreous | Discs possible seals |
| 1057 | 07/06/1997 | 161.012.03 | Cupreous | Discs possible seals |
| 1058 | 07/06/1997 | 161.012.04 | Cupreous | Discs possible seals |
| 1059 | 07/06/1997 | 161.012.05 | Cupreous | Discs possible seals |
| 1060 | 07/06/1997 | 161.012.06 | Cupreous | Discs possible seals |
| 1061 | 07/06/1997 | 161.012.07 | Cupreous | Discs possible seals |
| 1062 | 07/06/1997 | 161.012.08 | Cupreous | Discs possible seals |
| 1063 | 07/06/1997 | 161.012.09 | Cupreous | Discs possible seals |
| 1064 | 07/06/1997 | 161.012.10 | Cupreous | Discs possible seals |
| 1065 | 07/06/1997 | 161.13 | Cupreous | Chess piece |
| 1066 | 07/08/1997 | 162.01.01 | Stoneware | Martaban jar fragment |
| 1067 | 07/08/1997 | 162.01.02 | Stoneware | Martaban jar fragment |
| 1068 | 07/08/1997 | 162.01.03 | Stoneware | Martaban jar fragment |
| 1069 | 07/09/1997 | 163.01 | Cupreous | Fastener with beveled head |
| 1070 | 07/07/1997 | 164.01.01 | Lead | Shot |
| 1071 | 07/07/1997 | 164.01.02 | Lead | Shot |
| 1072 | 07/07/1997 | 164.01.03 | Lead | Shot |
| 1073 | 07/07/1997 | 164.01.04 | Lead | Shot |
| 1074 | 07/07/1997 | 164.01.05 | Lead | Shot |
| 1075 | 07/07/1997 | 164.01.06 | Lead | Shot |
| 1076 | 07/07/1997 | 164.01.07 | Lead | Shot |
| 1077 | 07/07/1997 | 164.01.08 | Lead | Shot |
| 1078 | 07/07/1997 | 164.01.09 | Lead | Shot |
| 1079 | 07/07/1997 | 164.01.10 | Lead | Shot |
| 1080 | 07/07/1997 | 164.01.11 | Lead | Shot |
| 1081 | 07/07/1997 | 164.01.12 | Lead | Shot |
| 1082 | 07/07/1997 | 164.01.13 | Lead | Shot |
| 1083 | 07/07/1997 | 164.01.14 | Lead | Shot |
| 1084 | 07/07/1997 | 164.01.15 | Lead | Shot |

| ID | DATE | ARTIFACT NUMBER | MATERIAL | DESCRIPTION |
|---|---|---|---|---|
| 1085 | 07/07/1997 | 164.01.16 | Lead | Shot |
| 1086 | 07/07/1997 | 164.01.17 | Lead | Shot |
| 1087 | 07/07/1997 | 164.01.18 | Lead | Shot |
| 1088 | 07/07/1997 | 164.01.19 | Lead | Shot |
| 1089 | 07/07/1997 | 164.01.20 | Lead | Shot |
| 1090 | 07/07/1997 | 164.01.21 | Lead | Shot |
| 1091 | 07/07/1997 | 164.01.22 | Lead | Shot |
| 1092 | 07/07/1997 | 164.01.23 | Lead | Shot |
| 1093 | 07/07/1997 | 164.01.24 | Lead | Shot |
| 1094 | 07/07/1997 | 164.01.25 | Lead | Shot |
| 1095 | 07/07/1997 | 164.01.26 | Lead | Shot |
| 1096 | 07/07/1997 | 164.01.27 | Lead | Shot |
| 1097 | 07/07/1997 | 164.01.28 | Lead | Shot |
| 1098 | 07/07/1997 | 164.01.29 | Lead | Shot |
| 1099 | 07/07/1997 | 164.01.30 | Lead | Shot |
| 1100 | 07/07/1997 | 164.01.31 | Lead | Shot |
| 1101 | 07/07/1997 | 164.01.32 | Lead | Shot |
| 1102 | 07/07/1997 | 164.01.33 | Lead | Shot |
| 1103 | 07/07/1997 | 164.01.34 | Lead | Shot |
| 1104 | 07/07/1997 | 164.01.35 | Lead | Shot |
| 1105 | 07/07/1997 | 164.01.36 | Lead | Shot |
| 1106 | 07/07/1997 | 164.01.37 | Lead | Shot |
| 1107 | 07/07/1997 | 164.01.38 | Lead | Shot |
| 1108 | 07/07/1997 | 164.01.39 | Lead | Shot |
| 1109 | 07/07/1997 | 164.01.40 | Lead | Shot |
| 1110 | 07/07/1997 | 164.01.41 | Lead | Shot |
| 1111 | 07/07/1997 | 164.01.42 | Lead | Shot |
| 1112 | 07/07/1997 | 164.01.43 | Lead | Shot |
| 1113 | 07/07/1997 | 164.01.44 | Lead | Shot |
| 1114 | 07/07/1997 | 164.01.45 | Lead | Shot |
| 1115 | 07/07/1997 | 164.01.46 | Lead | Shot |
| 1116 | 07/07/1997 | 164.01.47 | Lead | Shot |
| 1117 | 07/07/1997 | 164.01.48 | Lead | Shot |
| 1118 | 07/07/1997 | 164.01.49 | Lead | Shot |
| 1119 | 07/07/1997 | 164.01.50 | Lead | Shot |
| 1120 | 07/07/1997 | 164.01.51 | Lead | Shot |
| 1121 | 07/07/1997 | 164.01.52 | Lead | Shot |
| 1122 | 07/07/1997 | 164.01.53 | Lead | Shot |
| 1123 | 07/07/1997 | 164.01.54 | Lead | Shot |
| 1124 | 07/07/1997 | 164.01.55 | Lead | Shot |
| 1125 | 07/07/1997 | 164.01.56 | Lead | Shot |
| 1126 | 07/07/1997 | 164.01.57 | Lead | Shot |
| 1127 | 07/07/1997 | 164.01.58 | Lead | Shot |
| 1128 | 07/07/1997 | 164.01.59 | Lead | Shot |
| 1129 | 07/07/1997 | 164.01.60 | Lead | Shot |
| 1130 | 07/07/1997 | 164.01.61 | Lead | Shot |
| 1131 | 07/07/1997 | 164.01.62 | Lead | Shot |
| 1132 | 07/07/1997 | 164.01.63 | Lead | Shot |
| 1133 | 07/07/1997 | 164.01.64 | Lead | Shot |
| 1134 | 07/07/1997 | 164.01.65 | Lead | Shot |
| 1135 | 07/07/1997 | 164.01.66 | Lead | Shot |

| ID | DATE | ARTIFACT NUMBER | MATERIAL | DESCRIPTION |
|---|---|---|---|---|
| 1136 | 07/07/1997 | 164.01.67 | Lead | Shot |
| 1137 | 07/07/1997 | 164.01.68 | Lead | Shot |
| 1138 | 07/07/1997 | 164.01.69 | Lead | Shot |
| 1139 | 07/07/1997 | 164.01.70 | Lead | Shot |
| 1140 | 07/07/1997 | 164.01.71 | Lead | Shot |
| 1141 | 07/07/1997 | 164.01.72 | Lead | Shot |
| 1142 | 07/07/1997 | 164.01.75 | Lead | Shot |
| 1143 | 07/07/1997 | 164.01.76 | Lead | Shot |
| 1144 | 07/07/1997 | 164.01.77 | Lead | Shot |
| 1145 | 07/07/1997 | 164.01.78 | Lead | Shot |
| 1146 | 07/07/1997 | 164.01.79 | Lead | Shot |
| 1147 | 07/07/1997 | 164.01.80 | Lead | Shot |
| 1148 | 07/07/1997 | 164.01.81 | Lead | Shot |
| 1149 | 07/07/1997 | 164.01.82 | Lead | Shot |
| 1150 | 07/07/1997 | 164.01.83 | Lead | Shot |
| 1151 | 07/07/1997 | 164.01.84 | Lead | Shot |
| 1152 | 07/07/1997 | 164.01.85 | Lead | Shot |
| 1153 | 07/07/1997 | 164.01.86 | Lead | Shot |
| 1154 | 07/07/1997 | 164.01.87 | Lead | Shot |
| 1155 | 07/07/1997 | 164.01.88 | Lead | Shot |
| 1156 | 07/07/1997 | 164.01.89 | Lead | Shot |
| 1157 | 07/07/1997 | 164.01.90 | Lead | Shot |
| 1158 | 07/07/1997 | 164.01.91 | Lead | Shot |
| 1159 | 07/07/1997 | 164.01.92 | Lead | Shot |
| 1160 | 07/07/1997 | 164.01.93 | Lead | Shot |
| 1161 | 07/07/1997 | 164.01.94 | Lead | Shot |
| 1162 | 07/07/1997 | 164.01.95 | Lead | Shot |
| 1163 | 07/07/1997 | 164.01.96 | Lead | Shot |
| 1164 | 07/07/1997 | 164.01.97 | Lead | Shot |
| 1165 | 07/07/1997 | 164.01.98 | Lead | Shot |
| 1166 | 07/07/1997 | 164.01.99 | Lead | Shot |
| 1167 | 07/07/1997 | 164.01.100 | Lead | Shot |
| 1168 | 07/07/1997 | 164.01.101 | Lead | Shot |
| 1169 | 07/07/1997 | 164.01.102 | Lead | Shot |
| 1170 | 07/07/1997 | 164.01.103 | Lead | Shot |
| 1171 | 07/07/1997 | 164.01.104 | Lead | Shot |
| 1172 | 07/07/1997 | 164.01.105 | Lead | Shot |
| 1173 | 07/07/1997 | 164.01.106 | Lead | Shot |
| 1174 | 07/07/1997 | 164.01.107 | Lead | Shot |
| 1175 | 07/07/1997 | 164.02.01 | Cupreous | Nail or tack |
| 1176 | 07/07/1997 | 164.02.02 | Cupreous | Nail or tack |
| 1177 | 07/07/1997 | 164.02.03 | Cupreous | Nail or tack |
| 1178 | 07/07/1997 | 164.02.04 | Cupreous | Nail or tack |
| 1179 | 07/07/1997 | 164.02.05 | Cupreous | Nail or tack |
| 1180 | 07/07/1997 | 164.02.06 | Cupreous | Nail or tack |
| 1181 | 07/07/1997 | 164.02.07 | Cupreous | Nail or tack |
| 1182 | 07/07/1997 | 164.02.08 | Cupreous | Nail or tack |
| 1183 | 07/07/1997 | 164.02.09 | Cupreous | Nail or tack |
| 1184 | 07/07/1997 | 164.02.10 | Cupreous | Nail or tack |
| 1185 | 07/07/1997 | 164.02.11 | Cupreous | Nail or tack |
| 1186 | 07/07/1997 | 164.03.01 | Cupreous | Coin or button |

| ID | DATE | ARTIFACT NUMBER | MATERIAL | DESCRIPTION |
|---|---|---|---|---|
| 1187 | 07/07/1997 | 164.03.02 | Cupreous | Coin or button |
| 1188 | 07/07/1997 | 164.03.03 | Cupreous | Coin or button |
| 1189 | 07/07/1997 | 164.03.04 | Cupreous | Coin or button |
| 1190 | 07/07/1997 | 164.03.05 | Cupreous | Coin or button |
| 1191 | 07/07/1997 | 164.03.06 | Cupreous | Coin or button |
| 1192 | 07/07/1997 | 164.03.07 | Cupreous | Coin or button |
| 1193 | 07/07/1997 | 164.03.08 | Cupreous | Coin or button |
| 1194 | 07/07/1997 | 164.03.09 | Cupreous | Coin or button |
| 1195 | 07/07/1997 | 164.03.10 | Cupreous | Coin or button |
| 1196 | 07/07/1997 | 164.04.01 | Lead | Fragment |
| 1197 | 07/07/1997 | 164.04.02 | Lead | Fragment |
| 1198 | 07/07/1997 | 164.04.03 | Lead | Fragment |
| 1199 | 07/07/1997 | 164.04.04 | Lead | Fragment |
| 1200 | 07/07/1997 | 164.04.05 | Lead | Fragment |
| 1201 | 07/07/1997 | 164.04.06 | Lead | Fragment |
| 1202 | 07/07/1997 | 164.04.07 | Lead | Fragment |
| 1203 | 07/07/1997 | 164.04.08 | Lead | Fragment |
| 1204 | 07/07/1997 | 164.04.09 | Lead | Fragment |
| 1205 | 07/07/1997 | 164.04.10 | Lead | Fragment |
| 1206 | 07/07/1997 | 164.05.01 | Lead | Shot |
| 1207 | 07/07/1997 | 164.05.02 | Lead | Shot |
| 1208 | 07/07/1997 | 164.05.03 | Lead | Shot |
| 1209 | 07/07/1997 | 164.05.04 | Lead | Shot |
| 1210 | 07/07/1997 | 164.05.05 | Lead | Shot |
| 1211 | 07/07/1997 | 164.05.06 | Lead | Shot |
| 1212 | 07/07/1997 | 164.05.07 | Lead | Shot |
| 1213 | 07/07/1997 | 164.05.08 | Lead | Shot |
| 1214 | 07/07/1997 | 164.05.09 | Lead | Shot |
| 1215 | 07/07/1997 | 164.05.10 | Lead | Shot |
| 1216 | 07/07/1997 | 164.05.11 | Lead | Shot |
| 1217 | 07/07/1997 | 164.06.01 | Metal | Cupreous possible seal |
| 1218 | 07/07/1997 | 164.06.02 | Metal | Cupreous possible seal |
| 1219 | 07/07/1997 | 164.06.03 | Metal | Lead possible seal |
| 1220 | 07/07/1997 | 164.07.01 | Lead | Sounding weight |
| 1221 | 07/07/1997 | 164.07.02 | Lead | Fishing net weight |
| 1223 | 07/07/1997 | 164.08 | Cupreous | Button with soldered ring |
| 1224 | 07/07/1997 | 164.09 | Lead | Undetermined |
| 1225 | 07/21/1997 | 165.01 | Pewter | Plate |
| 1226 | 07/21/1997 | 165.02.01 | Lead | Shot |
| 1227 | 07/21/1997 | 165.02.02 | Lead | Shot |
| 1228 | 07/21/1997 | 165.03 | Stoneware | Coarse gray-bodied fragment |
| 1229 | 07/23/1997 | 166.01.01 | Porcelain | Blue and white vase neck fragment |
| 1230 | 07/23/1997 | 166.01.02 | Porcelain | Blue and white sherd with deer motif |
| 1231 | 07/23/1997 | 166.02 | Earthenware | Whiteware with black transfer print |
| 1232 | 07/23/1997 | 166.03 | Glass | Intrusive green shard |
| 1233 | 07/23/1997 | 167.01 | Earthenware | Red-bodied rim sherd |
| 1234 | 07/23/1997 | 167.02 | Glass | Dark crizzled shard |
| 1235 | 07/24/1997 | 168.01 | Pewter | Plate |
| 1236 | 07/24/1997 | 168.02 | Pewter | Plate |
| 1237 | 07/24/1997 | 168.02A | Organic | Fruit pit likely peach |
| 1238 | 07/24/1997 | 169.01.01 | Organic | Fruit pit likely peach |

| ID | DATE | ARTIFACT NUMBER | MATERIAL | DESCRIPTION |
|---|---|---|---|---|
| 1239 | 07/24/1997 | 169.01.02 | Organic | Fruit pit likely peach |
| 1240 | 07/24/1997 | 169.01.03 | Organic | Fruit pit likely peach |
| 1241 | 07/25/1997 | 170.02.01 | Stoneware | Dark gray coarse bodied fragment |
| 1242 | 07/25/1997 | 170.02.02 | Stoneware | Dark gray coarse bodied fragment |
| 1243 | 07/26/1997 | 171.01 | Pewter | Plate |
| 1244 | 07/26/1997 | 171.02 | Pewter | Plate |
| 1245 | 07/26/1997 | 171.03 | Porcelain | Blue and white fragment |
| 1246 | 07/26/1997 | 171.04 | Porcelain | Blue and white fragment |
| 1247 | 07/26/1997 | 171.05 | Porcelain | Blue and white fragment |
| 1248 | 07/26/1997 | 171.06 | Porcelain | Blue and white fragment |
| 1249 | 07/26/1997 | 171.07 | Coral | Raw coral fragment—trade coral |
| 1250 | 07/26/1997 | 171.08 | Stoneware | Dragon jar fragment |
| 1251 | 07/26/1997 | 171.09 | Ceramic | Buff-pasted fragment with black slip and glaze |
| 1252 | 07/26/1997 | 171.10 | Ceramic | Gray-bodied fragment |
| 1253 | 07/26/1997 | 171.11 | Ceramic | Gray-bodied fragment with lustrous glaze |
| 1254 | 07/26/1997 | 171.12 | Stoneware | Brown-bodied coarse tempered sherd |
| 1255 | 07/26/1997 | 171.13 | Earthenware | Red-bodied fragment |
| 1256 | 07/27/1997 | 172.01 | Cupreous | Navigation compass |
| 1257 | 07/27/1997 | 172.02 | Cupreous | Navigation compass |
| 1258 | 07/27/1997 | 172.03 | Porcelain | Blue and white rim sherd |
| 1259 | 07/27/1997 | 172.04 | Porcelain | Blue and white fragment with crows and pine trees |
| 1260 | 07/27/1996 | 172.05 | Stoneware | Dragon jar sherd |
| 1261 | 07/27/1997 | 172.06 | Porcelain | Blue and white sherd |
| 1262 | 07/27/1997 | 172.07 | Earthenware | Dark gray-bodied sherd |
| 1263 | 07/27/1997 | 172.08 | Ceramic | Coarse red-bodied gravel tempered sherd |
| 1264 | 07/27/1997 | 172.09 | Ceramic | Coarse red-bodied gravel tempered sherd |
| 1265 | 07/27/1997 | 172.10 | Organic | Fruit pit likely peach |
| 1266 | 07/29/1997 | 173 | Likely ferrous | Unknown concretion |
| 1267 | 07/30/1997 | 174.01 | Stoneware | Dragon jar fragment |
| 1268 | 07/30/1997 | 174.02 | Unknown | Concretion with cupreous strip |
| 1269 | 07/31/1997 | 175.01.01 | Organic | Fruit pit likely peach |
| 1270 | 07/31/1997 | 175.01.02 | Organic | Fruit pit likely peach |
| 1271 | 07/31/1997 | 175.01.03 | Organic | Fruit pit likely peach |
| 1272 | 07/31/1997 | 175.01.04 | Organic | Fruit pit likely peach |
| 1273 | 07/31/1997 | 175.01.05 | Organic | Fruit pit likely peach |
| 1274 | 07/31/1997 | 175.01.06 | Organic | Fruit pit likely peach |
| 1275 | 07/31/1997 | 175.01.07 | Organic | Fruit pit likely peach |
| 1276 | 07/31/1997 | 175.01.08 | Organic | Fruit pit likely peach |
| 1277 | 07/31/1997 | 175.01.09 | Organic | Fruit pit likely peach |
| 1278 | 07/31/1997 | 175.01.10 | Organic | Fruit pit likely peach |
| 1279 | 07/31/1997 | 175.01.11 | Organic | Fruit pit likely peach |
| 1280 | 07/31/1997 | 175.01.12 | Organic | Fruit pit likely peach |
| 1281 | 07/31/1997 | 175.02 | Organic | Coconut shell |
| 1282 | 07/31/1997 | 175.03 | Organic | Coconut shell |
| 1283 | 07/31/1997 | 175.04 | Plastic | Telephone cord |
| 1284 | 07/31/1997 | 175.05 | Ceramic | Dark gray sherd |
| 1285 | 07/31/1997 | 175.06 | Stoneware | Coarse tempered sherd partial black glaze possible Martaban jar |

| ID | DATE | ARTIFACT NUMBER | MATERIAL | DESCRIPTION |
|---|---|---|---|---|
| 1286 | 07/31/1997 | 175.07.01 | Ceramic | Creamware fragment |
| 1287 | 07/31/1997 | 175.07.01 | Ceramic | Creamware fragment |
| 1288 | 07/31/1997 | 175.07.03 | Ceramic | Creamware fragment |
| 1289 | 07/31/1997 | 175.07.04 | Ceramic | Creamware fragment |
| 1290 | 07/31/1997 | 175.07.05 | Ceramic | Creamware fragment |
| 1291 | 07/31/1997 | 175.07.06 | Ceramic | Creamware fragment |
| 1292 | 07/31/1997 | 175.07.07 | Ceramic | Creamware fragment |
| 1293 | 07/31/1997 | 175.08.01 | Stoneware | Gray rim sherd |
| 1294 | 07/31/1997 | 175.08.01 | Stoneware | Red-bodied sherd |
| 1295 | 07/31/1997 | 175.08.01 | Stoneware | Dragon jar sherd |
| 1296 | 07/31/1997 | 175.09.01 | Ceramic | Red-bodied Earthenware sherd |
| 1297 | 07/31/1997 | 175.09.02 | Ceramic | Red-bodied Earthenware sherd |
| 1298 | 07/31/1997 | 175.09.03 | Ceramic | Red-bodied Earthenware sherd |
| 1299 | 07/31/1997 | 175.09.04 | Ceramic | Rock |
| 1300 | 07/31/1997 | 175.10 | Ceramic | Basalt |
| 1301 | 07/31/1997 | 175.11 | Cupreous | Possible quadrant base |
| 1302 | 08/01/1997 | 176.02 | Organic | Coconut shell fragments |
| 1303 | 08/01/1997 | 176.03.01 | Ceramic | Red-bodied Earthenware fragment |
| 1304 | 08/01/1997 | 176.03.02 | Ceramic | Red-bodied Earthenware fragment |
| 1305 | 08/01/1997 | 176.03.03 | Ceramic | Red-bodied Earthenware fragment |
| 1306 | 08/01/1997 | 176.03.04 | Ceramic | Masonry |
| 1307 | 08/01/1997 | 176.04 | Lead | Shot |
| 1308 | 08/01/1997 | 176.05 | Stoneware | Gray-bodied sherd |
| 1309 | 08/01/1997 | 176.06 | Stoneware | Gray-bodied sherd |
| 1310 | 08/01/1997 | 176.07 | Rock | Rock |
| 1311 | 08/01/1997 | 176.08 | Cupreous | Decorative elements |
| 1312 | 08/01/1997 | 176.09 | Organic | Fruit pit likely peach |
| 1313 | 08/02/1997 | 177.01 | Porcelain | Blue and white sherd |
| 1314 | 08/02/1997 | 177.02 | Coral | Fragment—trade coral |
| 1315 | 08/03/1997 | 178.01.01 | Lead | Shot |
| 1316 | 08/03/1997 | 178.01.02 | Lead | Shot |
| 1317 | 08/03/1997 | 178.02.01 | Cupreous | Probable coin or seal |
| 1318 | 08/03/1997 | 178.02.02 | Cupreous | Probable coin or seal |
| 1319 | 08/03/1997 | 178.03.01 | Cupreous | Probable coin or seal |
| 1320 | 08/03/1997 | 178.03.02 | Cupreous | Probable coin or seal |
| 1321 | 08/03/1997 | 178.03.03 | Cupreous | Probable coin or seal |
| 1322 | 08/03/1997 | 178.03.04 | Cupreous | Probable coin or seal |
| 1323 | 08/03/1997 | 178.04.01 | Cupreous | Nail or tack |
| 1324 | 08/03/1997 | 178.04.02 | Cupreous | Nail or tack |
| 1325 | 08/03/1997 | 178.04.03 | Cupreous | Nail or tack |
| 1326 | 08/03/1997 | 178.04.04 | Cupreous | Nail or tack |
| 1327 | 08/03/1997 | 178.04.05 | Cupreous | Nail or tack |
| 1328 | 08/03/1997 | 178.04.06 | Cupreous | Nail or tack |
| 1329 | 08/03/1997 | 178.04.07 | Cupreous | Nail or tack |
| 1330 | 08/03/1997 | 178.04.08 | Cupreous | Nail or tack |
| 1331 | 08/03/1997 | 178.04.09 | Cupreous | Nail or tack |
| 1332 | 08/03/1997 | 178.04.10 | Cupreous | Nail or tack |
| 1333 | 08/03/1997 | 178.05 | Cupreous | Decorative element |
| 1334 | 08/03/1997 | 178.06.01 | Lead | Probable fishing weight |
| 1335 | 08/03/1997 | 178.06.02 | Lead | Probable fishing weight |

| ID | DATE | ARTIFACT NUMBER | MATERIAL | DESCRIPTION |
|---|---|---|---|---|
| 1336 | 08/03/1997 | 178.06.03 | Lead | Probable fishing weight |
| 1337 | 08/03/1997 | 178.06.04 | Lead | Probable fishing weight |
| 1338 | 08/03/1997 | 178.06.05 | Lead | Probable fishing weight |
| 1339 | 08/03/1997 | 178.06.06 | Lead | Probable fishing weight |
| 1340 | 08/03/1997 | 178.06.07 | Lead | Probable fishing weight |
| 1341 | 08/03/1997 | 178.06.08 | Lead | Probable fishing weight |
| 1342 | 08/03/1997 | 178.07.01 | Lead | Fragment |
| 1343 | 08/03/1997 | 178.07.02 | Lead | Fragment |
| 1344 | 08/03/1997 | 178.07.03 | Lead | Fragment |
| 1345 | 08/03/1997 | 178.07.04 | Lead | Fragment |
| 1346 | 08/03/1997 | 178.07.05 | Lead | Fragment |
| 1347 | 08/03/1997 | 178.07.06 | Lead | Fragment |
| 1348 | 08/03/1997 | 178.08 | Organic | Bone fragment |
| 1349 | 08/03/1997 | 178.09 | Cupreous | Open ring of drawn wire |
| 1350 | 08/03/1997 | 178.10.01 | Likely cupreous | Fragment |
| 1351 | 08/03/1997 | 178.10.02 | Likely cupreous | Fragment |
| 1352 | 08/03/1997 | 178.10.03 | Likely cupreous | Fragment |
| 1353 | 08/05/1997 | 179.01 | Likely ferrous | Concretion |
| 1354 | 08/05/1997 | 179.02 | Slag | |
| 1355 | 08/05/1997 | 179.04.01 | Lead | Probable sheathing fragment |
| 1356 | 08/05/1997 | 179.04.02 | Lead | Probable sheathing fragment |
| 1357 | 08/05/1997 | 179.04.03 | Lead | Probable sheathing fragment |
| 1358 | 08/07/1997 | 180.01.01 | Stoneware | Gray-bodied sherd with black glaze |
| 1359 | 08/07/1997 | 180.01.02 | Stoneware | Gray-bodied sherd with black glaze |
| 1360 | 08/07/1997 | 180.02.01 | Cupreous | Possible handle |
| 1361 | 08/07/1997 | 180.02.02 | Cupreous | Hanging hook handle |
| 1362 | 08/07/1997 | 180.02.03 | Cupreous | Hooked object |
| 1363 | 08/07/1997 | 180.03 | Earthenware | Creamware sherd |
| 1364 | 08/07/1997 | 180.04.01 | Lead | Shot with visible seam and sprue |
| 1365 | 08/07/1997 | 180.04.02 | Lead | Shot with visible seam and sprue |
| 1366 | 08/07/1997 | 180.04.03 | Lead | Shot with visible seam and sprue |
| 1367 | 08/07/1997 | 180.04.04 | Lead | Shot with visible seam and sprue |
| 1368 | 08/07/1997 | 180.04.05 | Lead | Shot with visible seam and sprue |
| 1369 | 08/07/1997 | 180.04.06 | Lead | Shot with visible seam and sprue |
| 1370 | 08/07/1997 | 180.04.07 | Lead | Shot with visible seam and sprue |
| 1371 | 08/07/1997 | 180.04.08 | Lead | Shot with visible seam and sprue |
| 1372 | 08/07/1997 | 180.04.09 | Lead | Shot with visible seam and sprue |
| 1373 | 08/07/1997 | 180.04.10 | Lead | Shot with visible seam and sprue |
| 1374 | 08/07/1997 | 180.04.11 | Lead | Shot with visible seam and sprue |
| 1375 | 08/07/1997 | 180.04.12 | Lead | Shot with visible seam and sprue |
| 1376 | 08/07/1997 | 180.04.13 | Lead | Shot with visible seam and sprue |
| 1377 | 08/07/1997 | 180.05 | Likely ceramic | Unknown |
| 1378 | 08/07/1997 | 180.06 | Organic | Mammalian bone fragment |
| 1379 | 08/07/1997 | 180.07.01 | Ceramic | Red-bodied sand tempered fragment |
| 1380 | 08/07/1997 | 180.07.02 | Ceramic | Red-bodied sand tempered fragment |
| 1381 | 08/07/1997 | 180.07.03 | Ceramic | Red-bodied sand tempered fragment |
| 1382 | 08/07/1997 | 180.08.01 | Glass | Aqua shard |
| 1383 | 08/07/1997 | 180.08.02 | Glass | Intrusive clear shard |
| 1384 | 08/07/1997 | 180.08.03 | Glass | Intrusive clear shard |
| 1385 | 08/07/1997 | 180.09 | Cupreous | Decorative element |

| ID | DATE | ARTIFACT NUMBER | MATERIAL | DESCRIPTION |
|---|---|---|---|---|
| 1386 | 08/07/1997 | 180.10 | Unknown | Undetermined |
| 1387 | 08/07/1997 | 180.11 | Organic | Bone possible tooth or nail |
| 1388 | 08/07/1997 | 180.12.01 | Organic | Fruit pit likely peach |
| 1389 | 08/07/1997 | 180.12.02 | Organic | Fruit pit likely peach |
| 1390 | 08/07/1997 | 180.12.03 | Organic | Fruit pit likely peach |
| 1391 | 08/07/1997 | 180.12.04 | Organic | Fruit pit likely peach |
| 1392 | 08/07/1997 | 180.12.05 | Organic | Fruit pit likely peach |
| 1393 | 08/07/1997 | 180.12.06 | Organic | Fruit pit likely peach |
| 1394 | 08/07/1997 | 180.12.07 | Organic | Fruit pit likely peach |
| 1395 | 08/07/1997 | 180.12.08 | Organic | Fruit pit likely peach |
| 1396 | 08/07/1997 | 180.12.09 | Organic | Fruit pit likely peach |
| 1397 | 08/07/1997 | 180.12.10 | Organic | Fruit pit likely peach |
| 1398 | 08/07/1997 | 180.12.11 | Organic | Fruit pit likely peach |
| 1399 | 08/07/1997 | 180.12.12 | Organic | Fruit pit likely peach |
| 1400 | 08/07/1997 | 180.12.13 | Organic | Fruit pit likely peach |
| 1401 | 08/07/1997 | 180.12.14 | Organic | Fruit pit likely peach |
| 1402 | 08/07/1997 | 180.12.15 | Organic | Fruit pit likely peach |
| 1403 | 08/07/1997 | 180.12.16 | Organic | Fruit pit likely peach |
| 1404 | 08/07/1997 | 180.12.17 | Organic | Fruit pit likely peach |
| 1405 | 08/07/1997 | 180.12.18 | Organic | Fruit pit likely peach |
| 1406 | 08/07/1997 | 180.12.19 | Organic | Fruit pit likely peach |
| 1407 | 08/07/1997 | 180.12.20 | Organic | Fruit pit likely peach |
| 1408 | 08/07/1997 | 180.12.21 | Organic | Fruit pit likely peach |
| 1409 | 08/07/1997 | 180.13 | Organic | Likely gourd seed |
| 1410 | 08/07/1997 | 180.14 | Unknown | Pot lid |
| 1411 | 08/08/1997 | 181.01 | Organic | Likely bone fragment |
| 1412 | 08/08/1997 | 181.02.01 | Organic | Fruit pit likely peach |
| 1413 | 08/08/1997 | 181.02.02 | Organic | Fruit pit likely peach |
| 1414 | 08/08/1997 | 181.02.03 | Organic | Fruit pit likely peach |
| 1415 | 08/08/1997 | 181.02.04 | Organic | Fruit pit likely peach |
| 1416 | 08/08/1997 | 181.02.05 | Organic | Fruit pit likely peach |
| 1417 | 08/08/1997 | 181.02.06 | Organic | Fruit pit likely peach |
| 1418 | 08/08/1997 | 181.02.07 | Organic | Fruit pit likely peach |
| 1419 | 08/08/1997 | 181.02.08 | Organic | Fruit pit likely peach |
| 1420 | 08/08/1997 | 181.03 | Cupreous | Wing nut possibly machined |
| 1421 | 08/08/1997 | 181.04.01 | Porcelain | Blue and white sherd |
| 1422 | 08/08/1997 | 181.04.02 | Porcelain | Blue and white sherd |
| 1423 | 08/08/1997 | 181.05.01 | Ceramic | Unknown |
| 1424 | 08/08/1997 | 181.05.02 | Ceramic | Unknown |
| 1425 | 08/08/1997 | 181.05.03 | Ceramic | Red-bodied sherd |
| 1426 | 08/08/1997 | 181.05.04 | Ceramic | Buff-bodied sherd |
| 1427 | 08/08/1997 | 181.05.05 | Ceramic | Buff-bodied sherd |
| 1428 | 08/08/1997 | 181.05.06 | Ceramic | Unknown |
| 1429 | 08/08/1997 | 181.05.07 | Ceramic | Red-bodied sherd |
| 1430 | 08/08/1997 | 181.06.01 | Likely ferrous | Concretion |
| 1431 | 08/08/1997 | 181.06.02 | Likely ferrous | Concretion |
| 1432 | 08/08/1997 | 182.01.01 | Stoneware | Gray-bodied black glazed fragment likely Martaban jar |
| 1433 | 08/08/1997 | 182.01.02 | Stoneware | Gray-bodied black glazed fragment likely Martaban jar |

| ID | DATE | ARTIFACT NUMBER | MATERIAL | DESCRIPTION |
|---|---|---|---|---|
| 1434 | 08/08/1997 | 182.01.03 | Stoneware | Gray-bodied black glazed fragment likely Martaban jar |
| 1435 | 08/08/1997 | 182.01.04 | Stoneware | Gray-bodied black glazed fragment likely Martaban jar |
| 1436 | 08/08/1997 | 182.01.05 | Stoneware | Gray-bodied black glazed fragment likely Martaban jar |
| 1437 | 08/08/1997 | 182.01.06 | Stoneware | Gray-bodied black glazed fragment likely Martaban jar |
| 1438 | 08/08/1997 | 182.01.07 | Stoneware | Gray-bodied black glazed fragment likely Martaban jar |
| 1439 | 08/08/1997 | 182.01.08 | Stoneware | Gray-bodied black glazed fragment likely Martaban jar |
| 1440 | 08/08/1997 | 182.02.01 | Earthenware | Gray-bodied coarse tempered fragment |
| 1441 | 08/08/1997 | 182.02.02 | Earthenware | Gray-bodied coarse tempered fragment |
| 1442 | 08/08/1997 | 182.03 | Stoneware | Gray-bodied fragment with black glaze |
| 1443 | 08/08/1997 | 182.04 | Ceramic | Probably buff-bodied with brown glaze |
| 1444 | 08/08/1997 | 182.05.01 | Organic | Fruit pit likely peach |
| 1445 | 08/08/1997 | 182.05.02 | Organic | Fruit pit likely peach |
| 1446 | 08/08/1997 | 182.05.03 | Organic | Fruit pit likely peach |
| 1447 | 08/08/1997 | 182.05.04 | Organic | Fruit pit likely peach |
| 1448 | 08/08/1997 | 182.05.05 | Organic | Fruit pit likely peach |
| 1449 | 08/08/1997 | 182.06 | Organic | Coconut shell |
| 1450 | 08/08/1997 | 182.07.01 | Organic | Wood fragment |
| 1551 | 08/08/1997 | 182.07.02 | Organic | Wood fragment |
| 1552 | 08/08/1997 | 182.07.03 | Organic | Wood fragment |
| 1553 | 08/08/1997 | 182.07.04 | Organic | Wood fragment |
| 1554 | 08/08/1997 | 182.07.05 | Organic | Wood fragment |
| 1555 | 08/10/1997 | 183.01.01 | Stoneware | Gray jar fragment |
| 1556 | 08/10/1997 | 183.01.02 | Stoneware | Gray jar fragment |
| 1557 | 08/10/1997 | 183.01.03 | Stoneware | Gray jar fragment |
| 1558 | 08/10/1997 | 183.01.04 | Stoneware | Gray jar fragment |
| 1559 | 08/10/1997 | 183.01.05 | Stoneware | Gray jar fragment |
| 1560 | 08/10/1997 | 183.01.06 | Stoneware | Gray jar fragment |
| 1561 | 08/10/1997 | 183.02 | Porcelain | Blue and white sherd |
| 1562 | 08/10/1997 | 183.03 | Stoneware | Buff-bodied rim section with green exterior |
| 1563 | 08/10/1997 | 183.04.01 | Organic | Fruit pit likely peach |
| 1564 | 08/10/1997 | 183.04.02 | Organic | Fruit pit likely peach |
| 1565 | 08/10/1997 | 183.04.03 | Organic | Fruit pit likely peach |
| 1566 | 08/10/1997 | 183.04.04 | Organic | Fruit pit likely peach |
| 1567 | 08/10/1997 | 183.04.05 | Organic | Fruit pit likely peach |
| 1568 | 08/10/1997 | 183.05 | Organic | Small mammalian bone likely rodent |
| 1569 | 08/10/1997 | 183.08.01 | Cupreous | Decorative element likely button |
| 1570 | 08/10/1997 | 183.08.02 | Cupreous | Decorative element likely button |
| 1571 | 08/10/1997 | 183.09 | Porcelain | Blue and white plate from the Wan-Li Period of the Ming Dynasty |
| 1572 | 08/10/1997 | 183.10 | Porcelain | Blue and white plate from the Wan-Li Period of the Ming Dynasty |
| 1573 | 08/10/1997 | 183.11 | Porcelain | Blue and white plate from the Wan-Li Period of the Ming Dynasty |

| ID | DATE | ARTIFACT NUMBER | MATERIAL | DESCRIPTION |
|---|---|---|---|---|
| 1574 | 08/10/1997 | 183.12 | Porcelain | Blue and white plate from the Wan-Li Period of the Ming Dynasty |
| 1575 | 08/10/1997 | 183.13 | Porcelain | Blue and white plate from the Wan-Li Period of the Ming Dynasty |
| 1576 | 08/10/1997 | 183.14 | Porcelain | Blue and white plate from the Wan-Li Period of the Ming Dynasty |
| 1577 | 08/10/1997 | 183.15 | Porcelain | Blue and white plate from the Wan-Li Period of the Ming Dynasty |
| 1578 | 08/11/1997 | 184.02 | Cupreous | Decorative element |
| 1579 | 08/11/1997 | 184.03.01 | Porcelain | Blue and white fragment |
| 1580 | 08/11/1997 | 184.03.02 | Porcelain | Blue and white fragment |
| 1581 | 08/11/1997 | 184.03.03 | Porcelain | Blue and white fragment |
| 1582 | 08/11/1997 | 184.03.04 | Porcelain | Blue and white fragment |
| 1583 | 08/11/1997 | 184.03.05 | Porcelain | Blue and white fragment |
| 1584 | 08/11/1997 | 184.03.06 | Porcelain | Blue and white fragment |
| 1585 | 08/11/1997 | 184.04.01 | Organic | Fruit pit likely peach |
| 1586 | 08/11/1997 | 184.04.02 | Organic | Fruit pit likely peach |
| 1587 | 08/11/1997 | 184.04.03 | Organic | Fruit pit likely peach |
| 1588 | 08/11/1997 | 184.04.04 | Organic | Fruit pit likely peach |
| 1589 | 08/11/1997 | 184.04.05 | Organic | Fruit pit likely peach |
| 1590 | 08/11/1997 | 184.05.01 | Lead | Shot |
| 1591 | 08/11/1997 | 184.05.02 | Lead | Shot |
| 1592 | 08/11/1997 | 184.06 | Cupreous | Intrusive copper wire |
| 1593 | 08/11/1997 | 184.07.01 | Cupreous | Decorative element probable button |
| 1594 | 08/11/1997 | 184.07.02 | Cupreous | Decorative element probable button |
| 1595 | 08/11/1997 | 184.08.01 | Ceramic | Fragment |
| 1596 | 08/11/1997 | 184.08.02 | Ceramic | Fragment |
| 1597 | 08/11/1997 | 184.08.03 | Ceramic | Fragment |
| 1598 | 08/11/1997 | 184.08.04 | Ceramic | Fragment |
| 1599 | 08/11/1997 | 184.08.05 | Ceramic | Fragment |
| 1600 | 08/11/1997 | 184.08.06 | Ceramic | Fragment |
| 1601 | 08/11/1997 | 184.08.07 | Ceramic | Fragment |
| 1602 | 08/11/1997 | 184.08.08 | Ceramic | Fragment |
| 1603 | 08/11/1997 | 184.08.09 | Ceramic | Fragment |
| 1604 | 08/11/1997 | 184.08.10 | Ceramic | Fragment |
| 1605 | 08/11/1997 | 184.08.11 | Ceramic | Fragment |
| 1606 | 08/11/1997 | 184.09.01 | Organic | Bone fragment |
| 1607 | 08/11/1997 | 184.09.02 | Organic | Bone fragment |
| 1608 | 08/11/1997 | 184.09.03 | Organic | Bone fragment |
| 1609 | 08/11/1997 | 184.09.04 | Organic | Bone fragment |
| 1610 | 08/11/1997 | 184.09.05 | Organic | Bone fragment |
| 1611 | 08/11/1997 | 184.09.06 | Organic | Bone fragment |
| 1612 | 08/11/1997 | 184.09.07 | Organic | Bone fragment |
| 1613 | 08/11/1997 | 184.09.08 | Organic | Bone fragment |
| 1614 | 08/11/1997 | 184.09.09 | Organic | Bone fragment |
| 1615 | 08/11/1997 | 184.10 | Metal | Concretion |
| 1616 | 08/11/1997 | 184.11.01 | Carbon | Coal |
| 1617 | 08/11/1997 | 184.11.02 | Carbon | Coal |
| 1618 | 08/11/1997 | 184.13 | Clay | |
| 1619 | 08/11/1997 | 184.14.01 | Stoneware | Fragment likely Martaban jar |
| 1620 | 08/11/1997 | 184.14.02 | Stoneware | Fragment likely Martaban jar |
| 1621 | 08/11/1997 | 184.14.03 | Stoneware | Fragment likely Martaban jar |

| ID | DATE | ARTIFACT NUMBER | MATERIAL | DESCRIPTION |
|---|---|---|---|---|
| 1622 | 08/11/1997 | 184.14.04 | Stoneware | Fragment likely Martaban jar |
| 1623 | 08/11/1997 | 184.14.05 | Stoneware | Fragment likely Martaban jar |
| 1624 | 08/11/1997 | 184.14.06 | Stoneware | Fragment likely Martaban jar |
| 1625 | 08/11/1997 | 184.14.07 | Stoneware | Fragment likely Martaban jar |
| 1626 | 08/11/1997 | 184.14.08 | Stoneware | Fragment likely Martaban jar |
| 1627 | 08/11/1997 | 184.14.09 | Stoneware | Fragment likely Martaban jar |
| 1628 | 08/11/1997 | 184.14.10 | Stoneware | Fragment likely Martaban jar |
| 1629 | 08/11/1997 | 184.14.11 | Stoneware | Fragment likely Martaban jar |
| 1630 | 08/11/1997 | 184.14.12 | Stoneware | Fragment likely Martaban jar |
| 1631 | 08/11/1997 | 184.14.13 | Stoneware | Fragment likely Martaban jar |
| 1632 | 08/11/1997 | 184.14.14 | Stoneware | Fragment likely Martaban jar |
| 1633 | 08/11/1997 | 184.14.15 | Stoneware | Fragment likely Martaban jar |
| 1634 | 08/11/1997 | 184.14.16 | Stoneware | Fragment likely Martaban jar |
| 1635 | 08/11/1997 | 184.14.17 | Stoneware | Fragment likely Martaban jar |
| 1636 | 08/11/1997 | 184.14.18 | Stoneware | Fragment likely Martaban jar |
| 1637 | 08/11/1997 | 184.15 | Organic | Wood fragment |
| 1638 | 08/11/1997 | 184.17 | Cupreous | Decorative element |
| 1639 | 08/11/1997 | 184.18.01 | Organic | Fish vertebra |
| 1640 | 08/11/1997 | 184.18.02 | Organic | Fish vertebra |
| 1641 | 08/11/1997 | 184.18.03 | Organic | Fish vertebra |
| 1642 | 08/11/1997 | 184.18.04 | Organic | Fish vertebra |
| 1643 | 08/11/1997 | 184.18.05 | Organic | Fish vertebra |
| 1644 | 08/11/1997 | 184.18.06 | Organic | Fish vertebra |
| 1645 | 08/12/1997 | 185.01.01 | Lead | Shot |
| 1646 | 08/12/1997 | 185.01.02 | Lead | Shot |
| 1647 | 08/12/1997 | 185.01.03 | Lead | Shot |
| 1648 | 08/12/1997 | 185.01.04 | Lead | Shot |
| 1649 | 08/12/1997 | 185.01.05 | Lead | Shot |
| 1650 | 08/12/1997 | 185.01.06 | Lead | Shot |
| 1651 | 08/12/1997 | 185.01.07 | Lead | Shot |
| 1652 | 08/12/1997 | 185.01.08 | Lead | Shot |
| 1653 | 08/12/1997 | 185.01.09 | Lead | Shot |
| 1654 | 08/12/1997 | 185.01.10 | Lead | Shot |
| 1655 | 08/12/1997 | 185.01.11 | Lead | Shot |
| 1656 | 08/12/1997 | 185.01.12 | Lead | Shot |
| 1657 | 08/12/1997 | 185.01.13 | Lead | Shot |
| 1658 | 08/12/1997 | 185.01.14 | Lead | Shot |
| 1659 | 08/12/1997 | 185.01.15 | Lead | Shot |
| 1660 | 08/12/1997 | 185.01.16 | Lead | Shot |
| 1661 | 08/12/1997 | 185.01.17 | Lead | Shot |
| 1662 | 08/12/1997 | 185.01.18 | Lead | Shot |
| 1663 | 08/12/1997 | 185.01.19 | Lead | Shot |
| 1664 | 08/12/1997 | 185.01.20 | Lead | Shot |
| 1665 | 08/12/1997 | 185.01.21 | Lead | Shot |
| 1666 | 08/12/1997 | 185.01.22 | Lead | Shot |
| 1667 | 08/12/1979 | 185.02.01 | Stoneware | Gray-bodied sherd |
| 1668 | 08/12/1979 | 185.02.02 | Stoneware | Gray-bodied sherd |
| 1669 | 08/12/1979 | 185.02.03 | Stoneware | Gray-bodied sherd |
| 1670 | 08/12/1997 | 185.02.04 | Ceramic | Fragment |
| 1671 | 08/12/1997 | 185.03.01 | Cupreous | Decorative element probably button |
| 1672 | 08/12/1997 | 185.03.02 | Cupreous | Decorative element probably button |
| 1673 | 08/12/1997 | 185.03.03 | Cupreous | Decorative element probably button |

| ID | DATE | ARTIFACT NUMBER | MATERIAL | DESCRIPTION |
|---|---|---|---|---|
| 1674 | 08/12/1997 | 185.03.04 | Cupreous | Decorative element probably button |
| 1675 | 08/12/1997 | 185.03.05 | Cupreous | Decorative element probably button |
| 1676 | 08/12/1997 | 185.04.01 | Organic | Fruit pit likely peach |
| 1677 | 08/12/1997 | 185.04.02 | Organic | Fruit pit likely peach |
| 1678 | 08/12/1997 | 185.04.03 | Organic | Fruit pit likely peach |
| 1679 | 08/12/1997 | 185.05.01 | Organic | Long bone fragment from a small mammal |
| 1680 | 08/12/1997 | 185.05.02 | Organic | Long bone fragment from a small mammal |
| 1681 | 08/12/1997 | 185.09 | Organic | Fish jaw |
| 1682 | 08/12/1997 | 185.11.01 | Organic | Likely almond shell |
| 1683 | 08/12/1997 | 185.11.02 | Organic | Likely almond shell |
| 1684 | 08/12/1997 | 186.01.01 | Ceramic | Unidentified |
| 1685 | 08/12/1997 | 186.01.02 | Ceramic | Unidentified |
| 1686 | 08/12/1997 | 186.01.03 | Ceramic | Unidentified |
| 1687 | 08/12/1997 | 186.02.01 | Ceramic | Red-bodied sherd |
| 1688 | 08/12/1997 | 186.02.02 | Ceramic | Red-bodied sherd |
| 1689 | 08/12/1997 | 186.02.03 | Ceramic | Unknown |
| 1690 | 08/12/1997 | 186.03 | Organic | Coconut husk |
| 1691 | 08/13/1997 | 187.01.01 | Organic | Fruit pit likely peach |
| 1692 | 08/13/1997 | 187.01.02 | Organic | Fruit pit likely peach |
| 1693 | 08/13/1997 | 187.01.03 | Organic | Fruit pit likely peach |
| 1694 | 08/13/1997 | 187.01.04 | Organic | Fruit pit likely peach |
| 1695 | 08/13/1997 | 187.01.05 | Organic | Fruit pit likely peach |
| 1696 | 08/13/1997 | 187.02.01 | Earthenware | Creamware fragment |
| 1697 | 08/13/1997 | 187.02.02 | Earthenware | Creamware fragment |
| 1698 | 08/13/1997 | 187.03.01 | Ceramic | Unidentified |
| 1699 | 08/13/1997 | 187.03.01 | Ceramic | Buff-bodied sherd |
| 1700 | 08/13/1997 | 187.03.01 | Ceramic | Unidentified |
| 1701 | 08/13/1997 | 187.03.01 | Ceramic | Unidentified |
| 1702 | 08/13/1997 | 187.03.01 | Ceramic | Gray-bodied sherd |
| 1703 | 08/13/1997 | 187.04 | Stoneware | Dragon jar sherd |
| 1704 | 08/13/1997 | 187.06 | Organic | Seed pod |
| 1705 | 08/15/1997 | 188.03 | Unknown | Unidentified |
| 1706 | 08/15/1997 | 188.05.01 | Organic | Coconut husk fragment |
| 1707 | 08/15/1997 | 188.05.02 | Organic | Coconut husk fragment |
| 1708 | 08/16/1997 | 189.01 | Unknown | Unidentified |
| 1709 | 08/16/1997 | 189.02 | Organic | Coconut husk |
| 1710 | 08/16/1997 | 189.03 | Cupreous | Degraded copper pot with embedded peppercorns |
| 1711 | 08/17/1997 | 190.01 | Stoneware | Martaban jar section |
| 1712 | 08/17/1997 | 190.02 | Stoneware | Buff-bodied fragment with black slip and overglaze |
| 1713 | 08/17/1997 | 190.03 | Ceramic | Chinaware—inclusive |
| 1714 | 08/17/1997 | 190.04.01 | Porcelain | Blue and white sherd |
| 1715 | 08/17/1997 | 190.04.02 | Ceramic | Whiteware sherd with blue transfer print |
| 1716 | 08/17/1997 | 190.04.03 | Ceramic | Whiteware sherd with blue transfer print |
| 1717 | 08/17/1997 | 190.05 | Earthenware | Whiteware with black transfer print |
| 1718 | 08/17/1997 | 190.06.01 | Organic | Fruit pit likely peach |
| 1719 | 08/17/1997 | 190.06.02 | Organic | Fruit pit likely peach |
| 1720 | 08/17/1997 | 190.06.03 | Organic | Fruit pit likely peach |

| ID | DATE | ARTIFACT NUMBER | MATERIAL | DESCRIPTION |
|---|---|---|---|---|
| 1721 | 08/17/1997 | 190.06.04 | Organic | Fruit pit likely peach |
| 1722 | 08/17/1997 | 190.06.05 | Organic | Fruit pit likely peach |
| 1723 | 08/17/1997 | 190.07 | Ceramic | Reddish gray bodied sherd with brown glaze |
| 1724 | 08/17/1997 | 190.08 | Earthenware | Sherd with interior green glaze |
| 1725 | 08/17/1997 | 190.09.01 | Ceramic | Red-bodied Earthenware sherd with interior dimpling |
| 1726 | 08/17/1997 | 190.09.02 | Ceramic | Gray stoneware sherd |
| 1727 | 08/18/1997 | 191.02.01 | Metal | Unidentified concretion likely ferrous |
| 1728 | 08/18/1997 | 191.02.02 | Metal | Unidentified concretion likely ferrous |
| 1729 | 08/18/1997 | 191.03 | Organic | Coconut husk |
| 1730 | 08/20/1997 | 192.01.01 | Porcelain | Blue and white sherd |
| 1731 | 08/20/1997 | 192.01.02 | Porcelain | Blue and white sherd |
| 1732 | 08/20/1997 | 192.01.03 | Porcelain | Blue and white sherd |
| 1733 | 08/20/1997 | 192.02.01 | Stoneware | Gray-bodied fragment with brown glaze likely Martaban jar |
| 1734 | 08/20/1997 | 192.02.02 | Stoneware | Gray-bodied fragment with brown glaze likely Martaban jar |
| 1735 | 08/20/1997 | 192.03.01 | Ceramic | Red-bodied Earthenware |
| 1736 | 08/20/1997 | 192.03.02 | Ceramic | Gray-bodied stoneware |
| 1737 | 08/20/1997 | 192.03.03 | Earthenware | Buff-bodied fragment with gray glaze |
| 1738 | 08/20/1997 | 192.04 | Stoneware | Dragon jar sherd |
| 1739 | 08/20/1997 | 193.01 | Stoneware | Gray-bodied sherd |
| 1740 | 08/20/1997 | 194.01 | Earthenware | Sand-tempered handle fragment |
| 1741 | 08/24/1997 | 195.01 | Stoneware | Dragon jar fragment |
| 1742 | 08/24/1997 | 195.02 | Stoneware | Fragment likely Martaban jar |
| 1743 | 08/24/1997 | 195.03 | Earthenware | Whiteware sherd |
| 1744 | 08/24/1997 | 196.01.01 | Stoneware | Martaban jar fragments |
| 1745 | 08/24/1997 | 196.01.02 | Stoneware | Martaban jar fragments |
| 1746 | 08/24/1997 | 196.01.03 | Stoneware | Martaban jar fragments |
| 1747 | 08/24/1997 | 196.01.04 | Stoneware | Martaban jar fragments |
| 1748 | 08/24/1997 | 196.01.05 | Stoneware | Martaban jar fragments |
| 1749 | 08/24/1997 | 196.01.06 | Stoneware | Martaban jar fragments |
| 1750 | 08/24/1997 | 196.02.01 | Stoneware | Red-bodied sherd |
| 1751 | 08/24/1997 | 196.02.01 | Stoneware | Red-bodied sherd |
| 1752 | 08/24/1997 | 196.02.01 | Stoneware | Buff-bodied sherd |
| 1753 | 08/24/1997 | 196.02.01 | Stoneware | Buff-bodied sherd |
| 1754 | 08/24/1997 | 196.02.01 | Stoneware | Buff-bodied sherd |
| 1755 | 08/24/1997 | 196.03.01 | Porcelain | Blue and white sherd |
| 1756 | 08/24/1997 | 196.03.02 | Porcelain | Blue and white sherd |
| 1757 | 08/24/1997 | 196.04 | Porcelain | Green-glazed fragment |
| 1758 | 08/24/1997 | 196.05.01 | Organic | Fruit pit likely peach |
| 1759 | 08/24/1997 | 196.05.02 | Organic | Fruit pit likely peach |
| 1760 | 08/24/1997 | 196.06 | Unknown | Unidentified |
| 1761 | 08/24/1997 | 196.07 | Ceramic | Off-white body possibly masonry |
| 1762 | 08/24/1997 | 197.01.01 | Earthenware | Red-bodied sherd |
| 1763 | 08/24/1997 | 197.01.02 | Earthenware | Red-bodied sherd |
| 1764 | 08/24/1997 | 197.01.03 | Earthenware | Red-bodied sherd |
| 1765 | 08/24/1997 | 197.02 | Unknown | Unidentified |
| 1766 | 08/24/1997 | 197.03.01 | Organic | Coconut husk fragment |
| 1767 | 08/24/1997 | 197.03.02 | Organic | Coconut husk fragment |

| ID | DATE | ARTIFACT NUMBER | MATERIAL | DESCRIPTION |
|---|---|---|---|---|
| 1768 | 08/24/1997 | 198.01.01 | Earthenware | Fragment |
| 1769 | 08/24/1997 | 198.01.02 | Earthenware | Fragment |
| 1770 | 08/24/1997 | 198.01.03 | Earthenware | Fragment |
| 1771 | 08/24/1997 | 198.01.04 | Earthenware | Fragment |
| 1772 | 08/24/1997 | 198.01.05 | Earthenware | Fragment |
| 1773 | 08/24/1997 | 198.01.06 | Earthenware | Fragment |
| 1774 | 08/24/1997 | 198.01.07 | Earthenware | Fragment |
| 1775 | 08/24/1997 | 198.01.08 | Earthenware | Fragment |
| 1776 | 08/24/1997 | 198.01.09 | Earthenware | Fragment |
| 1777 | 08/24/1997 | 198.02 | Stoneware | Gray-bodied Martaban jar fragment |
| 1778 | 08/24/1997 | 198.03.01 | Organic | Fruit pit likely peach |
| 1779 | 08/24/1997 | 198.03.02 | Organic | Fruit pit likely peach |
| 1780 | 08/24/1997 | 198.03.03 | Organic | Fruit pit likely peach |
| 1781 | 08/24/1997 | 198.03.04 | Organic | Fruit pit likely peach |
| 1782 | 08/24/1997 | 198.04 | Organic | Mammalian long bone with epiphysis |
| 1783 | 08/24/1997 | 198.05.01 | Organic | Wood fragment |
| 1784 | 08/24/1997 | 198.05.02 | Organic | Wood fragment |
| 1785 | 08/24/1997 | 198.06 | Unknown | Wooden or cupreous finial or gaming piece |
| 1786 | 08/24/1997 | 198.07 | Unknown | Unidentified |
| 1787 | 08/24/1997 | 198.08 | Slag | Iron slag |
| 1788 | 08/24/1997 | 198.09 | Earthenware | Likely Whiteware |
| 1789 | 08/24/1997 | 198.10 | Porcelain | Blue and white sherd |
| 1790 | 08/26/1997 | 199.01.01 | Earthenware | Whiteware sherd |
| 1791 | 08/26/1997 | 199.01.02 | Earthenware | Whiteware sherd |
| 1792 | 08/26/1997 | 199.02 | Glass | Olive green bottle glass |
| 1793 | 08/26/1997 | 199.03.01 | Lead | Shot |
| 1794 | 08/26/1997 | 199.03.02 | Lead | Shot |
| 1795 | 08/26/1997 | 199.03.03 | Lead | Shot |
| 1796 | 08/26/1997 | 199.03.04 | Lead | Shot |
| 1797 | 08/26/1997 | 199.03.05 | Lead | Shot |
| 1798 | 08/26/1997 | 199.03.06 | Lead | Shot |
| 1799 | 08/26/1997 | 199.03.07 | Lead | Shot |
| 1800 | 08/26/1997 | 199.03.08 | Lead | Shot |
| 1801 | 08/26/1997 | 199.03.09 | Lead | Shot |
| 1802 | 08/26/1997 | 199.03.10 | Lead | Shot |
| 1803 | 08/26/1997 | 199.03.11 | Lead | Shot |
| 1804 | 08/26/1997 | 199.03.12 | Lead | Shot |
| 1805 | 08/26/1997 | 199.03.13 | Lead | Shot |
| 1806 | 08/26/1997 | 199.03.14 | Lead | Shot |
| 1807 | 08/26/1997 | 199.03.15 | Lead | Shot |
| 1808 | 08/26/1997 | 199.03.16 | Lead | Shot |
| 1809 | 08/26/1997 | 199.03.17 | Lead | Shot |
| 1810 | 08/26/1997 | 199.03.18 | Lead | Shot |
| 1811 | 08/26/1997 | 199.03.19 | Lead | Shot |
| 1812 | 08/26/1997 | 199.03.20 | Lead | Shot |
| 1813 | 08/26/1997 | 199.03.21 | Lead | Shot |
| 1814 | 08/26/1997 | 199.03.22 | Lead | Shot |
| 1815 | 08/26/1997 | 199.03.23 | Lead | Shot |
| 1816 | 08/26/1997 | 199.03.24 | Lead | Shot |
| 1817 | 08/26/1997 | 199.03.25 | Lead | Shot |

| ID | DATE | ARTIFACT NUMBER | MATERIAL | DESCRIPTION |
|---|---|---|---|---|
| 1818 | 08/26/1997 | 199.03.26 | Lead | Shot |
| 1819 | 08/26/1997 | 199.03.27 | Lead | Shot |
| 1820 | 08/26/1997 | 199.03.28 | Lead | Shot |
| 1821 | 08/26/1997 | 199.03.29 | Lead | Shot |
| 1822 | 08/26/1997 | 199.03.30 | Lead | Shot |
| 1823 | 08/26/1997 | 199.03.31 | Lead | Shot |
| 1824 | 08/26/1997 | 199.03.32 | Lead | Shot |
| 1825 | 08/26/1997 | 199.03.33 | Lead | Shot |
| 1826 | 08/26/1997 | 199.03.34 | Lead | Shot |
| 1827 | 08/26/1997 | 199.03.35 | Lead | Shot |
| 1828 | 08/26/1997 | 199.03.36 | Lead | Shot |
| 1829 | 08/26/1997 | 199.03.37 | Lead | Shot |
| 1830 | 08/26/1997 | 199.03.38 | Lead | Shot |
| 1831 | 08/26/1997 | 199.03.39 | Lead | Shot |
| 1832 | 08/26/1997 | 199.03.40 | Lead | Shot |
| 1833 | 08/26/1997 | 199.03.41 | Lead | Shot |
| 1834 | 08/26/1997 | 199.03.42 | Lead | Shot |
| 1835 | 09/02/1997 | 200.01 | Likely ferrous | Unidentified concretion |
| 1836 | 09/02/1997 | 200.02 | Likely ferrous | Unidentified concretion |
| 1837 | 09/02/1997 | 200.03 | Likely ferrous | Unidentified |
| 1838 | 09/11/1997 | 202.01.01 | Organic | Fruit pit unidentified species |
| 1839 | 09/11/1997 | 202.01.02 | Organic | Fruit pit unidentified species |
| 1840 | 09/11/1997 | 202.01.03 | Organic | Fruit pit unidentified species |
| 1841 | 09/11/1997 | 202.02 | Stoneware | Light gray-bodied sherd greenish glaze on both sides |
| 1842 | 08/24/1997 | 202.03 | Coral | Fragment likely trade coral |
| 1843 | 09/11/1997 | 202.04 | Lead | Possible seal or medallion |
| 1844 | 09/16/1997 | 203.01.01 | Earthenware | Coarse tempered fragment |
| 1845 | 09/16/1997 | 203.01.02 | Earthenware | Coarse tempered fragment |
| 1846 | 09/16/1997 | 203.02.01 | Organic | Fruit pit likely peach |
| 1847 | 09/16/1997 | 203.02.02 | Organic | Fruit pit likely peach |
| 1848 | 09/19/1997 | 204.01 | Organic | Coconut husk fragment |
| 1849 | 09/19/1997 | 204.02.01 | Likely ferrous | Unidentified concretion |
| 1850 | 09/19/1997 | 204.02.02 | Organic | Fruit pit likely peach |
| 1851 | 09/19/1997 | 204.02.03 | Organic | Fruit pit likely peach |
| 1852 | 09/19/1997 | 205.01 | Pewter | Plate |
| 1853 | 09/19/1997 | 205.02.01 | Earthenware | Likely creamware |
| 1854 | 09/19/1997 | 205.02.02 | Earthenware | Gray-bodied coarse tempered sherd |
| 1855 | 09/23/1997 | 206.01 | Unknown | Unidentified |
| 1856 | 09/24/1997 | 207.01.01 | Organic | Unidentified seed pod |
| 1857 | 09/24/1997 | 207.01.02 | Organic | Unidentified seed pod |
| 1858 | 09/24/1997 | 207.01.03 | Unknown | Unidentified |
| 1859 | 09/24/1997 | 207.01.04 | Unknown | Unidentified |
| 1860 | 09/24/1997 | 207.02.01 | Earthenware | Whiteware sherd with black transfer print |
| 1861 | 09/24/1997 | 207.02.02 | Earthenware | Whiteware sherd with black transfer print |
| 1862 | 09/24/1997 | 207.02.03 | Earthenware | Whiteware sherd with black transfer print |
| 1863 | 09/24/1997 | 207.03.01 | Unknown | Unidentified |
| 1864 | 09/24/1997 | 207.03.02 | Likely organic | Likely bone fragment |

| ID | DATE | ARTIFACT NUMBER | MATERIAL | DESCRIPTION |
|---|---|---|---|---|
| 1865 | 09/24/1997 | 207.04.01 | Organic | Fruit pit likely peach |
| 1866 | 09/24/1997 | 207.04.02 | Organic | Fruit pit likely peach |
| 1867 | 09/24/1997 | 207.04.03 | Organic | Fruit pit likely peach |
| 1868 | 09/24/1997 | 207.05.01 | Stoneware | Coarse tempered fragment |
| 1869 | 09/24/1997 | 207.05.02 | Stoneware | Coarse tempered fragment |
| 1870 | 09/24/1997 | 207.06 | Unknown | Unidentified |
| 1871 | 09/27/1997 | 208 | Cupreous | Decorative element |
| 1872 | 09/27/1997 | 209.02 | Lead | Sounding weight |
| 1873 | 09/27/1997 | 210.01.01 | Porcelain | Blue and white sherd |
| 1874 | 09/27/1997 | 210.01.02 | Porcelain | Blue and white sherd |
| 1875 | 09/28/1997 | 211.03 | Organic | Unidentified seed pod |
| 1876 | 09/28/1997 | 211.06 | Organic | Fish bone |
| 1877 | 09/28/1997 | 212.02 | Organic | Rope of unidentified material |
| 1878 | 10/04/1997 | 213.02 | Ferrous | Modern signage |
| 1879 | 10/04/1997 | 213.03 | Porcelain | Blue and white sherd |
| 1880 | 10/04/1997 | 213.04 | Unknown | Unidentified |
| 1881 | 10/04/1997 | 213.05 | Ceramic | Unidentified |
| 1882 | 10/04/1997 | 213.06 | Cupreous | Broken hinge finger |
| 1883 | 10/07/1997 | 214.01 | Organic | Coconut shell with affixed meat |
| 1884 | 10/07/1997 | 214.02 | Organic | Unidentified |
| 1885 | 10/11/1997 | 215.01 | Ceramic | Unidentified |
| 1886 | 10/11/1997 | 215.02.01 | Organic | Fruit pit likely peach |
| 1887 | 10/11/1997 | 215.02.02 | Organic | Fruit pit likely peach |
| 1888 | 10/11/1997 | 215.03 | Ceramic | Unidentified |
| 1889 | 10/11/1997 | 215.04 | Porcelain | Blue and white sherd |
| 1890 | 10/11/1997 | 215.05.01 | Ceramic | Unidentified |
| 1891 | 10/11/1997 | 215.05.02 | Ceramic | Unidentified |
| 1892 | 10/11/1997 | 215.05.03 | Ceramic | Unidentified |
| 1893 | 10/11/1997 | 215.06 | Ceramic | Unidentified |
| 1894 | 10/11/1997 | 215.07 | Ceramic | Unidentified |
| 1895 | 10/11/1997 | 215.08 | Ceramic | Unidentified |
| 1896 | 10/12/1997 | 216.01 | Coral | Possible trade coral fragment |
| 1897 | 10/12/1997 | 216.02.01 | Ceramic | Unidentified |
| 1898 | 10/12/1997 | 216.02.02 | Ceramic | Unidentified |
| 1899 | 10/12/1997 | 216.02.03 | Ceramic | Unidentified |
| 1900 | 10/12/1997 | 216.02.04 | Ceramic | Unidentified |
| 1901 | 10/12/1997 | 216.02.05 | Ceramic | Unidentified |
| 1902 | 10/12/1997 | 217.02 | Coral | Possible trade coral fragment |

# Notes

### Chapter 1

1. Simonetta Luz Afonso, ed., Nossa Senhora dos Mártires: *The Last Voyage* (Lisboa: Verbo/Expo '98, 1998), hereafter cited as Afonso, *Last Voyage*.

2. See Francisco Alves et al., "Archaeology of a Shipwreck," in Afonso, *Last Voyage,* 183–215.

### Chapter 2

1. Lyle McAlister, *Spain and Portugal in the New World, 1492–1700* (Minneapolis: University of Minnesota Press, 1987), 21.

2. C. R. Boxer, *O Império Colonial Português* (Lisbon: Edições 70, 1981), 28.

3. A. de Oliveira Marques, *A Expansão Quatrocentista* (Lisbon: Ed. Estampa, 1998).

4. Silvio Bedini, *The Pope's Elephant* (Nashville: Sanders, 1998).

5. Vitorino Magalhães Godinho, *Os descobrimentos e economia mundial,* 4 vols. (Lisboa: Presença, 1991), 1:46.

6. Boxer, *O Grande Navio de Amacau* (Macao: Fundação Oriente e Centro de Estudos Marítimos de Macau, 1989), 2.

7. James C. Boyajian, *Portuguese Trade in Asia under the Habsburgs, 1580–1640* (Baltimore and London: Johns Hopkins University Press, 1993), 13.

8. Boyajian, *Portuguese Trade,* 39–42.

9. António Sérgio, *Breve Interpretação da História de Portugal* (Lisbon: Sá da Costa Ed., 1985), 95–107.

10. Paulo Guinote, Eduardo Frutuoso, and Afonso Lopes, *Naufrágios e outras perdas da carreira da India* (Lisboa: Grupo de Trabalho do Ministéerio da Educação para as Comemorações dos Descobrimentos, 1998), 63–67.

11. Sanjay Subrahmanyam. *The Portuguese Empire in Asia, 1500–1700: A Political and Economic History.* (New York: Longman, 1993).

12. Guinote, Frutuoso, and Lopes, *Naufrágios,* 63–67.

13. Boyajian, *Portuguese Trade,* 3, 136–37.

14. Henrique Alexandre da Fonseca, *Os Estaleiros da Ribeira da Naus* ( Lisboa: Academia de Marinha, 1990), 1–9.

15. Boyajian, *Portuguese Trade,* 3.

16. Ibid., 44.

17. Godinho, *Os descobrimentos e economia mundial,* 2:183. For Tomé Pires, Godinho cited Armando Cortesão's The *Suma Oriental of* Tomé Pires, Hakluyt Society, 2 vols., 1944; for Duarte Barbosa, he used Mansel Longworth Dames' *The Book of Duarte Barbosa,* also in the Hakluyt Society, 2 vols., 1918–21; finally, for Garcia de Orta [Horta], he used the *Colóquios dos Simples e Drogas e cousas medicinais da Índia, e assi de algumas frutas achadas nela, onde se tratam algumas cousas tocantes a medicina practica, e outras coisas boas para saber,* 3d ed. by Conde de Ficalho, 2 vols. (Lisboa: Academia Real das Sciencias, 1891).

18. A. R. Disney, *Twilight of the Pepper Empire,* Harvard University Press (Cambridge, Mass.: Harvard University Press, 1978), 30–31. The work of Francisco and Luis da Costa was published by Silva Rego, "Documentação Ultramarina Portuguesa," *Boletim da Filmoteca Ultramarina Portuguesa* (Lisboa: Centro de Estudos Históricos Ultramarinos, 1949), 293–361.

19. Marco Polo, cited in Godinho, *Os descobrimentos e economia mundial,* 2:197.

20. Godinho, *Os descobrimentos e economia mundial,* 2:197–98.

21. Ibid., 2:186.

22. Jan Huyghen van Linschoten, *The Voyage of Jan Huyghen van Linschoten to the East Indies,* 2 vols. (New York: Burt Franklin, 1970), 225.

23. Letters of D. Luis Bravo de Acuña to the King, quoted by Raffaella D'Intino, appendix I, in Afonso, *Last Voyage,* 265–70.

24. Orta cited in Godinho, *Os descobrimentos e economia mundial,* 2:191.

25. Godinho, *Os descobrimentos e economia mundial,* 2:191–93.

26. Orta quoted in Godinho, *Os descobrimentos e economia mundial,* 2:191.

27. Godinho, *Os descobrimentos e economia mundial,* 2:194–95.

28. Ibid., 2:201–23.

29. Boyajian, *Portuguese Trade,* 139.

30. Ibid., 137.

31. Maria da Graça A. Mateus Ventura, *Negreiros portugueses na rota das Indias de Castela* (Lisboa: Ed. Colibri, 1999), 121–33.

32. Linschoten, *The Voyage,* 225.

33. Manuel de Mesquita Perestrelo, "Relação sumária da viagem que fez Fernão d'Alvares Cabral . . . ," in Bernardo Gomes de Brito *História Trágico-Marítima,* 2 vols. (Lisboa: Coleção Livros de Bolso, no. 275, Publicações Europa-América).

34. Pablo E. Perez-Mallaína Bueno, *Spain's Men of the Sea* (Baltimore and London: Johns Hopkins University Press, 1992), 61.

35. Fernão Lopes de Castanheda, *História do descobrimento e conquista da India pelos portugueses,* 2 vols. (Porto: Editores Lello and Irmão, 1979), 1:211.

36. Linschoten, *The Voyage.*

37. Lyle, *Spain and Portugal,* 291–304.

38. Boyajian, *Portuguese Trade,* 128.

39. G. V. Scammel, *The World Encompassed* (Berkeley and Los Angeles: University of California Press, 1981), 396.

40. Godinho, *Os descobrimentos e economia mundial,* 3:35.

41. Saturnino Monteiro, *Batalhas e combates da Marinha Portuguesa,* 6 vols. (Lisboa: Livraria Sá da Costa Editora, 1994), 5:28.

42. Ibid., 5:8.

43. Ibid., 5:28.

44. Christiano Senna Barcelos, "Construcções de naus em Lisboa e Goa para a carreira da India no começo do século XVII," *Boletim da Sociedade de Geographia de Lisboa,* 17th series, 1 (1898–99): 70.

45. Godinho, *Os descobrimentos e economia mundial;* Leonor Freire Costa, *Naus e galeões na Ribeira de Lisboa* (Cascais, Portugal: Patrimóusa, 1997); Guinote, Frutuoso, and Lopes, *Naufrágios.*

46. Incomplete MS (m525) from the the Pierpont Morgan Library, New York, edited in facsimile, Lisuarte de Abreu, *Livro de lisuarte de abreu* (Lisboa: Comissão Nacional para as Comemorações dos Descobrimentos Portugueses, 1992); Codex in the Academia das Ciencias, Lisbon, edited in facsimile, *Memória das armadas* (Macau: Comissão Territorial de Macau para as Comemorações dos Descobrimentos Portugueses, 1995); Cte. Encarnação Gomes, "Subsídeos para o estudo da carreira da India," *Anais do Clube Militar Naval* part 1, 119 (April–June, 1989): 269–310; part 2, 119 (July–September, 1989): 497–518; part 3, 119 (October–December, 1989): 731–90; part 4, 120 (January–March, 1990): 109–24; part 5, 120 (July–September, 1990): 453–516; part 6, 121 (January–March, 1991): 87–161; part 7, 123 (July–September, 1993): 561–614, and (October–December, 1993): 869–918; part 8, 124 (January–March, 1994): 148–48; part 9, 125 (January–March, 1995): 65–102; part 10, 125 (April–June, 1995): 297–323 and (July–September, 1995): 491–519; part 11, 126 (April–June, 1996): 245–76.

47. Boyajian, *Portuguese Trade,* 86–105.

48. Scammel, *The World Encompassed,* 373–435.

49. Guinote, Frutuoso, and Lopes, *Naufrágios,* 431.

50. Ibid., 105.

51. Godinho, *Os descobrimentos e economia mundial,* 3:43–53; Henrique Quirino da Fonesca, *Os portugueses no mar,* facsimile of the 1st edition, 1926 (Lisboa: Livraria Portugal, 1972); James Duffy, *Shipwreck and Empire: Portuguese Maritime Disasters in a Century of Decline* (Cambridge, Mass.: Harvard University Press, 1955), 50–51 and 62–63; João Vidago, "Sumário da carreira da India (1497–1640)," *Anais do Clube Militar Naval,* nos. 1–3 to 10–12 (1969).

52. S.v., "Albuquerque," *Diccionário de História dos Descobrimentos Portugueses,* 1:209; Godinho, *Os descobrimentos e economia mundial* 3:43–53.

53. Warren Blake and Jeremy Green,"A Mid-Sixteenth-Century Portuguese Wreck Found in the Seychelles," *International Journal of Nautical Archaeology* 15, no. 1 (1986): 1–23.

54. The *S. João*'s story is quite well documented. The most important sources are an anonymous acount, "Relação da mui notável perda do galeão grande S. João em que se contam os grandes trabalhos . . . ," in Brito *História Trágico-Marítima;* Brian Stuckemberg, *Recent Studies of Historic Portuguese Shipwrecks in South Africa* (Lisboa: Academia de Marinha, 1986), and Tim Maggs, "The Great Galleon *S. João:* Remains of a Mid-

Sixteenth-Century Wreck on the Natal South Coast" in *Annals Natal Museum* 26, no. 1 (December, 1984): 173–86.

55. Though not as popular as the *S. João,* the wreck of the *S. Bento* is perhaps better documented. See Manuel de Mesquita Perestrello, "Relação sumária da viagem que fez Fernão d'Alvares Cabral . . . ," in Brito, *História Trágico-Marítima.* It is also mentioned in Stuckemberg's booklet, *Recent Studies of Historic Portuguese Shipwrecks,* and there is an article by Tim Maggs and C. Auret, "The Great Ship *S. Bento*—Remains from a Mid-Sixteenth- Century Portuguese Wreck on the Pondoland Coast" in *Annals Natal Museum* 25, no. 1 (October, 1982): 1–39. Her collection of guns has been analyzed by Nuno Valdez dos Santos, *A Artilharia Naval e os canhões do Galeão Santiago* (Lisboa: Academia da Marinha, 1986).

56. The story of the *Santiago* is also told in Brito, *História Trágico-Marítima,* by Manuel Godinho Cardoso under the title "Relação do naufrágio da nau Santiago no anno de 1585, e itinerário da gente que dele se salvou, escrita por Manuel Godinho Cardoso, e agora novamente acrescentada com mais algumas notícias." It is mentioned in Stuckemberg's booklet, *Recent Studies of Historic Portuguese Shipwrecks,* and in his *Story of the Wreck of the Santiago,* a brochure accompanying the exhibition in the Natal Museum. The *Santiago* is also mentioned by Linschoten, *The Voyage,* 176–80. In the 1980s the wreck site was visited by a French state archaeologist, Michel l'Hour, and the treasure hunter Erick Surcouf but no data of any interest on the site have been published as a result. See Michel l'Hour, Florence Richez, and G. Bousquet, "Découverte d'un navire de l'E.I.C.: Le Sussex," *Cahiers d'Archéologie Subaquatique*10 (1991): 175–98.

57. The supposed wreck of the *Santo António* is the only India route wreck about which relevant information regarding the hull has been published to date. See Blake and Green, "A Mid-Sixteenthth-Century Portuguese Wreck."

58. Little information on this wreck site is available. It is mentioned by Stuckemberg, *Recent Studies of Historic Portuguese Shipwrecks,* and by G. Bell-Cross, "A Brief Maritime History of the Coast between the Kei and Fish Rivers," *Coelacanth,* part 1, 20, no. 2 (1982), 20.2, and part 2 21, no. 1 (1983). It is also mentioned by Gillian Vernon, "Bounty on the Beach," *Under Water* 3 (Summer, 1987): 37–39, and "A Portuguese Shipwreck Site at Bonza Bay: Is It the Santa Maria Madre de Deus of 1643?" *Coelacanth* 32, no. 1 (June, 1994): 28–33; and by R. F. Kennedy, *Shipwrecks on and off the Coasts of Southern Africa* (Johannesburg Public Library, Johannesburg, 1955). The story of the wreck was written by João Baptista Lavanha and is part of Brito, *História Trágico-Marítima* under the title "Relação do naufrágio da nau *Sto. Alberto* no Penedo das Fontes no ano de 1593, e itinerário da gente que dele se salvou até chegarem a Moçambique, escrita por João Baptista Lavanha, Cosmógrafo-mor de Sua Majestade, no ano de 1597."

59. The site of the probable *Espiritu Santo* is mentioned by Bell-Cross, "A Brief Maritime History."

60. This wreck site has been identified by Paulo Monteiro of the Direcção Regional dos Assuntos Culturais da região Autónoma dos Açores. See P. Monteiro and Catarina Garcia, *Relatório da campanha arqueológica subaquática, desenvolvida pelo Centro Nacional de Arqueologia Náutica e Subaquática, do Instituto Português de Arqueologia, e pela Direcção Regional da Cultura, do Governo Regional dos Açores, na baía de Angra do*

*Heroísmo* (Lisbon: CNANS, 1999), report on file in CNANS library; and P. Monteiro, “Um naufrágio na carreira das Índias,” *Mundo Náutico* 34 (1997): 70–72. The story of the wreck is the subject of an article by M. Marques Guedes, “Viagem da Birmânia aos Açores. Filipe de Brito de Nicote e o naufrágio, no Faial, da capitânia *N.ª S.ª da Luz*” in *O Faial e a periferia açoreana nos sécs. XV a XIX* (Horta, Açores: Nucleo Cultural da Horta, 1995).

61. Little is known about this site. See Vernon “Bounty on the Beach” and “A Portuguese Shipwreck Site at Bonza Bay”; and Bell-Cross “A Brief Maritime History.”

62. On the *S. Gonçalo* see Costa Quintela, *Annaes da Marinha Portuguesa,* no. 18–19 (Lisboa, Col. Documentos, Ministério da Marinha, 1975); Eric Axelson, “Recent Identifications of Portuguese Wrecks in the South African Coast” *Estudos de História e Cartografia Antiga* (Lisboa: Instituto de Investigação Científica e Tropical, 1985), 25:43–61; and Andrew B. Smith, “Excavations at Plettemberg Bay,” *International Journal of Nautical Archaeology* 15, no. 1 (1986): 53–63.

63. See António Marques Esparteiro, *A peça do cabo da Roca* (Lisboa: Instituto Português de Arqueologia, História e Etnografia, 1966).

64. See Vernon “Bounty on the Beach,” and “A Portuguese Shipwreck site at Bonza Bay.”

65. See Geoffrey Allen and David Allen, *The Guns of Sacramento* (London: Robin Garton, 1978); António Marques Esparteiro, *Três séculos no mar (1640–1910),* 32 vols. (Lisboa: Ministério da Marinha, Colecção Estudos, 1975); and Bento Teixeira Feio, “Naufrágio das naus *Sacramento* e *Na. Sra. da Atalaia* no Cabo da Boa Esperança no ano de 1647,” in António Sérgio, *Naufrágios e combates no mar,* 2 vols. (Lisboa: Livros Horizonte, 1959).

66. The bibliography for the *N.S. da Atalaia* is the same as the one for the *Sacramento.*

## Chapter 3

1. See for instance Eugene Hugh Byrne, *Genoese Shipping in the Twelfth and Thirteenth Centuries* (Cambridge, Mass.: Medieval Academy of America, 1930; repr. New York: Kraus, 1970).

2. Carmen M. Radulet, “Os italianos nas rotas do comércio oriental (1500–1580),” in *A carreira da Índia e as Rotas dos Estreitos, Actas do VIII Seminário Internacional de História Indo- Portuguesa,* ed. Artur Teodoro de Matos and Luis Filipe F. R Thomaz (Angra do Heroísmo, Azores: Insitituto de Investigaças Cientifica Tropical, 1998); Octávio Lixa Filgueiras, “Gelmirez e a reconversão da construção naval tradicional do NW séc. XI–XII: Seus prováveis reflexos na época dos Descobrimentos.” *Actas do Congresso Internacional Bartolomeu Dias e a sua Época* (Porto: Universidade do Porto/Comissão Nacional para as Comemorações dos Descobrimentos Portugueses, 1989), 2:539–76.

3. As for instance in L. Costa, *Naus e Galeões na Ribeira de Lisboa,* or Adolfo Silveira Martins, *Fontes para o estudo da arqueologia naval em Portugal, do século XII a meados do século XVI* (Lisboa: Academia de Marinha, 1996).

4. Christiane Villain-Gandossi, *La Méditerranée aux XIIe–XIVe siècles* (London: Variorum Reprints, 1983).

5. Francisco Alves, et al., "Aproximação arqueológica às fontes escritas da arquitectura naval portuguesa" in *Humanism and the Art of Navigation in Renaissance Europe. Proceedings of the IX International Reunion for the History of Nautical Science and Hydrography* (Cascais: Patrimonia, 2000).

6. For the Plane 3 wreck see Serge Ximenes, "Etude preliminaire de l'épave sarrasine du rocher de l'Estéou," *Cahiers de Archéologie Subaquatique* 5 (1976): 139–50. For the wreck Agay A or Épave des Jarres see Ali Darmoul,"Les épaves sarrasines" in *L'homme méditeranéen et la mer,* ed. M. Galley and L. Ladjini Sebai, 152–65 (Tunis: Editions Salammbô, 1985), and Alain Visquis, "Premier inventaire du mobilier de l'épave dite "des Jarres" a Agay" *Cahiers de Archéologie Subaquatique* 2 (1973): 157–66. For *Batéguier* or *Cannes* wreck see Marie-Pierre Jézégou, et al., "Les épaves sarrasines d'Agay et de Cannes," *Archeologia* 337 (1997): 32–39.

7. Mathew Harpster personal communication. These texts were edited by H. Idris Bell, British Museum Department of Manuscripts.

8. Fernando Oliveira, 1580, *O Liuro da fabrica das naos.* Facsimile, transcription, and translation into English and Chinese (Lisboa: Academia de Marinha, 1991), 56.

9. See, for instance, Raúl Brandão, *Os pescadores* (Porto: Paisagem Editora Lda., 1982), and Octávio Lixa Filgueiras, "The Decline of Portuguese Regional Boats," *Maritime Monographs and Reports,* no. 47 (1980).

10. Oliveira, *O Liuro da fabrica das naos,* 76.

11. Ibid., 76, Richard Barker explores this topic further in "Shipshape for Discoveries, and Return," *Mariner's Mirror* 78, no. 4 (1992): 433–47.

12. Furio Ciciliot, "Notte sulle caravellae Medievali Mediterranee," in *Fernando Oliveira and his Era. Humanism and the Art of Navigation in Renaissance Europe. Proceedings of the IX International Reunion for the History of Nautical Science and Hydrography* (Cascais: Patrimónia, 1998).

13. Lisuarte de Abreu, *O livro de Lisuarte de Abreu,* MS 525 from the Pierpoint Morgan Library, New York (Lisboa: Comissão Nacional para as Comemorações dos Descobrimentos, 1992), or the *Memória das Armadas,* MS from the Academia das Ciências de Lisboa (Macau: Instituto Cultural de Macau, 1995).

14. Irisalva Moita, *Lisboa quinhentista* (Lisboa: Ed. Museu da Cidade de Lisboa, 1983), 107.

15. This shift of technology is best described by Lucien Basch, "Ancient Wrecks and Archaeology of Ships," *International Journal of Nautical Archaeology* 1, no. 1 (1972): 1–58; and J. Richard Steffy, *Wooden Shipbuilding and the Interpretation of Shipwrecks* (College Station: Texas A&M University Press, 1994), 79–100.

16. See Fred Hocker, "The Development of a Bottom-Based Shipbuilding Tradition in Northwestern Europe and the New World," Ph.D. diss., Texas A&M University, 1991.

17. Oliveira, *O Liuro da fabrica das naos,* 63, 140.

18. Kostas A Damianidis, "Methods Used to Control the Form of the Vessels in the Greek Traditional Boatyards," in Eric Rieth, *Technologies/Ideés/Pratiques: Concevoir et Construire les Navires* (Ramonville Saint-Agne: Érès, 1998), 217–44.

19. See Rieth, *Le Maître-gabarit, la Tablette et le Trebuchet. Éssai sur la conception non*

*graphique des carènes du Moyen-Âge au XXe siècle* (Paris: Comité des Travaux Historiques et Scientifiques, 1996).

20. Rieth, "Construction navale à Franc-Bord en Méditerranée et Atlantique (XIVe–XVIIe siècle) et 'Signatures Archictecturales' Une Première Approche Archéologique" in *Méditerranée Antique. Pêche, navigation, commerce,* ed. Rieth (Paris: Comité des Travaux Historiques et Scientifiques, 1998).

21. H. S. Vaughan, "Nodal Caravels of 1618," *Mariner's Mirror* 3, no. 6 (1913): 171–3, and John Bennell, "Queries, 3" *Mariner's Mirror* 39, no. 1 (1953); 64.

22. Richard Barker brought this MS to my attention, after it was presented by David McGee at a conference in Berlin in 2001: "Shipbuilding Practice and Ship Design Methods from the Renaissance to the Eighteenth Century," November 26–29, 2001, Max Planck Institute for the History of Science, Berlin. Only the abstracts of this conference were published (on the Internet).

23. Frederic Lane, *Venetian Ships and Shipbuilders of the Renaissance* (Baltimore: Johns Hopkins University Press, 1934), 64–71.

24. I am greatly indebted to Mauro Bondioli for sending so much information on these Italian texts and calling my attention to a series of other unpublished sixteenth-century texts, whose existence I did not know, namely *Misure di vascelli etcetera di . . . Proto nell'Arsenale di Venetia; Misure di vascelli della meta del Cinquecento; Disegni di bireme, trireme, quadrireme* (atributed to Alessandro Picheroni); and *Modo di far galee grossi e sottili,* by Nicolo e Hieronimo Secula. See M. Bondioli and G. Penzo, *Libro de rason de galie et nave de ogni sorte di pre' Todaro de Nicolò capo d'opera dell'Arsenale di Venezia: Manoscritto veneziano di architettura navale del XVI secolo* (Sottomarina di Venezia, forthcoming); Mauro Bondioli, "The Arsenal of Venice and the Art of Building Ships," in *Boats, Ships and Shipyards. Atti del IX International Symposium on Boat and Ship Archaeology, Venezia 2000,* a cura di C. Beltrame (Oxbow, Oxford) (in press); and Mauro Bondioli, "The art of designing and building Venetian galleys from the XVth to the XVIth centuries," in *Boats, Shipsm and Shipyards: Proceedings of the IX International Symposium on Boat and Ship Archaeology, Vennice 2000,* a cura di C. Beltrame (Oxford: Oxbow, forthcoming).

25. On this subject see Ulrich Alertz, "The Naval Architecture and Oar Systems of Medieval and Later Galleys," in *The Age of the Galley,* ed. Robert Gardiner (London: Conway Maritime Press, 1995).

26. Lane, *Venetian Ships and Shipbuilders of the Renaissance,* 56–57.

27. There are two copies of this MS: the first in the Biblioteca Nazionale Centrale di Firenze, codex Magliabecchiano, XIX.7; the second in the Austrian National Library, Marco Foscari Collection, cod. 6391, under the title "Arte di far galee e navi." The "Fabrica di galere" is accessible through the studies of Auguste Jal, who published a partial transcription in 1840: Auguste Jal, *Archéologie Navale* (Paris: Arthus Bertrand Éditeur, 1840). See also Lane, "Naval Architecture about 1550," *Mariner's Mirror* 20 (1934): 24–49; R. C. Anderson, "Jal's Memoire No. 5 and the Manuscript 'Fabrica di Galere,'" *Mariner's Mirror* 31 (1945): 160–67; Sergio Bellabarba, "The Square Rigged Ship of the 'Fabrica di Galere' Manuscript," *Mariner's Mirror* 74, no. 2 (1988): 113–30; John McManamon, "The 'Archaeology' of Fifteenth-Century Manuscripts on Ship-

building," *INA Quarterly* 28, no. 4 (2001): 17–26; and Eric Rieth, "A propos de des relations entre le texte et les illustrations d'un livre de recettes techniques: la Fabrica di galere (début du XVe siècle)."

28. The Timbotta MS is available through Anderson, "Italian Naval Architecture about 1445," *Mariner's Mirror* 11 (1925): 135–63.

29. McManamon, "The 'Archaeology' of Fifteenth-Century Manuscripts on Shipbuilding"; Alvise Chiggiato, "Le Ragioni antique dell'architettura navale," in *Razioni antique spettanti all'arte del mare et fabriche de vasselli,* ed. Giorgetta Bonfiglio Dosio, et al. (Venice: Il Comitato Editore, 1987), lviilxxix.

30. Ulrich Alertz, "The Naval Architecture and Oar Systems"; and Chiggiato, "Le Ragioni antique dell'architettura navale."

31. L. Th. Lehmann, *Baldissero Quinto Drachio. Visione del Drachio* (Amsterdam: S.M., 1992), and Mauro Bondioli personal communication.

32. Bartolomeo Crescenzio Romano, *Nautica Mediterranea* (Roma: Bartolomeo Bonfadino, 1607); Rieth, *Le Maître-gabarit, la Tablette et le Trebuchet.*

33. Ian Fennis, *La Stolonomie* (Amsterdam: APA Holland University Press, 1978).

34. Tom Glasgow, "Maturing the Naval Administration," *Mariner's Mirror* 56 (1970): 10, 24.

35. Barker, "'Many may peruse us': Ribbands, Moulds, and Models in the Dockyards," *Revista da Universidade de Coimbra* 34 (1988), and "Fragments from the Pepysian Library" *Revista da Universidade de Coimbra* 32 (1986).

36. John Coates, "The Authorship of a Manuscript on Shipbuilding, c. 1600–1620" *Mariner's Mirror* 67, no. 3 (1981): 285–86.

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## Appendix A

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2. Oliveira, *O Liuro da Fabrica das Naos,* 89 and 167.

3. William Salisbury, "Early Tonnage Measurement in England" *Mariner's Mirror* 52, n. 1 (1966): 50; and José Luis Casado Soto, "Atlantic Shipping in Sixtenth-Century Spain and the 1588 Armada," in *England, Spain, and the Gran Armada,* ed. M. J. Rodriguez-Salgado and Simon Adams, 102–106 (Madrid: Editorial San Martin, 1988).

4. I retrieved much of this information from the Web page of the Instituto Português da Qualidade, the department that regulates all matters concerning weights, measures, and standards in Portugal, and from Luis Filipe F. R. Thomaz, *De Ceuta a Timor* (Viseu: Difel, 1998), 323–44, and Rodrigo José de Lima Felner, *Subsídeos para a História da India Portuguesa* (Lisboa: Academia Real das Sciências, 1868), which includes the *Livro de Pesos Medidas e Moedas* by António Nunes, from 1554.

5. João da Gama Pimentel Barata, "Livro Primeiro de Arquitectura Naval. Estudo por João da Gama Pimentel Barata," in Lavanha, *Livro Primeiro de Architectura Naval,* 107–108; Fortunato Barreiros, *Memória sobre os Pesos e Medidas Antigas Usadas em Portugal Hespanha, Inglaterra Etc,* (Lisboa, 1838).

6. See for instance Godinho, *Os Descobrimentos e a Economia Mundial,* 1:95–138.

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