# THE *BATAVIA* SHIPWRECK: AN ARCHAEOLOGICAL STUDY OF AN EARLY SEVENTEENTH-CENTURY DUTCH EAST INDIAMAN

A Dissertation

by

WENDY VAN DUIVENVOORDE

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

August 2008

Major Subject: Anthropology

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Approved by:

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| Chair of Committee, | Kevin J. Crisman |
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August 2008

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# ABSTRACT


The *Batavia* Shipwreck: An Archaeological Study of an Early Seventeenth–Century Dutch East Indiaman. (August 2008)

Wendy van Duivenvoorde, M.A., The University of Amsterdam

Chair of Advisory Committee: Dr. Kevin J. Crisman

*Batavia*, a Dutch East Indiaman, sank in 1629 on its maiden voyage to the Indies in the Houtman Abrolhos Archipelago off the coast of Western Australia. The ship gained notoriety for the mutiny and horrific massacre that engulfed the survivors after the wreck, but the vessel itself was lost for centuries. The remains of the ship were discovered in 1963, and excavated between 1971 and 1980 by a team of archaeologists from the Western Australian Museum. The surviving hull timbers, raised from the seabed by archaeologists, represent approximately 3.5 percent of the original hull. They include part of the transom and aft port quarter of the ship. To date, *Batavia* represents the only excavated remains of an early seventeenth–century Dutch East Indiaman that have been raised and conserved in a way that permits detailed study. This is of great significance as there are no lines drawings or construction plans for any Dutch ships from this period. The study and comparison of the *Batavia* hull timbers with those of other Dutch shipwrecks and historic documentation contributes to the understanding of Dutch shipbuilding techniques at the end of the sixteenth and beginning of the seventeenth centuries.

# DEDICATION

To my parents, who have given me everything:

Jacobus Johannes van Duivenvoorde

and

Anna Klazina Maria van Duivenvoorde–Knopjes

# ACKNOWLEDGEMENTS

This Ph.D. dissertation is not the result of my own efforts and drive, but of the combined exertion of all those who were involved, supported my research, and made it possible for me to write it. Numerous institutions generously funded my education at Texas A&M University, my dissertation research, and my lengthy stays in the Netherlands and Australia. For financial support, I would like to thank the Prins Bernhard Cultuurfonds, NACEE Fulbright, Nuffic Talentenprogramma, Catharine van Tussenbroek Fonds, Stichting Fundatie Vrijvrouwe van Renswoude, Studiefonds Ketel I, Jo Kolk Stichting, Dr. Hendrik Muller's Vaderlandsch Fonds, Stichting Trireme, Allard Pierson Stichting, Marine Technology Society, and the Women Divers Hall of Fame. The last two years of researching and writing were supported with a Marion C. Cook Fellowship from the Nautical Archaeology Program, Texas A&M University, an AUF Liberal Arts Meritorious Graduate Student Tuition Fellowship and College of Liberal Arts Dissertation Research Award from the College of Liberal Arts at Texas A&M University, and a Research and Presentation Grant from the Association of Former Students and the Office of Graduate Studies at Texas A&M University. For these honors awarded by the university, I am most grateful. In addition, I would like to thank the Nautical Archaeology Program faculty for providing me with numerous plane tickets to conduct research and present my research at conferences overseas.

My sincere appreciation is offered to Lucas Brouwer, Fik Meijer, and Harald Kruithof, for their financial assistance and caring encouragement. Without them, it would have been impossible to complete my education and dissertation research. They kept my ship floating during my second year of studies when I had run aground financially. Thanks to them, I could set my sails towards my final destination again. I will never forget their generosity, and hope to provide the same support to someone else some day.

I thank Jeremy Green, Head of the Maritime Archaeology Department of the Western Australian Museum, for inviting me to study the archaeological hull remains of

*Batavia* for final publication. Without the research opportunities provided by him, it would have been impossible to study the *Batavia* hull remains. The museum staff, Jon Carpenter, Susan Cox, Ian Godfrey, Kalle Kasi, Tracey Miller, Maggie Myers, Richenda Prall, Jennifer Rodrigues, Vicki Richards, Corioli Souter, and Myra Stanbury, have been extremely hospitable and helpful.

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At the Rijksmuseum of Amsterdam, Ab Hoving provided me with a mutual interest, valuable dialogue, and constructive criticism whenever I asked for it. Academia needs more scholars —inquisitive, sharing, and empirical— like him. Undoubtedly, Ab has been for many years the most prominent and unsurpassed researcher in the field of Dutch Nautical History. Much of the research presented in this dissertation is based or elaborates on his pioneering work on Dutch shipbuilding practices from the sixteenth century onwards. Thank you, Ab, for being the inspiration of my formative years.

Also special thanks to Bill Leonard, curator of the Maritime History Department of the Western Australian Museum, for providing me with practical discussion and insight, and for sharing his passion for shipbuilding with me. Thank you, Bill.

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At BIAX Consult, Dr. Henk van Haaster, Caroline Vermeeren, and Pauline van Rijn conducted the analysis and identification of hair and wood samples of the *Batavia* hull. At RING, I must acknowledge Elsemieke Hanraets and Esther Jansma, who performed the dendrochronological investigation of the *Batavia* hull planking. Thank you for your time and support.

At the Laboratory for Isotope Geology, Swedish Museum of Natural History, Kjell Billström helped me with the lead isotope analyses of the *Batavia* copper samples. You were so helpful and facilitating, Kjell. Special thanks to Sophie Stos Gale and Martin Whitehouse for helping me to get in contact with Kjell and for their professional guidance.

At the Western Australian Museum, I would like to thank Geoff Kimpton, whose path crossed mine only a few times and who was retired by the time I started my research. Geoff spent nearly eleven years reconstructing the *Batavia*'s hull for museum display and did an outstanding job. He deserves much more credit than he got for doing so. His efforts cleared the way for my research, which would otherwise have taken untold years to accomplish. The accuracy with which he reassembled the ship's hull after conservation is an impressive accomplishment that continuously astonished me while I was doing my own research. What Sisyphus work!

Another person who has greatly contributed to the existence of an accurate record of the *Batavia* shipwreck, and facilitated this research more than anyone, is Patrick Baker. He photographed every *Batavia* timber in the field and underwater. His recording skills, as well as his memories of the *Batavia* excavation, have proven to be superb. Thank you, Pat, for your photographs, support, input, listening ears, and heart–warming smile.

Five others facilitated my work for this dissertation: Barbara Consolini, Adriaan de Jong, Tristan Mostert, Vibeke Roeper, and Lous Zuiderbaan, all trained in reading seventeenth–century Dutch script and willing to check references, transcribe archival resources, and/or look up entries for me in the Nationaal Archief in The Hague. Thank you so much, Barbara, Adriaan, Tristan, Vibeke, and Lous.

I must also thank my dear friend Hanneke Jansen for her assistance in sampling and recording the *Batavia* hull remains, for her near endless scanning of archival records, and for her patience in spite of demanding hours, many of which were overtime, working in the Western Australian Museum.  Thank you for your collegiality, support, and friendship.

And then there is fellow student Mark Polzer who has simply been there from the moment I started my studies in College Station.  Mark made my life in College Station so much easier and colorful by letting me confiscate his car for many years, by unconditionally accommodating my impulsive whims, and by enhancing my motivation and work ethic through a healthy sense of competition.  Thank you for your commitment, infinite patience, and most of all for being there.

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I am most grateful to my wonderful parents, sisters, and relatives for providing the foundations on which my life is built.  I love you and thank you for contributing so much to who I am today.  Finally, I am very grateful to Mack McCarthy, LeeAnne Gordon, and Kevin Crisman for their time and energy in editing this dissertation.

# LEGENDA FOR TIMBER DRAWINGS

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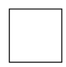
|  | Empty spike/nail hole |
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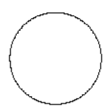
|  | Empty fastening hole |
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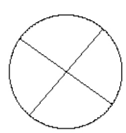
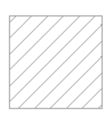
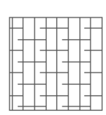
|  | Wooden treenail |
|  | Damaged, non–original surface |
|  | Possible brown–rot surface |
|  | Crack in timber |

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# CHAPTER I
# INTRODUCTION

On its maiden voyage to the Indies, the Dutch East Indiaman *Batavia* sank on Morning Reef in the Houtman Abrolhos off the western coast of Australia in the early morning hours of 4 June 1629. The new ship of the Dutch United East India Company (Verenigde Oostindische Compagnie or VOC) had set sail eight months earlier on 29 October 1628.[1] The 600–ton ship left Texel in the Dutch Republic with 341 people on board and was bound for the town that it was named after, Batavia, modern–day Jakarta in Indonesia.[2] It was the first of three *retourschepen* (return–voyage ships) to be named *Batavia* over the nearly two–hundred–year history of the VOC's existence from 1602 to 1795.[3]

In addition to its flagship, *Batavia*, the 1628 'Fair Fleet' was made up of six ships, five of them named after Dutch cities: the flutes *Assendelft*, like *Batavia*, newly built, and *Zaandam* (each 500 tons), the ships *Buren* (200 tons), *Dordrecht* (500 ton), '*s–Gravenhage* (300 tons), and the yacht *Kleine David* (100 tons).[4] The Fair Fleet, named after the traditional September fair, was typical for the 1630s. It was a third fleet added to the East India trade. The other two fleets set sail in December/January and April/May, and were known as the Christmas and Easter fleets, respectively. The Fair Fleet set sail in September or early October and, ideally, would arrive in the Indies in time for a favorable connection with the Asian trade network.[5] With the expansion of the company's Asian trading network into India, China, and Japan in the early seventeenth century, it had become increasingly important to arrive in Asia before the end of the summer monsoons. Monsoon season ran from June through September, and the monsoons facilitated sailing from Batavia, to India in the East and to China and Japan in the North. The third fleet was added because the Christmas fleet was not always able to arrive in Batavia before the end of the monsoon season; in this case, the VOC missed out on a portion of its trade.[6]

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This dissertation follows the style of *The Journal of Military History*.

*Batavia*'s 1628 Fair Fleet should be considered an experimental venture. Designed to capitalize on a favorable connection to the intra–Asiatic trade network, the addition of this particular fleet was largely supported by the Amsterdam Chamber.[7] With the exception of *Buren* and *Kleine David*, all ships of this particular fleet sailed for the Amsterdam Chamber. *Buren* and *Kleine David* set sail for the Enkhuizen and Hoorn Chambers, respectively.[8]

*Batavia*'s fleet was not blessed by particular good fortune. Only one ship of the 1628 Fair Fleet, '*s–Gravenhage,* returned to the Netherlands.[9] Three vessels, *Buren* and the two flutes, were destined to stay in the Indies from the onset. The fate of the others was less fortunate; *Batavia* was wrecked in the Houtman Abrolhos Archipelago before reaching its final destination, *Dordrecht* was burnt on its homebound voyage in April 1630 at 4°33' north, and the yacht *Kleine David* was destroyed by fire along the coast of the Coromandel, India, on 11 February 1630. The only ship to return, '*s–Gravenhage*, met a similar destiny during its second voyage and was burned by the Portuguese off Goa on 4 January 1634.[10]

Upon setting sail on 28 October 1628, *Batavia* ran aground off Texel immediately after departure. Fortunately, the ship came loose and continued its voyage one day later. It was only the first of a series of misfortunes that fell upon *Batavia* and its fleet. The next delay was probably at the roadstead of Duins (the Downs) on the southeastern coast of England. In general, VOC ships had to wait here for the right wind that would carry them through the Channel. It could take weeks for this wind to come up, which may have happened for *Batavia*'s fleet; the ship *Galiasse,* which set sail from Holland only at the end of December, overtook the ships before they made the Cape of Good Hope.[11]

Since 1617, all VOC ships had been instructed to sail south from the Cape of Good Hope and catch the strong westerly winds, the Roaring Forties, between the 40°S and 50°S latitudes. This ensured a faster and safer route to the Indies, as it expedited the sailing time to Indies by several months and circumvented Portuguese territory in Asia.[12] The new nautical highway, the so–called Brouwer Route, was first encountered by

Hendrik Brouwer in 1610–11 and made mandatory five years later.[13] After Dutch ships had caught the Roaring Forties in their sails, they followed this nautical passage one thousand miles (roughly 1,825 km) east and then turned north with the Southeast Trade Winds that would lead them directly into the Strait of Sunda.

An unpleasant side effect of the Brouwer Route was caused by the inability to determine longitude. Miscalculations, coupled with the strength of the trade winds, often caused the ships to miss their turn to the north. Having passed this junction, Dutch ships like *Batavia* ended up along the western coast of Australia. The frequency of this occurrence played a major role in Dutch reconnaissance of the Australian coast, and led to the European discovery and exploration of this vast continent.

The difficult sailing conditions in Western Australia's waters included treacherous reefs, strong currents, unpredictable winds, and shallow waters, the latter, occasionally in conjunction with a rough and inaccessible shore. Taking these navigational hazards into account, it is surprising that only a few VOC ships were lost in these waters in the near two hundred years of the company's existence from 1602 to 1795. These shipwrecks include *Batavia* (1629), *Vergulde Draak* (1656), *Zuiddorp* (1712), and *Zeewijk* (1727).

*Batavia* was, however, not the first European ship to sink in Australian waters. When the English took notice of the Brouwer Route, they followed the Dutch example and first sailed it in 1620–21; their initial voyage was considered a great accomplishment. During the second English attempt to use the new route, their ship *Trial*, however, sailed too far to the east and missed its turn off to the Sunda Strait.[14] It was wrecked on a reef of rock in the Indian Ocean, which now carries its name, in 1622, off the northwest outer edge of the Monte Bello Islands along the Australian coast. *Trial* became Australia's oldest known shipwreck, and the English consequently avoided the Brouwer Route for the next two decades.

It must also be noted that VOC ships like *Batavia*, sailing too far to the east with the Roaring Forties, were not the first to travel through Australian waters. The first recorded presence of the Dutch in Australian territory dates back to 1606, when skipper

Willem Jansz and upper–merchant Jan Lodewijksz van Rosingeyn sailed their ship *Duifje* (little dove) into the Gulf of Carpentaria off Australia's the Northern Territory. This Dutch expedition discovered New Guinea and other island groups and pre–dated Cook's exploration of the Australian continent in 1770 by 164 years.[15]

*Batavia* was the first Dutch ship to sink in Australian waters when it struck Morning Reef in the early morning hours on 4 June 1629. About three hundred among the crew and passengers survived the voyage and wrecking, and made it safely to the uninhabited and barren Abrolhos Islands. Commander–in–chief Francisco Pelsaert left the wreck site in one of the ship's boats with thirty–six men, two women, and one child to seek help in Batavia.[16] By the time Pelsaert returned over three months later there were fewer survivors left on the islands. The tragedy which befell *Batavia*'s stranded company makes the famous mutiny on the *Bounty* seem trivial by comparison.

Various Dutch authors from the seventeenth century have related the grisly events in which 125 men, women, and children were deliberately drowned, strangled, had their throats cut, or were brutally hacked to death by a group of men who had gathered around instigator and acting commander Jeronimus Cornelisz.[17] One month after the wrecking, the organized killing began in secret at night. It did not take long, however, before everyone on the islands knew what was going on, but most had become too weak to fight off the killers. One group of survivors sent off to find fresh water on West Wallabi Island did manage to fight back. When help finally arrived from Batavia, they managed to warn Pelsaert before his ship anchored at Beacon Island. The group that had camped out on West Wallabi and the remaining people on Beacon Island were brought safely to their final destination while the men who had formed the eager death squad were prosecuted, convicted, and executed by Dutch authorities.

Together with the many victims of the harrowing massacre, *Batavia*'s wreckage was left behind in the Houtman Abrolhos. Little mention was made of the shipwreck site for over two hundred years. In 1840, while surveying the Western Australian coast the crew of *Beagle* observed a shipwreck at the southern end of the Abrolhos Group of islands. They assumed it was the wreckage of *Batavia*. In the 1950s, historian Henrietta

Drake–Brockman argued that the wreck could not be situated at the southern end of the Abrolhos Group of islands, but must lie near the Wallabi Group. According to Drake–Brockman, the ship should have been wrecked here for the simple reason that only on these islands marsupials, more specifically tammar–wallabies, and some water holes with drinkable water are found.[18] She believed that the shipwreck was located near Noon Reef. Her theory was based on thorough historical research, which was published in a pivotal work on *Batavia*'s shipwrecking that included a full translation of Francisco Pelsaert's journal by E.D. Drok.[19] With Drake–Brockman's work in hand, journalist Hugh Edwards organized the first expedition to find the shipwreck around Beacon Island in the Wallabi Group of islands in 1960. They were, however, unable to determine the shipwreck's location.

On 4 June 1963, Abrolhos fisherman Dave Johnson showed a group of divers from Geraldton, including the brothers Max and Graham Cramer, and Greg Allen, a large anchor on Morning Reef, about two kilometers southeast of Beacon Island, that he had often observed from his boat while setting lobster pots. The three divers entered the water to find *Batavia*'s wreckage in shallow waters from 3 to 7 meters deep. The shipwreck site covered an area of about 50 meters in length and 15 meters in width, and was littered with cannon and anchors. This discovery showed that the shipwreck was not situated on Noon Reef, but slightly more to the east on Morning Reef.

In 1972, the Dutch and Australian governments signed a bilateral agreement, the 'Australian Netherlands Agreement on Old Dutch Shipwrecks,' in which the Dutch state transferred its ownership of VOC shipwrecks in Australian waters to Australia. The wreck of the *Batavia* and its associated land features have become one of Australia's most prominent archaeological heritage. Although protected under the Historic Shipwrecks Act of 1976, their significance was only officially recognized recently in 2006 when they were finally placed on the National Heritage List of the Australian Government.

After its discovery, *Batavia*'s wreckage was excavated between 1973 and 1976 by a team of archaeologists from the Maritime Archaeology Department of the Western

Australian Museum under the direction of Jeremy Green, and was revisited in 1980.[20] Thousands of artifacts that were once part of the ship's cargo, equipment or personal belongings of the crew, passengers, and soldiers, were uncovered from underneath the sand and coral concretions.[21] At the southern end of the wreck site, part of the ship's port side stern section was preserved below the wreck's debris. The wooden hull was recorded and raised from the seabed in the three excavation seasons between 1973 and 1975. The Western Australian Museum in Fremantle is the authority responsible for *Batavia*'s artifacts and hull remains.

Since the shipwreck's discovery and excavation, many scholars, students, and laymen have published books and articles on *Batavia*'s history and its archaeological materials. The study of *Batavia*'s construction and wooden hull, however, had not been finalized and published. Jeremy Green, the archaeologist responsible for the excavation and conservation of *Batavia,* invited the author to undertake a comprehensive study of *Batavia*'s hull in the summer of 2002. With help of several grants and fellowships, mainly from Texas A&M University and the Prins Bernhard Cultuurfonds, the study of *Batavia*'s hull timbers commenced in 2003.

The hull timbers raised from the seabed roughly weigh 20 tons, and represent approximately 3.5 percent of the original hull. They comprise the port side transom and part of the stern port quarter of the vessel, including the sternpost, a fashion piece, transom timbers, five transom knees, twenty–one planking strakes —including three wales—, twelve strakes of ceiling planking plus one shelf clamp, remnants of forty–six frames, one gunport lid, two deck beams, two hanging and one lodging deck knee. *Batavia*'s structural timbers are made of oak. A significant part of the hull remains has been reassembled and is displayed in the Shipwreck Galleries of the Western Australian Museum. Many timbers, however, including the ship's pine hull sheathing, inner floor of the ceiling planking, and frame wedges remain in storage.

To date, *Batavia* represents the only excavated remains of an early seventeenth–century Dutch East Indiaman that have been raised and conserved in a way that permits detailed study. This is of great significance since there are no construction plans, lines drawings, or building records for any East Indiamen of this period. We know that the ships built for the VOC were typically large merchantmen that rarely exceeded 500 tons in the early seventeenth century, whereas most Portuguese Indiamen were twice to three time that size. The smaller size of Dutch ships was a direct result of the shallow waterways, flats, tidal currents, and sandbanks in the Netherlands.[22] Since the establishment of the VOC, the first multinational corporation, in 1602, the company employed ships that were specifically designed and constructed for the lengthy voyage to Asia and back. They had to be large enough to provide sufficient hold space for their cargoes, as well as the ships' equipment and crews' food and water necessary to maintain the ship at sea for several months. Even though smaller than their Portuguese counterparts, they were heavily–built to stand up to hard service in stormy seas and last for six or more round–trip voyages.[23] Lastly, they were outfitted with heavy armament in order to repel attack by pirates, enemy warships, or other human dangers along the way.[24]

Early seventeenth–century Dutch Indiamen resembled a ship–type that the Spanish and Portuguese would call *galleon*. They had a square flat stern and, usually, two fully–planked decks that carried artillery, and aft of the main mast a quarterdeck and a poop deck.[25] Characteristic fore and after castles were well–integrated into the ships' hulls. The vessels carried three masts, with square–rigged sails on the fore and main masts and a lateen on the mizzen. *Batavia* also had a mizzen topmast, main topmast, main topgallant, fore topmast, fore topgallant, spritsail, and sprit topsail with square sails.[26]

Dutch Indiamen evolved from the late sixteenth to the eighteenth century, changing their shape, size, and rigging. In spite of their size and specific characteristics and their contribution to Dutch wealth and power, that inspired many artists to paint or draw them, construction details of these ships, particularly in the early seventeenth century, were poorly recorded or not recorded at all. Consequently, the study of Dutch East Indiamen dating to the early seventeenth century has been based on iconographic evidence, archival records, and contemporary documents on shipbuilding. In fact, a replica of *Batavia* built in the Netherlands in the 1980s was based entirely on secondary sources. Nevertheless, construction details of Dutch East Indiamen remain largely unknown. Although the wreck sites of at least forty–seven Dutch East Indiamen have been found and identified, *Batavia*'s wooden hull is the only one dating to the early seventeenth century from which all hull timbers have been raised and conserved in a way that permits detailed study. All the other known remains from the early seventeenth century have either been salvaged by treasure hunters, looted by fishermen and sport divers, or were subject to archaeological excavation that did not include the raising of the hull timbers but *in situ* observation only.

This dissertation is the result of five years of study aimed at reconstructing the hull of *Batavia*'s shipwreck site using data retrieved from the archaeological remains, interpreted in the light of VOC archives, ship journals, and Dutch texts on shipbuilding of this period. The foundation for this study, however, was laid by the many archaeologists, conservators, and volunteers, who have worked with the ship's timbers since their excavation in the seventies.

The study of a ship cannot be considered complete if the ship's maritime landscape is not considered. Therefore, the author has gone beyond the basic historical and socio–economic aspects, and emphasizes technological parameters and thought processes active in the production of the hull-related elements under study. This study attempts to develop a more systematic and analytical approach to the formulation, analysis, and evaluation of research questions relating to the *Batavia*. This includes detailed aspects of metallurgy, casting techniques, and woodworking for shipbuilding in order to relate the study of the ship to what is known about the people who built and sailed it, their understanding and objectives, and the technology available at the time of its construction.

The archaeological data are interpreted in the light of contemporary texts that yield information on shipbuilding, which include all early Dutch shipbuilding charters, ship journals, and administrative documents from the VOC. These works form the foundation of my theoretical research and are, therefore, most significant.

Chapter II provides a brief introduction to the history of Holland, its shipbuilding technology, the technological development that directly influenced its shipbuilding industry, its cultural and social–economic climate, and the Dutch India trade in the early seventeenth century. It delineates the origin of the Indiamen in the context of Dutch shipbuilding tradition, discusses construction sequence, emphasizing the techniques used at Dutch shipyards and their peculiarities. This chapter also discusses important VOC shipbuilding charters and texts, and the origin of construction features seen in Dutch ships designed and built for long–distance voyages. It also provides parallels to shipbuilding practices of other European countries, such as Spain, Portugal, England, and France, which seem to have influenced Dutch shipbuilding. This chapter provides a basic background and sets the stage for understanding *Batavia*'s construction.

Chapter III includes the archaeological circumstances in which *Batavia*'s shipwreck was found, starting with the site's location, the wrecking event, and the site's formation. Aspects of the site and its excavation methodology are discussed as they relate to the hull study. Moreover, the methodology for recording and drawing the *Batavia*'s hull timbers is evaluated. Keeping past study efforts in mind, a detailed discussion of the research method used for this particular study is delineated. It also outlines the reassembly of the hull for museum display and the method used to take *Batavia*'s lines from the reassembled structure.

Chapter IV focuses on *Batavia*'s construction history and overall appearance. The hull remains are described in detail, with discussions of each component, the size and shape of its scantlings, fasteners, and waterproofing.

Chapter V compares *Batavia*'s hull remains with archaeological finds from similar ships of the late sixteenth and early seventeenth centuries. It provides an overview of all archaeological examples known to date and introduces hull remains of shipwrecks that have not been published before, such as those of the VOC ship *Vergulde Draak* (1656). It also looks at the complications encountered when trying to compare the archaeological material from this period to VOC ships from the late seventeenth century.

The use of ship names in this dissertation is concomitant to the spelling provided by the Bruijn, Gaastra, and Schöffer's *Dutch-Asiatic Shipping in the 17th and 18th Centuries*. This three-volume publication offers a uniform spelling for numerous variants given in historic sources. In the seventeenth century, especially, the names of ships were not used in a consistent manner and often had additional words added to their names such as large or new. Following the Bruijn, Gaastra, and Schöffer's index of all VOC return voyages to the Indies over the two hundred years of its existence allows for easy checking of all voyages made by a specific ship, and its details.[27]

Chapter VI discusses late sixteenth– and early seventeenth–century shipbuilding as found in contemporaneous documentation, in particular ship's journals and VOC shipbuilding charters, and the late seventeenth–century manuscripts of Nicolaes Witsen and Cornelis Van IJk. These historic texts are compared to the archaeological data in the previous chapter, and are assessed in the light of what is learned from the archaeological evidence. This chapter specifically focuses on the use of double–hull planking, pine sheathing, other sheathing methods, and caulking of ships in service of the long–distance trading companies and the VOC. The last section of this chapter looks at the measures taken by the VOC, in particular, to maintain its ships at home and abroad.

Chapter VII delineates the analysis of the wood used in *Batavia*'s construction based on the wood species identification of its timbers, and their dendrochronological study. It presents the available historic documentation of the Dutch wood trade, and discusses the ensuing limitations, outlining the extent of trade, the provenance of timber used for shipbuilding in the early seventeenth century, the use of Baltic oak for hull planking, drying or seasoning of timber, and the methods of processing timber for shipbuilding, construction, and artwork. Based on the dendrochronology of *Batavia*'s timber, a hypothesis is put forward relating to the timber used for shipbuilding (particular by the VOC), the VOC's requirements for the quality of ship timber, and the possible influence of its policy on the deforestation of the regions along the Vistula River in Poland.

Chapter VIII interprets the data presented in the previous chapters and offers a proposed reconstruction of the *Batavia*. This chapter begins with a critical discussion of *Batavia*'s hull shape and moves into the discussion of its timbers. A lines drawing depicts the preserved hull shape. My goal is to show that the construction of Dutch Indiamen was different from other contemporary merchantmen and warships. Chapter IX summarizes the assumptions and conclusions of this dissertation, and critiques its methodology, stressing its most important strengths and weaknesses.

My primary objective is to create a better understanding of Dutch shipbuilding practices in the late sixteenth and early seventeenth centuries, in particular for ships that were designed and constructed to sail long distances over world's oceans. This study focuses on *Batavia*'s construction sequence and assembly details based upon the existing hull remains and supplemented by contemporary archival material. The ship's features are compared to other historic and archaeological data, and the hull remains are presented in the form of lines drawings showing *Batavia*'s preserved shape. Key elements of the original hull, for example the bow and keel, no longer exist and, therefore, any reconstruction of the *Batavia* ship must be partly conjectural. The reconstruction and presentation of *Batavia*'s hull remains should therefore be looked upon as an educated guess and a working hypothesis, respectively, rather than a final reconstruction and arrangement, even where data seems to fit into the theoretical framework or calculations. Hopefully, this work will set an example for other archaeologists studying the remains of Dutch Indiamen and ships dating to the sixteenth and seventeenth centuries and provide their studies with a theoretical framework for research.

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[1] Francisco Pelsaert mentions in his journal that the ship set sail on 28 October 1628, which is correct. However, the ship ran aground immediately and it took one day for the ship to be afloat again. Hence, its official day of departure is one day later on 29 October 1628. See, Jacobus R. Bruijn, Femme S. Gaastra, and Ivo Schöffer, *Dutch-Asiatic Shipping in the 17th and 18th Centuries: Outward-bound Voyages from the Netherlands to Asia and the Cape (1595-1794)* (The Hague: Martinus Nijhoff, 1979), no. 0372.1; E. François Pelsaert, *Ongeluckige voyagie, van 't schip* Batavia*, nae de Oost-Indien: Gebleven op de Abrolhos van Frederick Houtman, op de hooghte van 28⅓-graet, by zuyden de linie*

*Aequinoctiael. Uytgevaren onder den E. Francoys Pelsert* (Amsterdam: Jan Jansz, 1647), 1; and Vibeke Roeper, *De schipbreuk van de* Batavia*, 1629* (Zutphen: Walburg Pers, 1993), 15.

2 Roeper, *De schipbreuk van de* Batavia*, 1629*, 12.

3 Bruijn, Gaastra, and Schöffer, *Dutch-Asiatic Shipping in the 17th and 18th Centuries: Outward-bound Voyages from the Netherlands to Asia and the Cape (1595-1794)*, nos. 0372.1, 0746.1, 1055.1, 1150.2, 4260.1, 4368.2; and Jacobus R. Bruijn, Femme S. Gaastra, and Ivo Schöffer, *Dutch-Asiatic Shipping in the 17th and 18th Centuries: Homeward-bound Voyages from Asia and the Cape to the Netherlands (1597-1795)* (The Hague: Martinus Nijhoff, 1979), nos. 5571.1, 7986.1, and 8077.2.

4 Pelsaert, incorrectly mentions in his journal that at the beginning of its journey *Batavia* only sailed with two other ships, *Dordrecht* and *Assendelft*. He also refers to *Assendelft* as a yacht, not a flute. The ship set sail with six other ships, however. Pelsaert, *Ongeluckige voyagie, van* '*t schip* Batavia*, nae de Oost-Indien*, 1. Vibeke Roeper refers to *Zaandam* as a yacht and not a flute. Roeper, *De schipbreuk van de* Batavia*, 1629*, 15.

5 Tristan Mostert, "Chain of Command: The Military System of the Dutch East India Company 1655-1663" (M.A. thesis, Universiteit Leiden, 2007), 38.

6 Tristan Mostert, "Chain of Command," 38.

7 Tristan Mostert, letter to author, 16 January 2008.

8 Bruijn, Gaastra, and Schöffer, *Dutch-Asiatic Shipping in the 17th and 18th Centuries: Outward-bound Voyages from the Netherlands to Asia and the Cape (1595-1794)*, nos. 0366.1, 0367.1, 0368.1, 0369.5, 0370.1, 0371.1, and 0372.1.

9 Bruijn, Gaastra, and Schöffer, *Dutch-Asiatic Shipping in the 17th and 18th Centuries: Outward-bound Voyages from the Netherlands to Asia and the Cape (1595-1794)*, nos. 0366.1, 0367.1, 0368.1, 0369.5, 0370.1, 0371.1, and 0372.1.

10 Bruijn, Gaastra, and Schöffer, *Dutch-Asiatic Shipping in the 17th and 18th Centuries: Outward-bound Voyages from the Netherlands to Asia and the Cape (1595-1794)*, no. 0453.2.

11 Roeper, *De schipbreuk van de* Batavia*, 1629*, 15.

12 J. Peter Sigmond and Lous H. Zuiderbaan, *Dutch Discoveries of Australia: Shipwrecks, Treasures and Early Voyages off the West Coast* (Bussum: Unieboek, 1979), 31-35.

13 Bruijn, Gaastra, and Schöffer, *Dutch-Asiatic Shipping in the 17th and 18th Centuries: Outward-bound Voyages from the Netherlands to Asia and the Cape (1595-1794)*, nos. 0143.3, 0144.2; and Sigmond and Zuiderbaan, *Dutch Discoveries of Australia*, 32.

14 Jeremy H. Green, *Australia's Oldest Wreck: The Loss of the* Trial*, 1622* (Oxford: British Archaeological Reports, 1977)*,* 15-16.

15 Sigmond and Zuiderbaan, *Dutch Discoveries of Australia*, 19-26.

16 Roeper, *De schipbreuk van de* Batavia*, 1629*, 20.

17 See for an overview, Roeper, *De schipbreuk van de* Batavia*, 1629*, 9.

18 Henrietta Drake-Brockman, "The Reports of Francisco Pelsaert," *The Western Australian Historical Society* 5:2 (1956): 15.

19 Drake-Brockman, "The Reports of Francisco Pelsaert," 1-18; and Henrietta Drake-Brockman, *Voyage to Disaster: The Life of Francisco Pelsaert* (Sydney: Angus & Robertson Ltd., 1963), ix.

In this dissertation, the transcript of Pelsaert's journal and compilation of seventeenth-century documents on the *Batavia* shipwrecking by Vibeke Roeper is used as it is the most complete and thoroughly researched work printed in its original language. See, Roeper, *De schipbreuk van de* Batavia*, 1629*.

20 Jeremy N. Green, "The VOC Ship *Batavia* Wrecked in 1629 on the Houtman Abrolhos, Western Australia." *IJNA* 4:1 (1975): 43-63; and Jeremy N. Green, "The Planking-first Construction of the VOC Ship *Batavia*," in *Carvel Construction Technique Skeleton-first, Shell-first: Proceedings of the Fifth International Symposium on Boat and Ship Archaeology, Amsterdam 1988*, ed. H. Reinder Reinders and Kees Paul (Oxford: Oxbow Books, 1991), 70.

21 Jeremy N. Green, *The Loss of the Verenigde Oostindische Compagnie Retourschip* Batavia*, Western Australia 1629: An Excavation Report and Catalogue of Artifacts*, BAR International Series 489. Oxford: British Archaeological Reports, 1989.

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22 Generally, Dutch ships destined for long-distance journeys were much smaller than those of the Spanish, Portuguese, and English until the end of the sixteenth century after which their size increased steadily. See, Johan E. Elias, *De vlootbouw in Nederland in de eerste helft der 17e eeuw, 1596-1655* (Amsterdam: Noord-Hollandsche Uitgeversmaatschappij, 1933), 7; and Johannes Keuning, ed., *De tweede schipvaart der Nederlanders naar Oost-Indië onder Jacob Cornelisz. van Neck en Wybrant Warwijck*, *1598-1600* ('s-Gravenhage: Martinus Nijhoff, 1938), lvii.

23 Most of the ships of the English East India Company made only four voyages to the Indies, and rarely served for more than ten yeas. The VOC on the other hand used its vessels for round-trip voyages as long as the ships were able to function, after which they were usually deployed for the intra-Asiatic trade. See, Jacobus R. Bruijn, Femme S. Gaastra, and Ivo Schöffer, *Dutch Asiatic Shipping in the 17th and 18th Centuries: Introductory Volume* (The Hague: Martinus Nijhoff, 1987), 95.

24 Bruijn, Gaastra, and Schöffer, *Dutch Asiatic Shipping in the 17th and 18th Centuries: Introductory Volume*, 38-39.

25 Three full or continuous decks did not come into use until the eighteenth century. Bruijn, Gaastra, and Schöffer, *Dutch Asiatic Shipping in the 17th and 18th Centuries: Introductory Volume*, 48.

26 Roeper, *De schipbreuk van de* Batavia*, 1629*, fig. 10.

27 Bruijn, Gaastra, and Schöffer, *Dutch Asiatic Shipping in the 17th and 18th Centuries*; see also the on-line version: http://www.inghist.nl/Onderzoek/Projecten/DAS (accessed 19 June 2008).

# CHAPTER II
# FROM CARVEL CONSTRUCTION TO VOC SHIPBUILDING

## Introduction

This chapter provides a brief introduction to Dutch shipbuilding, its technological development from the fifteenth to the seventeenth centuries, and Holland's cultural and social–economic climate. Basically, the discussion will focus on those aspects that influenced Dutch shipbuilding during a dynamic period of expansion in the late sixteenth and early seventeenth centuries. In this time, the Dutch commenced their own trade with Asia and set sail beyond European waters. For the first time, they had to design and build ships for long–distance voyages. Dutch ships in this period were the result of both local and foreign traditions, for shipbuilding practices of countries such as Spain, Portugal, England, and France seem to have influenced Dutch shipbuilding. VOC shipbuilding charters have survived from the late sixteenth and early seventeenth centuries to aid to our understanding of Dutch East India ships. This chapter is intended to provide a background —to set the stage as it were— in which to place and understand *Batavia*'s construction.

## From lapstrake to carvel–planking in bottom–based shipbuilding

The cog builders of northwestern Europe, in particular the Dutch, were the first to incorporate flush–laid planks, above the ships' bottoms, into their shipbuilding during the late fifteenth century. The tradition was imported from the Mediterranean via Portugal, Spain, Bordeaux, and Brittany. The Dutch did not, however, immediately adopt the frame–based construction technique and design methods of the Mediterranean carvel–built vessels.[1] They first applied the carvel–planked technology to large vessels. Dutch records from the southern inland boundaries of the Netherlands mention *karveels* that were commissioned by Philips de Goede around 1439 and built by Portuguese shipwrights, probably in a Mediterranean design method.[2] Carvel–planked technology was, however, not evenly implemented in the entire Lowlands, and, therefore, not immediately adopted in the northern Netherlands.[3] It was a full two decades later that a carvel–planked ship was begun by Breton shipwrights in 1459 in the town of Zierikzee, followed thereafter by the construction of similar ships in the town of Hoorn in 1460 in the northern region of the Netherlands.[4] The earliest archaeological evidence of a carvel–planked boat from the Netherlands is a fishing vessel excavated in the IJsselmeerpolders dating to 1570.[5] Carvel–plank technology slowly became more common, particularly for ocean–going vessels. Lapstrake planking, on the other hand, did not completely disappear and its use continued for the construction of small craft. A contemporary example of a large vessel with lapstrake planking is seen in the archaeologically excavated U 34 ship, which dates to 1530. It was excavated in eastern Flevoland, Netherlands, in 1969. Its preserved hull remains measure 30 m in length, 9.5 m in width, and 5.4 m in height.[6] The study of this wreck's hull is still ongoing.[7]

Many Dutch shipbuilders continued to assemble ships using their traditional bottom–based method in order to build carvel–planked vessels. This bottom–based construction method combined features of both shell–first and frame–first construction. The bottom of a ship was assembled in a shell–based method, in which the planks were held together with temporary wooden cleats until the frame floors and first futtocks were inserted. The temporary cleats were removed as the ship's framework was installed, after which the side planking was fastened to the frames in the new frame–on–plank method. This bottom–based construction method appears to have developed independently from shell–based or frame–based construction and represents an entirely different shipbuilding philosophy.[8] Developed over many centuries, this construction method combined features of shell–first and frame–first construction, but was not a specific application of attributes from those methods. It must be noted that this was *not* an intermediate phase between the shell–based and frame–based method, as suggested in the past.[9] The bottom–based construction method is typical for northwestern Europe and had been used there at least since Roman times.[10] Due to their grounding in this technique, Dutch shipwrights had no immediate need to develop more scientific design methods in shipbuilding, and the bottom–based construction method allowed them to increase their technological lead over their French and English colleagues in the sixteenth and early seventeenth centuries.[11] According to Hocker, the Dutch skipped much of the experimenting that is normally associated with the adoption of a new technology, but could instead take immediate advantage of the economic benefits of carvel planking.[12] Hocker concluded that it was more cost effective to build carvel–planked ships, as this reduced the amount of labor and iron fasteners needed (long double–clenched iron nails were used extensively to fasten the lapstraked planks of clinker built ships).[13] It did not, however, reduce the amount of timber used to build a ship, for despite the elimination of overlap between the planking the wood saved by flush–laid planking is negligible.[14] Shipbuilders had to compensate for the decreased structural strength of the ship's skin or shell. They did so by increasing the number of frames used. Archaeological evidence from the Almere Cog (early fifteenth century) and the B71 *karveel* (late sixteenth century) demonstrate that frame room–and–space narrowed considerably in this time.[15] An important consequence of the Dutch head start was a significant amount of technical achievement. One important advantage of combining carvel planking with the bottom–based construction method was that the Dutch did not have to make major modifications to their construction method since they were already using carvel–construction approach in assembling the ship's bottom.[16] It was, therefore, not a completely new technology but an adjustment of existing technology that allowed the Dutch to jump into the lead.

**Shipbuilding and wood usage**

The Dutch became the foremost shipbuilders in northern Europe in the sixteenth and seventeenth centuries, and exported both finished vessels and labor to other countries. By 1640, approximately one thousand ships were built in the Lowlands on an annual basis. Nearly 320,000 cubic meters of oak were used in the Dutch shipyards for seagoing ships alone. This equals 2,500 hectares of forest used per year, and does not include the wood used to build ships for inland shipping.[17]

A significant portion of these ships were exported to foreign markets, such as Sweden, France, England, Russia, Denmark, the Italian states, Hamburg, Bremen, and the Baltic region.[18] In 1628, for example, three large ships were built in the shipyards of Saerdam (modern–day Zaandam) for the Cardinal de Richelieu, the Chief Minister of King Louis XIII of France; each ship measuring about 1,000 to 1,200 tons in size.[19]

The Lowlands did not have sufficient natural resources to provide the necessary timbers used for shipbuilding. Indeed, after the eleventh century, the Dutch could no longer provide the necessary quantity of wood from their native soil as a result of a steady rise in population and consequent demand for building materials, and thus had to import timber.[20] The first evidence for long–distance timber transport into the Netherlands comes from the town Dorestad, where wooden barrels from the Mainz area in Germany were found in the construction of wells dating to the ninth century.[21] Timber became one of the most significant import commodities used for the construction of buildings and ships. From the early medieval period onwards, the Lowlands and other western European countries conserved their own resources by importing oak from the Baltic Sea.[22] By 1650, the majority of imported softwoods, fir (*Picea abies*) and pine (*Pinus sylvestris*), came from Norway and the Baltic Sea region; most of the oak used in shipbuilding was obtained from the Weser and Elbe area in northern Germany (Table II.1).[23] Raw timber was imported by ship and distributed over the Lowlands through a trade network of towns such as Deventer, Dordrecht, Venlo, and Keulen.[24]

Table II.1 Provenance of timber coming into the Netherlands in *lasten* (approximately 2 metric tons), in 1650 and 1750.[25]

| **Geographic Region** | **1650** | **Percentage** | **1750** | **Percentage** |
|---|---:|---:|---:|---:|
| Norway | 130,000 | 75% | 38,000 | 22% |
| Baltic Sea | 27,000 | 16% | 80,000 | 47% |
| Rhine | 9,500 | 6% | 47,000 | 27% |
| Small East (Emden, Germany, to Esbjerg, Denmark) | 5,500 | 3% | 6,000 | 4% |
| Total | 172,000 | 100% | 171,000 | 100% |

The wood market of Deventer, for example, predominantly supplied Amsterdam and the towns situated on the western coast of the Zuiderzee with uncut oak, whereas the market of Dordrecht was the main supplier of wood for the shipyards of Saer region (modern–day Zaanstreek) and the southern Dutch towns.[26] Wood trade and timber for shipbuilding is discussed in more detail in Chapter VII.

**The invention of the sawmill**

Hocker noted that Dutch ships "were seaworthy, capacious, and inexpensive, partly due to superior management of the supply of imported timber."[27] The rapid production of Dutch ships, however, can also be attributed to something other than superior management of timber supply and applying carvel–planking to a bottom–based construction method. A noteworthy technological advantage was obtained by the invention of a wind–driven sawmill by Cornelis Corneliszoon from Uitgeest in 1594. This new type of mill made it possible to saw large quantities of planks and beams in a shorter time and with less labor than previously required. Consequently, sawmill production of timber in the Lowlands grew 3,000 percent compared to hand–sawn timber production. The mills were capable of sawing 60 beams in four to five workdays instead of 120 days for the same number of beams sawn by hand.[28] The enormous growth of Dutch shipbuilding in the beginning of the seventeenth century must, therefore, have been significantly influenced by this innovation.[29]

Flourishing trade in the Lowlands in the late sixteenth century increased the demand for timber to build houses, waterworks, and more ships. This demand for more timber is best illustrated by the pay raises given to the large group of hand sawyers employed in Amsterdam in 1590.[30] Wood cutting guilds in Amsterdam suffered from the competition of their colleagues in the northern Zaan area, the rural district directly north of Amsterdam, who were able to produce the same amount of timber for two–thirds the price due to cheaper living conditions, the absence of guilds and price regulations, and lack of quality control (Fig. II.1).


Fig. II.1 Map of Holland showing Amsterdam (red dot), Zaandam (yellow dot), Zaan region (yellow outline), and the VOC Chambers of Delft, Enkhuizen, Rotterdam, and Delft (blue dots). The Chamber of Zeeland (Middelburg) is situated south of the lower left edge of this map and, therefore, not present. Map: after I.P. Saenredam, Amsterdam University Library (UvA), University Museum, 1589.

While wind–driven mills facilitated the thriving Zaandam industry in the early seventeenth century, no major developments of a similar nature followed in Amsterdam until 1630. The first small, primitive sawmill was built in 1598 by Adriaen Corneliszoon on a float outside Amsterdam's gate of Saint Anthonis.[31] He was granted a monopoly for such a mill for twenty years. In 1607, when another entrepreneur requested permission to build a second small mill on a float to saw planks and sheathing between the Amstel Bridge and the bridge to the timber market, the request was turned down by the city council.[32] Consequently, Amsterdam's second sawmill was not constructed until 1619.[33] Thus, while some efforts were made to construct wind–driven mills before 1630, these efforts were not significant in comparison with the expansion of timber mills in the Zaan area.

By 1630, Amsterdam did not have a single sawmill inside its city walls, mainly due to the resistance of the hand sawyers' guild.[34] A contributing factor was the lack of space in the city for the construction of mills to cut wood. At this time, the Zaan region had 53 working sawmills. The hand sawyers of Amsterdam tried to ensure their income as indicated by an agreement, made in 1620, with two mill owners from Zaandam who had each built a sawmill directly outside of Amsterdam. The mill owners would only accept contracts to saw pine, keeping the privilege to saw oak entirely to the hand sawyers. However, a year later an edict was enacted in Amsterdam to boycott beams and planks processed elsewhere, as such timber kept making its way into the city (specifically, from sawmills in the Zaan region). It was also prohibited to transport uncut timber from Amsterdam to the surrounding areas.[35] According to Vibeke Kingma, these regulations were probably not too strictly enforced, as only a few cases of offence are known.[36] However, the hand sawyers' guild could not sustain itself and eventually dissolved in 1627.

Consequently, Amsterdam tried to meet local demand for wood by constructing its own sawmills from 1630 onwards.[37] A collection of Amsterdam's most prominent timber merchants, along with several carpenters, shipwrights, and coopers, raised 40,000 guilders and, on 5 January 1630, applied for a patent to establish the Sawmill

Development Company.[38] This patent was endorsed half a year later, on 28 June 1630, and the company was granted sole authority to construct new wind–driven sawmills in the city.[39] Sixteen windmills were consequently constructed outside the city gates Raampoort and Reguliersspoort. The starting capital eventually raised to found the Sawmill Development Company and construct wind–driven sawmills was 74,000 guilders.[40] The most important customers of the wind–driven sawmills were undoubtedly the VOC, the West India Company (WIC), and the Amsterdam Admiralty.[41] The Sawmill Development Company was disbanded in 1639 and its sixteen sawmills divided in two groups among its shareholders. Both parties agreed to be under an obligation to ensure sufficient sawn timber to sell to Amsterdam's citizens, city, Admiralty, VOC, and WIC.[42] The number of sawmills continued to expand throughout the seventeenth century. By 1645, the city of Amsterdam has 45 wind–driven sawmills, and in 1660 the first VOC owned sawmill came into operation.[43]

The invention of the sawmill by Cornelis Corneliszoon in 1594 must have played an important role in the rapid production of Dutch ships during the late sixteenth and early seventeenth centuries, perhaps more so than the Dutch fusion of carvel–planked and bottom–based construction methods, or Dutch efficiency in the wood trade. Unlike the Dutch, English and French shipwrights developed different naval architectural techniques due to the influence of Mediterranean builders. By the late seventeenth century, English and French shipwrights began to outpace the Dutch in ship construction after having taken their time to learn the design methods of the Mediterranean builders and experiment with new design methods.[44]

**Dutch shipbuilding for the intra–European and inter–continental trade**

In the sixteenth century, the socio–economic, technological, and political climates in the Netherlands resulted in dynamic developments in Dutch shipbuilding. Dutch shipwrights began lengthening existing vessels, building new ships with increased cargo capacities, and new ships destined for long–distance trade. The lengthening of merchant vessels is a prime example of these innovations.[45] This practice was a direct result of the enormous economic growth and the urgent need for more cargo capacity. Lengthened ships, the so–called *verlangers,* had their hulls cut in half amidships, after which an extra section was added.[46] Contemporaneous Dutch texts indicate that specific reference to the word *verlanger* was only made for the short period of time between 1587 and 1619.[47] Although closely related to the development of the flute ship, the term *verlanger* does not specifically refer to a type of ship but rather to the process of lengthening a vessel. Yachts, boats, carvel ships, *busses*, and *boeiers* are all known to have been lengthened.[48]

In addition to lengthening existing ships, new ship types appeared. The flute ship was launched, a type developed in the Netherlands over the last decennia of the sixteenth century to meet the need for ships for the Dutch Baltic trade. The flute's hull shape was designed to evade Danish Sound tolls without reducing cargo capacity.[49] Pieter Jansz Liorne is said to have invented the flute ship in 1595; but ship scholar André Wegener Sleeswyk has recently demonstrated that Liorne should not be credited as the "inventor" of this particular ship type. Liorne was not a shipbuilder; he was the mayor of the town of Hoorn who invested in the construction of this ship type, thereby carrying the financial risk and sponsoring its development.[50]

The seventeenth–century flute ship had a narrow top and upper stern with a round tuck and typically three wales girdling the sides of the ship below the level of its helm port. This hull form, pear–shaped in cross–section, is also referred to as turret–built or kettle–bottomed (Fig. II.2).[51] The characteristically narrow maindeck and poop contrasted sharply with the bulky cargo hold below; the maximum breadth of the ship lay below the waterline.[52] Flutes had an average cargo carrying capacity of approximately 200 tons around 1600, which increased during the course of the seventeenth century to 360 tons.[53] Flutes had a shallow draft and a relatively high length–to–beam ratio of 4:1 or more, although this was also characteristic for other ship types. *Batavia*, for example, being a large Indiaman had a similar length–to–beam ratio of 4.4:1 (Chapter IV). The Dutch managed to construct these flute ships at a much lower price than the merchant vessels of other European countries. Violet Barbour demonstrated that a flute ship built in the Netherlands cost 800 pounds sterling, whereas a similar ship would cost 1,300 pounds sterling in England. Additional examples have shown that the price of similar vessels could exceed the Dutch price by more than half the cost.[54] According to Richard Unger, the Dutch shipyards managed to keep the price down by constructing flutes and other ocean–going ships primarily in the Zaan region. Here, taxes were lighter and the cost of land was lower. Standardization and the establishment of a large–scale shipbuilding industry also kept the cost lower.[55] Other European nations, however, also had rural areas with similar conditions and industrial standardization. Dutch shipbuilders and merchants were not limited by royal or patron interference when deciding how to build their ships, which certainly made them more effective.[56] It must be noted that the Dutch had to import all timber used in shipbuilding, which did not necessarily make the construction of a ship cheaper.[57] Dutch flutes simply had lower construction costs, because their timber was mechanically sawn with wind–driven sawmills. Wegener Sleeswyk adds that the construction of round tuck sterns cost less than square tuck stern, seen in other contemporaneous ocean–going ship types, as they required less timber and were easier to assemble.[58] The construction cost of Dutch flutes was relatively low, but the ships may not have been "cheaper" as they may have had a shorter life expectancy than ships built by other European maritime powers.[59] Dutch shipbuilders are known to have used pine in the construction of some of their ships, particularly flutes. Pine was cheaper and lighter than oak and, although not as durable, it was still cost–effective for certain trades.[60] The mid–seventeenth century BZN 10 shipwreck found in the Dutch waters of the Waddenzee is an archaeological example of a large vessel as its hull remains measure 40 m in length, even though a Dutch origin is not necessarily agreed upon among archaeologists. BZN 10 has substantial amounts of pine in its frames, ceiling, internal structure, and some of the hull planking near the stern.[61]

Generally, flutes had tall masts and short yards, permitting easier handling. Sir Walter Raleigh mentioned in the early seventeenth century that Dutch flutes could sail


Fig. II.2 Flute ship with narrow upper deck and three wales below the helmsport. Engraving: Abraham Allard, 1650, National Maritime Museum Amsterdam. (A.0149–562).

with a crew of seven men and a boy, as opposed to English merchant ships that required twenty men.[62] The smaller crews on Dutch flutes were also a result of other circumstances as demonstrated by Wegener Sleeswyk. The Dutch were, for example, not bound by guilds and regulations like the Hanse cities were, and sailing from the Netherlands to the Baltic Sea was considered relatively safe, thus requiring less crew.[63] The crews were also paid low wages. The 'family business' nature of Dutch seafaring culture kept wages low in a time when there was a significant shortage of able seamen.[64] Regardless, the flute was a runaway success, though it did not help the Dutch to gain control of maritime commerce as the ship type had become established by the time Holland's hegemony was already secure.

In this period, the Dutch were also challenged by the need to contract, for the first time, large merchant ships for inter–continental seafaring. Among the European powers, the Dutch had entered the world's oceans last, more than a century after the Spanish, Portuguese, and French, and a few decades after the English. In the early 1590s, the Dutch started sailing in waters beyond their European trade network to acquire direct access to the colonial commodities of Asia and extend their trade realm. The first two Dutch attempts to sail to the Indies, in 1594 and 1595, were under the command of Jan Huygen van Linschoten and tried to sail via the Open Polar Sea, a hypothetical northern route along the North Pole.[65] The voyages were not successful. A third and last attempt to open up this route to the Indies was made one year later, in 1596, under the command of Willem Barents and Jacob van Heemskerck (Chapter V, section 'Yacht of Willem Barents').[66]

During the attempts to open up the route through the Open Polar Sea, in 1595, another Dutch expedition had set sail following the Portuguese route around Cape of Good Hope.[67] This expedition was organized by a consortium of nine Dutch businessmen. Five ships set sail under command of Cornelis Houtman and it took almost three years for the fleet to return with spices, such as nutmeg, mace, and black pepper. This first expedition was not a commercial success. The sale of its return cargo only covered the expedition's cost.[68] One ship, the 260–ton *Amsterdam*, and more than two–thirds of the seamen did not make it back to the Netherlands.[69] Regardless of the losses and lack of commercial profit, the expedition demonstrated that the Dutch were able to sail to Asia themselves and that Portugal could no longer exclude newcomers from the Asian trade.[70] On their first expedition, the Dutch went straight to the Indonesian islands to obtain the desired commodities, thereby circumventing the major Portuguese entrepôts.

By 1601, fifteen fleets totaling sixty–five ships had set sail to the Indies.[71] Most impressive was undoubtedly Jacob Corneliszoon van Neck who returned with four fully laden ships within fifteen months (1 May 1598 to 19 July 1599).[72] Successful expeditions, such as Van Neck's, made profits of more than 400%. By 1601 the Dutch volume of trade had become much greater than that of the Portuguese. The expeditions to the Indies were organized by the so–called *voorcompagnieën* or joint–stock companies from different town and regions in the Netherlands. The lack of coordination in this booming business swiftly entangled the *voorcompagnieën* in a competition that drove up the prices of spices at the source. To combine trade efforts, the Dutch *Verenigde Oostindische Compagnie*, or United East India Company (referred to as the VOC), was founded in 1602 after lengthy negotiations with the Dutch Government.

The company's organizational structure was divided in six Chambers represented by the port cities Amsterdam, Hoorn, Enkhuizen, Rotterdam, Delft, and Middelburg (the latter is also referred to as Zeeland). The delegates of these Chambers formed a board of directors and convened as the Heren XVII (Gentlemen XVII).[73] They were selected from the directors of each Chamber, who were the most prominent or highest class of shareholders, and met two or three times per year for meetings that could last for several weeks. The Gentlemen XVII consisted of eight delegates from the Chamber of Amsterdam, four from the Chamber of Zeeland, and one from each of the other Chambers.[74] The seventeenth delegate would come in turn from the Chamber of Zeeland or the five small chambers to prevent Amsterdam from dominating the decision making. The VOC was given extraordinary independence from the Dutch Government and was granted a complete monopoly in the east, with the right to appoint governors, raise armies, build fortresses, and make treaties with foreign potentates.[75]

From the late 1590s, the Dutch, for the first time, had to build heavier ships specially designed and constructed for the lengthy voyage to Batavia and back. Although an established trading post since 1610, the town of Jakarta became the VOC's purposely established Asian headquarters and was renamed Batavia in 1619. It became the main centre within a trading network to which most outbound–ships from Holland sailed and from which most homebound ships set sail (with the exception of some ships that were destined to sail directly to China, Bengal, or Ceylon). It was also the transshipping point and staple market for all inter–port trade of the VOC in Asia.

Until the end of the sixteenth century, Dutch ships destined for long–distance journeys were much smaller than those of the Spanish, Portuguese, and English.[76] The ships were also of shallower draft, which made them better suited to the peculiarities of Dutch waterways. In general, the number of ships over 200 tons was negligible in 1599.[77] An exception, however, were the ships sailing for the joint–stock companies between 1595 and 1601. They varied between 50 to 900 tons, averaging around 350 tons.[78] The Portuguese, on the other hand, built ships up to 1,600 tons. A Dutch report, dating to 1604, for example, lists a Portuguese fleet of carracks in the Indies: The Admiral's ship of 1600 tons, the Vice–Admiral's ship of 1,400 tons, four carracks of 800 tons and two of 600 tons.[79] At the time, the largest VOC ships equaled the smallest Portuguese ships in size.

The Dutch certainly had the ability to build large ships in the early seventeenth century, of which *Hollandse Tuin* is an example (Fig. II.3). This four–masted ship was the 1,000–ton showpiece of the Amsterdam Admiralty, but was offered for service in the long–distance trade and military operations as it proved unmanageable in Dutch waters. It sailed to Brazil in a flotilla of five ships under the command of Paulus van Caerden in 1603. In the early seventeenth century, four–masted ships like *Hollandse Tuin* entered the Dutch seafaring scene briefly, although they were not common.[80]

Fig. II.3 Warships sailing into the IJ upon return from Brazil in 1605. In the center, Dutch warship *Hollandse Tuin* of the Amsterdam Admiralty. Painting: Hendrik Cornelisz Vroom, 1605–1640, Rijksmuseum Amsterdam (SK–A–1361).

From its founding, the VOC followed the advice of the Dutch Government and leaned toward the use of fewer larger ships that were sufficiently manned and armed to trade, attack Portuguese interests, and protect prospective allies in trade. In the early years of its existence, the VOC used ships of different sizes. The larger vessels, with a cargo capacity of 300 tons and more, were referred to as ships, whereas smaller ships were referred to as yachts (in the late sixteenth and early seventeenth centuries they were sometimes also referred to as *pinassen*, *pinnaces,* or *pinances*).[81] All ships were similar in appearance; they had a gundeck with cannon, a transom stern with a square tuck, and three masts with a full ship rig.[82] Small yachts could be rowed if needed, but they were not specially designed for this type of propulsion.[83] Some ships were built to sail directly to the Indies and back, while others often remained in the Indies for some period of time. The large Indiaman was the type of ship that the VOC would later refer to as *retourschip* (plural: *retourschepen*) or return–voyage ship. The name originates from the cargoes brought back to the Netherlands from Asia, which were called *retouren* (or returns) in the seventeenth century.[84] Although the designation for cargoes as *retouren* occurs in the early seventeenth century, the name return–voyage ship emerges only after 1620.[85] Prior to 1620, all return–voyage ships were simply referred to as India ships (Appendix A). The name return–voyage ship does not refer to a specific ship type as ships, yachts, and flutes were all return–voyage ships if destined to make the trip to Asia and back. The large Indiamen, however, were by default return–voyage ships as the VOC did not specifically send this particular ship type to Asia to stay in the Indies and become a local workhorse of the company. Despite the VOC's intentions, large Indiamen were occasionally employed for the intra–Asiatic trade before returning to the Netherlands or deployed in Asia at the end of their working lives. Many yachts, on the other hand, were specifically employed by the VOC to stay in the Indies and become permanent additions to the company's fleet overseas. Over the VOC's lifespan hundreds of yachts were permanently stationed in the Indies.[86] The designation of the term yacht included larger ships in the course of the seventeenth century, and those with cargo carrying capacities of 300 to 500 tons were more often called yachts from the late seventeenth century onwards.[87]

When Pieter Both, the first Governor–General of the Dutch East Indies, was to implement a permanent structure for the VOC in Asia in 1610, the company's management strategy was to use large Indiamen for the lengthy return voyages and employ a permanent fleet of yachts in Asia.[88] The VOC was keen to implement the policy in order to reduce the risk of losing these valuable freight carriers in Asian waters. This policy was, however, not realized easily due to the lack of an established fleet and infrastructure within Asia. It took until the founding of Batavia, as a permanent VOC headquarters in Asia in 1619, for the return–voyage plan to finally be put into practice.[89] After around 1614, other ship types, such as flutes, frigates, and warships became more common and were added to the VOC's permanent fleet in order to diversify the fleet with ships suited for specific purposes.[90]

From the commencement of the Dutch long–distance voyages in 1594, a new and different type of ship had to be designed and constructed specifically for the lengthy voyage to Asia and back. Such ships were not commonly available and necessitated new developments from VOC shipyards. Know–how from other countries was combined with new innovations to produce the Dutch Indiaman. The result was a custom–made ship for the India route, much like the verlangers and flutes had been specifically designed and developed for the European trade. The development and improvement of the Dutch Indiamen was an ongoing process throughout the VOC's existence. The ships had to be large enough to provide sufficient hold space for their cargoes, as well as the ships' equipment, food, and water necessary for the lengthy voyages. Even though smaller than their Portuguese counterparts, they were heavily built to stand up to hard service in stormy seas and last for six or more round–trip voyages.[91] They were outfitted with heavy armament to repel attacks by pirates, enemy warships —mainly the Portuguese— or other human dangers along the way.[92]

The early seventeenth–century Indiamen and yachts resembled a ship type that the Spanish and Portuguese would call *galleon*. They had a square, flat transom stern and, usually, two full decks, a quarterdeck, forecastle deck, and a poop deck aft of the main mast.[93] Characteristic fore and after castles were well–integrated into the ships' hulls. The vessels carried three masts, with square sails on the fore and main masts and a lateen sail on the mizzen mast.

In the late sixteenth century new construction features were introduced, presumably from Iberian shipyards, possibly via England, that were not seen in Holland before. The introduction of the flat transom, for example, became prevalent in the construction of warships, Indiamen, and yachts. On the 1544–map of Anthoniszoon, only a few ships are shown with such stern configuration. Nearly 50 years later, only one ship with a round tuck is represented among numerous vessels with flat transoms on the map of Piet Bas, dating to 1597.[94] These well–known maps illustrate the introduction of flat transom sterns in Dutch shipbuilding.

Recently, a heated debate sparked off in the journal *The Great Circle*, in which the application of flat transom sterns for small Dutch yachts around 1600 was contested.[95] This discussion is, however, irrelevant as crucial evidence from iconographic and written sources was not included in Karl Marquardt's study on Dutch


Beschrijvinghe vande Voyagie om den geheelen Werelt Cloot/ghedaen door Olivier van Noort van Vtrecht, Generael over vier Schepen/te weten: Mauritius als Admirael/Hendrick Frederick Vice-Admirael/de Eendracht, midtsgaders de Hope, op hebbende tsamen 248. man/om te zeylen door de Strate Magellanes, te handelen langs de Custen van Cica, Chili eñ Peru, om den gantschen Aerden Cloot/ende door de Molucques wederom thuys te comen. Te zeyl gegaen van Rotterdam/den tweeden July 1598. Ende den Generael met het Schip Mauritius is alleen weder ghekeert in Augusto/Anno 1601.

Daer in dat vertelt wort zyne wonderlijcke avontueren, ende vremdigheden hem bejegent, by hem ghesien, ende die hem vvedervaren zijn, Met vele Copere Caerten ende Figueren afgebeelt, by hemlieden nieulicx gheteeckent ende mede ghebracht.



Tot Rotterdam.
By Ian van Waesberghen, ende by Cornelis Claesz tot Amstelredam, op't Water int Schryfboeck, Anno 1602.

Fig. II.4 Three Indiamen and one yacht (right) with a flat transom and a square tuck. Drawing: Jan W. IJzerman, *De Reis om de Wereld door Olivier van Noort, 1598–1601* ('s–Gravenhage: Martinus Nijhoff, 1926), title page.

shipbuilding.[96] First of all, numerous illustrations of yachts showing square tucks can be found in the ship journals of the Dutch long–distance trading companies and the VOC from 1595 onwards. The ships depicted in these journals are definitely small yachts since they are specifically designated as such; additionally, their names and tonnages are given. The drawings of the two small yachts *Zwaan* (80 tons) and *Griffioen* (172 tons), for example, clearly show that they were constructed with a flat transom stern or square tuck.[97] The yachts were used in the first two Dutch attempts to sail to China through the Open Polar Sea in 1594 and 1595. Another example includes all the drawings of the yacht *Hoop* (50 tons), which circumnavigated the world with Olivier van Noort from 1598 to 1601 (Fig. II.4).[98] Furthermore, the earliest VOC construction charter or contact for 160–ton yachts refers specifically to the size of the wing transom, which shows that yachts were built with a flat transom (Appendix A). This charter dates to 1603.

Dutch Indiamen evolved from the late sixteenth to the eighteenth century, changing in shape, size, and rigging. In spite of their size, importance, and specific characteristics that inspired many artists to paint or draw them, no construction details of these ships, particularly in the early seventeenth century, were recorded. Consequently, the study of Dutch East Indiamen dating to the early seventeenth century has been based on iconographic evidence, archival records, and contemporary documents on shipbuilding. Their construction details remain largely unknown.

**Written sources and VOC shipbuilding charters**

The best–known Dutch manuscripts on naval architecture date to the late seventeenth century. The oldest of these, *Aeloude en Hedendaagsche Scheeps–bouw en Bestier,* was published in 1671 by Nicolaes Witsen.[99] Twenty–six years later, in 1697, Cornelis van IJk published his manuscript on Dutch shipbuilding, *De Nederlandsche Scheepsbouw Konst Opengestelt*.[100] Witsen discussed the principles of Dutch bottom–based construction in his shipbuilding manual, whereas the work of Van IJk expounded on the frame–based construction used in the Rotterdam shipyards in the late seventeenth century. Unlike their European colleagues, who mainly focused on hull design methods in their manuscripts, both Witsen and Van IJk described the construction sequence of Dutch shipbuilding employed in the seventeenth century, which exemplifies a practice that seems typical of Dutch shipyards.[101] The most significant difference between the two books is the construction methods they define. Witsen delineated bottom–based construction, which had its origin in northwestern Europe, whereas Van IJk explains frame–based construction, which evidently was being practiced in the Netherlands by 1697.

The works of Witsen and Van IJk are considered the first and foremost Dutch manuscripts on shipbuilding. Late sixteenth– and early seventeenth–century sources are, however, available, and are perhaps more applicable to *Batavia*'s construction. The documents that survive from this period, in particular those of the VOC and Dutch Admiralties, and contemporary ship journals frequently refer to shipbuilding or provide construction details. The earliest Dutch shipbuilding charter found to date, comes from the archives in Zeeland and dates to 1593.[102] It was written for the construction of an 85.5–foot–long *pinasse* or yacht (roughly 25.5 m long depending on local Dutch foot measure used).[103] From the late sixteenth century onwards, ships were built according to charters in which the main purpose and dimensions were defined. These charters were basically used as instructions in which the VOC and other large establishments, such as the West India Company and Admiralties, laid down the standardized guidelines for the construction of their ships.

It is no simple matter to get an overall understanding of the construction of large ocean–going vessels, as built by the *voorcompagnieën*, or the long–distance Dutch trading companies, and the VOC. The VOC–counselor and historian Pieter van Dam devoted many pages to the company's ships and their construction in his multi–volume description of the United East India Company. His work is valuable but does not provide a clear and comprehensive insight to the modern–day audience.[104] The shipbuilding charters published by Van Dam are ambiguous and also contain minor transcription errors which, in the past, undoubtedly have further confused those trying to interpret and understand the texts. The most detailed VOC shipbuilding charters from the first half of the seventeenth century, dating from 1603 to 1653, have been transcribed directly from the archives and are translated into English for this study (Appendix A).

In the early seventeenth century, the basis of the VOC's shipbuilding policy was laid down by trial and error in the construction of ships and influenced by the advice of experienced shipwrights, captains, VOC officials in Asia, and other informed sources. It is known, for example, that Pieter Jansz Liorne provided technical advice to the VOC.[105] The Amsterdam shipbuilder Jan Rijcksen played an important role in the development of the VOC's Indiamen and yachts. Born in 1560, he had his own shipyard at the end of the sixteenth century, and became employed by the VOC in the 1620s as the director of its Amsterdam shipyard.[106] The VOC shipbuilding charters were updated from time to time to cater to the changing demands and conditions. Technical decisions, resulting from these updates, were made by men with extensive experience in shipbuilding, such as Rijcksen and Liorne.

The VOC charters demonstrate that the ships and yachts were strong vessels with two full decks. The ships were mainly built of oak. The earliest charters show that even the planking of the lower and upper decks was made of oak, whereas in 1653, the deck planks of the upper deck were made of pine. The quarterdeck, forecastle deck, and poop deck were made of pine with oak waterways from the early seventeenth century onwards. Each VOC ship was inspected in its last stage of construction by a committee of experts from the combined VOC Chambers, to ensure that the current charter was followed. Such inspection had been standard routine since 1616.[107]

Although the shipbuilding charters provided rigid guidelines for shipwrights in the shipyards of all VOC chambers, they were not always followed scrupulously. In 1627 and 1628, for example, the Chambers of Zeeland and Amsterdam were caught building their large ships with a height of approximately 14 Amsterdam feet (3.96 m) below the lower deck instead of the prescribed 12.5 Amsterdam feet (3.54 m), for which only the Chamber of Zeeland was reprimanded (see Chapter IV).[108] The inspection committee must have concluded, however, that VOC ships needed more height in the hold, as the change was included as an adjustment to the later 1628 charters for Amsterdam and Zeeland.[109] The VOC master shipwrights were responsible for the final product and were not permitted to take any liberties with the prescribed shipbuilding charters, but the practice of bottom–based construction method sometimes required or allowed for changes to be implemented. Flexibility is inherent to this construction method but the VOC tried to restrain any diversions from its prescribed charters. Master shipwrights, such as Rijcksen, had to swear under oath not to deviate from the charters and were threatened with removal from their posts for any leniency.[110] On 12 December 1631, for example, a new charter was read and handed over to Rijcksen during a meeting of the Gentlemen XVII. He accepted it under oath and promised to follow it “as much as possible."[111] The Chambers were also known to tamper with the charters in order to carry more cargo back from Asia.[112] The fines for not adhering to the charters became heavier over time.[113] The delegates of the Chambers were held personally responsible for violations of the shipbuilding charters. In 1632, for example, each Chamber was threatened by a fine of 1,000 Flemish pounds for violating ship construction charters; the fine was to be given as alms to the poor.[114]

Although overall dimensions for the ships were regulated, construction details depended on local traditions, which resulted in differences between the VOC Chambers. The Chambers of Amsterdam and Enkhuizen were, for example, highly praised for the use of closely–set sheathing nails.[115] These local differences could be incidental, such as in 1605, when the Amsterdam Chamber decided to outfit its ships without forecastles and quarterdecks.[116]

**Naval architecture in the seventeenth century**

The late–sixteenth– and seventeenth–century ships built according to a bottom–based construction tradition were not predesigned on paper. Detailed information on shipbuilding was not written down, probably to safeguard the secrets of the trade; if it were written, it simply has not survived to our time. The VOC shipwrights used the overall dimensions from the charters and applied these to known proportional rules that were taught through master–apprentice relationship and verbally communicated from one generation to the next.

It is important to recognize that in the sixteenth and seventeenth centuries the design methods known to modern naval architecture were not in use.[117] Dutch shipwrights did not derive the information for curvatures of a ship's hull from two–dimensional plans or lines drawings. Naval architects in England and France were still experimenting with midships moulds and tail frames to design a vessel's overall shape. These designs were probably applied in the shipyards through the use of moulds, gauges, and battens from which the frame shapes could be easily measured off and transferred to cut timbers in the correct proportions. These battens temporarily dictated the eventual curve of the planking and, thus, the shape of the hull.[118] No midships or tail frame moulds have as yet been found in shipyards in archaeological contexts. Obviously, frame–based construction required the development of a specific design method for predetermining the shapes of the frames, which eventually led to more efficient and standardized design methods in England and France in the late seventeenth and eighteenth centuries.[119] If the shape of a hull was portrayed in a plan, as a mold pattern, or a half–model, it could more easily be reproduced if a vessel subsequently demonstrated desirable qualities, such as good sailing. Once design methods had progressed to the point where curvatures of important timbers, mainly frames, became predetermined and could be taken off plans or models, shipbuilding became more efficient in its use of labor and materials. By 1700 the English and French were able to standardize and, consequently, economize the construction of their ships, replacing the Dutch as the dominant shipbuilders of Europe.[120] The performance of Dutch ships, in particular men–of–war, then compared poorly with those of the British and French.

European shipbuilding manuscripts of the late sixteenth and early seventeenth centuries, such as those written by Matthew Baker, John Wells, and Edmund Bushnell, often discuss hull design based on one or several sectional curves (master and tail–frame moulds, Fig. II.5).[121] The dimensions of these mould frames were altered fore and aft following specific mathematical proportions for the narrowing, or defining breadth, and rising, or height above the keel, to delineate a vessel's hull shape. The keel, stem, and sternpost, or the central spine, master frame, and tail frames were designed on paper by the application of proportions, using fractions and sweeping arcs or circles with a pair of compasses (Fig. II.6). Arcs and circles played a dominant role in drafting hull shapes in this period.[122] These design methods are similar to the conceptual tradition of fifteenth– and sixteenth–century Italian ship design, although the hull shapes differ (Fig. II.7). English shipbuilding must have been influenced by Venetian or Mediterranean design methods.[123] It is known that Italian master shipwrights were commissioned by Henry VIII in the royal yards around 1543, and received one third more pay than their English colleagues.[124]

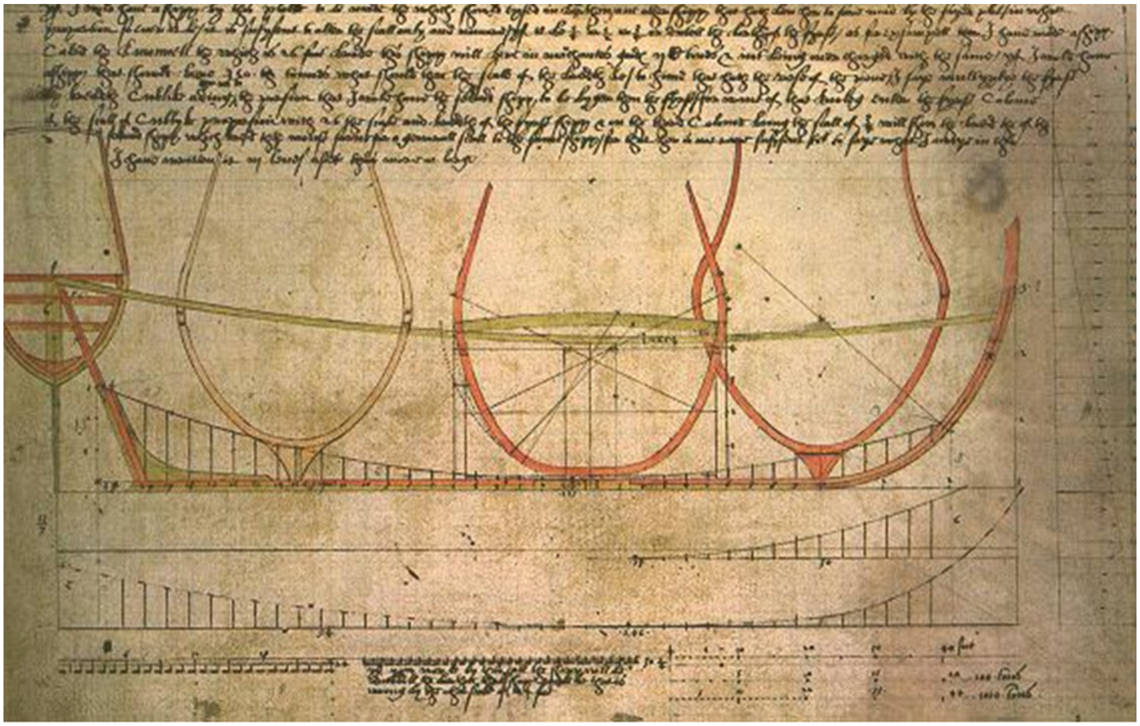

Fig. II.5 Design of keel, stem, sternpost, midships and tail frames. Drawing: Matthew Baker, *Fragments of Ancient English Shipwrightry*, ca. 1570–1630, 21 (Manuscript: The Pepys Library, Magdalene College, Cambridge, CB3 OAG–PL 2920).

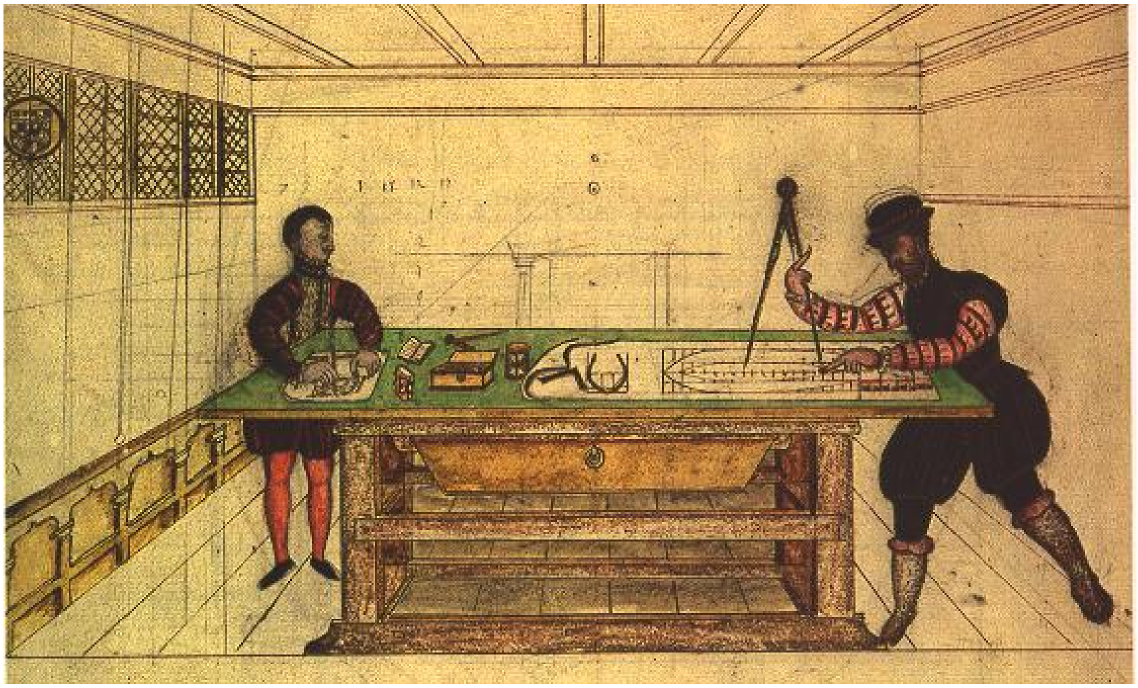

Fig. II.6 Naval architect at work, possibly a self–portrait. Drawing: Matthew Baker, *Fragments of Ancient English Shipwrightry*, ca. 1570–1630, 21 (Manuscript: The Pepys Library, Magdalene College, Cambridge, CB3 OAG–PL 2920), 8.

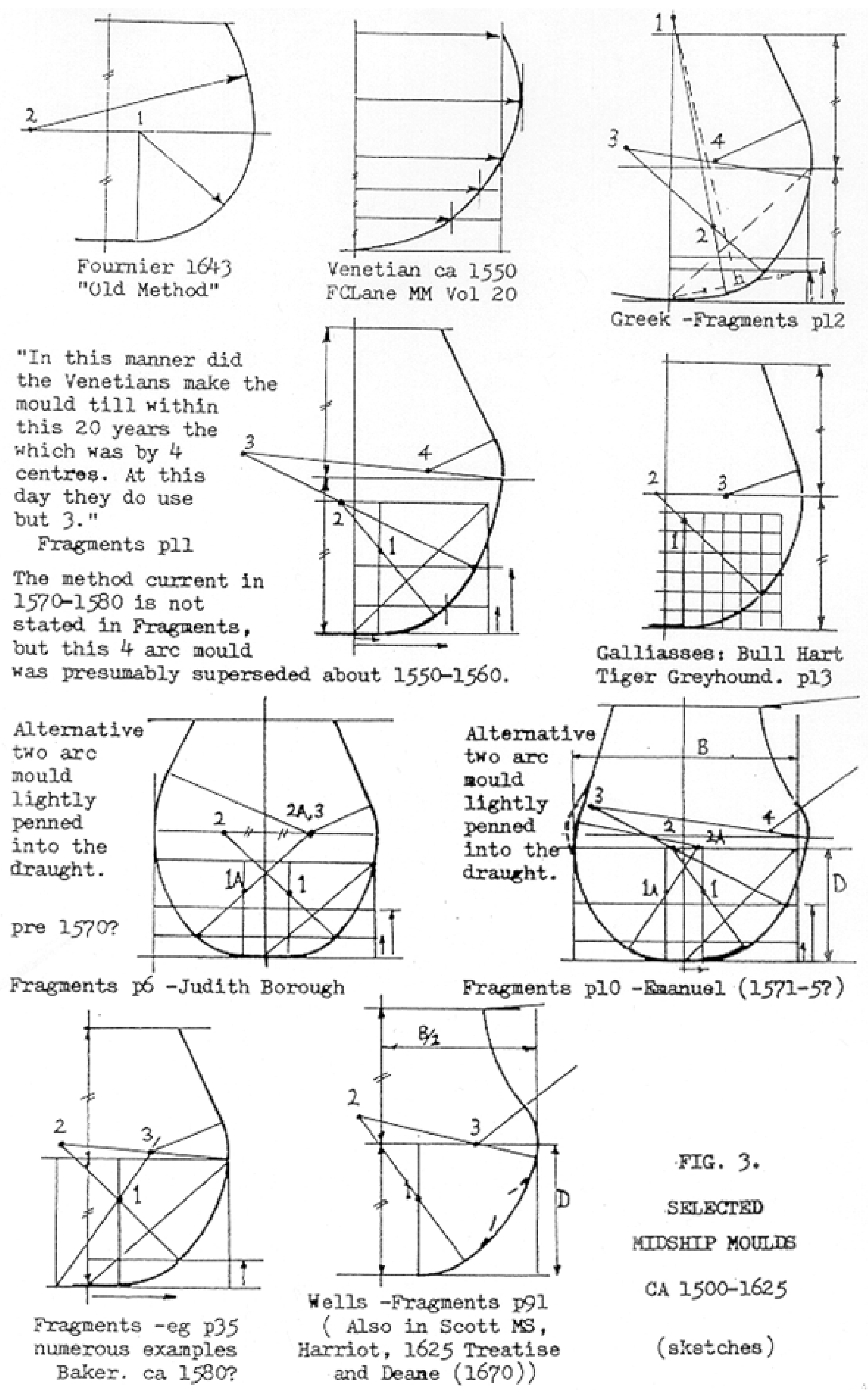


Fig. II.7 Selected midships moulds. Drawing: Richard Barker, “Fragments of the Pepysian Library,” *Revisa da Universidade de Coimbra* V.XXXII (1986): Fig. 3.

The earliest northern European manuscript on shipbuilding was written between 1580 and 1630 by Matthew Baker, a shipwright in service of the royal yards in England. Recent studies of Baker's manuscript indicate that he was describing accepted methods rather than new ideas, and the use of midships moulds must, therefore, have been introduced before 1580.[125]

**Master frames in bottom–based construction?**

Dutch shipwrights were familiar with the use of midships moulds in foreign frame–based ship construction, the use of compasses to draw curves, and applying proportional relations to design mould frames, as is evident in Rembrandt's painting of VOC shipwright Jan Rijcksen and his wife Griet Jans dating to 1633 (Fig. II.8). In this painting, Rijcksen holds a pair of compasses or dividers in his hand, and on his drafting paper a midships section or master frame, central spine, and transom are depicted (Fig. II.9). This resembles the midships mould design methods of the French and English as discussed by Baker. It is noteworthy to see Rijcksen with such a design on paper and using a pair of compasses or dividers as he worked in Amsterdam, where bottom–based construction predominated in shipyards at the time Rembrandt made his portrait.

Witsen demonstrates the use of a master frame in Dutch bottom–based construction, which was inserted after the assembly of the bottom planking had been completed.[126] One floor and two futtocks were installed in the ship's *hals* (neck) at one–third of the ship's length from the stem (Fig. II.10–C).[127] According to Witsen, only one master floor with a pair of futtocks was placed on the bottom, but in reality it could have been more. By inserting the frame floor and first futtocks the first step was made to define the hull curvature above the bottom, which was dictated by the second futtocks that made up the turn of the bilge. The shipwright defined this curvature based on the shape of the bottom, and did not design it by drawing a midships mould. Witsen does describe how to draw the dimensions of the master frame on paper, but it is not certain whether such drawings were truly used in the shipyard (Fig. II.11).[128] According to

Fig. II.8 Master Shipwright of the VOC shipyard in Amsterdam, Jan Rijcksen, and his wife Griet Jans. Painting: Rembrandt van Rijn, Queen's Gallery, Buckingham Palace, London, 1633 (RCIN 405533). The Royal Collection © 2008, Her Majesty Queen Elizabeth II.

Fig. II.9 Detail showing ship's central spine and master frames. Painting: Rembrandt van Rijn, Royal Collection, Queen's Gallery, Buckingham Palace, London, 1633 (RCIN 405533). The Royal Collection © 2008, Her Majesty Queen Elizabeth II.

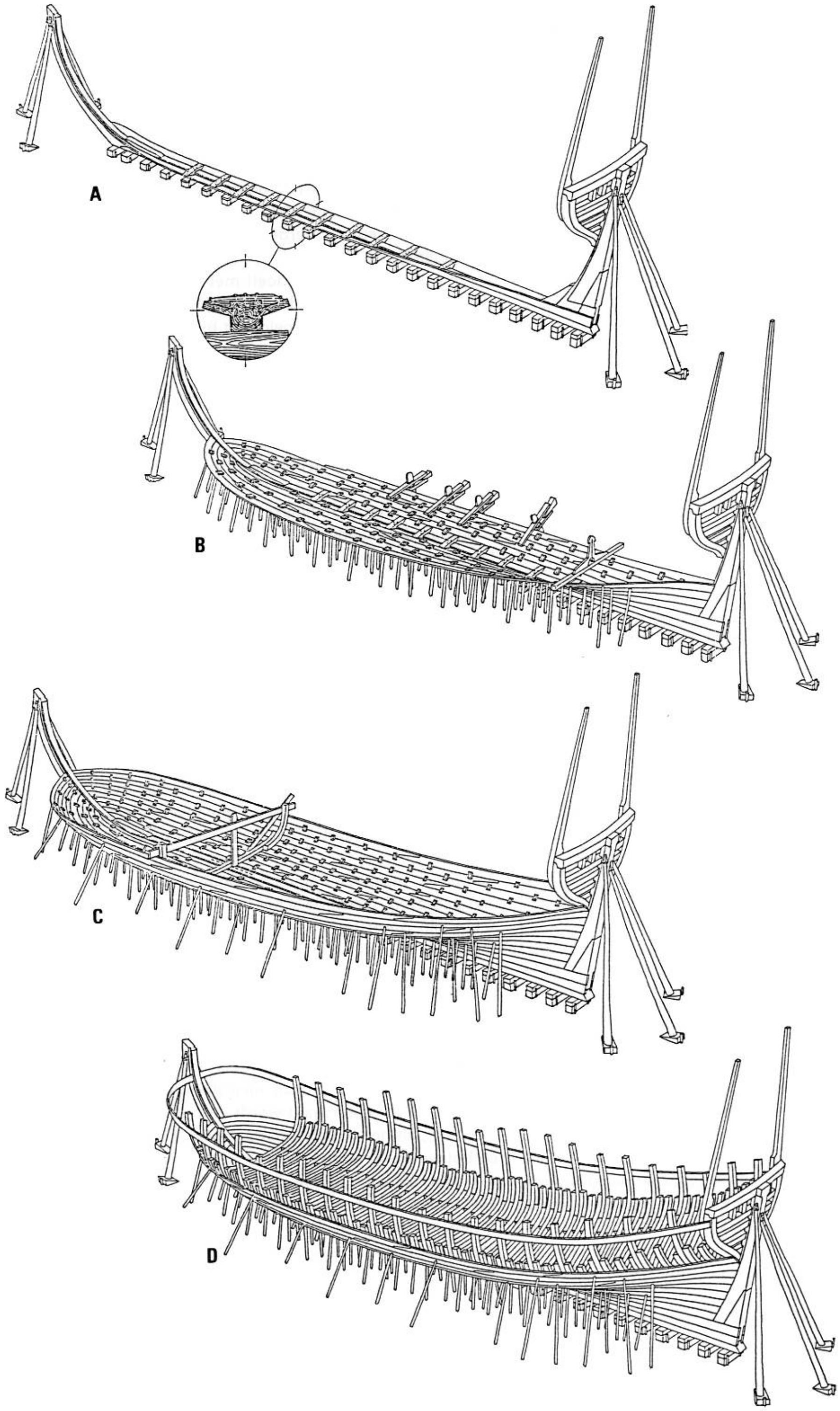


Fig. II.10 Bottom–based construction method as described by Witsen. Illustration: Anton van de Heuvel.

Ab Hoving, the shipwright may have simply used a batten to record the shape of the bottom to define the curve of master frame in the *hals*.[129] Figure II.11 illustrates the design of the master frame: line *a–d* corresponds to the deck level, the curves are drawn from points *e* and *h* with a pair of compasses, *f* and *l* are height of the bottom, *y* is the keel, and *k* denotes the location where the keelson and floors are placed. Witsen explained that to assure the proper curve of the futtocks and the bilge of a model or on paper, a vertical line should be drawn from the center of the deck–line (a–d) through the center of the keel, and the width of the deck–line should be divided in four even sections. Unfortunately, the dimensions for Witsen's master frame are not complete. He indicated that points *f, k, l* and *y* are the rising of the ship's bottom and point *f* is situated three–fifths of the breadth from the center–line of the keel, but he does not indicate how much point *f* rises from the lower end of the line it is on. He also mentions that point *g* is situated approximately two–thirds down from the deck level. The curvature of the first futtock may or may not have been drawn with a pair of compasses from point *f* to *g*. Witsen did not specify the radius for the first futtock, but indicated that an arc was swung from point *f* and an arc of the same radius is swung from point *g*. From the intersection of both arcs, marked as point *h*, from which point the curve from *f* to *g* was drawn. The method and radius to swing the curve between point *g* and *a* from point *e*, were not discussed at all. In addition, the two arcs were not tangent as is indicated by Witsen's illustration (Fig. II.11). More interesting is that Witsen's master frame was actually nothing more than a simple section as it not only indicates the combined curvature of the floor and futtocks, but also of the rising of the bottom planking from the keel.[130] The latter is different from the curvature of the floors as the garboard strakes were angular and did not sit flush against the floors (discussed below).

According to Hoving, this so–called master frame demonstrates that Dutch shipbuilders did not use arcs and curvatures in which radii were drawn from specific points by compasses. If they had, Witsen would have provided the dimensions of the radii or the exact point from which the arcs were swept. There was actually no need for

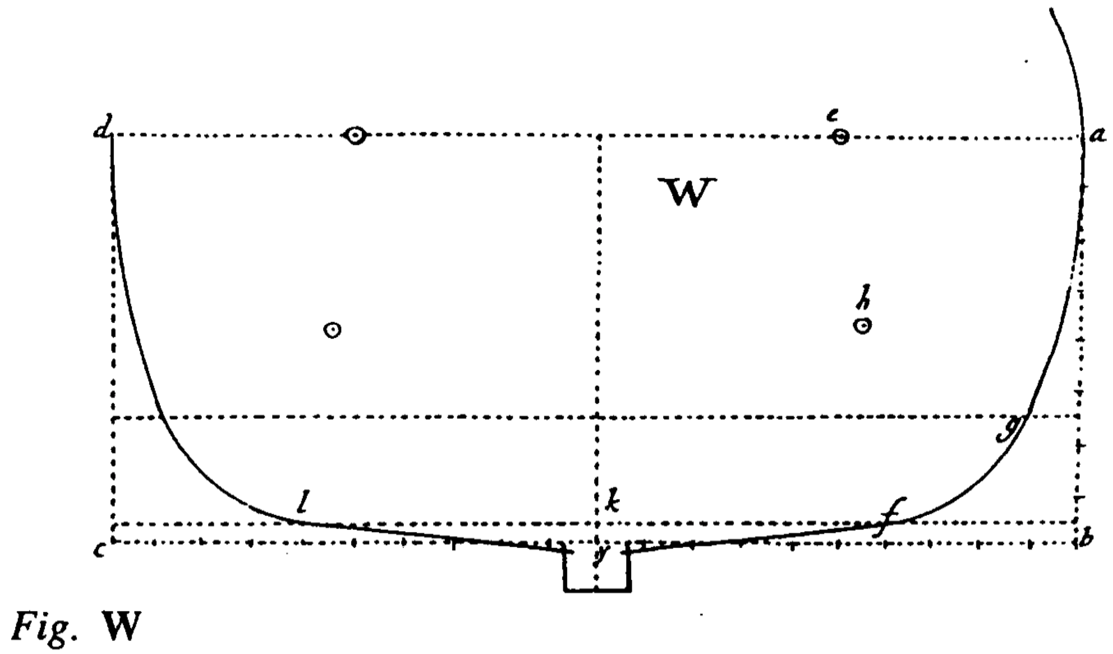


Fig. II.11 Midship section as described by Witsen. Illustration: Nicolaes Witsen, *Architectura navalis et reginem nauticum*, LII, W.

the shipwright to apply this design method. Furthermore, Witsen had 'borrowed' his so–called Dutch master frame from Georges Fournier's manuscript *Hydrographie,* which was published in 1646.[131] Witsen had access to foreign sources through the Vossius Library in Leiden where he studied law, and in his own manuscript he discussed shipbuilding methods from foreign manuscripts by Joseph Furttenbach, Bartholomeus Crescentius, Fernando Oliveira, F. Dassié, and Thomas Miller. He also mentions having gathered much information through personal communication with French and English shipwrights.[132] He was a scholar who basically applied the more scientific methods used in foreign frame–based construction to Dutch bottom–based construction. Witsen's work was not meant for design purposes but as a tool to describe the curve of a vessel's section amidships. Regardless, Dutch scholars, such as Witsen, and shipwrights like Rijcksen were familiar with foreign shipbuilding techniques exercised in England, France, the Iberian Peninsula, and the Mediterranean.

**Nicolaes Witsen's description of bottom–based construction**

Nicolaes Witsen is the only author of the seventeenth century who discussed the assembly of a ship using a bottom–based construction method. The most important chapters in Witsen's manuscript for Dutch shipbuilding methods are Chapters 8 to 11. In these chapters, Witsen described the construction of a 134–foot long *pinas* or warship, listed its structural timbers (their appearance, function and measurements), and, in Chapter 11, he elaborated step by step how to assemble all the timbers in the process of building the ship.[133] This description may have been based on his father's notes, which he used for the shipbuilding charter of a boat.[134] His father was a wealthy and influential merchant in Amsterdam. According to Hoving, however, Witsen most likely obtained his information partly from books and informants, but mainly from Amsterdam shipwrights who provided him with information on contemporary Dutch practices.[135]

According to Witsen, it was not always possible to give conclusive dimensions and proportions of ships due to the numerous pronounced curves and bends in the hull. He points out that two ships, like two humans, never completely resemble one another. His basic approach seemed to be "Mutatis Mutandis" (change what needs to be changed), which justifies changing whatever the shipwright thought he needed to change while building a ship.[136] Witsen adds, however, that devoting more attention to dimensions and proportions yielded a ship with better sailing performance, and a more beautiful and elegant appearance.[137] He also specified general distinctions in different types of ship. Warships, for example, were beamier at their tops and centers to withstand attacks and defend better, whereas merchantmen were narrower on the top so they require the least amount of crew.[138]

Witsen does not provide a complete set of dimensions or proportions, but in Chapter 11 of his work he does provide a relatively detailed outline of how a large vessel was built in practice. The first step was the assembly of the central spine, consisting of the keel, stem, and sternpost.[139] To make the sternpost, for example, a piece of timber of a desired length, thickness, and width was used. Then two battens were laid down at a right angle; one extending straight down from the after side of the post's top end (Fig.

II.12–ab), and one horizontal along the sternpost–keel scarf forming a straight angle with the first (Fig. II.12–bf). After having checked whether the two battens were placed at a right angle with a carpenter's square, points *e* and *f* were marked off in case the two battens shifted. The only dimension given in the description of the sternpost is the rake, which was one foot per six feet of length of the sternpost which is equivalent to nine

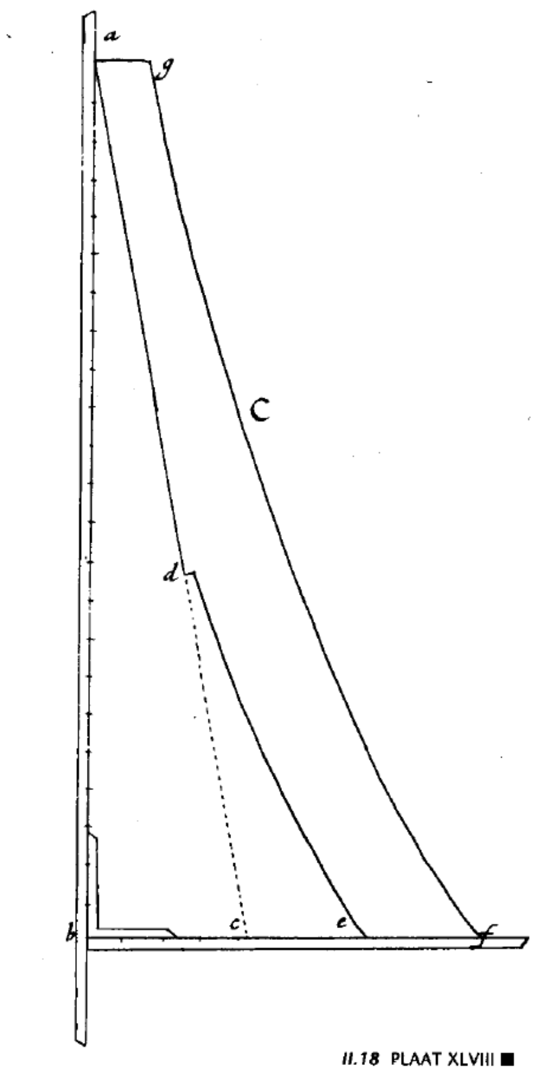


Fig. II.12 Sternpost of a 134–foot long *pinas* or warship. Illustration: Nicolaes Witsen, *Architectura navalis et reginem nauticum*, XLVIII.

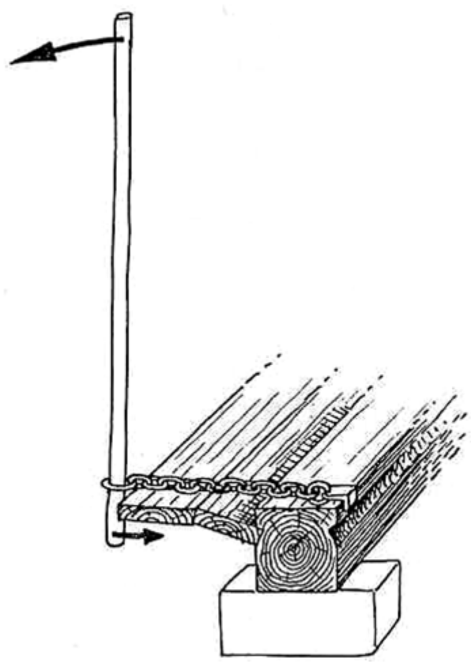

Fig. II.13 Tightening of planks with a chain and lever. The lever was pulled out to push the planks together (the arrows indicating the direction of movement). The garboard strake was fitted into the keel rabbet at a slight angle. Illustration: after Nicolaes Witsen, *Architectura navalis et reginem nauticum*, 168.

degrees of rake.[140] Witsen did provide proportions for various timbers that made up the entire stern assembly in thickness, width, and length, for the assembly of parts and their construction sequence was clearly the main theme of the discussion.[141] Witsen specifically mentioned that each timber was shaped on the ground, after which it was erected and attached.[142]

After the keel was laid and the central spine assembled, the garboard strake was inserted. Witsen called the garboard strake the *kielgang*, which literally translates as *keelway* or keel strake. The garboard strake was not horizontal, but angular in order to collect bilge water atop of the keel, which according to Witsen facilitated pumping the water out of the hull (Fig. II.13).[143]

After garboard strakes were inserted, the bottom was assembled and leveled (Fig. II.10–12). In order to create symmetry on both sides of the keel, a line was strung from stem to sternpost over the centerline of the keel, which was used as a baseline.[144] Witsen specifically mentioned that in Amsterdam the bottom planks dictated the shape of the vessel. The bottom planking of the ship comprised approximately two–thirds of the ship's total breadth (Fig. II.10).[145] Witsen explains that the bottom planking of the hull was tightened or pressed together with a chain and lever (Fig. II.13), and then temporarily fastened with wooden cleats held in place by iron nails (Figs. II.14– II.15). Upon removal of the cleats and nails, the nail holes were plugged with square wooden pegs (called *spijkerpennen* or nail plugs). These nail plugs have been found on the archaeological remains of all Dutch–built ships dating to the late sixteenth and seventeenth centuries (discussed in Chapter V).[146] In addition, large wooden clamps were used to keep the hull planks in place and prevent them from bending or slipping downwards (Fig. II.16). The planks of the vessel were flexed or bent into shape by heating them over fire and then set in place.[147] On the exterior, the bottom planking was supported or propped by wooden shores (Fig. II.10).[148] While cleats, clamps, and shores may have exerted a fair amount of force, they did not provide as solid a foundation for the hull planking as a rigid pre–erected framework.[149]

As mentioned, a master frame consisting of one floor and two futtocks was installed in the ship's *hals* at one–third of the ship's length. After the remaining floors and first futtocks were installed, the bilges of the ship were planked. The uppermost plank of the bilge planking corresponded with one–third the height of the hold.[150] Then a transverse beam was laid on the planking edge (Fig. II.17–d), and the second futtock was fitted on but not attached to the master frame in the ship's neck. A plumb line was dropped from the center of the two futtocks (*c*) over the centerline of the keel (*b,g*). From this line, the width between the two second futtocks was measured to ensure symmetry on either side of the keel (the distance from centerline *b* and *g* to the sides *f*). Subsequently, a plumb bob was dropped from *f* to check whether the second futtocks flared the same distance out from the bilges.

After these second futtocks were properly installed, additional second futtocks were added to the hull at every fourth frame. To these futtocks, a *scheerstrook,* or sheer

Fig. II.14 The use of temporary cleats in the assembly of the ship's bottom hull planking during the reconstruction of VOC ship *Duifje*. Photograph: Patrick Baker, Western Australian Museum.

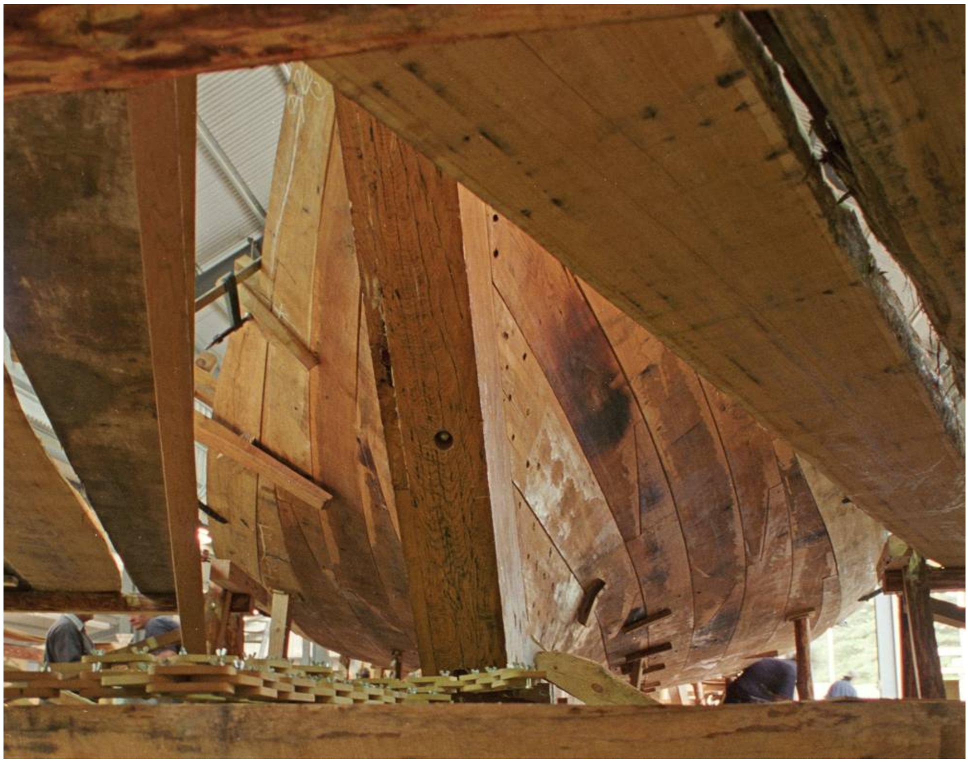

Fig. II.15 The use of temporary cleats on the exterior of the ship's hull to keep the planking in place during the reconstruction of VOC ship *Duifje*. Photograph: Patrick Baker, Western Australian Museum.

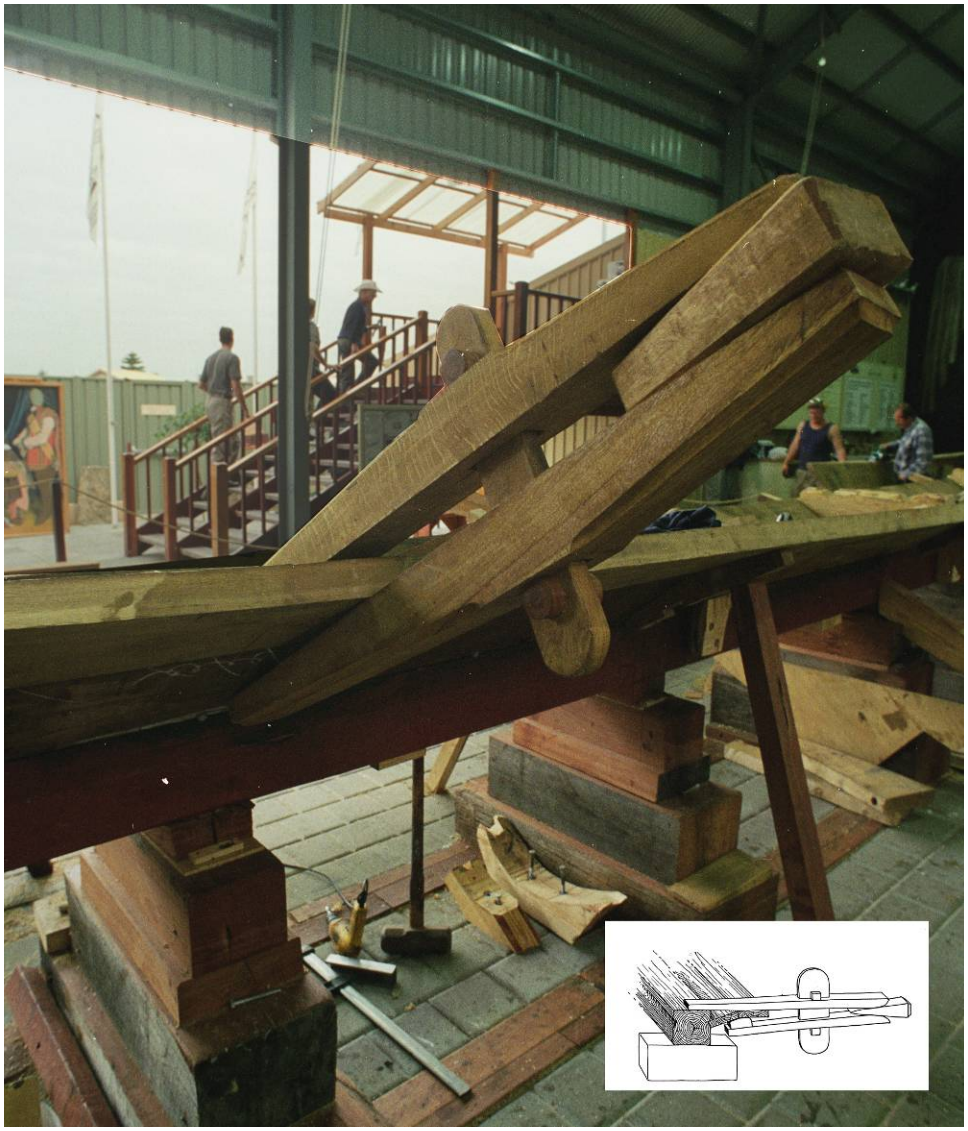

Fig. II.16 The use of clamps to keep the hull planking in place during the reconstruction of VOC ship *Duifje*, 1606. Photograph: Patrick Baker, Western Australian Museum. Illustration in lower right: after Nicolaes Witsen, *Architectura navalis et reginem nauticum*, 168.

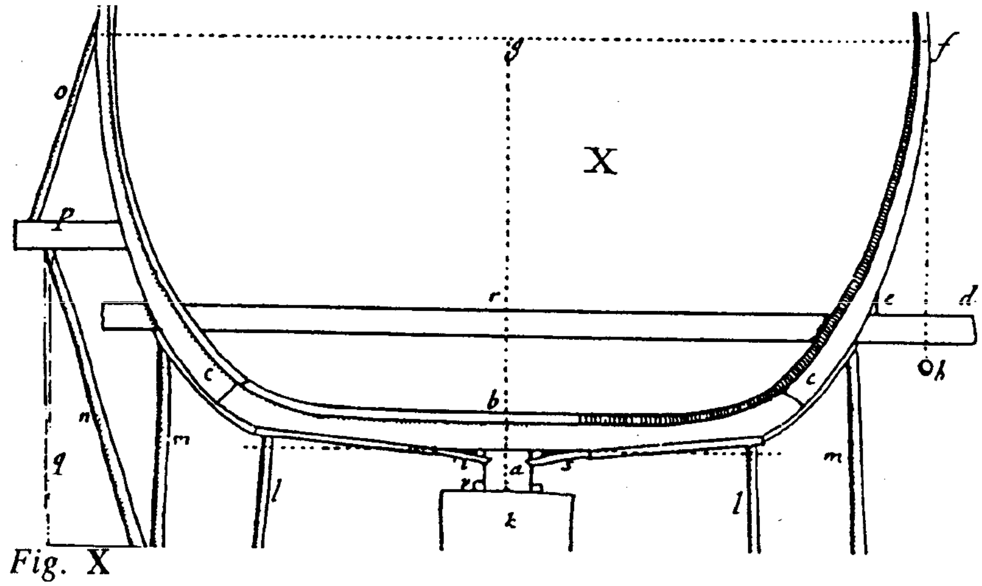


Fig. II.17 Master frame after insertion of second futtocks as described by Witsen. Illustration: Nicolaes Witsen, *Architectura navalis et reginem nauticum*, LII, X.

strake, was fastened, which served as a master ribband that defined the sheer of first deck and the vessel. On this ribband, the deck beams, placement of gunports, masts, and hatches were marked off.[151] Then deck beams and temporary beams were inserted; the latter functioned as a platform for the carpenters while they were working on the upper works of the ship. The hull planking was added up to the master ribband, which characterized the widest part of the hull. The futtocks were not fastened to each other or to the floors, but directly to the planking.

When Witsen published his manuscript in 1671, the shipyards of Rotterdam and possibly at other locales in the southern Netherlands had started to build their ships using a frame–based construction method.[152] This Mediterranean method was to entirely supersede the traditional Dutch method for the construction of warships and large merchantmen by the early eighteenth century.

The co–existence of the two construction methods was first noticed by scholars studying the manuscripts of Witsen and Van IJk, based on a remark by Van IJk that some people in the *Noorderkwartier* of the Netherlands were still using bottom–based construction to build ships.[153] Shipyards in the *Noorderkwartier*—the region of Holland situated north of the river IJ—, such as Zaandam, Enkhuizen, and Hoorn, continued to use the bottom–based construction sequence as described by Witsen until the late seventeenth century.[154] A Frenchman, named Arnoud visited English and Dutch shipyards on an assignment for Admiral Colbert, confirmed that the bottom–based construction method was still in use in 1670. He stated that the Dutch shipwrights did not insert frames until the first ten or twelve planks were erected, and that they adjusted the hull shape by eye as they went along.[155] In Amsterdam, however, —situated south of the river IJ and, therefore, not included in the *Noorderkwartier*— experimenting with frame–based construction may have begun as early as the mid–seventeenth century, as suggested by Ludolf Bakhuysen's drawing of the Amsterdam Admiralty shipyard, dated to around 1655–60 (Fig. II.18). It must be noted that even when the bottom–based construction method was no longer employed for large vessels, it continued to be used in local shipyards for the assembly of small traditional craft or inland watercraft.

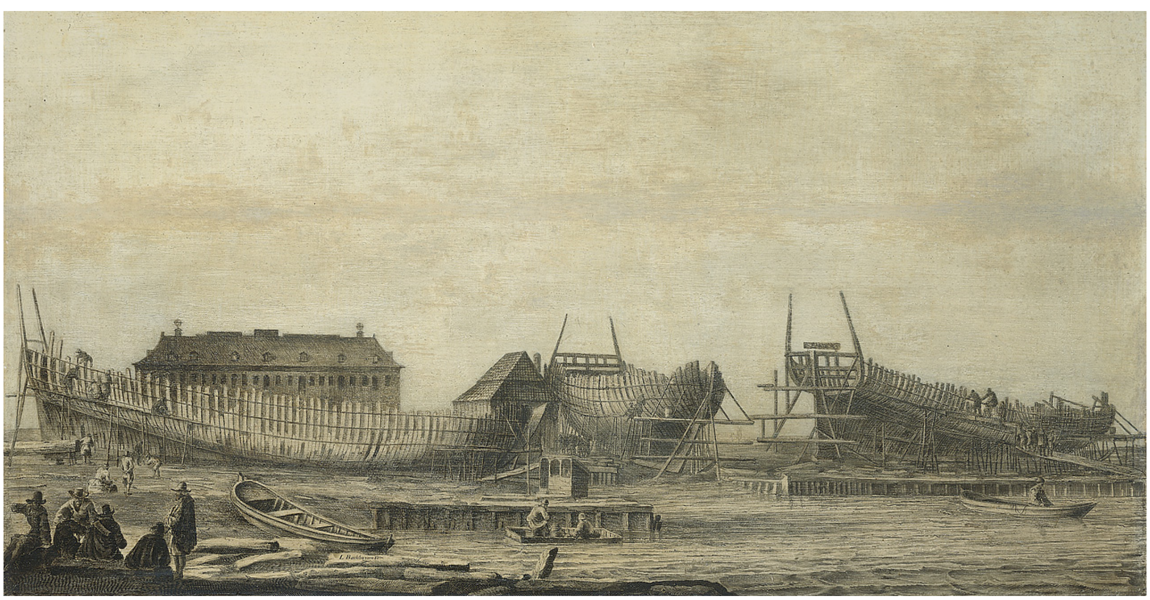

Fig. II.18 The shipyard of the Amsterdam Admiralty with three warships being constructed in a frame-first method. Ink on Painting: Ludolf Bakhuysen, 1655–60, Rijksmuseum Amsterdam (SK–A–1428).

**Frame–based construction in the late seventeenth century**

Cornelis van IJk published his book *Nederlandsche scheeps–bouw–konst open gestelt* on shipbuilding and seafaring in 1697. As a shipwright from Delft, van IJk did not descend from a high social class. He was born and bred in a family of shipwrights, and became an apprentice in a shipyard at the age of twelve. Van IJk mainly worked on shipyards in the southern Lowlands. He probably decided to write his book after his uncle, who was also a shipwright, left him a thick pile of shipbuilding notes.[156] Van IJk knew Witsen's work very well as he praises it in his introduction and cites it quite often. Although van IJk writes from an experienced point of view as a shipwright, and obviously knows the particulars of his profession very well, Witsen's work is much more detailed.

Van IJk described the design and construction of a complete vessel from step one, as Nicolaes Witsen did, but for a frame–based construction method. Similar to Witsen's construction sequence, the garboard strakes were inserted after the keel was laid and the central spine were assembled (Fig. II.19). Where Witsen discussed the assembly of the ship's bottom planking, Van IJk continued with the erection of two full main frames consisting of seven timbers each: One floor, two first futtocks, two second futtocks, and two third futtocks (Fig. II.19). The first pre–assembled main frame was placed at a measured distance from the stem, this distance was the sum of half the length of the hull and half the length of the stem. The second one was placed on one quarter distance from the first frame to the beginning of stem. Between these two frames, the shape of the hull did not change. Van IJk did not discuss the design of the two master frames or their dimensions. The curvatures of both frames depended mainly on the beam and depth of the vessel, and on the eye and judgment of the master builder.[157] If this applied to frame–based construction in late–seventeenth century Holland, it must have applied to the bottom–based construction as described by Witsen as well.

Next, vertical poles were driven into the ground around the ship to define the sheer line or the shape of the hull from a bird's eye view (Fig. II.19). In addition, a second row of poles was inserted to allow the construction of scaffolding and create a

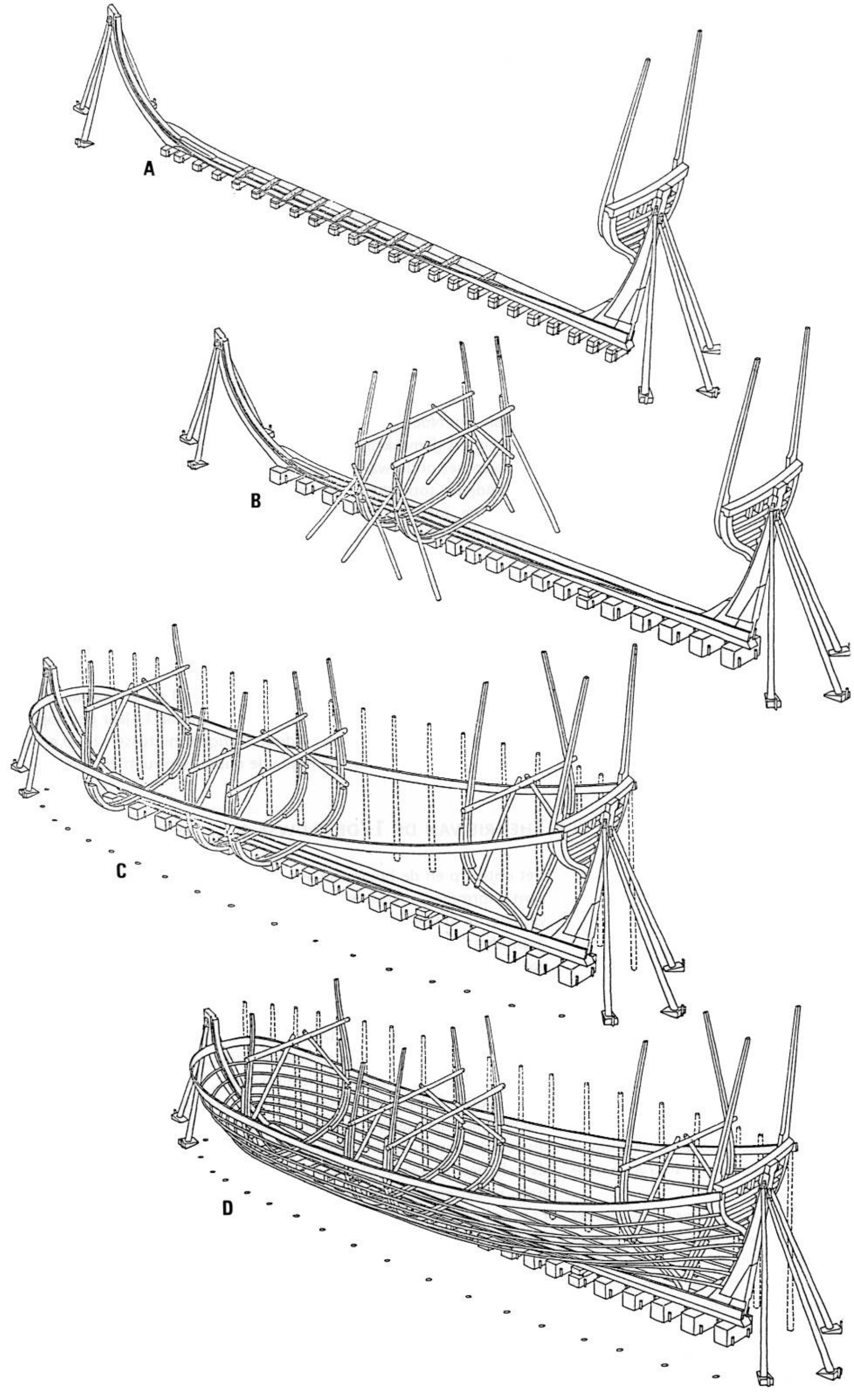


Fig. II.19 Frame–based construction method as described by Van IJk. Illustration: Anton van de Heuvel.

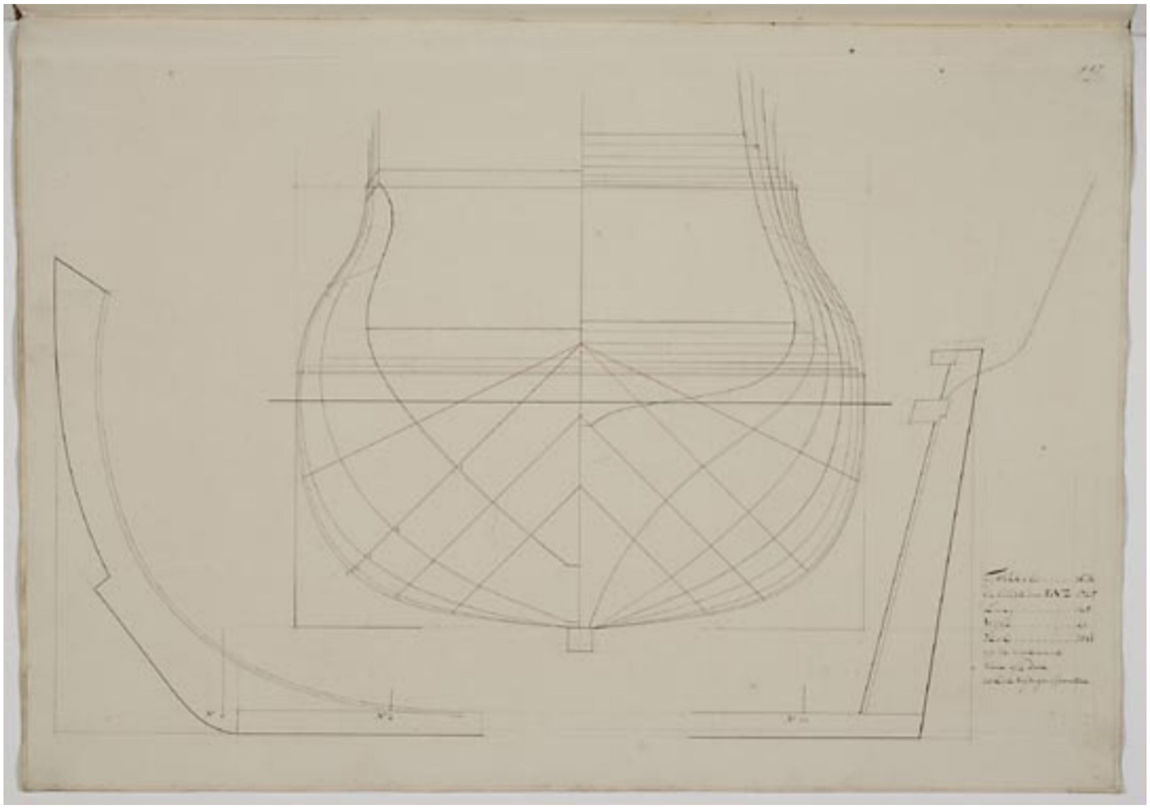

Fig. II.20 Body plan with diagonals, stem and sternpost of *Twikkelo,* built by Paulus van Zwijndregt in 1725. Drawing: Paulus van Zwijndregt, Rotterdam Maritiem Museum, T1126–37.

working platform for the upper parts of the hull.[158] On the interior of the first line of poles, the shipwrights fastened the sheer strake or main ribband. Van IJk specifically mentioned that the main ribband was sometimes used to build several similar vessels, as the deck beams, placement of gunports, masts, and hatches were marked off on it.[159] After this main ribband was fastened, a third full frame was inserted on the scarf of the keel and the stem. The distance from the stem to this new frame was measured, and a tail frame was placed at the same distance from the sternpost.[160] Subsequently, eight to ten ribbands, depending on the size of the vessel, were placed on each side of the hull between the garboard strakes and main ribband. The ribbands ran over the entire length of the hull (Fig. II.19).[161] They determined the final shape of the hull and indicated the curvature of each hull planking strake. They were also used as a mould for the curvatures of the remaining frames. According to van IJk, the master shipwright shifted the ribbands up and down along the sides until he was satisfied with their shapes.[162]

It is not known exactly when Dutch shipbuilders brought the frame–based construction method, described by Van IJk, into their shipyards, but it must have been some time after 1650. The frame–based construction method became established by the early eighteenth century in all major Dutch shipyards. The first body plan that survived of a warship was drawn in 1725: it shows diagonals, as well as a stem and sternpost. This warship, named *Twikkelo*, was built by shipwright Paulus van Zwijndregt for the Rotterdam Admiralty (Fig. II.20).[163] It measured 145 feet in length, 41 feet in breadth, and 18 feet in height. It carried 56 guns.[164] By this time, Dutch shipwrights had learned to work with drawings. It had been one century since bottom–based construction was the foremost method of shipbuilding in the Netherlands. At the time *Batavia* was built in the VOC shipyard of Amsterdam, in the late 1620s, frame–based construction was not yet used in that region.

**VOC shipbuilding in the Netherlands and the Indies**

In the first decades after its establishment in 1602, the VOC bought existing vessels and refitted them to build up its fleet. Ideally, the VOC would construct vessels for its service according to its own standards. The company, however, continued to purchase vessels when certain circumstances, such as the sudden loss of assets or the need for a quickly outfitted military campaign, arose.[165] Purchased ships had to be modified and outfitted for the long journeys to Southeast Asia.[166]

The VOC shipyards could be found in its Chamber cities: Amsterdam, Hoorn, Enkhuizen, Rotterdam, Delft, and Middelburg (Zeeland). Unlike the Portuguese, Spanish, and English, the VOC built its large ships at home in the Netherlands. No large Indiamen were built in Asia; this probably allowed the VOC to control the construction costs and the prescribed construction guidelines. The VOC had no facilities and no good resources available in Asia to build such large ships. It had also been problematic to gain access to resources in the VOC's formative years, mainly due to inexperience and hostilities.

Pieter van Dam mentions the anomalous construction of a large Indiaman, named *Standvastigheid*, in 1690 in the VOC shipyard of Cochin on the southwestern coast of India. The ship was 114 Amsterdam feet (33 m) in length and 27.5 Amsterdam feet (7.8 m) in breadth. According to the records, it cost the VOC factory 34,642 guilders to build such a ship. This amount was roughly one–third of what it would have cost to build such vessel at home; it did not, however, include the wages of the Dutch carpenters that worked on it. The exclusion of the wages was reason enough for the VOC to revoke the construction of large ships, anywhere other than in Holland.[167] The ostensible reasoning for limiting outside work was the Gentlemen XVII's discomfort with exporting the VOC's shipbuilding knowledge abroad and its desire to avoid higher expenses in Asia. These may simply have been rationalizations to keep profits within the Netherlands.[168]

Jan Pieterzoon Coen, Governor–General of the Dutch Indies from 1619 to 1623, and from 1624 to 1629, would have liked to build large ships in Batavia, if it was not for the deficient number of carpenters, who already had their hands full with the doubling and maintenance of ships.[169] A chronic lack of ship carpenters and sawyers in VOC shipyards overseas continued throughout the seventeenth century.[170] The deficiency of craftsmen was evident in all Dutch shipyards in the Indies. The extracts of the daily journal kept in Batavia Castle note that ships were sent elsewhere to be doubled as the VOC shipyards in Jakarta were overstrained and ships had to wait in line for repairs.[171] On 10 June 1626, for example, the ship *Zuid–Holland* had just arrived from Holland and was sent to Japan to be renovated and repaired as its condition was nearly beyond redemption. It is specifically stated that the ship could not be repaired in Jakarta because of a lack of carpenters. Moreover, it would have taken a long time before the vessel could undergo repairs, due to a large number of ships and yachts in poor condition already waiting.[172]

The VOC did occasionally try to accommodate the constant shortage of ship carpenters in the Indies. The twelve ships that set sail to the Indies in 1612 under command of Adriaen Block Martenszoon were manned by double the usual number of ship carpenters.[173] Each ship of the 1612 fleet had one master carpenter, assisted by four competent carpenters, who were to stay in the Indies for two or three years.[174] In general, each VOC ship set sail from the Netherlands with two carpenters as, for example, the eleven ships of the Nassau fleet in 1623[175] Another complicating factor was the large percentage of carpenters that died during the lengthy voyages.

The construction of large ships in Asia was proposed throughout the VOC's existence. In 1651, VOC officials in Batavia suggested the construction of 120– to 200–ton ships at its shipyards in Japara and Siam. These ships were only to be used within the intra–Asiatic network, thereby saving the VOC from sending such vessels from the Netherlands.[176] The answer to this proposal from the VOC directors in the Netherlands was that the costs would, in fact, be much higher due to the expenses of transporting shipbuilding resources to Asia and the wages of the Dutch shipbuilders sent to Asia. In the late seventeenth century, it was mentioned by VOC officials that it was better to construct ships locally, in the Netherlands, as it provided work and kept the wages and profits within the country, which was preferred over sending money for shipbuilding to the Indies.[177]

The VOC did build smaller and lighter craft on the shipyards in the Indies, with a maximum length of 60 Amsterdam feet (17 m).[178] On the island Onrust, for example, small vessels such as ship's boats, chaloupes, and local watercraft such as *pantchialing* were built. These boats were also maintained there.[179]

Special expeditions were organized to construct small vessels on Mauritius or other stations in Asia. In September 1604, the VOC decided to send men with its ship *Eendracht* to Mauritius and Monomotapa (modern–day South Africa) to build two sloops. The crew was instructed to build one sloop of 54 feet (about 15.3 m) in length, 13 feet in breadth (about 3.7 m), and 6 feet (about 1.7 m) in height amidships.[180] It was to be assembled with oak planks and doubled with pine sheathing, animal hair, and filling nails. The second sloop was to be 36 or 38 feet (10.2 m or 10.8 m) in length, 9 feet (2.6 m) in breadth, and 4.5 feet (1.3 m) in height.[181]

At sea, Dutch seamen kept an eye out for good anchorages, wood–providing forests with suitable timber, and potential shipyards. The availability, height, and quality of trees for masts and planks were, for example, closely observed during the journey with the yachts *Vos* and *Kraan* under the command of Jan Corneliszoon May to the Arctic Ocean and North America in 1611 and 1612.[182] In the Indies, Pieter van den Broecke noted in 1615: "This island [Ternate] is, to my mind, a very appropriate and well–situated location for our nation, as an abundance of resources are available here, specifically good wood to build light watercraft, such as galleys and frigates, and double ships."[183] These personal opinions about the availability of trees did not necessarily result in actual quality timber for shipbuilding. The Dutch experiences with tropical wood were still in their infancy. A galley was, for example, built in Kambello (Ceram, Moluccas) with local timber from so–called *Coninxberger* trees. This was probably a softwood resembling pine that was imported into the Lowlands from Kaliningrad, an area located between Lithuania and Poland. According to Witsen, the best pine and also oak available on the market came from here.[184] What the Dutch refer to as *Coninxberger* wood in the Moluccas used for the construction of the galley turned out be local lumber of a slightly different quality. Although the galley proved to be an admirable rowing vessel, it almost literally fell apart due to worm damage within three months after it was built. The wood was apparently not worm–resistant, but, to the contrary, was worm–attracting.[185]

VOC shipyards in Asia were mainly focused on keeping the fleet and return–voyage ships afloat and shipshape. The company simply had no interest in commencing a colonial shipbuilding program like its European counterparts.

**Construction costs of Indiamen**

According to Witsen, it was not realistic to try and calculate the total construction costs of a ship as it was different for each ship due to availability of workers or craftsmen, wood prices, prices of other resources such as iron and copper, and incidental expenses during construction.[186] He does list a cost of 93,635 guilders for a ship of 165 Amsterdam feet (47 m). Making his calculation, he included wood for the hull and masts, nails, tar, wadding, rope, rigging, iron, waterproofing, labor, anchors, and outfitting, everything except the armament.[187]

Van IJk elaborated on this amount and added to it. He insisted on higher labor costs regarding the number of decks. He increased the weight of the anchors, pointed out an error in Witsen's calculations for the rope work, and specified that Witsen missed an entry for the rigging blocks.[188] Van IJk rectified the amount for building this ship to an estimate of 113,000 guilders.[189] He agreed with Witsen that many factors affected cost estimates, as many conditions influenced the actual building costs. Lastly, he added that trying to come up with an estimate will always result in a much cheaper or much more expensive ship.[190] Nevertheless, the construction of large 1200–ton Indiamen roughly cost 100,000 guilders in the second half of the seventeenth century. Timbers and wages for the construction of the hull and masts comprised seventy percent of the total costs.[191] The remaining thirty percent was allocated to the sails, rigging, anchors, and armament.

The previously mentioned Indiaman *Standvastigheid* was probably the only large VOC ship built by the Dutch in Asia up to 1690. Its construction cost of 34,642 guilders was one–third of that of a similar ship in the Netherlands. It may have been cheaper to build ships in the Indies, but it is difficult to compare this amount to estimates provided by Witsen and Van IJk, since it did not include the wages of the Dutch workmen.[192] The costs of construction increased exponentially in the eighteenth century. Ships built according to the shipbuilding charter for the largest VOC ships cost roughly 135,000 to 140,000 guilders in 1735, whereas they cost approximately 184,000 guilders in 1790.[193]

All the costs listed above derive from the late seventeenth century. Unfortunately, the total costs for the construction of similar VOC ships in the Netherlands were not written down in the early seventeenth century. The monetary values of ships were, however, listed when they were bought by the VOC or if they were appraised during annual inspections. In the fall of 1604, for example, the VOC bought three large ships from private long–distance trading companies: *Amsterdam* (700 tons), *Mauritius* (700 tons), and *Witte Leeuw* (540 tons). They paid 21,000 guilders for *Amsterdam*, 23,500 for *Mauritius*, and 55,000 for *Witte Leeuw*.[194] The last ship was twice as expensive although it was much smaller than the other two ships. *Witte Leeuw* had just returned from the Indies and it had only made such a journey once. In order to prepare these purchased ships for their journey to the Indies, they were refitted in the VOC shipyards, which undoubtedly added a substantial sum to the investment.[195] How much was spent to re–fit the ships and to make them suitable for their purpose is unknown.

From ships' appraisals in general, it is known that VOC ships were categorized as new, half–worn, and old ships. These appraisals were part of annual inspections introduced by the VOC directors in Batavia in order to use ships as efficiently as possible. New ships were those considered to be in good condition for the trip to Europe, half–worn ships or ships in moderate condition were used for the intra–Asiatic trade on the China–Japan and India–Arabia routes. Old ships were those considered to be in poor condition. Even if ships were considered 'old,' their careers were not over and they were deployed on short trips, mainly from Batavia to the Spice Islands.[196] Large 800–ton ships that were considered new (being a few years old), were generally valued at 80,000 guilders in the 1620s.[197] This amount does not include their armament, which easily added an extra 15,000 guilders.[198]

**Conclusion**

The invention of the sawmill in 1594 by Cornelis Corneliszoon of Uitgeest played a significant role during the sixteenth and seventeenth centuries in advancing the Dutch to the forefront of rapid production of ships. The economizing of labor and material gained by combining carvel–planking with the Dutch bottom–based tradition, and the efficiency of the Dutch timber trade were contributing factors to the edge afforded to Dutch shipbuilding during this period. While the Dutch adopted carvel building practices from the Mediterranean during this period, they did not further attempt to experiment with the Mediterranean design concept employing frame–based methods.

The manuscripts of Witsen and Van IJk, dating to the late seventeenth century, demonstrate the mnemonic and practical character of Dutch shipbuilding. In the first instance, Witsen appears to describe the design of a midship mould on paper in order to define the amidships curve for a bottom–based hull, but based on his explanation of the construction sequence, it is clearly understood that Dutch shipbuilders following a bottom–based design method could do so perfectly well by eye only. Witsen used a midship mould to describe the basic curvature of the hull amidships, so he actually referred to a midship section and not a mould for the design of floors and futtocks. The method described by Witsen did not require hull design on paper. At the time Witsen was writing his manuscripts, the 'newer' Mediterranean frame–based method started to take over the 'old–fashioned' Dutch bottom–based construction method. The frame–based construction method was first introduced to the southern part of the Netherlands, and by the beginning of the eighteenth century had made its way up north. By this time the method described by van IJk was part of the daily routine in the shipyard and he does not discuss matters of ship design from the naval architects point of view. Both Witsen and van IJk give a thorough explanation of practical matters of shipbuilding, and they are both extremely useful sources on Dutch shipbuilding practices in the seventeenth century. Although more theoretical manuscripts on naval architecture do not exist for the Dutch seventeenth century, Witsen and Van IJk are the most comprehensive manuscripts in Europe to describe the ins and out of shipyard procedures.

The late sixteenth century saw dynamic developments in the Dutch shipbuilding industry as a result of the country's socio–economic, technological, and political climates. Two major developments were the lengthening of existing vessels and the introduction of new ship types such as the flute. Also, construction features such as the flat transom were introduced and quickly became widespread for yachts and large ships. From 1595, when the Dutch started sailing to Asia themselves, new ships had to be designed and constructed for the long–distance trading voyages to Asia and back. Not much is known of these ships from historical sources in the late sixteenth and early seventeenth century. With the founding of the VOC in 1602, specific guidelines for its shipwrights were written down in so–called construction charters. These charters are important documents for the study of the Dutch East India yachts and ships, and demonstrate that the vessels were heavily constructed and had two decks in the early seventeenth century.

It is however not specifically known what made these fully–rigged ships so different from other mercantile ships, other than their obvious physical features such as a flat transom, pine sheathing, and deck arrangement, and what specific customized features were considered important for their long voyage to Asia. In the coming chapters, the archeological remains of *Batavia* and other Dutch–built long–distance trading vessels will be assessed to learn more on how these ships were constructed. The archaeological evidence will then be compared to what is known about VOC shipbuilding from its charters, and the manuscripts of Witsen and Van IJk.

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1 Frederick M. Hocker, "Bottom–Based Shipbuilding in Northwestern Europe," in *The Philosophy of Shipbuilding: Conceptual and Approaches to the Study of Wooden Ships*, ed. Frederick M. Hocker and Cheryl A. Ward (College Station: Texas A&M University Press, 2004), 80.

2 Jules van Beylen, *Schepen van de Nederlanden, van de late middeleeuwen tot het einde van de 17e eeuw* (Amsterdam: Van Kampen, 1970), 7.

3 Frederick M. Hocker, "The Development of the Bottom–Based Shipbuilding Tradition in Northwestern Europe and the New World" (Ph.D. diss., Texas A&M University, 1991), 163.

4 Jaap Ypey, "Wrak van een laat–zestiende–eeuws spiegeljacht," *Berichten Rijksdienst voor het Oudheidkundig Bodemonderzoek* III.1 (1952): 64.

5 Alice Overmeer, "Searching for the Missing Link? A Research on Clinker Built Ships in the 15th and 16th Centuries," in *SOJAbundel 2006*, ed. Ellen Gehring (Amsterdam: Symposium voor Onderzoek door Jonge Archeologen, 2006), 67.

6 Overmeer, "Searching for the Missing Link?" 63–72.

7 Alice Overmeer, letter to author, 6 February 2006.

8 Hocker, "Bottom–Based Shipbuilding in Northwestern Europe," 65–67.

9 Richard W. Unger, "The *Fluit*: Specialist Cargo Vessels 1500 to 1650," in *Cogs, Caravels, and Galleons: The Sailing Ship 1000–1650*, ed. Robert Gardiner (London: Conway Maritime Press, 1994), 124.

10 Hocker, "Bottom–Based Shipbuilding in Northwestern Europe."

11 Hocker, "The Development of the Bottom–Based Shipbuilding Tradition in Northwestern Europe and the New World," 179.

[12] Hocker, "The Development of the Bottom–Based Shipbuilding Tradition in Northwestern Europe and the New World," 178.

[13] Hocker, "The Development of the Bottom–Based Shipbuilding Tradition in Northwestern Europe and the New World," 166–67.

[14] Hocker, "Bottom–Based Shipbuilding in Northwestern Europe," 80.

[15] Hocker, "The Development of the Bottom–Based Shipbuilding Tradition in Northwestern Europe and the New World," 225.

[16] Hocker, "The Development of the Bottom–Based Shipbuilding Tradition in Northwestern Europe and the New World," 178–79.

[17] Including the inland–water ships, the annual forest area needed to build ships was 450,000 cubic meters, which equals a forest of 3,500 hectares. Nanning Porsius and Eric de Munck, "Over hout, de herkomst, de kwaliteitseisen en de bewerking daarvan," in *Cornelis Corneliszoon van Uitgeest: Uitvinder aan de basis van de Gouden Eeuw*, ed. Wladimir Dobber and Cees Paul (Zutphen: Walburg Pers, 2002), 147–48; Nanning Porsius, "Hout en schepen," *Zaans Erfgoed* 1:2 (2002): 10.

[18] Cornelis A. Schillemans, "De houtveilingen van Zaandam in de jaren 1655–1811" (Ph.D. diss., Universiteit van Amsterdam, 1947), 5, 9, and 17.

[19] Schillemans, "De houtveilingen van Zaandam in de jaren 1655–1811," 17.

[20] Porsius and De Munck, "Over hout, de herkomst, de kwaliteitseisen en de bewerking daarvan," 137.

[21] Dieter Eckstein, Willem A. Van Es, and Ernst Hollstein, "Beitrag zur Datierung der frühmittelalterlichen Siedlung Dorestad, Holland," *Berichten van de Rijksdienst voor het Oudheidkundig Bodemonderzoek: Proceedings of the State Service for Archaeological Investigations in the Netherlands* 1975 (25): 165–75; and Thomasz Wazny, "The Origin, Assortments and Transport of Baltic Timber," in *Constructing Wooden Images: Proceedings of the Symposium on the Organization of Labour and Working Practices of Late Gothic Carved Altarpieces in the Low Countries, Brussels, 25–26 October 2002*, ed. Carl van de Velde et al. (Brussels, VUB Press, 2006), 115.

[22] Wazny, "The Origin, Assortments and Transport of Baltic Timber," 116.

[23] Jacobus R. Bruijn, "The Timber Trade: The Case of Dutch-Norwegian Relations in the 17th Century," in *The North Sea: A Highway of Economic and Cultural Exchange, Character–History*, ed. Arne Bang-Andersen, Basil Greenhill, and Egil Harald Grude (Oslo: Norwegian University Press, 1985), 123-135; Porsius and De Munck, "Over hout, de herkomst, de kwaliteitseisen en de bewerking daarvan," 148; and Porsius, "Hout en schepen," 11.

[24] Jur Kingma, "De wereld van hout en mechanische zagerij in *Cornelis Corneliszoon van Uitgeest: Uitvinder aan de basis van de Gouden Eeuw*, ed. Wladimir Dobber and Cees Paul (Zutphen: Walburg Pers, 2002), 66; and Hans Bonke, "Van Amsterdam tot Japara: Houtzagen voor de VOC," in *Cornelis Corneliszoon van Uitgeest: Uitvinder aan de basis van de Gouden Eeuw*, ed. Wladimir Dobber and Cees Paul (Zutphen: Walburg Pers, 2002), 140–41.

[25] Porsius and De Munck, "Over hout, de herkomst, de kwaliteitseisen en de bewerking daarvan," 148; and Porsius, "Hout en schepen," 11.

[26] Kingma, "De wereld van hout en mechanische zagerij," 67; Porsius, "Hout en schepen," 13; and Cornelis van IJk, *De Nederlandsche scheeps–bouw–konst open gestelt: Vertoonende naar wat regel, of evenredenheyd, in Nederland meest alle scheepen werden gebouwd; mitsgaders masten, zeylen, ankers, en touwen, enz. daar aan gepast: Soo uit de schriften van ouder, als jonger bouw–meesters, als ook by eygen ondervindinge, tot nut van alle jonge bouw–meesters, en knechten, als ook uitreeders, en liefhebbers van scheepen* (Delft: Andries Voorstad, 1697), 37.

[27] Hocker, "The Development of the Bottom–Based Shipbuilding Tradition in Northwestern Europe and the New World," 179.

[28] Bonke, "Van Amsterdam tot Japara: Houtzagen voor de VOC," 206.

[29] Bonke, "Van Amsterdam tot Japara: Houtzagen voor de VOC," 205.

[30] Vibeke Kingma, “De betekenis van de uitvindingen van Cornelis Corneliszoon voor de Nederlandse nijverheid,” in *Cornelis Corneliszoon van Uitgeest: Uitvinder aan de basis van de Gouden Eeuw*, 133.

[31] Gerrit J. Honig, “De molens van Amsterdam: De invloed van de molens op het industrieele leven in de Gouden Eeuw,” *Jaarboek van het genootschap Amstelodamum* 27 (1903): 95.

[32] Honig, “De molens van Amsterdam,” 95–96.

[33] Honig, “De molens van Amsterdam,” 96.

[34] Kingma, “De betekenis van de uitvindingen van Cornelis Corneliszoon voor de Nederlandse nijverheid,” 133; see also Porsius, “Hout en schepen,” 11.

[35] Cornelis A. Schillemans, “De houtveilingen van Zaandam in de jaren 1655–1811” (Ph.D. diss., Universiteit van Amsterdam, 1947), 11.

[36] Kingma, “De betekenis van de uitvindingen van Cornelis Corneliszoon voor de Nederlandse nijverheid,” 133.

[37] Kingma, “De betekenis van de uitvindingen van Cornelis Corneliszoon voor de Nederlandse nijverheid,” 133–34.

[38] Johannes G. van Dillen, *Bronnen tot de geschiedenis van het bedrijfsleven en het gildewezen van Amsterdam* (’s–Gravenhage: Martinus Nijhoff, 1933), 694–96 (no. 1250).

[39] Van Dillen, *Bronnen tot de geschiedenis van het bedrijfsleven en het gildewezen van Amsterdam* (1933), 716–17 (no. 1284).

[40] Van Dillen, *Bronnen tot de geschiedenis van het bedrijfsleven en het gildewezen van Amsterdam* (1933), 721–22 (no. 1292).

[41] Kingma, “De betekenis van de uitvindingen van Cornelis Corneliszoon voor de Nederlandse nijverheid,” 134.

[42] Johannes G. van Dillen, *Bronnen tot de geschiedenis van het bedrijfsleven en het gildewezen van Amsterdam* (’s–Gravenhage: Martinus Nijhoff, 1974), 182–83 (no. 355).

[43] Bonke, “Van Amsterdam tot Japara: Houtzagen voor de VOC,” 157–58.

[44] Hocker, “The Development of the Bottom–Based Shipbuilding Tradition in Northwestern Europe and the New World,” 111–15.

[45] André Wegener Sleeswyk, *De Gouden Eeuw van het fluitschip* (Franeker: Van Wijnen, 2003), 39.

[46] Christian P.P. Lemée, *The Renaissance Shipwrecks from Christianshavn: An Archaeological and Architectural Study of Large Carvel Vessels in Danish Waters, 1580–1640* (Roskilde: The Viking Ship Museum, 2006), 262.

[47] Wegener Sleeswyk, *De Gouden Eeuw van het fluitschip*, 39.

[48] Unger, “The *Fluit*: Specialist Cargo Vessels 1500 to 1650,”, 121; and Wegener Sleeswyk, *De Gouden Eeuw van het fluitschip*, 40.

[49] Tolls or dues had to be paid to the Danish Crown by all ships passing through the Danish Sound, the narrow waterway between Denmark and Sweden.  Wegener Sleeswyk, *De Gouden Eeuw van het fluitschip*, 9–10, 18.

[50] Wegener Sleeswyk, *De Gouden Eeuw van het fluitschip*, 29–35.

[51] Wegener Sleeswyk, *De Gouden Eeuw van het fluitschip*, 17–19.

[52] Wegener Sleeswyk, *De Gouden Eeuw van het fluitschip*, 17.

[53] Wegener Sleeswyk, *De Gouden Eeuw van het fluitschip*, 9.

[54] Violet Barbour, “Dutch and English Merchant Shipping in the Seventeenth Century,” *The Economic History Review* 2.2 (1930): 275.

[55] Unger, “The *Fluit*: Specialist Cargo Vessels 1500 to 1650,” 125.

[56] Geoffrey V. Scammell, *The World Encompassed: The First European Maritime Empires c. 800–1650* (London and New York: Methuen, 1981), 427.

[57] Wegener Sleeswyk, *De Gouden Eeuw van het fluitschip*, 27.

[58] Wegener Sleeswyk, *De Gouden Eeuw van het fluitschip*, 27.

[59] Wegener Sleeswyk, *De Gouden Eeuw van het fluitschip*, 27.

[60] Unger, “The *Fluit*: Specialist Cargo Vessels 1500 to 1650,” 122.

[61] Martijn R. Manders, "The BZN 10–Wreck, Threatened by Nature?" *Bulletin of the Australasian Institute for Maritime Archaeology* 26 (2002): 101.

[62] Unger, "The *Fluit*: Specialist Cargo Vessels 1500 to 1650," 122.

[63] Wegener Sleeswyk, *De Gouden Eeuw van het fluitschip*, 25–26.

[64] Bruijn, "The Timber Trade," 124; Wegener Sleeswyk, *De Gouden Eeuw van het fluitschip*, 26–27.

[65] Jan H. van Linschoten, *Reizen van Jan Huyghen van Linschoten naar het Noorden (1594–1595)* ('s–Gravenhage: Martinus Nijhoff, 1914).

[66] Samuel P. L'Honoré Naber, *Reizen van Willem Barents, Jacob van Heemskerck, Jan Cornelisz Rijp en anderen naar het Noorden, 1594–1597* ('s–Gravenhage: Martinus Nijhoff, 1917); and Ab J. Hoving, and Cor Emke, *Het schip van Willem Barents: Een hypothetische reconstructie van een laat–zestiende–eeuws jacht* (Hilversum: Verloren, 2004), 15.

[67] Gerret P. Rouffaer and Jan W. IJzerman, ed., *De Eerste Schipvaart der Nederlanders naar Oost–Indië onder Cornelis de Houtman, 1595–1597* ('s–Gravenhage: Martinus Nijhoff, 1915); and Gerret P. Rouffaer and Jan W. IJzerman, ed., *De Eerste Schipvaart der Nederlanders naar Oost– Indië onder Cornelis de Houtman, 1595–1597* ('s–Gravenhage: Martinus Nijhoff, 1925).

[68] Bruijn, Gaastra, and Schöffer, *Dutch Asiatic Shipping in the 17th and 18th Centuries: Introductory Volume*, 3.

[69] Femme S. Gaastra, *The Dutch East India Company: Expansion and Decline* (Zutphen: Walburg Pers, 2003), 16.

[70] Gaastra, *The Dutch East India Company*, 17.

[71] Gaastra, *The Dutch East India Company*, 19.

[72] Keuning, *De tweede schipvaart der Nederlanders naar Oost–Indië onder Jacob Cornelisz. van Neck en Wybrant Warwijck, 1598–1600* (1938); Johannes Keuning, ed., *De tweede schipvaart der Nederlanders naar Oost–Indië onder Jacob Cornelisz. van Neck en Wybrant Warwijck*, *1598–1600* ('s–Gravenhage: Martinus Nijhoff, 1944); and Johannes Keuning, ed., *De tweede schipvaart der Nederlanders naar Oost–Indië onder Jacob Cornelisz. van Neck en Wybrant Warwijck*, *1598–1600* ('s–Gravenhage: Martinus Nijhoff, 1947).

[73] Gaastra, *The Dutch East India Company*, 21.

[74] Gaastra, *The Dutch East India Company*, 21.

[75] Gaastra, *The Dutch East India Company*, 23.

[76] Elias, *De vlootbouw in Nederland in de eerste helft der 17e eeuw, 1596–1655*, 7; and Keuning, *De tweede schipvaart der Nederlanders naar Oost–Indië onder Jacob Cornelisz. van Neck en Wybrant Warwijck*, *1598–1600* (1938), lvii.

[77] F.L. Diekerhoff, *De oorlogsvloot in de zeventiende eeuw* (Bussum: Fibula–Van Dishoeck, 1967), 54–55.

[78] This calculation was based on the ships listed in: Bruijn, Gaastra, and Schöffer, *Dutch–Asiatic Shipping in the 17th and 18th Centuries: Homeward–bound Voyages from Asia and the Cape to the Netherlands (1597–1795)*; and Bruijn, Gaastra, and Schöffer, *Dutch–Asiatic Shipping in the 17th and 18th Centuries: Outward–bound Voyages from the Netherlands to Asia and the Cape (1595–1794)*.

[79] Perry Moree, *Dodo's en galjoenen. De reis van het schip* Gelderland *naar Oost–Indië*, *1601–1603* (Zutphen: Walburg Pers, 2001), 166.

[80] Van Beylen, *Schepen van de Nederlanden*, 10–11.

[81] *Pinasses* were small warships used by the Dutch Admiralties in the late sixteenth century. Sometimes *yachts* were referred to as *pinasses* as well. The name is used in the Netherlands in the seventeenth century for heavily–armed vessels, which became larger over time. Robert Parthesius, "Dutch Ships in Tropical Waters: The Development of the Dutch East India Company (VOC) Shipping Network in Asia 1595–1660" (Ph.D. diss., University of Amsterdam, 2007), 75.

[82] Keuning, *De tweede schipvaart der Nederlanders naar Oost–Indië onder Jacob Cornelisz. van Neck en Wybrant Warwijck*, *1598–1600*, lviii; Pieter van Dam, *Beschrijvinge van de Oostindische Compagnie*, ed. Frederik W. Stapel ('s–Gravenhage: Martinus Nijhoff, 1927), 456; Parthesius, "Dutch Ships in Tropical Waters," 65.

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[83] Oars were occasionally used even for ships up to 300 ton. Jan P. Coen, *Bescheiden omtrent zijn bedrijf in Indië*, ed. Herman T. Colenbrander ('s–Gravenhage: Martinus Nijhoff, 1922), 316; Parthesius, "Dutch Ships in Tropical Waters," 75.

[84] Parthesius, "Dutch Ships in Tropical Waters," 59.

[85] Parthesius, "Dutch Ships in Tropical Waters," 59.

[86] Lodewijk J. Wagenaar, "Het eiland Onrust bij Batavia als onderdeel van het VOC–scheepsbedrijf in de 17de en 18de eeuw," *Antiek* 25:2 (1990): 65.

[87] Parthesius, "Dutch Ships in Tropical Waters," 65.

[88] Petrus J.A.N. Rietbergen, *De eerste landvoogd Pieter Both (1568–1615): Gouverneur–generaal van Nederlands–Indië (1609–1614)* (Zutphen: De Walburg Pers, 1987), 222–23.

[89] Parthesius, "Dutch Ships in Tropical Waters," 59–85.

[90] The development of the different types of ships used by the VOC has been discussed in detail by Robert Parthesius ("Dutch Ships in Tropical Waters: The Development of the Dutch East India Company (VOC) Shipping Network in Asia 1595–1660" (Ph.D. diss., University of Amsterdam, 2007), 59–85).

[91] Most ships of the English East India Company made only four voyages to the Indies, and rarely served for more than ten yeas. The VOC, on the other hand, used its vessels for round–trip voyages as long as the ships were able, after which they were usually deployed for the intra–Asiatic trade. See, Bruijn, Gaastra, and Schöffer, *Dutch Asiatic Shipping in the 17th and 18th Centuries: Introductory Volume*, 95.

[92] Bruijn, Gaastra, and Schöffer, *Dutch Asiatic Shipping in the 17th and 18th Centuries: Introductory Volume*, 38–39.

[93] Three full or continuous decks do not come into use until the eighteenth century. Bruijn, Gaastra, and Schöffer, *Dutch Asiatic Shipping in the 17th and 18th Centuries: Introductory Volume*, 48.

[94] Ypey, "Wrak van een laat–zestiende–eeuws spiegeljacht," 65.

[95] Karl H. Marquardt, "The *Duyfken* Enigma: Some Alternative Design Possibilities," *The Great Circle* 29.1 (2007): 41–57.

[96] Adriaan de Jong, "Comment: Back to Square One: The *Duyfken* Strikes Back," *The Great Circle* 29.2 (2007): 3–15; Nick Burningham, "Round Sterns and Circular Arguments: A Response to Karl Heinz Marquardt's "The *Duyfken* Enigma"," *The Great Circle* 29.2 (2007): 16–28.

[97] Van Linschoten, *Reizen van Jan Huyghen van Linschoten naar het Noorden (1594–1595)*, plates by 38, 72, and 296.

[98] Jan W. IJzerman, *De Reis om de Wereld door Olivier van Noort, 1598–1601* ('s–Gravenhage: Martinus Nijhoff, 1926), title page, 12, 62, and 120.

[99] English translation of the title: *Ancient and Contemporary Shipbuilding and Management*. Nicolaes Witsen, *Architectura navalis et reginem nauticum: Ofte Aaloude en hedendaagsche scheeps–bouw en bestier, waar in wydtloopigh wert verhandelt de wyze van scheeps–timmeren, zoo als de zelve eertydts by de Grieken, en Romeinen, in gebruik was: Scheeps–oeffeningen, stryden, tucht, wetten en gewoonten: Beneffens evenmatige grootheden van de scheepen onzes tydts, ontleedt in alle hare delen: Verschil van bouwen tusschen landtaart: Indisch en Russisch vaar–tuigh: Galey–bouw, en hedendaagsche scheeps–plichten: Verrykt met een reeks verklaarde zeemans spreek–woorden en benaamingen* (Amsterdam: Pieter en Joan Blaeu, 1690).

[100] English translation: *The Art of Dutch Shipbuilding Exposed*. Van IJk, *De Nederlandsche scheeps–bouw–konst open gestelt*.

[101] Matthew Baker, *Fragments of Ancient English Shipwrightry* (Manuscript in the Pepysian Library of the Magdalene College, Cambridge University, CB3 OAG–PL 2920, ca. 1570–1630; Richard Barker, "Many May Peruse Us: Ribbands, Moulds and Models in Dockyards," *Revisa da Universidade de Coimbra* V.XXXIV (1988): 539–59; Richard Barker, "Fragments of the Pepysian Library," *Revisa da Universidade de Coimbra* V.XXXII (1986): 161–78; Ian Fennis, *Manuel de construction des galères (1691)* (Amsterdam: APA–Holland University Press, 1987); Joseph Furttenbach, *Architectura martialis; Architectura navalis; Architectura universalis* (Hildesheim and New York: George Olms Verlag, 1975); and William Salisbury and Roger C. Anderson, ed., *A Treatise on Shipbuilding and a Treatise on Rigging Written about 1620–1625* (London: The Society for Nautical Research, 1958).

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[102] Hoving and Emke, *Het schip van Willem Barents*, 117–20.

[103] This ship was presumably built according to a Dutch foot measure used by one of the towns in the Zeeland region, such as Middelburg (0.299 m), Vlissingen (0.301 m), or Veere (0.306 m). Cor Emke, letter to author, 23 April 2008.

[104] Van Dam, *Beschrijvinge van de Oostindische Compagnie*, 450–553.

[105] Parthesius, "Dutch Ships in Tropical Waters," 60.

[106] Parthesius, "Dutch Ships in Tropical Waters," 60.

[107] Bruijn, Gaastra, and Schöffer, *Dutch Asiatic Shipping in the 17th and 18th Centuries: Introductory Volume*, 38.

[108] National Archives (NA) of the Netherlands, The Hague, *Archieven van de Verenigde Oostindische Compagnie, 1602–1795*, reference code 1.04.02, item number 229 (Resoluties van de ordinaris en extraordinaris vergaderingen van de kamer Amsterdam, 18 November 1627).

[109] Van Dam, *Beschrijvinge van de Oostindische Compagnie*, 462–63.

[110] Van Dam, *Beschrijvinge van de Oostindische Compagnie*, 464.

[111] National Archives (NA) of the Netherlands, The Hague, *Archieven van de Verenigde Oostindische Compagnie, 1602–1795*, reference code 1.04.02, item number 230 (Minuut– en net–resoluties van de ordinaris en extraordinaris vergaderingen van de kamer Amsterdam), 12 December 1631.

[112] Parthesius, "Dutch Ships in Tropical Waters," 61.

[113] Parthesius, "Dutch Ships in Tropical Waters," 167.

[114] Van Dam, *Beschrijvinge van de Oostindische Compagnie*, 464.

[115] See Chapter VI, section 'Pine or fir sheathing'. W. Philippus Coolhaas, *Generale missiven van gouverneurs–generaal en raden aan Heren XVII der Verenigde Oostindische Compagnie* ('s–Gravenhage: Martinus Nijhoff, 1960), 478–79 (Henrick Brouwer, Antonio van Diemen, Jan van der Burch en Jan van Broeckum, Batavia, 27–December–1634).

[116] See Chapter V, section 'Dutch East Indiaman *Nassau* (1606).' Jacques l'Hermite de Jonge, *Breeder verhael ende klare beschrijvinge van tghene den admirael Cornelis Matelief de Jonge inde Oost–Indien voor de stadt Malacca, ende int belegh der zelver wedervaren is: als ooc den vreesselijcke strijdt ter zee, tusschen den admirael voorsz. ende de Portugijsen, ende andere gheschiedenissen meer* (Rotterdam: Jan Jansz, 1608), 339.

[117] Daniel G. Harris, *F.H. Chapman*: *The First Naval Architect and His Work* (London: Conway Maritime Press, 1989), 9; J. Richard Steffy, *Wooden Shipbuilding and the Interpretation of Shipwrecks* (College Station: Texas A&M University Press, 1998), 142.

[118] Barker, "Many May Peruse Us," 539–59; Hocker, "The Development of the Bottom–Based Shipbuilding Tradition in Northwestern Europe and the New World," 172.

[119] Barker, "Many May Peruse Us," 539–59; and Hocker, "The Development of the Bottom–Based Shipbuilding Tradition in Northwestern Europe and the New World," 172.

[120] Richard W. Unger, *The Ship in the Medieval Economy 600–1600* (London: Croom Helm, 1980), 111–15; and Harris, *F.H. Chapman*, 13.

[121] Baker, *Fragments of Ancient English Shipwrightry*; Edmund Bushnell, *The Compleat Ship–wright Microform: Plainly and Demonstratively Teaching the Proportions Used by Experienced Ship–wrights According to Their Custome of Building, Both Geometrically and Arithmetically Performed: to Which Is Added, Certain Propositions in Geometry* (London: Printed by W. Leybourn for George Hurlock, 1664); and Salisbury and Anderson, *A Treatise on Shipbuilding and a Treatise on Rigging Written about 1620–1625*.

[122] Barker, "Many May Peruse Us," 543–45 ; and Barker, "Fragments of the Pepysian Library," 162.

[123] Barker, "Fragments of the Pepysian Library," 162.

[124] Westcott Abell, *The Shipwright's Trade* (London: Conway Maritime Press, 1981), 28–38; and Steffy, *Wooden Shipbuilding and the Interpretation of Shipwrecks*, 142.

[125] Abell, *The Shipwright's Trade*, 28–38; and Steffy, *Wooden Shipbuilding and the Interpretation of Shipwrecks,* 142–45.

[126] Witsen, *Architectura navalis et reginem nauticum*, 168–70.

[127] Ab J. Hoving, and Gerald A. de Weerdt, *Nicolaes Witsens scheeps–bouw–konst open gestelt* (Franeker: Van Wijnen, 1994), 58–61.
[128] Witsen, *Architectura navalis et reginem nauticum*, 170.
[129] Ab J. Hoving and Robert Parthesius, "Twee 17de–eeuwse bouwmethoden," in *Herbouw van een Oostindïevaarder:* Batavia *Cahier* 3, ed. Robert Parthesius (Lelystad: Stichting Nederland bouwt een VOC–retourschip, 1991), 7.
[130] Witsen, *Architectura navalis et reginem nauticum*, 170.
[131] Ab Hoving, "Dutch Shipbuilding in the Seventeenth Century," *Nautical Research Journal* 53.1 (2008): 29.
[132] Witsen, *Architectura navalis et reginem nauticum*, 210–39, 340.
[133] Witsen, *Architectura navalis et reginem nauticum*, 94–177.
[134] Witsen, *Architectura navalis et reginem nauticum*, 190; and Hoving and De Weerdt, *Nicolaes Witsens scheeps–bouw–konst open gestelt*, 22.
[135] Hoving and De Weerdt, *Nicolaes Witsens scheeps–bouw–konst open gestelt*, 22–23.
[136] Witsen, *Architectura navalis et reginem nauticum*, 94.
[137] Witsen, *Architectura navalis et reginem nauticum*, 94.
[138] Witsen, *Architectura navalis et reginem nauticum*, 94–95.
[139] Witsen, *Architectura navalis et reginem nauticum*, 165–68.
[140] Witsen, *Architectura navalis et reginem nauticum*, 165.
[141] Witsen, *Architectura navalis et reginem nauticum*, 165–68.
[142] Witsen, *Architectura navalis et reginem nauticum,* 167.
[143] Witsen, *Architectura navalis et reginem nauticum*, 169.
[144] Witsen, *Architectura navalis et reginem nauticum*, 169.
[145] Hoving and Parthesius, "Twee 17de–eeuwse bouwmethoden," 7.
[146] Remnants of nail plugs are found on the hull planking of the Scheurrak T24 (post 1655), Inschot/Zuidoostrak (early seventeenth century), and Oostflevoland B71 (1614–1619) ships. See, Hocker, "The Development of the Bottom–Based Shipbuilding Tradition in Northwestern Europe and the New World," 214–15; Thijs J. Maarleveld, *Archaeological Heritage Management in Dutch Waters: Exploratory Studies* (Ketelhaven: Nederlands Instituut voor Scheeps– en onderwaterArcheologie, Rijksdienst Oudheidkundig Bodemonderzoek (NISA/ROB), 1998), 116–17, 127–29; and Thijs J. Maarleveld, Boudewijn Goudswaard, and Rob Oosting, "New Data on Early Modern Dutch–flush Shipbuilding: Scheurrak T24 and Inschot/Zuidoostrak," *IJNA* 23:1 (1994): 20, 22–24.
[147] Witsen also mentions that in Sweden planks are boiled to bend them more easily. Witsen, *Architectura navalis et reginem nauticum*, 170 and 334; and Van IJk, *De Nederlandsche scheeps–bouw–konst open gestelt*, 75.
[148] Witsen, *Architectura navalis et reginem nauticum*, 169.
[149] Hocker, "The Development of the Bottom–Based Shipbuilding Tradition in Northwestern Europe and the New World," 177.
[150] Witsen, *Architectura navalis et reginem nauticum*, 170.
[151] Hoving and Parthesius, "Twee 17de–eeuwse bouwmethoden," 8.
[152] Van IJk, *De Nederlandsche scheeps–bouw–konst open gestelt*, 69–70.
[153] Van IJk, *De Nederlandsche scheeps–bouw–konst open gestelt*, 78; Robert Parthesius, "De *Batavia* , een retourschip van de VOC," in *De* Batavia *te water*, ed. Vibeke Roeper, Robert Parthesius, and Lodewijk Wagenaar (Amsterdam: De Bataafsche leeuw, 1996), 81.
[154] For information on the *Noorderkwartier*, see Adrianus M. van der Woude, *Het Noorderkwartier: Een regionaal historisch onderzoek in de demografische en economische geschiedenis van westelijk Nederland van de late middel–eeuwen tot het begin van de negentiende eeuw* (Wageningen: H. Veenman en Zonen N.V., 1972), vol. 1, 19-30.
[155] Hocker, "The Development of the Bottom–Based Shipbuilding Tradition in Northwestern Europe and the New World," 176.
[156] Parthesius, "De *Batavia* , een retourschip van de VOC," 81.
[157] Van IJk, *De Nederlandsche scheeps–bouw–konst open gestelt*, 69.

[158] Van IJk, *De Nederlandsche scheeps–bouw–konst open gestelt*, 71.
[159] Van IJk, *De Nederlandsche scheeps–bouw–konst open gestelt*, 75.
[160] Van IJk, *De Nederlandsche scheeps–bouw–konst open gestelt*, 77.
[161] Van IJk, *De Nederlandsche scheeps–bouw–konst open gestelt*, 78–79.
[162] Van IJk, *De Nederlandsche scheeps–bouw–konst open gestelt*, 78–79.
[163] Ab Hoving, "Drawing the Line, or Why the Rotterdam Shipwrights Would Not Adopt the Amsterdam (English) Drafting Techniques," *Nautical Research Journal* 52.2 (2007): 71.
[164] Hoving, "Drawing the Line, or Why the Rotterdam Shipwrights Would Not Adopt the Amsterdam (English) Drafting Techniques," 71.
[165] Tristan Mostert, "Chain of Command," 54.
[166] National Archives (NA) of the Netherlands, The Hague*, Admiraliteitscolleges*, reference code 1.01.46, item number 1360; Van Dam, *Beschrijvinge van de Oostindische Compagnie*, 450; and Robert Parthesius, "De dubbele huid van Oostindïevaarders aan het begin van de 17de eeuw," in *Herbouw van een Oostindïevaarder:* Batavia *Cahier 3,* ed. Robert Parthesius (Lelystad: Stichting Nederland bouwt een VOC–retourschip, 1991), 26.
[167] Van Dam, *Beschrijvinge van de Oostindische Compagnie*, 453.
[168] Parthesius, "Dutch Ships in Tropical Waters," 167.
[169] Jan P. Coen, *Bescheiden omtrent zijn bedrijf in Indië*, ed. Herman T. Colenbrander ('s–Gravenhage: Martinus Nijhoff, 1920), 109 (14 May 1616).
[170] Hans Bonke, "Het eiland Onrust: Van scheepswerf van de VOC tot bedreigd historisch archeologisch monument," in *Hollanders uit en thuis: archeologie, geschiedenis en bouwhistorie gedurende de VOC–tijd in de Oost, de West en thuis: Cultuurhistorie van de Nederlandse expansie*, ed. Michiel H. Bartels, Erich H.P. Cordfunke, and Herbert Sarfatij (Hilversum: Verloren, 2002)*,* 49; Jan P. Coen, *Bescheiden omtrent zijn bedrijf in Indië*, ed. Herman T. Colenbrander ('s–Gravenhage: Martinus Nijhoff, 1919), 581; Coen, *Bescheiden omtrent zijn bedrijf in Indië* (1920), 109; W. Philippus Coolhaas, *Generale missiven van gouverneurs–generaal en raden aan Heren XVII der Verenigde Oostindische Compagnie* ('s–Gravenhage: Martinus Nijhoff, 1964), 481; A. de Booy, *De derde reis van de V.O.C. naar Oost–Indië onder het beleid van admiraal Paulus van Caerden uitgezeild in 1606* ('s–Gravenhage: Martinus Nijhoff, 1970), 143–44, and 151; Jan E. Heeres, ed., *Dagh–register gehouden int Casteel Batavia vant passerende daer ter plaetse als over geheel Nederlandts–India, anno 1624–1629* ('s–Gravenhage, Martinus Nijhoff, 1896), 164 and 260; and Margaretha E. van Opstall, ed., *De reis van de vloot van Pieter Willemsz Verhoeff naar Azië, 1607–1612* ('s–Gravenhage, Martinus Nijhoff, 1972), 125.
[171] Heeres, *Dagh–register gehouden int Casteel Batavia vant passerende daer ter plaetse als over geheel Nederlandts–India, anno 1624–1629*, 5, 26, 325.
[172] Heeres, *Dagh–register gehouden int Casteel Batavia vant passerende daer ter plaetse als over geheel Nederlandts–India, anno 1624–1629*, 260 (10 June 1626).
[173] National Archives (NA) of the Netherlands, The Hague, *Archieven van de Verenigde Oostindische Compagnie, 1602–1795*, reference code 1.04.02, item number 100 (Kopie–resoluties van de Heren XVII, 1608–1623), folio 169, point 13 (14 November 1611).
[174] National Archives (NA) of the Netherlands, The Hague, *Archieven van de Verenigde Oostindische Compagnie, 1602–1795*, reference code 1.04.02, item number 100 (Kopie–resoluties van de Heren XVII, 1608–1623), folio 148 (1611).
[175] Willem Voorbeijtel Cannenburg, ed., *De reis om de wereld van de Nassausche vloot, 1623–1626* ('s–Gravenhage, Martinus Nijhoff, 1964), 20; and Bruno E.J.S Werz, *Diving up the Human Past: Perspectives of Maritime Archaeology, with Specific Reference to Developments in South Africa until 1996* (Oxford: J. and E. Hedges, 1999), 202–4. Two ship's carpenters and two carpenter's mates are, for example, enlisted on the VOC–ship *Haarlem*, and one ship's carpenter and two carpenter's mates are enlisted on the VOC–ship *Oosterland*.
[176] Coolhaas, *Generale missiven van gouverneurs–generaal en raden aan Heren XVII der Verenigde Oostindische Compagnie*, 481.
[177] Van Dam, *Beschrijvinge van de Oostindische Compagnie*, 453.
[178] Van Dam, *Beschrijvinge van de Oostindische Compagnie*, 453.

[179] Wagenaar, "Het eiland Onrust bij Batavia als onderdeel van het VOC–scheepsbedrijf in de 17de en 18de eeuw," 68.

[180] It is not known whether they were built according to the Amsterdam, Rotterdam, or another Dutch feet measure.

[181] National Archives (NA) of the Netherlands, The Hague, *Archieven van de Verenigde Oostindische Compagnie, 1602–1795*, reference code 1.04.02, item number 99 (Kopie–resoluties van de Heren XVII, 1602–1607), folio 145 (September 1604).

[182] Jan C. May, *De reis van Jan Cornelisz. May naar de IJszee en de Amerikaanse kust, 1611–1612*, ed. Samuel Muller ('s–Gravenhage, Martinus Nijhoff, 1909), xlviii, 46–53.

[183] Pieter van den Broecke, *Pieter van den Broecke in Azië*, ed. W. Philippus Coolhaas ('s–Gravenhage: Martinus Nijhoff, 1962), 62, March 1615. Frigates were small open boats rigged with two lateen sails.

[184] Witsen, *Architectura navalis et reginem nauticum*, 199.

[185] Jan P. Coen, *Bescheiden omtrent zijn bedrijf in Indië*, ed. Herman T. Colenbrander ('s–Gravenhage: Martinus Nijhoff, 1952), 530.

[186] Witsen, *Architectura navalis et reginem nauticum*, 175–76.

[187] Witsen, *Architectura navalis et reginem nauticum*, 175–77.

[188] Van IJk, *De Nederlandsche scheeps–bouw–konst open gestelt*, 287–99.

[189] Van IJk, *De Nederlandsche scheeps–bouw–konst open gestelt*, 299.

[190] Van IJk, *De Nederlandsche scheeps–bouw–konst open gestelt*, 287.

[191] Bruijn, Gaastra, and Schöffer, *Dutch Asiatic Shipping in the 17th and 18th Centuries: Introductory Volume*, 27.

[192] Van Dam, *Beschrijvinge van de Oostindische Compagnie*, 453.

[193] Bruijn, Gaastra, and Schöffer, *Dutch Asiatic Shipping in the 17th and 18th Centuries: Introductory Volume*, 28.

[194] National Archives (NA) of the Netherlands, The Hague, *Archieven van de Verenigde Oostindische Compagnie, 1602–1795*, reference code 1.04.02, item number 99 (Kopie–resoluties van de Heren XVII, 1602–1607), folio 146 (September–December 1604); Van Dam, *Beschrijvinge van de Oostindische Compagnie*, 450.

In the VOC archives, *Amsterdam* is listed as a ship of approximately 500 tons, *Mauritius* approximately 800 tons, and *Witte Leeuw* approximately 600 tons. This is an estimate provided at the time when the ships were purchased by the VOC. When the three ships were refitted and set sail to the Indies, the VOC archives and the first page of the journal of the journey under Commander Cornelis Matelief de Jonge, listed the ships respectively, more accurately, as 700, 700, and 540 tons. See: National Archives (NA) of the Netherlands, The Hague, *Archieven van de Verenigde Oostindische Compagnie, 1602–1795*, reference code 1.04.02, item number 99 (Kopie–resoluties van de Heren XVII, 1602–1607), folio 161; and Isaac Commelin, ed., and Cornelis Matelief de Jonge, "Historische verhael vande treffelijcke reyse, gedaen naer de Oost–Indien ende China met elf Schepen, door den manhaften Admirael Cornelis Matelief de Jonge, inden jaren 1605, 1606, 1607, ende 1608," in *Begin ende Voortgangh der Vereenigde Nederlantsche Geoctroyeerde Oost–Indische Compagnie. Begrypende de volgende twaelf voyagien door de inwoonderen der selviger provintien derwaerts gedaen* (Amsterdam: Facsimile Uitgaven Nederland, 1969), 1.

[195] National Archives (NA) of the Netherlands, The Hague, *Archieven van de Verenigde Oostindische Compagnie, 1602–1795*, reference code 1.04.02, item number 99 (Kopie–resoluties van de Heren XVII, 1602–1607), folio 146 (September–December 1604).

[196] Bruijn, Gaastra, and Schöffer, *Dutch Asiatic Shipping in the 17th and 18th Centuries: Introductory Volume*, 95, 100.

[197] Coen, *Bescheiden omtrent zijn bedrijf in Indië* (1922), 52–54.

[198] Coen, *Bescheiden omtrent zijn bedrijf in Indië* (1922), 52–54.

# CHAPTER III
# SITE FORMATION, EXCAVATION, AND RECONSTRUCTION

This chapter discusses the archaeological circumstances in which *Batavia*'s wreck was found, starting with the site's location, the wrecking event, and the site's formation. The excavation methodology is discussed when directly related to the hull study. The methodology used to record and draw *Batavia*'s hull timbers is assessed. This chapter then outlines the reassembly of the ship's hull for museum display and the methods used to take *Batavia*'s lines from the reassembled structure. The main purpose is to evaluate excavation and recording methods pertaining to *Batavia*'s hull and their influence on this study. The chapter concludes with a detailed discussion of the research method used for this particular study.

**The formation of the shipwreck site**

The Houtman Abrolhos is an archipelago of islands and reefs situated about sixty kilometers off the Western Australian coast. It includes one distinct island and three main island groups: North Island, the Pelsaert Group, also known as the Southern Group, the Easter Group, and the Wallabi Group (Fig. III.1). The remains of the *Batavia* lie at a depth of 3 to 7 meters at the southwestern end of Morning Reef in the Wallabi Group of islands (Fig. III.2). The wreck site covers an area of about 50 m in length and 15 m in width and is orientated in a north–south direction with the ship's bow at the northern end on top of the reef edge in the shallower part of the site (Figs. III.3–4).

Over time, portions of *Batavia*'s hull structure were buried beneath a layer of concretion, sand, and coral–lumps. They were pressed into the reef by the heavy weight of the ship's cargo, equipment, and the belongings of the people on board. The cavity left behind after the wreck's excavation and the removal of the ship's timbers is still visible today when seas are calm. From a bird's eye view, it stands out like a visual memorial of *Batavia*'s shipwrecking event (Fig. III.3). In addition to the imprint created by *Batavia*'s hull timbers, twelve iron cannon and eight anchors —seven on the


Fig. III.1 The location of the *Batavia* shipwreck among the islands of the Houtman Abrolhos. GIS: Wendy Van Duivenvoorde.

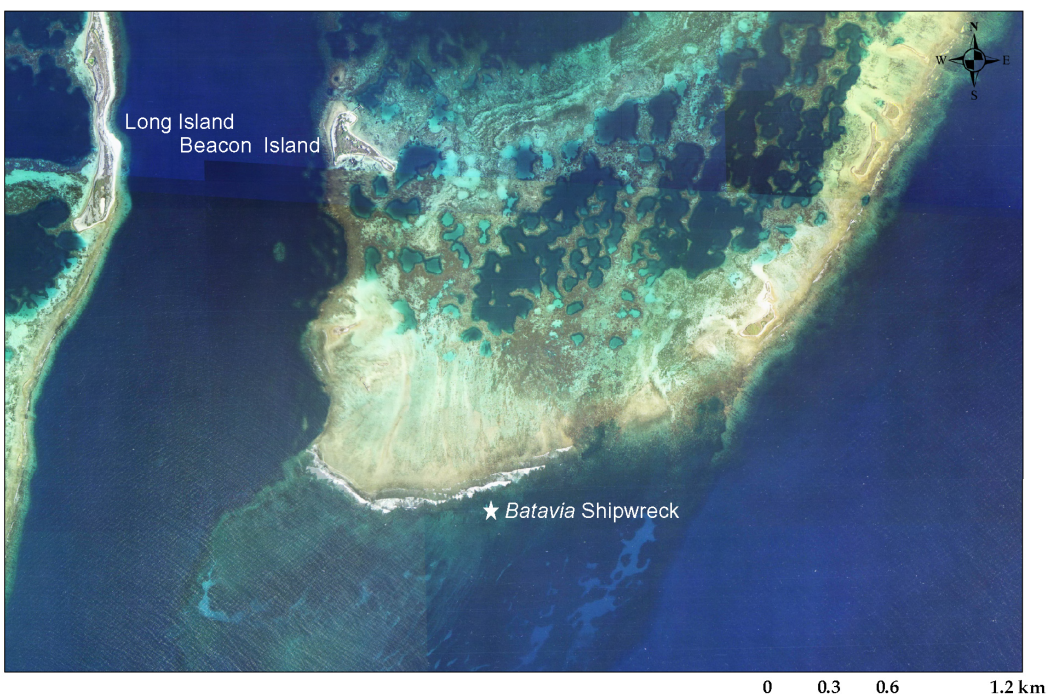


Fig. III.2 The *Batavia* shipwreck site, marked with a star, south of Beacon Island in the Wallabi Group of islands, Houtman Abrolhos. GIS: Wendy van Duivenvoorde.

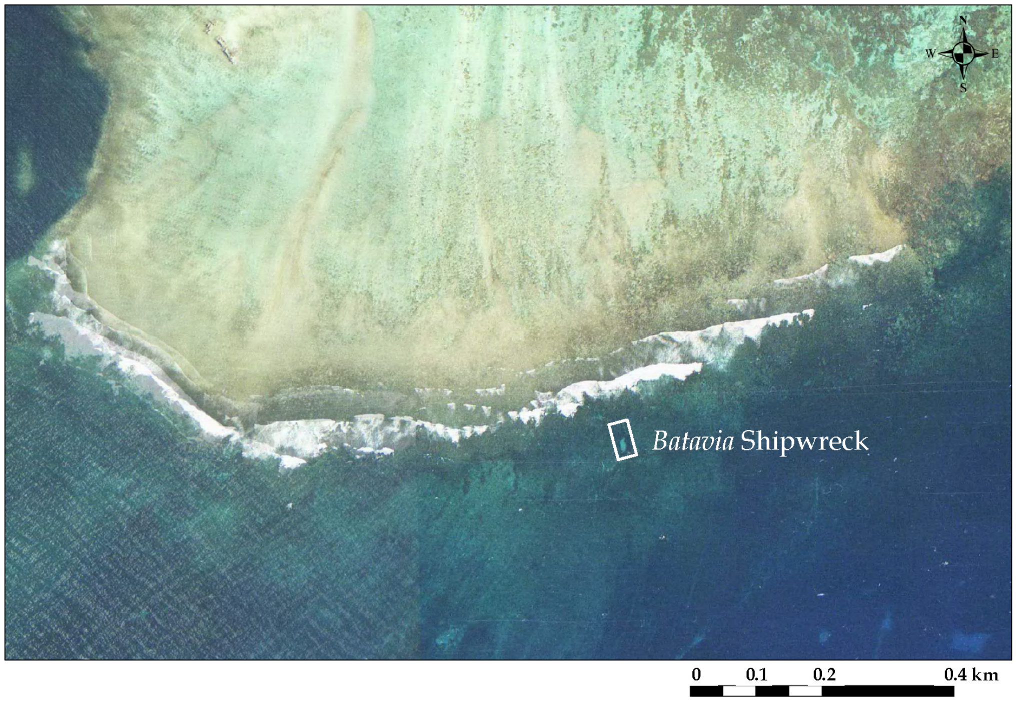


Fig. III.3 Map of Morning Reef and the *Batavia* shipwreck site. GIS: Wendy van Duivenvoorde.

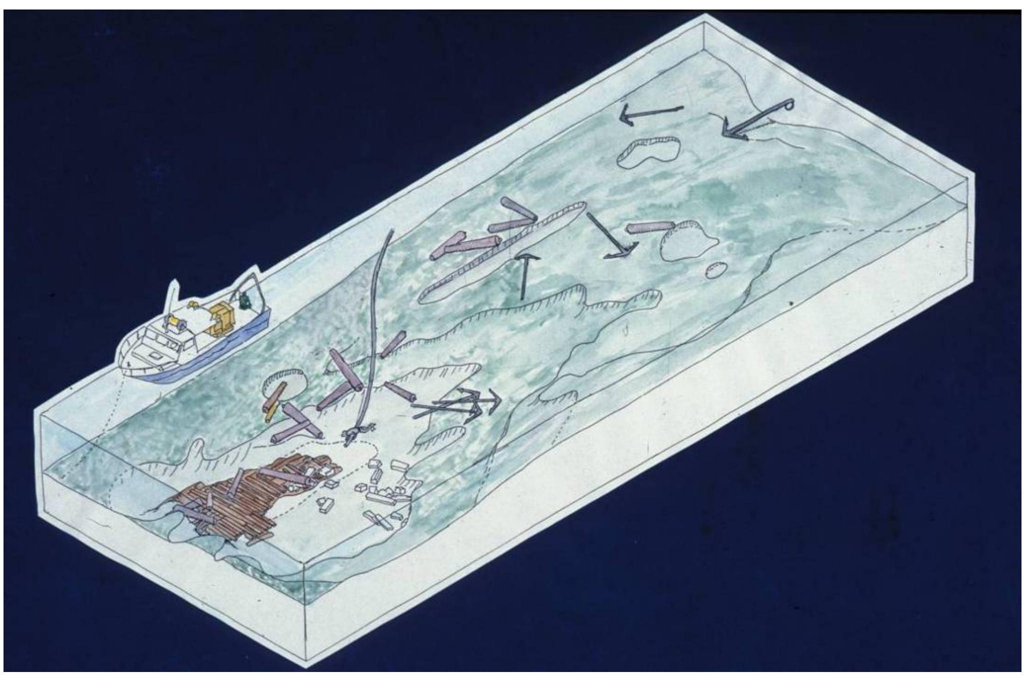

Fig. III.4 Isometric view of the *Batavia* shipwreck excavation site. Illustration: Patrick Baker, Western Australian Museum (BT–D–0033).

shipwreck site and one on the reef— were purposely left *in situ* to maintain the veracity of the shipwreck site for its visitors.[1]

The hull timbers of *Batavia*'s port side stern at the southern end of the wreck site were first observed during the 1972–1973 excavation season. The archaeologists were surprised to find such a substantial portion of the ship's hull structure due to the conditions at the site, which included strong water movement due to the swell and the shallow, exposed sea bottom on which the wreck was situated.[2]

According to Pelsaert's declaration for the Council of Justice in July 1629, *Batavia* lost its rudder when it struck the reef for the first time in the early morning hours of 4 June 1629.[3] After the ship's second collision with the reef, it was stuck in 12 feet (3.4 m) of water at its bow and in 18 feet (5.1 m) of water aft at the transom.[4] These depths are consistent with the conditions in which the shipwreck was found over three hundred years later. Reluctantly, the ship did not last very long in this exposed situation. During his interrogation of the mutiny suspects, Pelsaert enquired:

> [H]ow matters had fared regarding the ship or wreck, and how long it had remained whole after having been wrecked, they said that for eight days it had mostly held together, but the transom and other upper works had been washed away first of all, in which days it had mostly blown very hard and there was an enormous surf, and at last the starboard side had been thrown out…[5]

Pelsaert states in his journal that upon return to the Houtman Abrolhos on 16 September 1629*,* sections of *Batavia*'s bow and stern were still visible above the water's surface. At his departure from the islands on 15 November 1629, those sections had all washed away due to the strong currents and the fierce surf dashing against the timbers. He observed that only the keel and few remains of the ship's hold were kept in place below the weight of ordnance, anchors, rope work, and other heavy items:[6]

> Towards evening [18 September 1629], [we] sailed to the wreck, [and] found that the ship was lying in several pieces, namely a section of the keel, with the adjacent bottom of the hold, all above water had been washed away, all except for a small part of the upper fashion piece protruding above the water surface at the stern, it was almost exactly in the same place where the ship had first struck. Part of the bow, broken off at the rider bitts was thrown wholly on the shallow, there in were lying two pieces of ordnance, one of metal [bronze], with one of iron, fallen from the gun carriages without anything more. Near the bow of the ship was lying also one part of its side stern broken off at the starboard mizzen gunport. Then there were several pieces of a lesser size that had drifted apart to various places, so that there did not look to be much hope of salvaging much of the money or other goods.[7]

Pelsaert went on to mention how he sailed to some of the neighboring islands and reefs on 25 October 1629 to check whether goods and valuables had washed ashore, but found only ship timbers with which the islands seemed to be littered.[8]

It is, therefore, remarkable that such a substantial section of *Batavia*'s stern has survived, as Pelsaert's journal suggests differently. In addition, the site's conditions are not favorable for the preservation of ship's timbers amidst fierce breakers dashing against the reef during southwesterly winds. The hull structure that survived three centuries of immersion was initially well protected from the elements, pressed into the reef and sealed off by the ship's stone ballast, cannon, and cannon balls. These materials created a protective seal of artifacts, iron concretion, and sand to encapsulate the timbers. Without this protection more of *Batavia* timbers would surely have been destroyed by excessive water movement and biological degradation.

Interestingly, however, the site's formation has caused post–conservation problems associated with the acid deterioration of the wood matrix. The iron artifacts, such as the cannon, cannon balls, and iron fittings, corroded and iron corrosion products leached into the wood cells of *Batavia*'s timbers. This iron corrosion caused the formation of a dense, encapsulating concretion over parts of the timber wreck remains. Under the layers of deposited sand and concretion, an anaerobic environment ensued, where sulfate–reducing bacteria were active, producing high concentrations of sulfide ions. The reaction between the soluble iron chloride corrosion products and the sulfide ions caused the precipitation of iron sulphides, mainly pyrite ($FeS_2$) and pyrrhotite ($FeS$) within the wood structure *in situ*.[9] The conservation treatment did not extract these insoluble corrosion products and the complex oxidation of these iron sulphides and other sulphide containing compounds has since led to the production of acidic by–products that even now cause on–going deterioration of *Batavia*'s timbers.[10]

### ***Batavia*'s hull structure**

The hull structure found by archaeologists comprised the transom and the after port side of the vessel, including part of the sternpost, fashion piece, part of the upper fashion piece, five transom beams, part of the wing transom, five transom knees, the remains of twenty–one hull planking strakes —including three wales—, twelve strakes of ceiling planking plus a shelf clamp, forty–six frames, one gunport, two deck beams, two hanging knees, and one lodging deck knee. Neither the keel nor any timbers from *Batavia*'s starboard side have survived.[11] The hull structure is preserved up to above the lower deck.

A substantial part of the hull has been reassembled and is displayed in the Shipwreck Galleries of the Western Australian Museum in Fremantle (Fig. III.5). The reassembled structure on display measures 11 m in length, 6.5 m in height, and 4 m in width. Many other timbers still remain in storage at the Western Australian Museum, however. These timbers are disassociated because of poor preservation, their precise location on the hull was not known at the time of reassembly, or they are detached or fragmented (Figs. III.6–9). The timbers in storage include all pine sheathing, all frame wedges, fragments of the ceiling planking and its inner floor boards, and several hull planks and frame timbers.

Fig. III.5 The *Batavia* ship remains on display in the Shipwreck Galleries of the Western Australian Museum, Fremantle. Photograph: Wendy van Duivenvoorde.

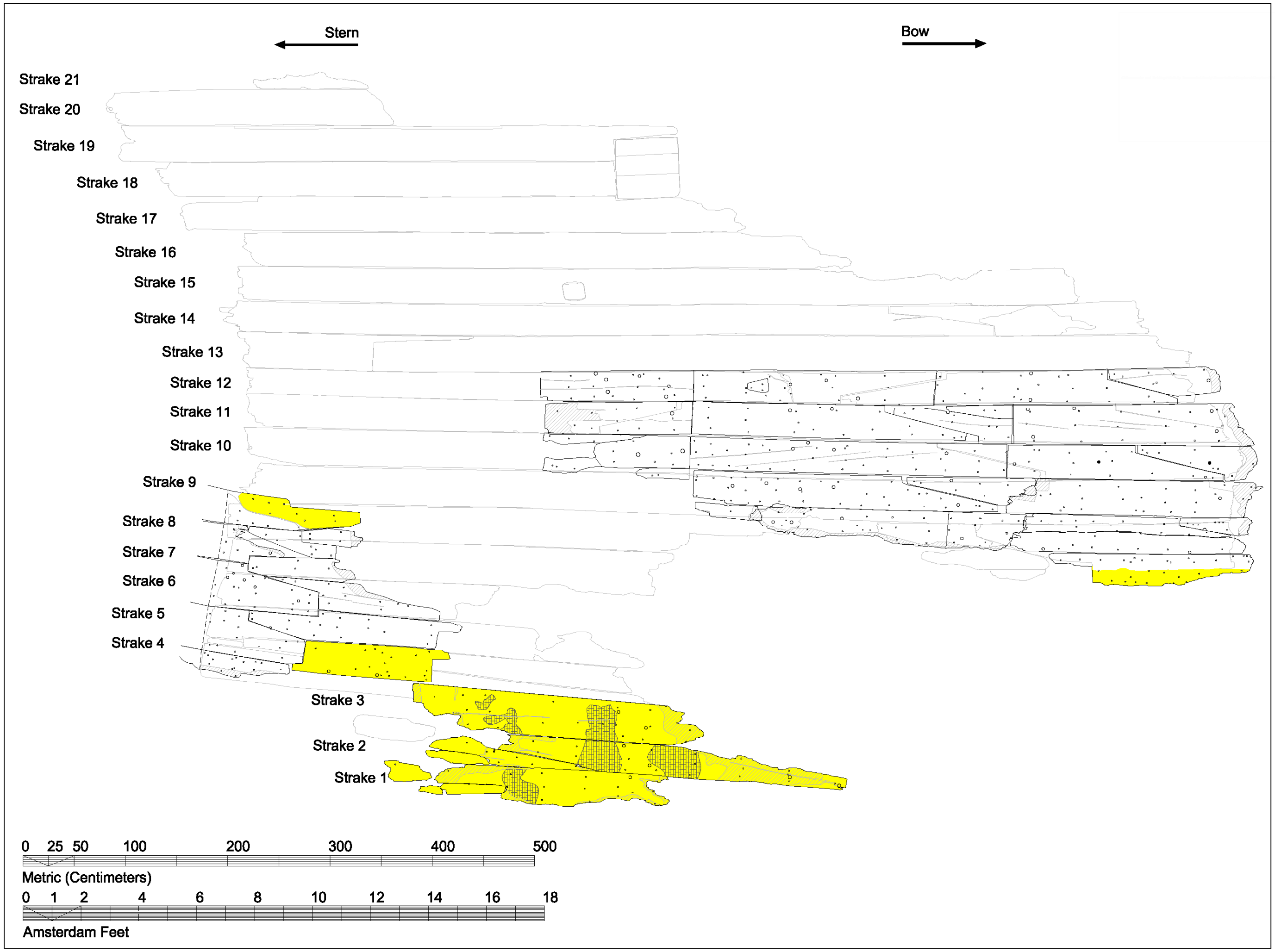


Fig. III.6 Outer layer of hull planking of *Batavia*'s hull, indicating all timbers excluded from display in yellow. Port side, interior face. Inner layer of hull planking is shown in background, in gray, for orientation. Illustration: Wendy van Duivenvoorde.

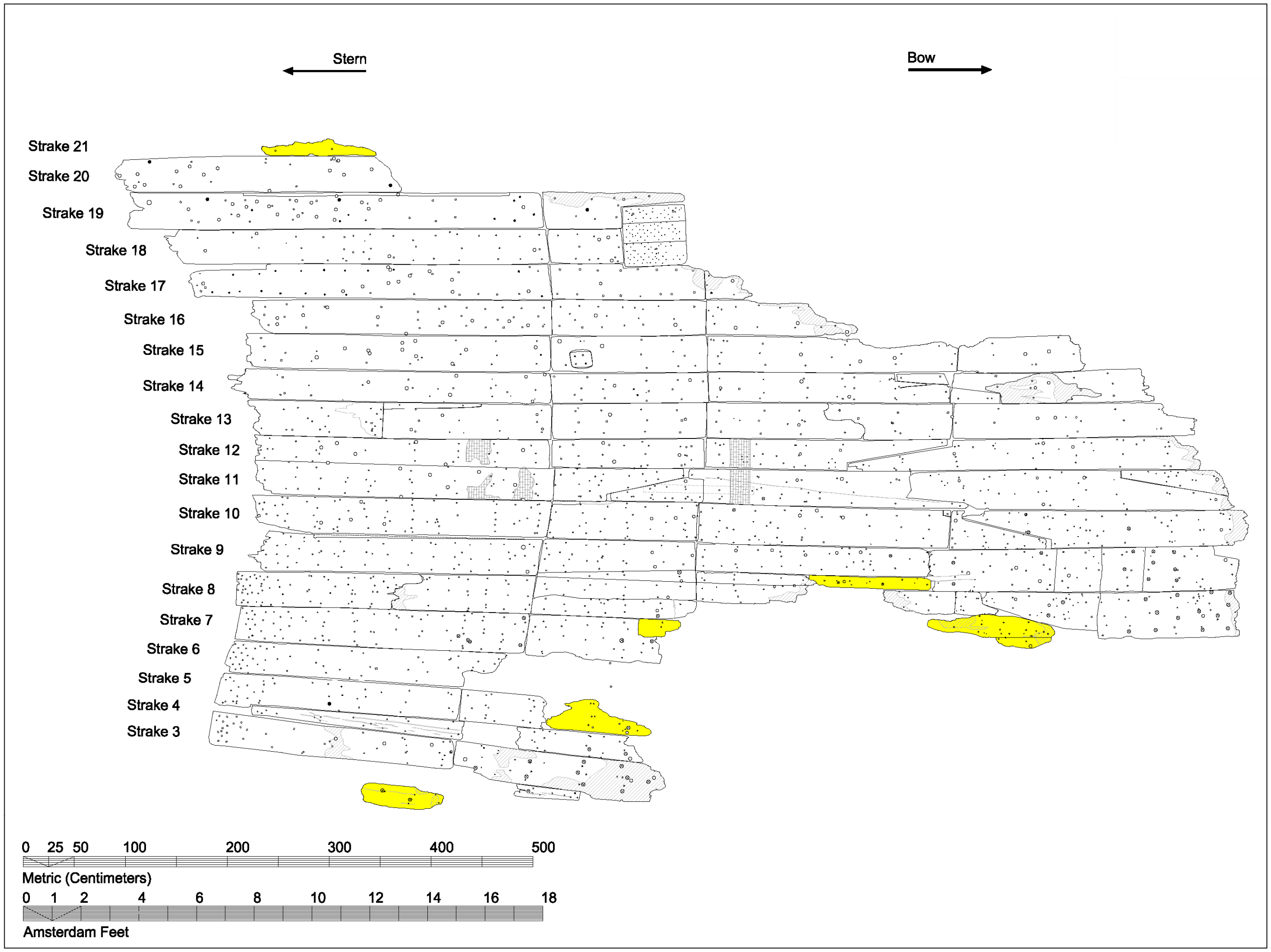


Fig. III.7 Inner layer of hull planking of *Batavia*'s hull, indicating all timbers excluded from display in yellow. Port side, interior face. Illustration: Wendy van Duivenvoorde.

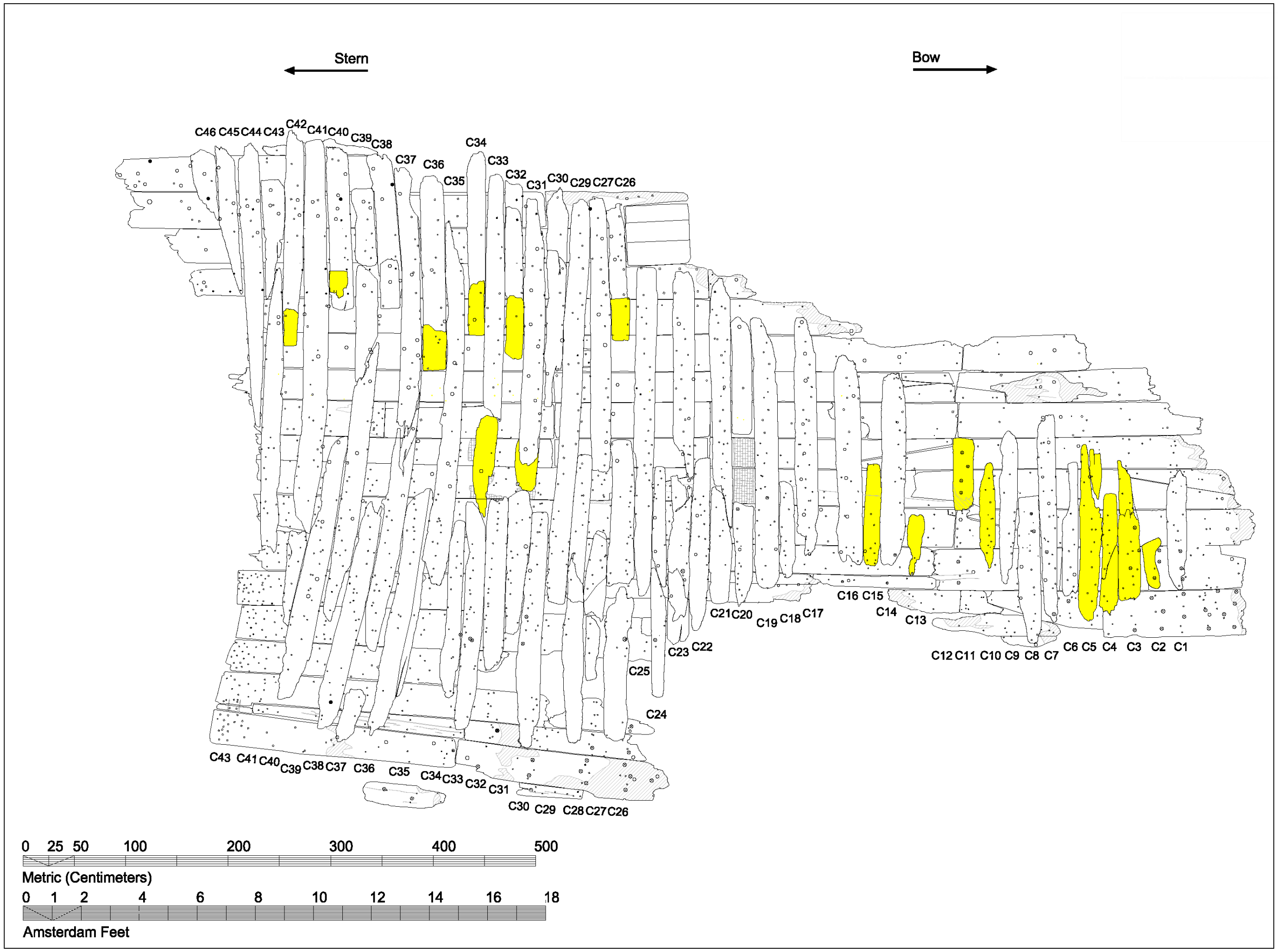


Fig. III.8 Frame timbers of *Batavia* 's hull, indicating all timbers excluded from display in yellow. Port side, interior face. Illustration: Wendy van Duivenvoorde.

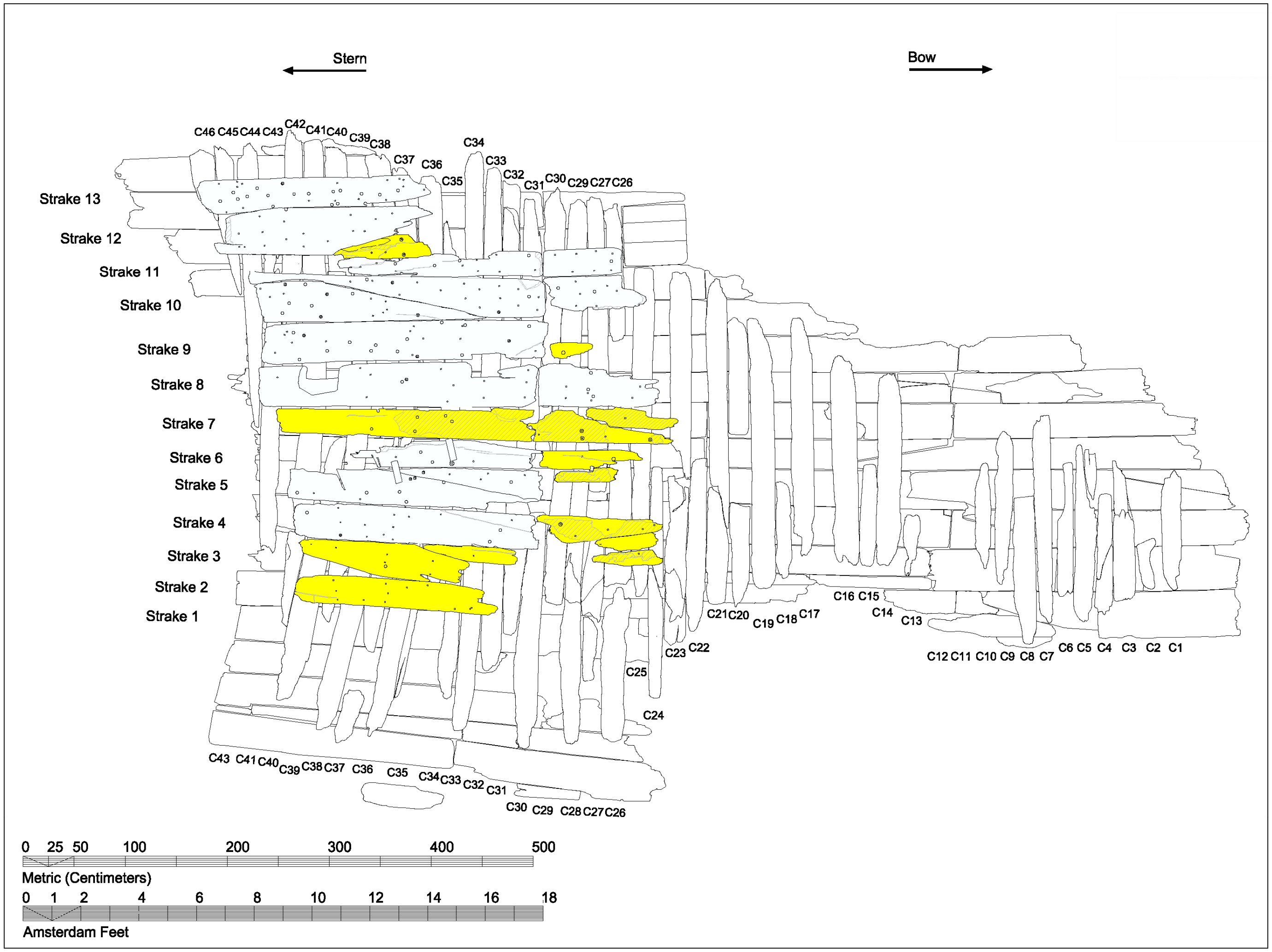


Fig. III.9 Ceiling planking of *Batavia*'s hull, indicating all timbers excluded from display. Port side, interior face. Illustration: Wendy van Duivenvoorde.

**The excavation of *Batavia*'s hull**

The timbers were exposed and raised in sections during the three fieldwork seasons from 17 December 1972 to 8 April 1975.[12] The northernmost section, or forward part of the hull structure, was raised in the first excavation season from 17 December 1972 to 6 May 1973 (Figs. III.10–12).[13] This section is part of the side of the ship's hull and includes remnants of frames, two layers of hull planking, and one or two layers of pine sheathing. The second season stretched from 1 January to 4 April 1974; in this season the middle section of hull structure was raised, which included a gunport.[14] No pine sheathing has been preserved from this segment. In the third and last excavation season from 21 December 1974 to 8 April 1975, the aftermost section of the stern was excavated. In addition to another section of the ship's side, the transom timbers and sternpost were raised.[15] This section also includes the scarce remains of the lower deck of the ship. Pine sheathing was mainly preserved on the transom planking of the ship. The outer layer of hull planking in this section is poorly preserved and probably worn down due to the abrasion of the ship chafing against the seabed before settling firmly into the sediments. This wear and tear of the timbers is most apparent on the exterior corner where the hull planking meets the transom (Fig. III.13).

Between excavation seasons, timbers exposed in the previous season were covered with sand and coral bags held down by sections of steel railroad track, in order to protect the timbers until the next excavation season. The last of *Batavia* timbers were brought to the surface on 8 April 1975. The only wood remaining on the site was isolated fragments and pockets of pine sheathing that have not been raised.[16] The timbers were processed in the excavation camp until 16 April 1975. According to the project log: "A significant event took place at 4.30 PM today. The last of the major timbers were processed. Only few odds and sods to be done."[17] The timbers were transported several days later to Fremantle where they were stored in tanks filled with fresh water for one to two years until conservation treatment commenced.

After *Batavia*'s timbers had been cleaned of coral growth and soaked in deionized water during their last stage of desalination, they were placed in large tanks

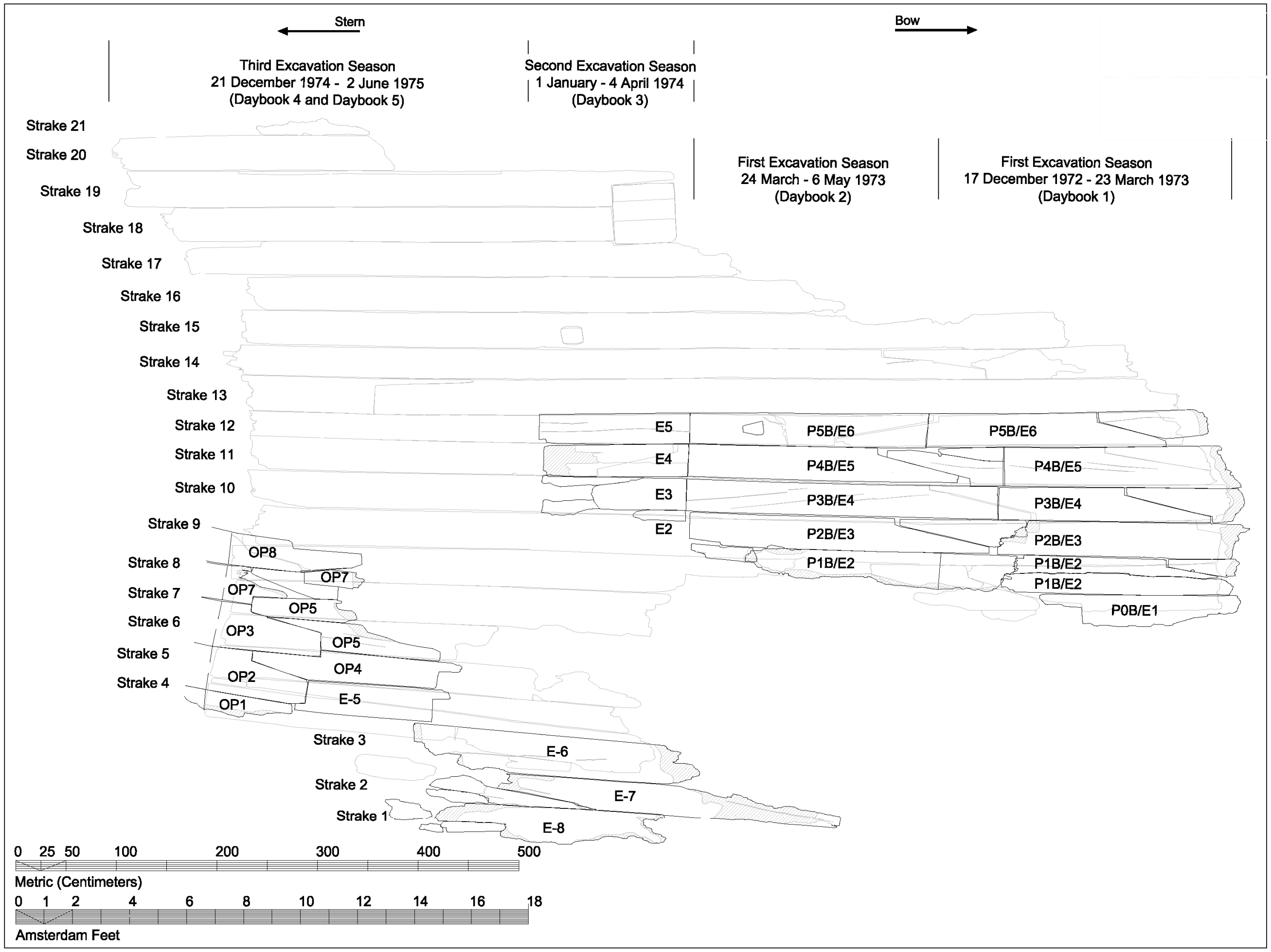


Fig. III.10 Field numbers per excavation period for the outer layer of hull planking of *Batavia*'s hull. Port side, interior face. Inner layer of hull planking is shown in background, in gray, for orientation. Illustration: Wendy van Duivenvoorde.

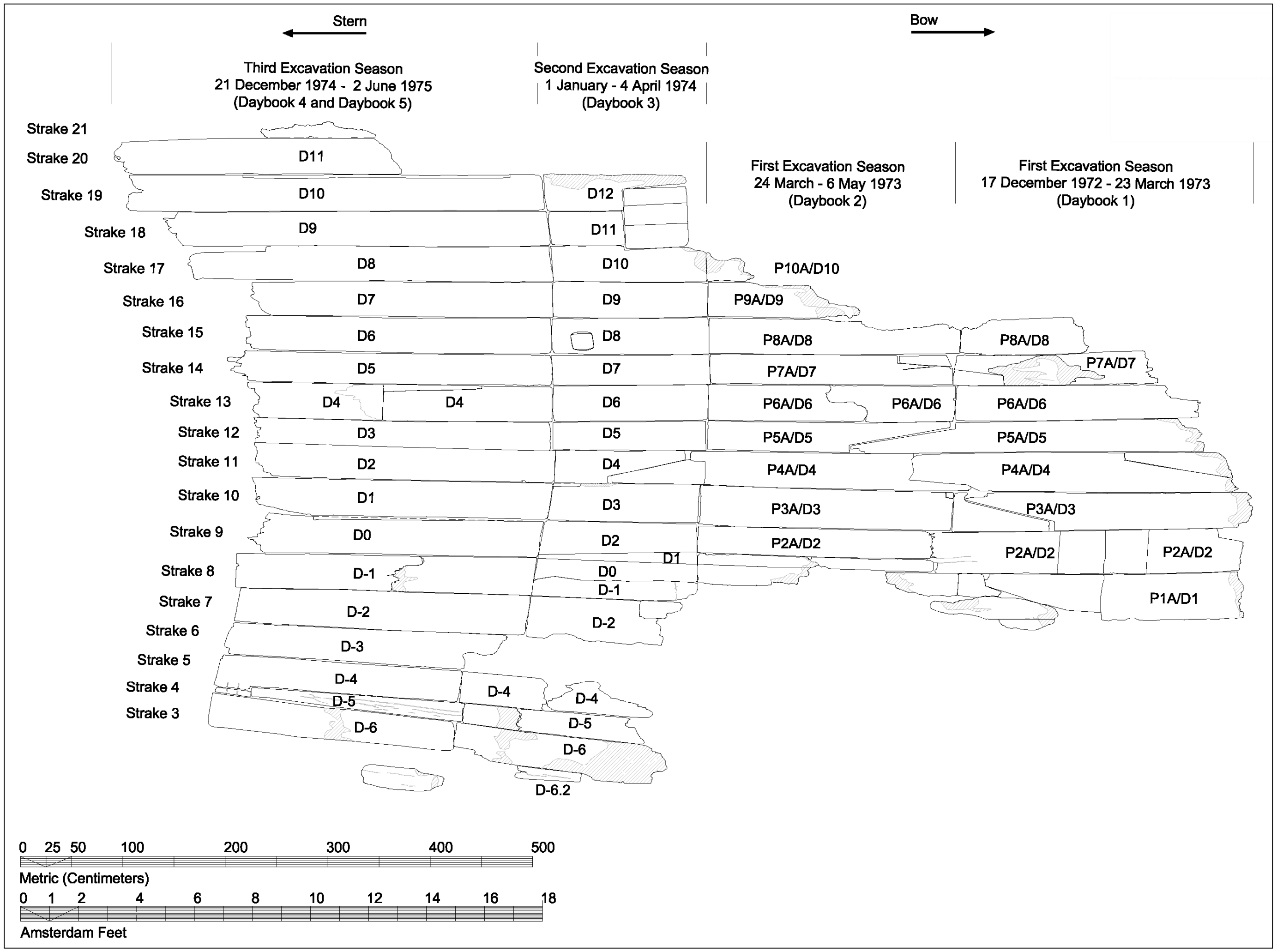


Fig. III.11 Field numbers per excavation period for the inner layer of hull planking of *Batavia*'s hull. Port side, interior face. Illustration: Wendy van Duivenvoorde.

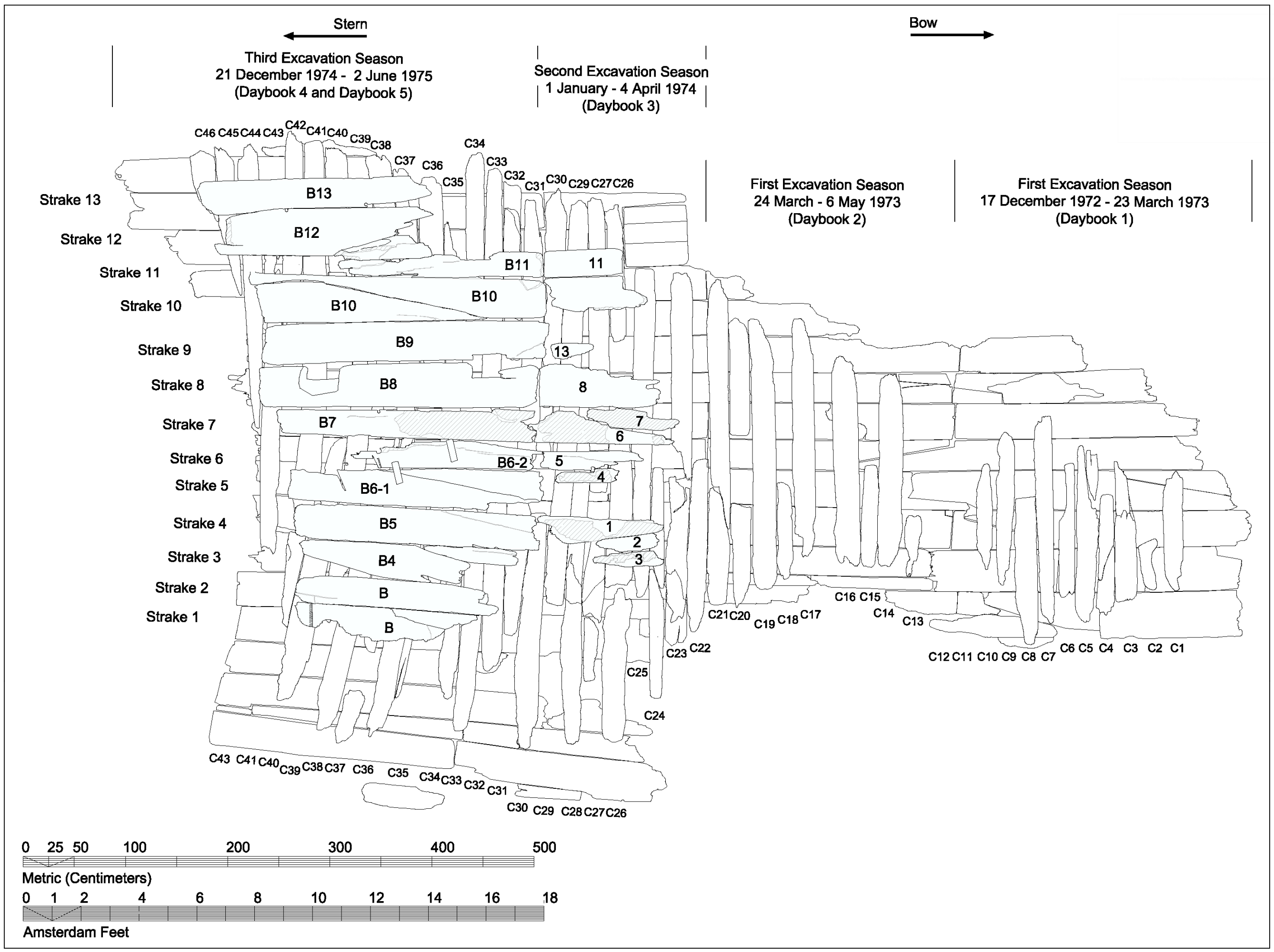


Fig. III.12 Field numbers per excavation period for the ceiling planking and frames of *Batavia*'s hull. Port side, interior face. Illustration: Wendy van Duivenvoorde.

Fig. III.13 Corner of ship's side and transom, showing erosion of the timbers. Photograph: Patrick Baker, Western Australian Museum (BT–T–0455).

and consolidated with polyethylene glycol (PEG), which gradually replaced the water in the wood cells over a period of two or three years.

After the timbers were saturated with PEG, they were placed in a dehumidifying chamber where the PEG solidified and the timbers dried slowly in a controlled environment. The latter was done to prevent the timbers from drying too quickly and minimizing the risk of their warping or cracking. In spite of this, many timbers show surface cracking not obvious prior to their conservation treatment.

The conservation treatment of the first batch of timbers was completed in December 1981. Other batches followed suit every six months until all timbers had completed their conservation treatment. However, the retreatment of timbers has been ongoing since. Information on the transport of the timbers and their conservation method including their consolidation with polyethylene glycol (PEG) 1500 can be found in publications by various authors who have been involved in the conservation treatment of *Batavia*'s timbers, including James Pang, Ian McLeod, Ian Godfrey, and Vicki Richards.[18] The subject will not be discussed in this dissertation.

The methods of recording—*in situ* and directly after excavation— and excavating the *Batavia* hull structure and timbers have been published in detail by Patrick Baker and Jeremy Green, and the 1989 excavation report published by Green in the BAR International Series.[19] The methods will be briefly discussed to evaluate how they have influenced this study of *Batavia*'s hull remains and their reconstruction. Furthermore, the discussion below is intended to complement and update any information published elsewhere.

Underwater photography, both standard and stereo, was used to record *Batavia*'s timbers once they had been exposed and to document the individually tagged timbers after excavation in the base camp. Conventional measuring systems were considered too impractical for the use in the conditions surrounding the *Batavia* site. The surge made it difficult, but not impossible, to get accurate measurements from tapes, bubble tubes, or differential pressure gauges.[20]

The three seasons of excavation on the *Batavia* shipwreck site demonstrated, however, that it was possible to document and raise a large amount of heavy ship timbers despite the presence of strong currents, heavy swells, and rough seas. In the 1970s, the excavation of intact hull structure was unprecedented for archaeologists working in the southern hemisphere. Incidentally, such excavation has not since occurred on any other shipwreck site in Australasian waters.

After being recorded *in situ*, the timbers were lifted from, or sawn off, the intact hull structure and raised from the seabed. The transom knees and hull and ceiling planking of *Batavia*'s structure were sawn under water with a pneumatic chainsaw. The sections, measuring approximately 2.97 m, 2.41 m, 1.70 m, and 3.91 m in width from bow to stern—north to south— were easier to handle in hazardous conditions and presented less of a storage problem for the temporary holding area on Beacon Island (Figs. III.10–12 and III.14). It was the most obvious solution for many logistic problems at the time of the excavation. The long planking strakes could also not have been recovered due to the applied excavation methods as the site was excavated in sections. The excavation in sections made it unfeasible to raise the 10–m timbers as they continued underneath the sections that still needed to be exposed. In retrospect and with all advantages conferred by hindsight, however, it is clear that such methods should not have been applied in order to maintain the hull's historic integrity and aesthetic appearance. The historic integrity would have facilitated a more accurate research and reconstruction of the timbers. After the reassembly of the timbers in the Shipwreck Galleries, the saw cuts in the planking strakes remain visible even though they have been concealed as much as possible. The adhesive used to repair broken timbers was 75% (w/v) polyvinylpyrrolidone (PVP) in ethanol, and the filling solution for covering the saw cuts was 90% PEG 3350/10% PVP in ethanol (w/w).[21]

In contrast to the planking, *Batavia*'s frame timbers were removed from the structure by gently easing them off the planking by hand or with the help of a crowbar, which was possible because the iron bolts that once held the timbers together had corroded away. The frames, transom beams, fashion piece, and deck timbers were all

Fig. III.14 Diver sawing *Batavia*'s hull planking with a pneumatic chainsaw during the first excavation season. Photograph: Jeremy Green, Western Australian Museum (BT–A–0223).

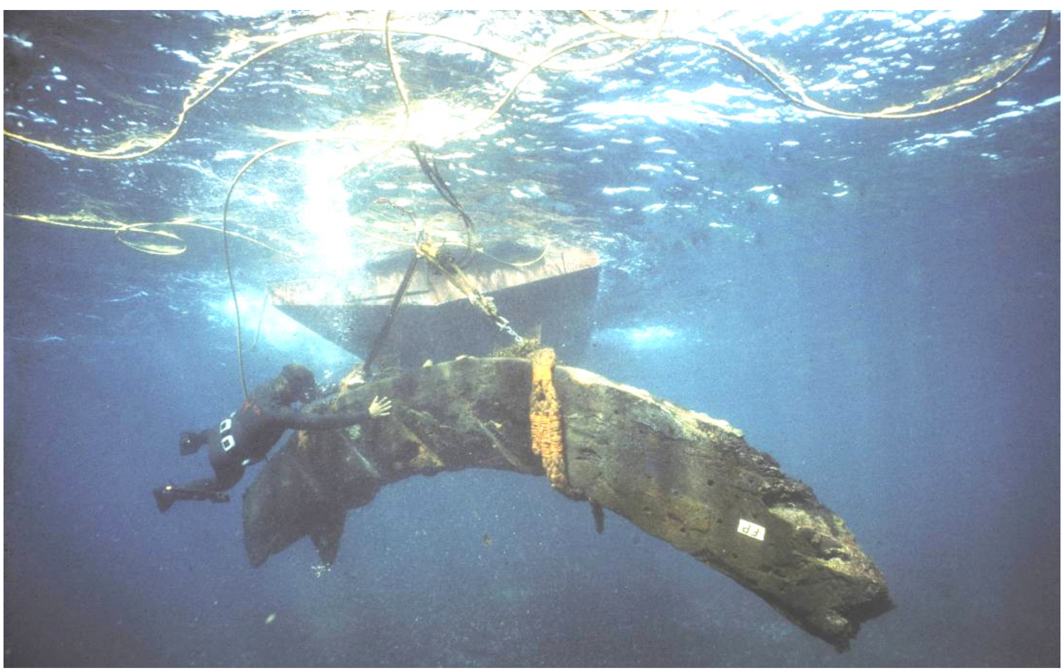

Fig. III.15 *Batavia*'s fashion piece being raised with a winch on the excavation boat *Henrietta* during the third excavation season. Photograph: Patrick Baker, Western Australian Museum (BT–A–0840).

raised individually and were not sawn in easy manageable sections (Fig. III.15). The fashion piece is the single largest timber raised intact from the seabed, measuring 4.6 m in length, 0.60 m in width, and 0.32 m in thickness.

When the timbers were loosened from the hull structure, they were placed in a sling of nylon rope encased in canvas. The sling was then attached to a steel cable from the excavation boat's winch and the timbers were lifted aboard the vessel and brought to the excavation camp on Beacon Island (Figs. III.4 and III.15).

**Timber recording on the seabed**

Each individual timber was tagged *in situ* on the seabed with a PVC label denoting the timber's temporary field number (Fig. III.16). This number was written on the tag with a waterproof permanent marker pen and consisted of an alphabetical prefix followed by a number. The prefix designated the type of timber, such as frame or hull plank, and the number for each timber was consecutive within the types of timber identified on the seabed. The alphabetical prefix related to the basic layers within the ship's hull structure from its interior to its exterior as viewed on wreck site. The alphabetical prefixes for the timbers' field numbers are listed in Table III.1.

The port side of the ship's hull from its interior to its exterior basically consists of a pine cargo or inner floor on top of ceiling planking (B–layer), frames (C–layer), an inner layer of hull planking strakes (D–layer), and an outer layer of hull planking (E–layer). Towards the stern, the planking strakes were numbered from east to west as D0 to D6, but additional planking strakes were uncovered beyond D0 to the east and D6 to the west. These additional strakes were given negative numbers D–1 to D–8 in the east and consecutive numbers D7–D12 in the west.[22] The ship had two layers of hull planking extending from its keel to preserved strake 12, which was located six strakes below the gunport. Eight strakes of the outer layer of hull planking (E–layer) were preserved from strake 1 to strake 12 (E1 to E6, E–5 to E–8, and OP1–OP8). Forty–six frame remnants were numbered (C1–C46) throughout the excavation of the ship. In the foremost section

Table III.1 Alphabetical prefix used for field numbers of *Batavia* timbers.

| **Alphabetical Prefix** | **Description** |
|---|---|
| A | Knees, decks beams, or other timbers on top of the ceiling planking |
| B | Ceiling planking |
| C | Frames |
| D or P[#]A* | Inner layer of hull planking |
| E or P[#]B* | Outer layer of hull planking |
| F or SK* | Skin (pine sheathing) |
| FP | Fashion piece |
| OP | Outer layer of transom planking |
| SP | Sternpost |
| T | Transom timbers |
| TP | Inner layer of transom planking |
| TSK | Transom skin (pine sheathing) |

* The letter designations P[#]A and P[#]B, and prefix SK were only used in the first excavation season.

Fig. III.16 Diver attaching an identification tag with field number, P7A, onto *Batavia*'s inner layer of hull planking, strake 14, during the first excavation season. Photo: Jeremy Green, Western Australian Museum (BT–A–0215).

of the hull at the ship's exterior, there were remains of a layer of pine sheathing (F–layer).

Twelve strakes of ceiling planking (B1–B7, B9–B13) and one shelf clamp (B8) were raised off the seabed. On top of the ceiling planking (B1–B13), remains of small floor beams or laths have been found that were nailed to the ceiling planking to support a pine inner floor, which protected the ceiling planking. At the junction of *Batavia*'s transoms and the side of the ship, massive lodging knees or transom knees (T–layer) reinforce the interior of the two surfaces of the different planes. They are placed against the transom beams and the ceiling planking at the side of the ship. *Batavia*'s large fashion piece (FP) defined the shape of its stern. The transom beams were slotted into dovetails joints in the fashion piece and secured in place by iron bolts below the transom knees, whereas part of the transom wing was bolted to the fashion piece (T–layer).

The transom beams are no longer connected to the sternpost. The three lowest transom beams nearly touch the side of the endpost, whereas the two upper transom beams have been worm–eaten and eroded down to two–thirds of their original port side lengths. On the exterior of the transom beams, two layers of transom planking have been preserved. The inner layer of transom planking (TP–layer) runs at a diagonal angle between the sternpost and fashion piece. On the exterior of this inner layer, an outer layer of diagonal transom planking has been preserved (OP–layer). This layer of planking strakes (TP–layer) is nailed to the inner layer, covering the transom, and then runs from the transom to the side of ship. This planking extends at an angle, varying from 140 to 152 degrees, and cups around the transom and the side of the ship. On the exterior of the transom planking, a layer of pine sheathing has been preserved which was also diagonally fitted (TSK). This layer was not recorded underwater.

The hanging deck knee, lodging deck knee, two fragmentary deck beams, and deck timbers were randomly given an 'A'–designation. Only a modest number of A–layer timbers were encountered, but complications might have occurred if more of the relatively complex interior deck and reinforcing structure had been preserved.[23] These timbers should, in hindsight, have been given separate alphabetical codes in the field that reflected their varying purposes.

Nevertheless, the tags with the alphanumerical system or field numbers are present in the underwater photographs and provide an easy reference while trying to find the location of structural elements on the seabed. Furthermore, the tags were also beneficial as easy references in timber photographs and timber drawings when trying to identify specific pieces.

This method was not however applied consistently throughout the three seasons of excavation as timber prefixes and strake numbers assigned to the forward end do not correspond to the strake number designations of the hull and the ceiling planking in the after end of the preserved hull section (Figs. III.10–12). This discrepancy sometimes caused confusion during the later studies of the hull remains.

As each area was excavated, the hull structure was cleared of coral sand and coral rubble with an airlift and the fully–exposed area was then photographed. The hull was photographed at each stage of excavation by both standard and stereo photography. A Nikonos camera was used, with several different water–corrected lenses for different circumstances. For all photogrammetry, either a 28 mm UW Nikkor or a 15 mm lens was used with the camera. Two ultra wide–angle lenses, a 15 mm UW Nikkor and a 19 mm Canon lens, were employed for record and illustrative photography, whereas the first lens was specifically used for overall views of the ship's stern. The whole timber area could be photographed in one frame at a distance of 4 m (Fig. III.17).

A photomosaic was made of each timber layer showing the timber *in situ*, its orientation, its position in relationship to other timbers, and its tag.[24] The timber mosaics were made in a manner similar to the overall site mosaic that was made in the first season of excavation.[25] For the timber mosaic, each photo taken includes a mobile grid frame. This grid was laid flat on the timbers and then photographed with an approximate camera height of 2.5 m, which covered an area of 2.4 m by 1.6 m and was close enough for fine details to be recorded. Photographs were taken at one meter intervals providing a 60% overlap between the photographs. The height of the camera and its tilt were simply judged by the photographer's eye.[26]

**Timber recording after excavation**

The timbers were registered upon their arrival on land. Each individual piece was given the prefix BAT —letters indicating the shipwreck— followed by a four digit museum registration number. They were stored in dug–out pits on Beacon Island lined with heavy duty polyethylene sheets and filled with sea water until they were drawn and photographed. The registration books include a brief description of each timber, for example 'hull planking' or 'frame.' However, no descriptive catalog entry for each timber has ever been made.

Fig. III.17 *Batavia* hull structure, showing inner layer of hull planking and transom timbers as seen in the third excavation season. Photo: Patrick Baker, Western Australian Museum (410/19).


Fig. III.18 Tracing pine sheathing of *Batavia*'s sternpost on Beacon Island during the third excavation season. Photograph: Lloyd Capps, Western Australian Museum (BT–B–0696).

The timbers were then partially cleaned in the excavation camp of their gross concretions and full–size drawings were made by tracing them on plastic film with permanent marker pens (Fig. III.18). This plastic film was applied directly over the timbers, which caused many difficulties. The material occasionally caused condensation to form, which obscured the drawing surface. In addition, the plastic film easily shifted resulting in measurement errors, and failed to provide a straight surface for accuracy in tracings. Moreover, the polyethylene film used for these timber drawings shrank within six years in an irregular fashion caused by temperature change due to its anisotropic nature.[27]

The full–size timber drawings were later reproduced photographically to a 1:4 scale to make a timber plan. The timber drawings were placed over a 0.04 m by 0.04 m grid and photographed. By printing these photographs, reduced scale drawings of the timbers were produced. These photographically reduced scale drawings have not been used for this study as full–size drawings are preferable.

Timber plans were only made for the hull planks and frames raised during the first two excavation seasons and do not exist for all timbers. No timber plan was made for any of the pine sheathing or the timbers excavated in the third excavation season, which comprise a substantial section of the side and transom.

In addition to being traced, each individual timber was photographed on land. The photography was done in an open–ended shed on Beacon Island, which provided suitable shade from direct sunlight.[28] A 35 mm Nikon F camera was placed two meters above the ground on a roof beam and focused with a right angle view finder (Figs. III.19–20). Timbers were wheeled into the shed on a flat–bed trolley and placed directly below the camera. The camera was mounted so that the film plane was exactly horizontal and timbers were then leveled using a builder's spirit level.[29] Special care was taken to ensure this parallel relationship between the timber surface and the plane of the camera in order to reduce distortion.

The field view of the camera lens (55 mm Micro–Nikkor–P lens), however, was not large enough to capture each timber in its entirety. Many of the timbers were simply too long. Photographer Patrick Baker then made several overlapping photographs of each timber by moving the trolley in a straight line through the camera's field. These overlapping photographs can then be joined together into one photograph without losing detail and quality. Baker strung a taut white string along lengths of timbers which proved to be extremely useful for finding the correct orientation and creating a continuous line through various photographs of one timber when rotating and matching them up.[30] Every photo was taken with a one–meter scale, which was placed along the upper edges of each plank or timber, and included a small blackboard with the timber's registration number, field number, and thickness of timber.[31] Generally, three or more sides of each timber were photographed. Additionally, a 24 mm Nikkor–N lens was used to obtain single photographs of the complete timber length. Baker noted that extra care was taken in leveling camera, timber, and meter scale when using this particular lens.[32]

Fig. III.19 Photography set–up for timber recording on Beacon Island during third excavation season. Photograph: ABC Peach's Australia, *The Unlucky Voyage*, 1990, Western Australian Museum.

Fig. III.20 Patrick Baker photographing *Batavia*'s timbers with a 35 mm Nikon F camera mounted onto a roof beam of a shed on Beacon Island, third excavation season. Photograph: ABC Peach's Australia, *The Unlucky Voyage*, 1990, Western Australian Museum.

The photographs taken directly after a timber's excavation, in particular those made with the 55 mm Micro–Nikkor–P lens, have proved to be the most important record of the *Batavia* timbers as will be discussed in the section "Hull study" of this chapter. After the timbers were drawn and photographed on each side, they were wrapped in polyethylene sheets with an aqueous fungicide solution for transport to Fremantle.

**Post–conservation timber recording**

After the timbers had completed their conservation treatment, their condition was recorded for comparison with their state prior to conservation. They were photographed again and traced at full– scale to record features not visible prior to conservation, as well as to correct and double–check the timber drawings made in the field.[33] These tracings and photographs were reduced photographically to the same scale as drawings and photographs that were made prior to conservation so they could be compared for distortion that occurred during conservation. The comparison proved problematic due to the shrinkage of the polyethylene film used in the field.

The photography setup was similar to the one used in the field where a camera was fixed a few meters above the gallery floor to photograph each timber. In this case, a Nikon 35 mm camera with a 105 mm or 55 mm lens was used.[34] The quality of the photographs taken at this stage, however, is not as high as those taken in the field; they are dark and details are not readily visible. Only two faces of each plank and timber were photographed whereas the field photographs show more surfaces of each timber. Furthermore, the photographic scale was not consistently placed at the same level as the timber surface so they do not provide adequate dimensions. These photographs have, therefore, not been used in this study.

The timbers were traced underneath a level glass table on top of which acetate tracing film was affixed. The pieces were raised as close as possible to the glass' surface and then leveled to the same plane as the glass. The outline of each timber, fastening holes, and significant features were drawn on the acetate with permanent marker pens.

Four fluorescent lamps were placed under the glass top to provide oblique lighting that enhanced specific surface features.[35] The acetate tracing film used for this purpose is not subject to non–uniform shrinkage and, therefore, provides a more stable record of the timbers than the polyethylene sheets used in the field.

The timber tracings were photographically reproduced with a Toyo 4x5 view camera with an 85 mm lens. This is a large format camera which was used to reduce camera lens distortion to a minimum. The camera was mounted at a fixed distance from a wall in the museum gallery on which the tracings were hung.[36]

**Reassembly and display**

In preparation for the reassembly of *Batavia*'s hull structure in the Shipwreck Galleries of the Western Australian Museum in Fremantle, Paul Hundley and Geoff Kimpton built one research model of the preserved hull remains at 1:10 scale, after which Nick Burningham worked on a full model of the ship's reconstruction on the same scale (Figs. III.21–III.22). The first model was mainly made with the help of the photomosaics of *Batavia*'s hull structure prior to excavation and the photographs taken of the timbers on the seabed and after being raised.[37] Due to lack of funding, the second model still awaits completion, but is on display at the Shipwreck Galleries of the Western Australian Museum.

In May 1981, the conservation of the fashion piece was completed. After the timber was moved from the dehumidification area into the gallery, it was drawn full–size. This drawing was subsequently used for the fabrication of a 0.01 m thick steel outline of the timber (Fig. III.23). This template was used as a backing plate to support the timber on display and as the outline of the framework for the transom.[38] The timber was laid on the plate and bolted to cross–pieces on its opposite surface which functioned as a splint. The encased fashion piece formed the base of the transom reassembly which was built up from this template (Fig. III.24). It also delineates the outer shape of the transom.

Fig. III.21 1:10 scale model of the initial design for the reassembly of the *Batavia* hull. Photograph: Patrick Baker, Western Australian Museum (BT–T–0164).

Fig. III.22 Nick Burningham working on 1:10 scale model of the *Batavia* ship. Photograph: Patrick Baker, Western Australian Museum (BT–M–0031).

Fig. III.23 Geoff Kimpton (right) and Jeremy Green (left) constructing the steel backing plate for *Batavia*'s fashion piece. Photograph: Brian Richards, Western Australian Museum (BT–T–0100).

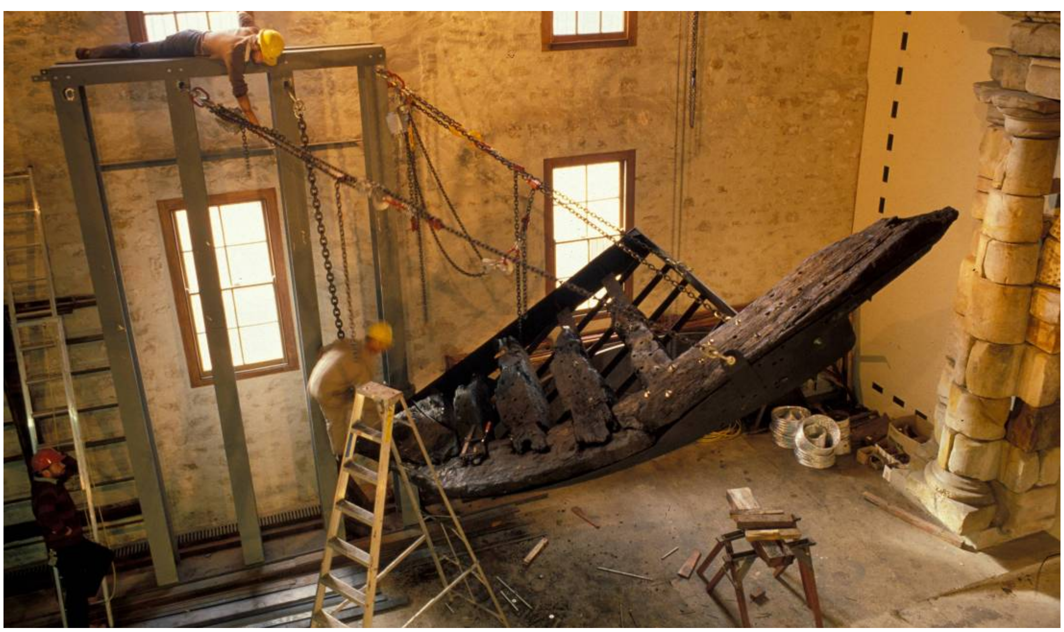

Fig. III.24 Raising the steel framework to support the transom timbers in place, in the Shipwreck Galleries, Western Australian Museum, Fremantle. Photograph: Brian Richards, Western Australian Museum (BT–T–0303).

Fig. III.25 Sorting *Batavia* hull planking after conservation in the Shipwreck Galleries of the Western Australian Museum, Fremantle. Photograph: Patrick Baker, Western Australian Museum (BT–T–0155).

In December 1981, the first of fifteen batches of timbers had completed its conservation treatment. The timbers were laid out on the floor of the gallery and rearranged in their position as found on the seabed as if part of a giant jigsaw puzzle (Fig. III.25). The timber plans from the first two excavation seasons and the photomosaics facilitated this process. This process was started over every six months when the next batch of timber came out of conservation.

The final reconstruction began when the most significant timbers of the hull — the transom and fashion–piece— were raised into position in June 1986 by Kimpton. Kimpton had designed and constructed a custom–made steel framework to support the whole timber assembly. After he had determined the main principle of how the timbers needed to be supported, he realized that he had to fix the framework in place starting from the aftermost end of the hull to determine its correct shape.

The framework itself is carried by five Royal Steel Industry (R.S.I) steel pillars, four forming a square encased set and a fifth one placed away from this assembly, that are fixed into concrete supports in the floor and bolted against the wall of the *Batavia* gallery (Fig. III.26). These load–bearing pillars carry the heavy weight of the display, by seating the timber in an open framework that resembles a ship's lines drawing. Kimpton designed the framework in such manner that the timbers can be taken off if necessary for study or conservation treatment. The design is unique as it does not penetrate or tamper with the timbers themselves. It carries the weight of each individual plank as a shelf. In fact, no timbers were altered or damaged in any way during the reassembly of *Batavia*'s hull structure. In addition to each hull plank resting on its own steel batten, the original fastening holes were used to secure the ceiling planking and frames to the two layers of hull planking with galvanized bolts. During the hull's reassembly, a crane was used to move the timbers into their respective places. In addition, the relatively lightweight sections of the framework that support the ship's side were assembled with temporary scaffolding on wheels.

After the steel supports of the fashion piece and its futtock were finalized, the transoms were placed in their seatings on the fashion piece and a custom–made support of steel was added to the steel backing for the fashion piece. The bolt holes of the diagonal transom planks were used to fit the transom timbers in their proper place. At this stage the bolt holes of the transom knees were also lined up with the beams and transom planking to prevent assembly problems later on. For the transom planking, 1.2–cm–thick steel strips were welded diagonally to the steel frame in between each transom plank (Fig. III.26). After the framework of the transom was completed, it was lifted in place from pulleys on the steel pillars alongside the gallery wall. The lower end of the transom framework was attached to a 50–ton load–bearing pivot point on the side of the pillars, which enabled the transom to be lifted into position and altered as the structure advanced and corrections needed to be made. Both the angle and height of the transom framework could be altered as required.

Fig. III.26 Constructing the steel support for the transom planking on the backing plate of the fashion piece and transom beams, Shipwreck Galleries of the Western Australian Museum, Fremantle. Photograph: Brian Richards, Western Australian Museum (BT–T–0239).

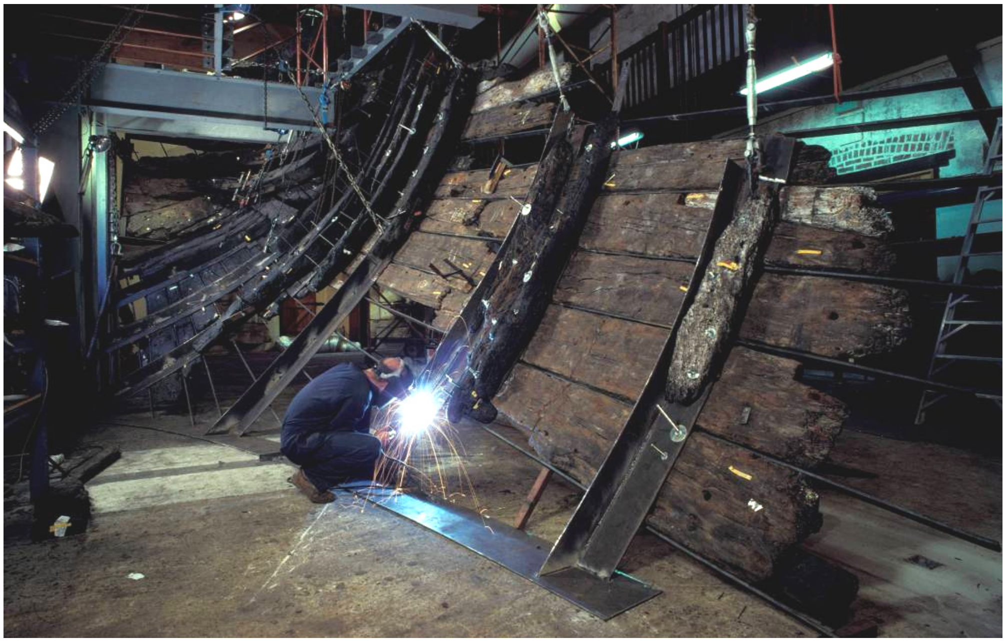

Fig. III.27 Geoff Kimpton welding the backing plate of the frame to steel battens that support the hull planking, Shipwreck Galleries of the Western Australian Museum, Fremantle. Photograph: Patrick Baker, Western Australian Museum (BT–T–0404).

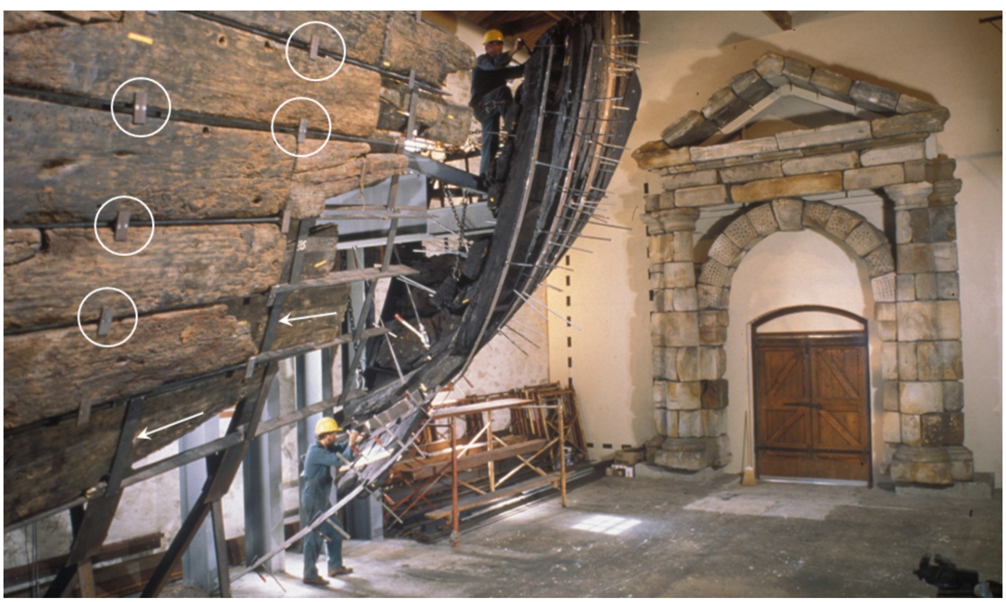

Fig. III.28 Vertical strips (arrows) and stoppers (encircled) preventing the hull planks from falling out of the framework, Shipwreck Galleries of the Western Australian Museum, Fremantle. Photograph: Patrick Baker, Western Australian Museum (BT–T–0377).

The framework for the side of the ship is constructed on steel strips that support the timbers. A number of frames were selected, for which backing plates were made. These plates basically form the stationary lines of the framework that are welded to a steel band that runs over the floor as a curved pathway (Fig. III.27). Initially, they were held upright by steel cables that were tightened to temporary cross–beams that extended from the load–bearing pillars alongside on the wall. The cross–beams and cables were eventually replaced by steel rods (see below).

The planks are placed in between flat strips of steel that run along the side of the hull like battens (varying between 0.025 m and 0.05 m in width and 0.01–0.012 m in thickness). These steel battens are seated between each layer of planking and welded to the vertical backing plates of the frames (Fig. III.27). This assembly takes the main load off the planks. In between the two layers of hull planking, vertical strips run from one batten to another to keep the inner layer of hull planking from leaning against the outer layer. The vertical strips are screwed, not welded, to the edges of the steel battens so they can be removed if a timber needs to be taken off the display (Fig. III.28). Initially, small vertical lips were added to the edges of the battens (one on top and one on the bottom) to prevent the outer layer of hull planking from falling out (Fig. III.28). Most of them have been removed as the 16¾–mm threaded galvanized rods, used in the reassembly to fasten the frames to the hull planking, provided sufficient strength for keeping the outer layer of hull planking in place. The galvanized rods were inserted into selected original bolt holes (Fig. III.29). They were used as large screws with a washer and nut on either side of the timber assembly. They were trimmed to lie flush with the exterior surface after the entire hull was reassembled.

The weight of the entire framework that supports the *Batavia* hull is counterbalanced by seven diagonally affixed steel rods run from the upper gallery balustrade and the load–bearing pillars to the side of the hull where they are fastened to the backing plates of the frames (Fig. III.30).

Fig. III.29 Galvanized 16¾ mm rods were used as screws to hold the planks and frames together, Shipwreck Galleries of the Western Australian Museum, Fremantle. Photograph: Patrick Baker, Western Australian Museum (BT–T–0414, BT–T–0431).

Fig. III.30 Interior view of *Batavia*'s hull on display, Shipwreck Galleries of the Western Australian Museum, Fremantle. Photograph: Patrick Baker, Western Australian Museum (MA05049–33).

The construction of the steel framework, which carries *Batavia*'s timbers, and the reassembly of the hull timbers began in 1981 and was carried on for many years. The entire operation was eventually completed in 1991, and the *Batavia* Gallery was officially opened on 16 December 1991.

**Original hull shape and distortion**

During the *Batavia* excavation no profile measurements were made underwater due to the site conditions, even though test profile measurements taken in calm seas later proved accurate to within 0.02 m.[39] It was assumed that the timbers would maintain their overall shape and curvature which could then be recorded on land under more favorable conditions.[40] Therefore, no comparison can be made between the hull shape as found on the seabed and as it stands today in the museum gallery. It must be pointed out that, at the time of excavation, the archaeologists worked to their best abilities and the learning curve was steep as they had to deal with many complications not encountered previously. Plans of the hull and timber curvature should ideally have been made when the timber was still underwater by conventional methods of hull recording. The arrangement of *Batavia*'s timbers can be reconstructed from the underwater photographs of the hull structure, but the actual shape cannot be determined from this record. Furthermore, the timbers of the transom assembly make up a structure that is fixed in place and too rigid to be moved in different directions, whereas the hull planking and frames of the ship's side can be pulled and twisted to some extent. Without accurate measurements taken on the seabed, their exact final shape cannot be determined and remains to some degree conjectural.

In fact, the reconstructed hull structure may no longer exactly represent the original hull shape of *Batavia* as several factors could have caused distortion. The timbers may have been deformed to some extent beneath the heavy weight of ballast, cannon, cannon balls, and other materials that covered the ship's hull for over three centuries.

Furthermore, all timbers twist, shrink, and distort to some degree during conservation treatment, on *Batavia* this was particularly true of planks that were bent into shape during the construction in the seventeenth century. All of this became evident when reconstructing the hull timbers in the 1980s. The double layer of hull planking, for example, did not fit easily together. The conserved planks were, however, flexible enough to be bent into original shape by aligning their bolt holes. This was done over a period of time to some distorted planks and a few frames by continually tightening new bolts until they provided a perfect fit.

Study of the timbers during their dehydration process before their reassembly has, however, shown that the dimensional shrinkages of the wood were 1–2% in longitudinal, 2% in radial, and 3–4% in tangential direction, with an overall timber shrinkage of only 2±1.5 %.[41] The conservation treatment has, therefore, had only a minor effect on the timbers' distortion.

Lastly, some errors may have been made during the reassembly of the timbers. Kimpton, for example, is certain that he reassembled the hull section slightly off from being parallel to the side of the museum building (imagining the side of the building being parallel to the ship's centerline). As a result of this, the hull structure is supposed to be approximately 0.5 m wider at its foremost section than it would have been if he had lined it up properly. When he started the ship's reassembly, Kimpton focused on ensuring that the transom and sternpost were erected in the exact perspective between both sections, and did not take the hull's position into consideration in relationship to the side of the building. However, after having taken the lines off the hull and reconstructing *Batavia*'s lines on paper, this error turned out be non–existent.

The after three sections of the side of the hull that were excavated were put together by lining up the fastening holes of the planking, frames, and ceiling planking, and following the curvature of the frame timbers. Unfortunately, only a few frames of the original construction were preserved in the foremost section of the hull that was raised during the first excavation season. These frame timbers are too few in number to act as a guideline and facilitate an accurate reconstruction of *Batavia*'s original shape. The curvature of the hull in this section is, therefore, an approximation.

Regardless, deformation on the seabed, distortion during conservation, and possible errors made in the reassembly of the timbers are the three factors that may have influenced the current shape of *Batavia*'s preserved hull structure. However, the accurate alignment of the bolt and nail holes suggest that the current hull shape is actually close to its original form.

**Hull study**

The study of the ship's hull construction was commenced by the author in 2003. Although *Batavia*'s timbers were drawn and photographed in the field prior to conservation and again after conservation, the full–scale drawings did not include certain important fasteners. As the surface condition of the timbers was much better immediately after the timbers were raised, a substantial amount of information can be found on the field photographs of the timbers. Biological and physical forces have affected the current state of the timbers and have damaged their surfaces. By the same token, some details are only visible on the timbers today, as some parts were not entirely cleaned in the field or after conservation. Interestingly, wooden fasteners have become slightly more visible due to differential shrinkage between the fasteners and the planking, which is a result of the different shrinkage rates in radial (fasteners) and longitudinal (planks) direction.

Furthermore, not all timbers were drawn or photographed prior to conservation or after conservation. The photographs taken prior to conservation provide the most complete record of each individual timber. As previously noted, almost all timbers were photographed in the field and these photographs were generally more helpful than those taken after conservation. All timbers photographed prior to conservation were leveled to the plane of the camera, the scale was placed level with the face of the timber being photographed, and the quality of the photographs shows each timber at its best. These photos were mainly taken by one person, Patrick Baker, who consistently ensured the highest possible quality. The timber drawings, on the other hand, were made by different people with different levels of experience and training in the recording of archaeological wood, which has resulted in a variety of different drawings. Some drawings are detailed and accurate, whereas others are of such poor quality that they are practically useless.

All timbers were therefore redrawn for this study in AutoCAD on a full–size scale by tracing the timber drawings, which were then checked and corrected against the field photographs made by Patrick Baker and then against the actual timbers. They were only checked against the actual timbers if they are accessible at present; in other words, not being covered by other timbers on the display. Some timbers were completely redrawn if their respective field drawings were missing or did not provide adequate information such as nail plugs and treenail pegs. The position of each timber in the ship's hull was double–checked with the underwater photography to confirm the accuracy of the timber's location on display. This process demonstrated that the reassembly of the timbers for museum display was very accurate—an outstanding achievement given that Geoff Kimpton had no finalized timber plans.

For this study, the timbers are drawn and represented in their physical shape or state directly after excavation and prior to conservation as this represents them as closely as possible to their original condition, which makes the reconstruction more accurate.

The redrawing of the timbers was started in January 2005 with the scanning of the *Batavia* timber photographic archive in the Maritime Archaeology Department of the Western Australian Museum. Altogether, 4,699 black–and–white negatives taken of *Batavia*'s hull structure underwater and of each individual timber after excavation, and 508 color slides of the post–excavation recording and reassembly of the timbers were used to create the ship's full timber plans. These negatives and slides were all scanned in a Tag Image File Format (tiff) with a Nikon Super Coolscan 4000 ED at 4,000 dpi to ensure archival quality and maximum visibility of details.

The photographic record of the *Batavia* shipwreck has proven to be the most important and beneficial tool for the reconstruction of the ship's hull as no timber plan or set of timber plans of the structure was made for each excavation season. Furthermore, some of the tags that carried the timbers' registration numbers had disappeared during post–excavation processing and conservation, and most are obscured now that the timbers have been reassembled, which has resulted in many timbers becoming numberless. Some registration tags simply got separated from their respective timbers, whereas others had become illegible during treatment by chemicals or by iron corrosion products. This has been particularly problematic for the study and reconstruction of *Batavia*'s hull. The initial basic goal was to get all the registration numbers back on the respective timbers. The timber photographs made directly after excavation facilitated this process best. The actual timbers were simply compared to the hundreds of timber photographs until a matching photograph was found.

Sequential photographs taken in the field of one face of a timber using the 55 mm Micro–Nikkor–P lens were joined together using Adobe Photoshop. They include all photographs of large timbers (mainly hull planking, frames, and pine sheathing). It must be noted that the different photographs of each timber often provided a perfect overlay for its outline and all fastening holes, for things such as iron spikes, bolts, treenails, and sheathing nails. This was surprising as it indicates a negligible parallax distortion caused by the camera lens. Furthermore, these timber photos match the full–size timber drawings remarkably well when the two records are superimposed. The outlines of the timbers hardly deviate between one and the other. The fastener and surface details of the drawings and photographs sometimes form a perfect match but occasionally disagree by 0.05 m or less.

In addition, all underwater photographs of the hull structure were studied in detail to relocate exactly where each timber came from on the seabed. Both tasks proved to be tedious. The ship's inner layer of hull planking alone took one year's worth of full–time work to figure out the registration numbers of the timbers and redraw them. The new timber drawings were then placed in their original position as on the seabed and the nail or bolt holes of overlaying timbers matched up to determine their correct location within the hull structure.

Although the timber drawings were made as accurately as possible, fasteners may have been missed as they are sometimes obscured by excess PEG or because they cannot be observed in the display where the timbers are covered by others. Additionally, many wooden nail plugs and treenail pegs are not easily detectable and can simply be overlooked. All timber plans are projected onto a flat plane and do not take the ship's curvature into consideration, to show all the features and details as clearly as possible.


Fig. III.31 Bill Leonard using the Prexiso laser distance meter. Photograph: Patrick Baker, Western Australian Museum.

**Taking *Batavia*'s lines**

*Batavia*'s hull curvature as displayed in the Shipwreck Galleries was measured and drawn in two days, 17 and 18 February 2008, with the help of Bill Leonard of the Maritime History Department of the Western Australian Museum.[42] Leonard brought in a Prexiso laser distance meter, which made our exercise easy and saved stretching measuring tapes in a straight line when taking off–set measurements (Fig. III.31). This small handheld device measures distance quickly and efficiently within an accuracy of 0.003 m. Its measuring capability ranges from a distance of 0.1 m to 40 m, and it is operated with a 9–Volt block battery. In addition to distance, it can also add, subtract, and calculate volume; these options were not used in this case. The default reference setting is the base of the instrument, which had to be taken into consideration for taking the offset measurements. All Prexiso laser meter measurements were taken twice and the deviation between the two measurements was not once greater than 0.002 m.

Setting up the measuring system was more time consuming than taking the actual measurement. First, two parallel baselines were laid out on the gallery floor that were 11 m in length and set 5 m apart. The first baseline was stretched along the inside of the five steel pillars that carry the framework of *Batavia*'s timbers. These pillars mark the portside surface of the preserved sternpost (and, thus, that of the keel). From this baseline, the angle of the sternpost and the exact height of the 20–foot waterline mark were measured. A five meter measuring tape was affixed perpendicular to this baseline aft of the transom (=station 0). From here, the lateral and vertical curvature of the wing transom was measured. Scaffolding was placed outside this five–meter line (x–axis), from which a plumb bob was lowered that was held against the wing transom at 0.50–m intervals along the 5–m line (x–values). The wing transom points indicated by the plumb bob were marked on a piece of white masking tape on the floor with a permanent marker. Then, the distance between the mark on floor and the five–meter baseline was measured with a tape measure (y–value). A large builder's angle was used to ensure a 90–degree angle between the 0.50–m interval value on the x–axis and the y–values of the wing transom. From the points, marked on the floor, an easy vertical measurement


Fig. III.32 Measuring set–up for taking curvatures off *Batavia*'s hull, showing leveled x–axis and z–axis beams for taking station lines, Shipwreck Galleries of the Western Australian Museum, Fremantle. Photograph: Patrick Baker, Western Australian Museum.

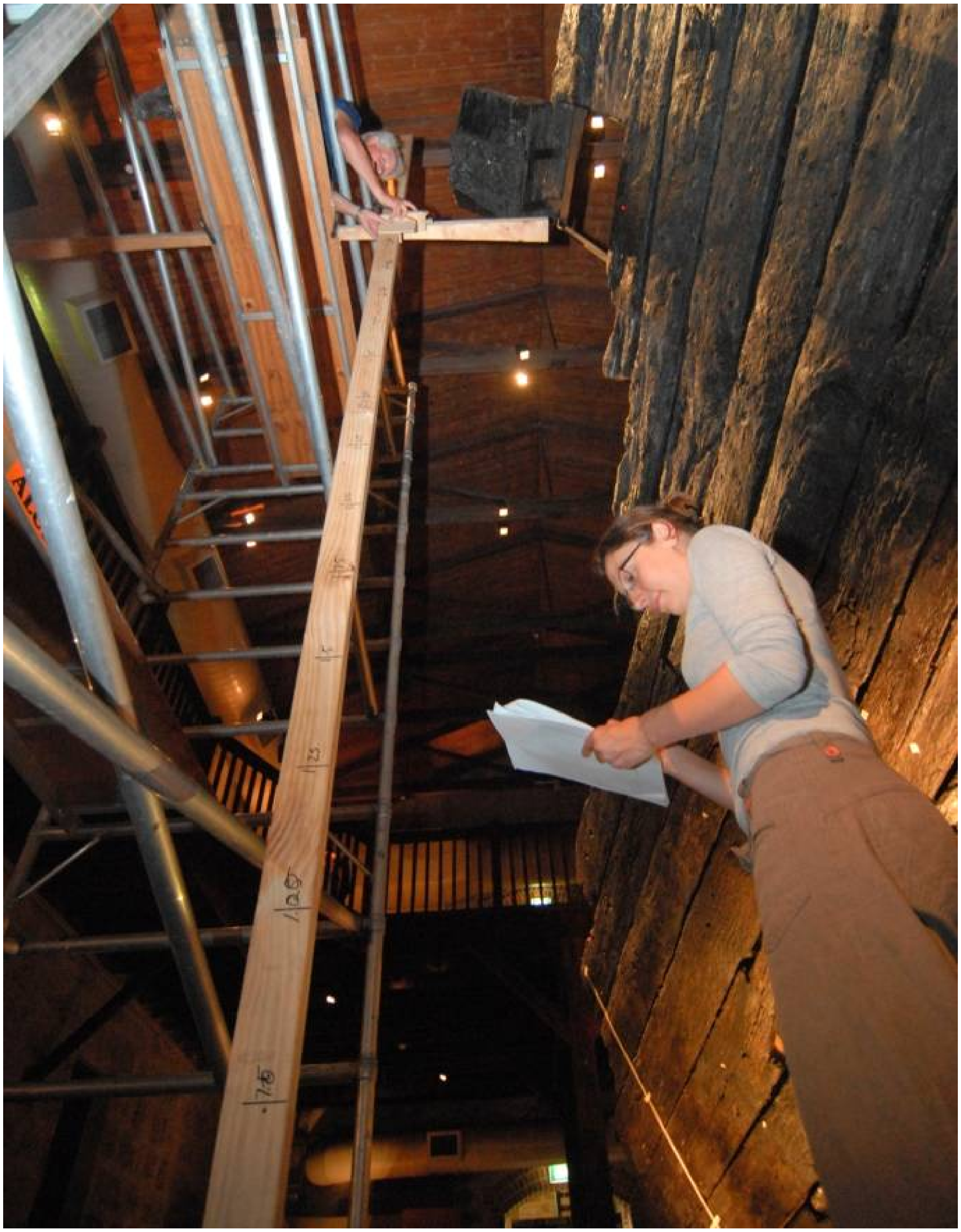

Fig. III.33 Bill Leonard (top left) and the author (lower right) taking a distance measurement from the z–axis beam to the hull, at a height of 3.75 m, Shipwreck Galleries of the Western Australian Museum, Fremantle. Photograph: Patrick Baker, Western Australian Museum.

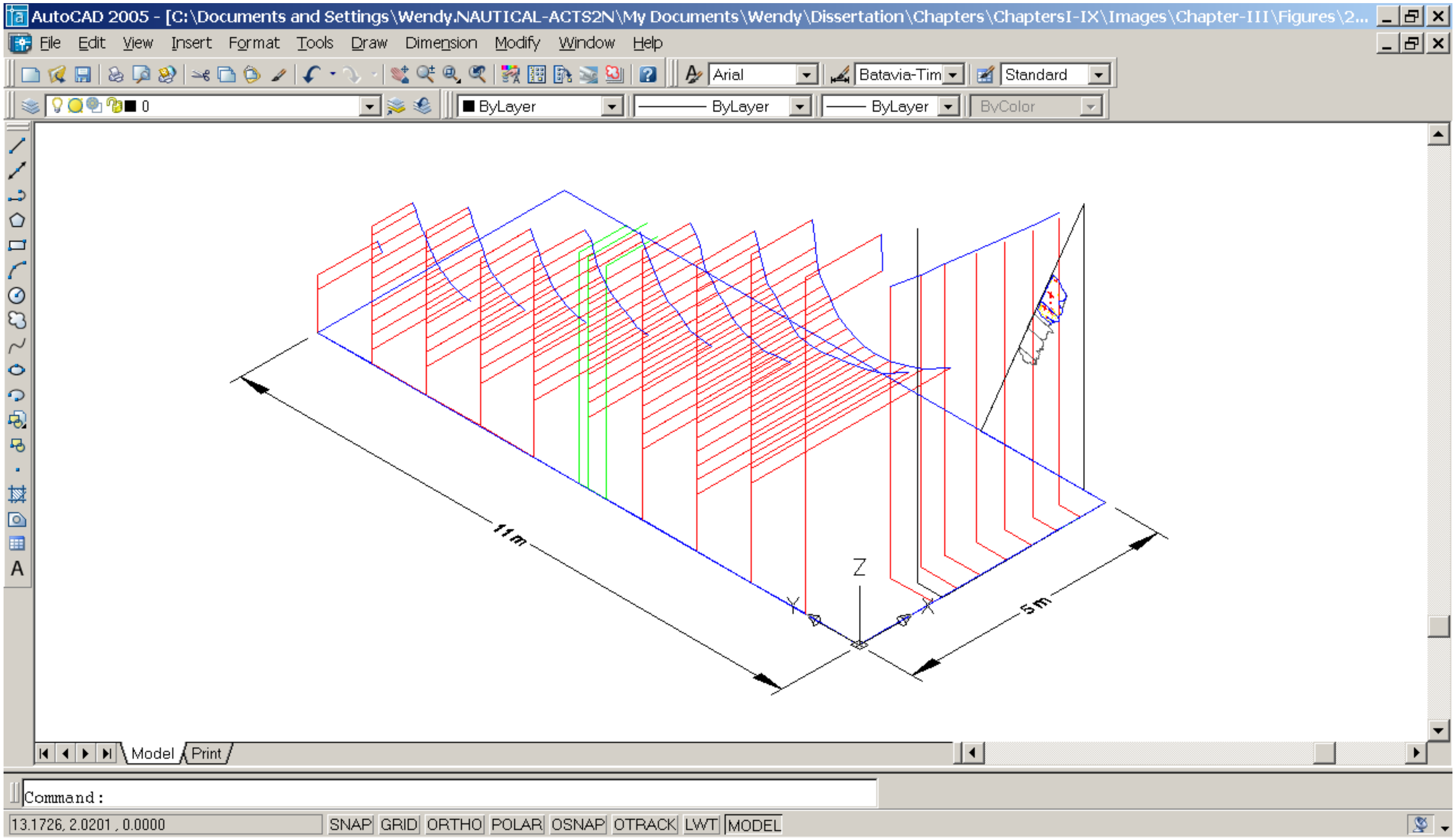


Fig. III.34 Measurements of *Batavia*'s hull lines entered into AutoCAD 2005 program. Illustration: Wendy van Duivenvoorde, Western Australian Museum.

could be taken with the Prexiso laser distance meter from the mark on the floor to the corresponding point on the wing transom, where the plumb bob was being held. This provided a height measurement (z–value) to the wing transom.

After these measurements were completed, a second parallel baseline was measured out from the first baseline to the exterior of the hull, which formed the baseline from which the offsets of the station lines were taken. Ten station lines were measured at intervals of 1.10 m along the second base line (x–values). Flush against the exterior of the baseline, a stiff pine straightedge, 0.10 m by 0.05 m in section, was affixed on which the stations were marked (Fig. III.32). On these station marks, another vertical straightedge (z–axis) was positioned and clamped to the scaffolding that was set up behind the baseline. On this straightedge the vertical off–set measurements (waterlines) were marked at an interval of 0.25 m from the baseline up (Fig. III.33). This straightedge was accurately leveled plumb in both vertical directions with a spirit level to ensure a 90–degree angle between the x and z–values. Also, great care was taken to align the interior surface of baseline straightedge flush with the interior surface of the z–axis straightedge to minimize any measurement errors. Subsequently, the Prexiso laser distance meter was placed perpendicular against the z–axis straightedge in a custom–made wooden case to ensure it measured square to the hull in the xy–axis (Fig. III.31). It also guaranteed that the back of the distance meter, from where the measurements are taken, was seated flush against the interior surface of the z–axis straightedge. As mentioned before, the device measures the distance from its back end. The box with the distance meter could be moved up the straightedge to each 0.25–m waterline marker to take a y–value measurement to the ship's hull. Each measurement was taken twice to ensure accuracy and to double–check the distance readings.

In the evenings, all measurements taken during the day were entered and plotted in AutoCAD, so they could be redone the next day if errors or other problems occurred (Fig. III.34). It must be noted that all measurements were taken to the outside of the hull. Furthermore, some measurements of the four aftermost stations were taken in places where the outer layer of hull planking is no longer present. In this case, an adjustment needed to be made to correct the difference in planking thickness. Overall, this method has proven to be an efficient and accurate means to take lines of *Batavia*'s after port side and transom.

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1 Green, *The Loss of the Verenigde Oostindische Compagnie Retourschip* Batavia*, Western Australia 1629*, 45 and 104; and Geoff Kimpton, memorandum to Jeremy Green, 1 November 1999 (Maritime Archaeology Archive, Western Australian Museum, MA74/74).

2 Paul Hundley, "*Batavia* Reconstruction," in *Proceedings of the Second Southern Hemisphere Conference of Maritime Archaeology,* ed. William Jeffery and Jenifer Amess (Adelaide: South Australian Department of Environment and Planning and Commonwealth Department of Home Affairs and Environment, 1983), 249.

3 Roeper, *De schipbreuk van de* Batavia*, 1629*, 212.

4 Roeper, *De schipbreuk van de* Batavia*, 1629,* 212.

5 Roeper, *De schipbreuk van de* Batavia*, 1629*, 90.

6 Roeper, *De schipbreuk van de* Batavia*, 1629*, 191.

7 Roeper, *De schipbreuk van de* Batavia*, 1629*, 90. The *d'achter windtveeringh* in this passage has been translated by Henrietta Drake–Brockmann as bulwark but should have been correctly the upper fashion piece or stern quarter. Additionally, the word *kruijspoorte* translates to the gun port at the mizzenmast, not the gunners' room. See, Drake–Brockman, *Voyage to Disaster*, 145.

8 Roeper, *De schipbreuk van de* Batavia*, 1629*, 175.

9 Emil L. Ghisalberti et al., "The Analysis of Acid–Affected *Batavia* Timbers," in *Proceedings of the 8th ICOM–CC Group on Wet Organic Archaeological Materials Conference, Stockholm* , ed. Per Hoffmann et al. (Bremerhaven: ICOM, 2002), 281.

10 Ghisalberti et al., "The Analysis of Acid–Affected *Batavia* Timbers," 281–83.

11 Patrick E. Baker and Jeremy N. Green, "Recording Techniques Used During the Excavation of the *Batavia*," *IJNA* 5:2 (1976): 146.

12 Baker and Green, "Recording Techniques Used During the Excavation of the *Batavia*," 143–58; Green, *The Loss of the Verenigde Oostindische Compagnie Retourschip* Batavia*, Western Australia 1629*; Green, "The VOC Ship *Batavia,* Wrecked in 1629 on the Houtman Abrolhos, Western Australia," 43–63; and Catherina Ingelman–Sundberg, "The VOC Ship *Batavia* 1629: Report on the Third Season of Excavation," *Australian Archaeology* 3 (1975): 45–52.

13 *Batavia Daybook 1*; *Batavia Daybook 2*.

14 *Batavia Daybook 3*.

15 *Batavia Daybook 4*; *Batavia Daybook 5*, 1–28.

16 *Batavia Daybook 5*, 8 April 1975, 28.

17 *Batavia Daybook 5*, 8 April 1975, 44.

18 Ghisalberti et al., "The Analysis of Acid–Affected *Batavia* Timbers," 281–308; Ian MacLeod, "Conservation of Waterlogged Timbers from the *Batavia* 1629," *Bulletin of the Australian Institute for Maritime Archaeology* 14.2 (1990): 1–8; James T.T. Pang, "The Treatment of Waterlogged Timbers from a 17th Century Dutch East Indiaman *Batavia* Using Polyethylene Glycol," *ICOM Committee for Conservation*. Reprints the 6th Triennial Meeting, Ottawa, 1–6 July 1981, 1–6; Vicki L. Richards, "The Consolidation of Degraded, Deacidified *Batavia* timbers," *AICCM Bulletin* 16.3 (1990): 35–53; and Vicki Richards, "Cosmetic Treatment of Deacidified *Batavia* Timbers," *AICCM Bulletin* 27 (2002), 12–13.

19 Green, *The Loss of the Verenigde Oostindische Compagnie Retourschip* Batavia*, Western Australia 1629*; and Baker and Green, "Recording Techniques Used During the Excavation of the *Batavia*," 143–58.

20 Baker and Green, "Recording Techniques Used During the Excavation of the *Batavia*," 144.

21 Vicki Richards, letter to author, 28 February 2008.

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[22] D–7 and D–8 were labeled as such in the field, but should actually have been labeled E–7 and E–8. When the strakes were raised, they turned out to be part of the outer layer of hull planking as the inner layer had in fact completed eroded way.

[23] Baker and Green, "Recording Techniques Used During the Excavation of the *Batavia*," 147–48.

[24] Baker and Green, "Recording Techniques Used During the Excavation of the *Batavia*," 149.

[25] Baker and Green, "Recording Techniques Used During the Excavation of the *Batavia*," 146.

[26] Baker and Green, "Recording Techniques Used During the Excavation of the *Batavia*," 150.

[27] MacLeod, "Conservation of Waterlogged Timbers from the *Batavia* 1629," 1.

[28] Baker and Green, "Recording Techniques Used During the Excavation of the *Batavia*," 151.

[29] Baker and Green, "Recording Techniques Used During the Excavation of the *Batavia*," 151.

[30] Baker and Green, "Recording Techniques Used During the Excavation of the *Batavia*," 153.

[31] Baker and Green, "Recording Techniques Used During the Excavation of the *Batavia*," 153.

[32] Baker and Green, "Recording Techniques Used During the Excavation of the *Batavia*," 153.

[33] Hundley, "*Batavia* Reconstruction," 254.

[34] Hundley, "*Batavia* Reconstruction," 254.

[35] Hundley, "*Batavia* Reconstruction," 254.

[36] Hundley, "*Batavia* Reconstruction," 254.

[37] Hundley, "*Batavia* Reconstruction," 254–55.

[38] Hundley, "*Batavia* Reconstruction," 255.

[39] Baker and Green, "Recording Techniques Used During the Excavation of the *Batavia*," 149.

[40] Baker and Green, "Recording Techniques Used During the Excavation of the *Batavia*," 149.

[41] MacLeod, "Conservation of Waterlogged Timbers from the *Batavia* 1629," 5; Pang, "The Treatment of Waterlogged Timbers from a 17th Century Dutch East Indiaman *Batavia* Using Polyethylene Glycol," 5.

[42] Bill Leonard is best known as the shipwright of the reconstructions of VOC yacht *Duifje*, built in the late 1990s, and HM Bark *Endeavour*, built in the late 1980s. Both reconstructions were built in Fremantle, Australia.

# CHAPTER IV
# HULL STUDY AND DESCRIPTION

## Construction history

The construction of two East Indiamen was begun by the VOC Chamber of Amsterdam sometime after the spring of 1626. It is unknown whether these two ships included *Batavia*. They were, however, the first two ships built according to the VOC shipbuilding charter of 29 March 1626. This charter prescribed that, henceforth, the following dimensions had to be applied to the construction of Indiamen: "length within the endposts one hundred and sixty Amsterdam feet, height of the hold twelve and a half Amsterdam feet, the lower deck five and a quarter Amsterdam feet, and breadth of thirty six feet of eleven thumbs per foot."[1] One Amsterdam foot measured 0.2831 m and was divided in eleven thumbs (0.02573 m).[2] This entry, recorded in the minutes of a meeting of the Gentlemen XVII, ends with the memorandum that two new ships would be built by the Chamber of Amsterdam as prescribed above. It is possible that these Indiamen were the two ships under construction, one of which being *Batavia*, at the Amsterdam shipyard in the summer of 1628.[3] If not, then it is unknown when *Batavia*'s construction was officially commissioned by the Gentlemen XVII —the sole authority within the VOC to order new ships to be built.[4] Generally, the construction time of a VOC ship was about eight months.[5] It took more than one year, from the moment a decision was made to construct, to get a new ship seaworthy. In July and August 1627, during their summer meeting, the construction of ships was not discussed, and the following spring the Gentlemen XVII did not gather.

In the minutes of the Amsterdam Chamber, dating to Thursday 18 November 1627, the Chamber of Zeeland was specifically admonished that it was *not* permitted to construct ships or make changes to the VOC shipbuilding charter without consent of the Gentlemen XVII.[6] The reprimand included the threat of a fine. The construction of ships at the Amsterdam yard is not mentioned in the minutes until 25 May 1628. On this day, two VOC administrators, President Mr. Weers and Mr. Hasselaer were sent with shipwright Jan Rijcksen to the *vaert* to purchase timber for the construction of two ships, one of which was *Batavia*, in the VOC shipyard in Amsterdam.[7] It is not known where or what the *vaert* was. The term may refer to the western islands of Amsterdam; which in those days was a place known for its timber trade. Here, all timber was imported for the *Noorderkwartier*. The word *vaart* in Dutch, however, means canal or connective waterway. It could be seventeenth–century slang of which the meaning is no longer known today, or refer to a place outside of Amsterdam. As the word *vaert* is not capitalized in the original handwritten text, it probably does not refer to an official geographic name. On maps of Amsterdam dating to the seventeenth century, the word *vaert* does not occur.[8]

One month later on Thursday 29 June 1628, the newly–built ships were named: "The large one is resolved to be named *Batavia* [600 tons] and the ship of Major Boom '*s–Gravenhage* [300 tons]."[9] During the summer months of 1628, *Batavia*'s construction had progressed far enough for the representatives of other VOC chambers to visit the shipyard and inspect whether construction of the ship was performed according to the shipbuilding charters.

In the minutes of VOC meeting that commenced on 18 July 1628, no mention is made by the Amsterdam Chamber of any departures from, or changes to, the 1626 shipbuilding charter in the construction of the new ships.[10] Interestingly, in the minutes of the same meeting by the Chamber of Zeeland a scribbled note adds that Rijcksen built the two ships slightly larger, with a depth of 14 Amsterdam feet instead of 12.5 Amsterdam feet.[11] It is not surprising that the Zeeland Chamber representatives took notice of this change, since the Amsterdam Chamber had officially reprimanded them eight months earlier for diverting from the new shipbuilding charter without the consent of the Gentlemen XVII. Furthermore, the Chamber of Zeeland minutes delineate there had been setbacks, following the 1626 charter, during the construction of the two ships in the Amsterdam shipyard.[12] The general consensus was that no ships would be built any larger than 800 tons, and that the height of 1626 charter should be adjusted to 14 Amsterdam feet, keeping the same length and breadth. It is not clearly spelled out, what exactly caused the setback in *Batavia*'s construction but it was probably related to the ship's height. If the construction was delayed, *Batavia* was certainly one of the ships ordered in the spring of 1626. Moreover, the shipbuilding charter of 1626 had obviously caused problems during the building process; such problems would also have surfaced if two ships had been built according this charter prior to *Batavia*. It is, therefore, likely that it would have taken more then two years from the *Batavia*'s building instruction to its completion.

The *Batavia* is mentioned again after its naming, in the minutes of the summer meeting of 1628. The Gentlemen XVII discussed at this time whether it would be possible to have the new ships ready for the next fleet, which was scheduled to leave in September or October 1628. *Batavia* is listed as the first and foremost ship scheduled to sail in this fleet.[13] The construction of the two ships must have been completed soon thereafter as Jan Rijcksen was commissioned to build the next ship for the Amsterdam Chamber on 18 September 1628. Both *Batavia* and '*s–Gravenhage* set sail for the first time in the fall of 1628.[14]

**Hull dimensions, shape and rigging**

The newly–built Indiaman *Batavia* was 160 Amsterdam feet (45.296 m) in length over its upper deck and 36 Amsterdam feet (10.192 m) in beam.[15] The height between the top of *Batavia*'s keel and its lower deck was 14 Amsterdam feet (3.936 m) and the height between the lower and upper deck was 5.25 Amsterdam feet (1.486 m).[16] *Batavia*'s length to beam ratio was 4.4:1 and its volume 300 *lasten* (600 metric tons).[17]

The hull of *Batavia* resembled a ship type that the Spanish and Portuguese called *galleon* (Figs. IV.1–11). It was a flat–sterned ship, like all Dutch Indiamen, with its hull ending aft in a transom and counter.[18] Its forecastle was lower than the aft structure, and heavy wales girdled the ship's sides to provide longitudinal and transverse stiffening. The ship had a relatively shallow draft, a forward–raking, broadly–curved stem, and its sternpost raked aft.

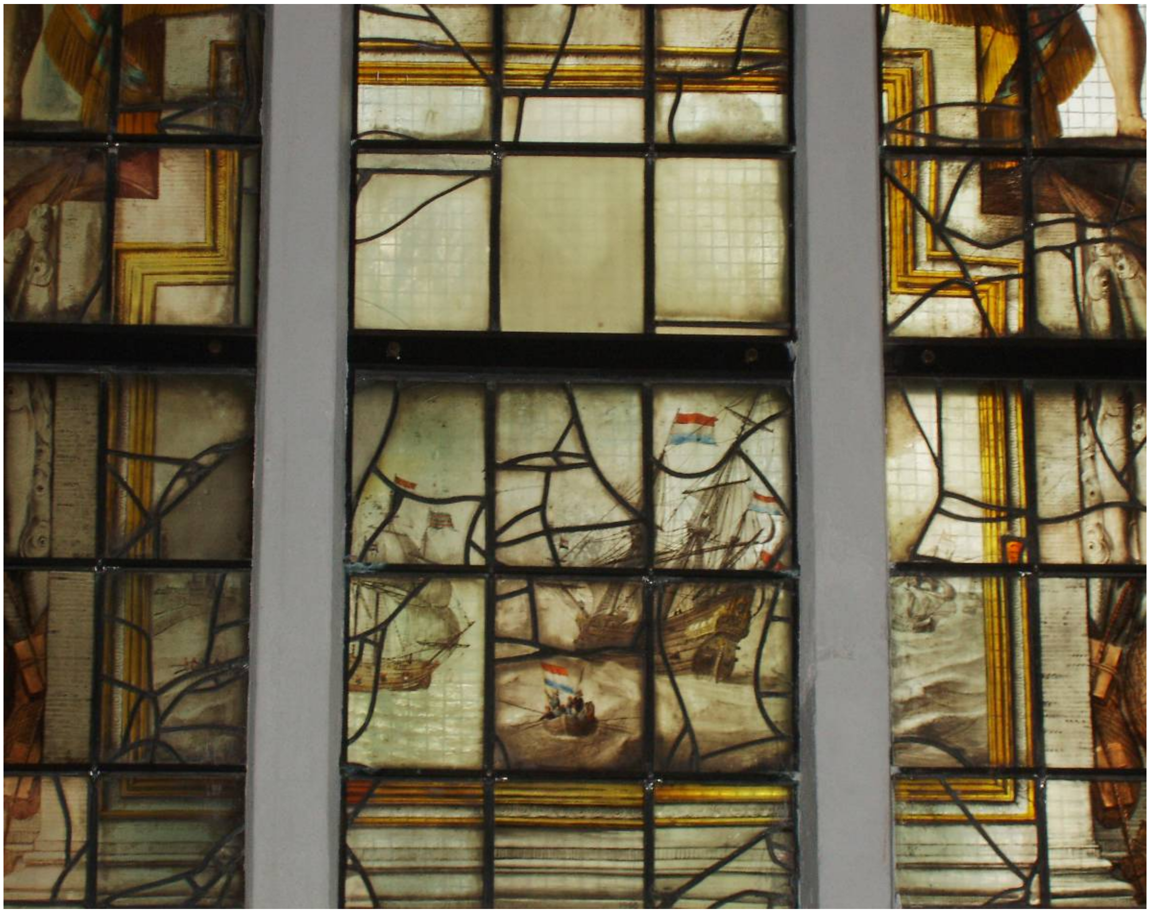

Fig. IV.1 Ships sailing on the Zuider Sea in the Netherlands, with a Dutch East Indiaman and its boat in the center. Stained–glass window by J.M. Engelsman, 1633, Chapel of the 'Egmond aan den Hoef' Castle. Photograph: Johan Knopjes.

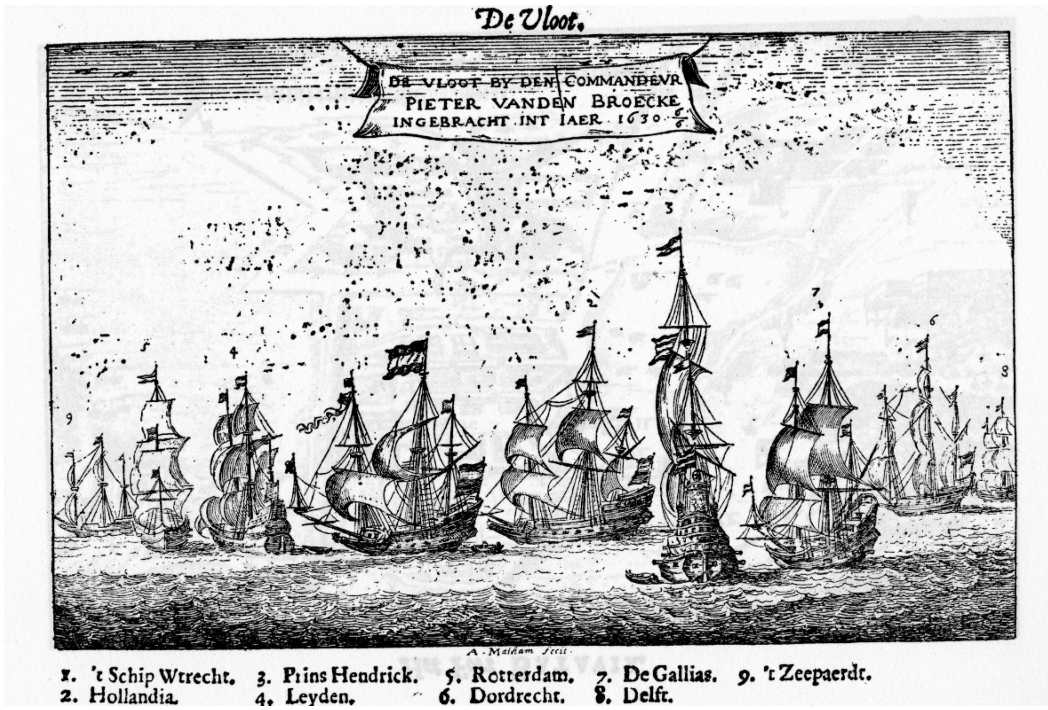


Fig. IV.2 The VOC fleet of Pieter van den Broecke upon return to the Netherlands in 1630. Engraving: Adriaen Matham, 1634.


Fig. IV.3 Dutch East Indiaman *Salamander*, partially unrigged, built in 1639 by the VOC Chamber of Amsterdam. Engraving: Reinier Nooms, 1652–1654, Rijksmuseum Amsterdam (RP–P–OB–20.528).

Fig. IV.4 A fleet of Indiamen passing through the Marsdiep, the waterway between Texel and Den Helder. In the center, Dutch East Indiaman *Mauritius*. Painting: Hendrik Cornelisz Vroom, 1600, Rijksmuseum Amsterdam (SK–A–3108).

Fig. IV.5 Dutch ships ramming Spanish galleys off the English coast, 3 October 1602. Painting: Hendrik Cornelisz Vroom, 1617, Rijksmuseum Amsterdam (SK–A–460).

Fig. IV.6 Dutch East Indiaman of the VOC Chamber of Amsterdam. Tableau of tiles: Anonymous, 1625–1650, Rijksmuseum Amsterdam (BK–NM–10596).

Fig. IV.7 Representations of *Batavia*. Engraving: from Francisco Pelsaert, *Ongeluckige Voyagie* (Amsterdam: Jans Jansz, 1647), between pages 2 and 3.

Fig. IV.8 Representation of VOC ships *Batavia* (left) and *Zaandam* (right). Engraving: from Francisco Pelsaert, *Ongeluckige Voyagie* (Amsterdam: Joost Hartgers, 1648), title page.

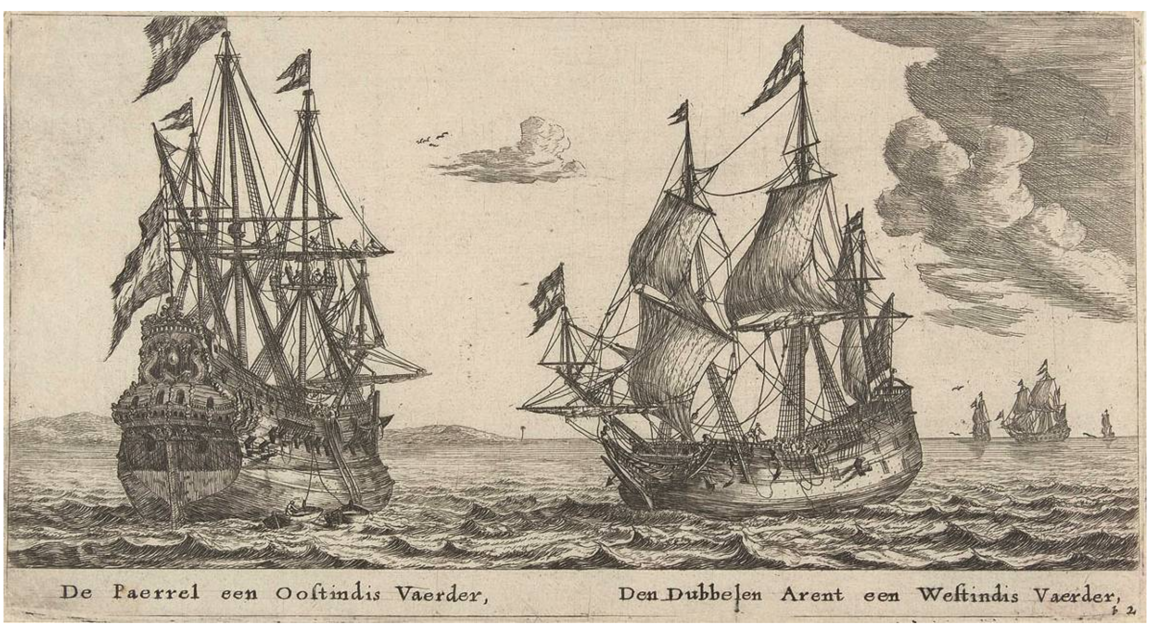


Fig. IV.9 Dutch East Indiaman *Parel* (left) built in 1651 by the VOC Chamber of Amsterdam, and West Indiaman *Dubbele Arend* (right). Engraving: Reinier Nooms, 1652–1654, Rijksmuseum Amsterdam (RP–P–OB–20.534).


Fig. IV.10 Battle of Rachado, Strait of Malacca, 1606. Portuguese and Dutch fleets (right), latter under command of Admiral Cornelis Matelief de Jonge. Among Dutch fleet (left), the three ships *Mauritius*, *Nassau*, and *Witte Leeuw*. Manuscript drawing: Museum Meermanno, Westreenianum, The Hague (MMW 74 A 6).

Fig. IV.11 Contemporary model of Dutch East Indiaman *Prins Willem*. Model: Anonymous, 1651, Rijksmuseum Amsterdam.

The hull planks on *Batavia*'s stern narrow slightly but slant significantly, which indicates a full–hulled flat–floored vessel. The floors amidships probably only had slight deadrise creating a flatter bottom and a sharply–curved turn of the bilge. *Batavia* had gently curving sides that terminated in a tumblehome amidships. Its shape is different from contemporary English ships, which had much rounder bilges and more deadrise amidships. The Dutch had to build their large ships shallower than other nations as they had to sail them into shallow waters at home and, therefore, tended to go with flat–floored ships.

The *Batavia* hull remains indicate that the ship was constructed with the bottom–based method and was, therefore, typical of early seventeenth–century Dutch ship–

building. The bottom of a ship was first assembled by fastening the planks together with temporary wooden cleats, after which frame floors were inserted. The temporary cleats were removed as the framework was installed, after which the ship's side planking was fastened to the frames following the frame–first method. The futtocks of *Batavia* were not fastened to each other, which is typical for a bottom–based construction method.[19] Moreover, rows of small wooden pegs in the lowest preserved planking strakes have provided conclusive evidence for this construction method.[20] The pegs were used to plug nail holes after the removal of the temporary cleats (see section 'Nail plugs or *spijkerpennen*').

*Batavia* sailed as a fully–rigged ship, with additional sails such as a spritsail topsail, topgallant sails, and a mizzen topsail, all of which were introduced in the first quarter of the seventeenth century. Several contemporary representations of Dutch Indiamen demonstrate the VOC's use of such rigs for its large Indiamen at the time *Batavia* was built. Examples include a Dutch Indiaman and its boat on a stained–glass window in the small chapel of the 'Egmond aan den Hoef' Castle dating to 1633 (Fig. IV.1), and the ships of Pieter van den Broecke's fleet arriving in Holland in 1630 with the first news of the *Batavia* shipwrecking (Fig. IV.2). A spritsail topmast and a mizzen topmast are also seen on the engraving of the partially unrigged Dutch East Indiaman *Salamander* (1000 tons), which was built in 1639 according to the same shipbuilding charter as *Batavia* (Fig. IV.3).

The exact arrangement of *Batavia*'s decks is not known, but contemporary documents and illustrations offer some insight. Dutch East Indiamen normally had two fully–planked decks that carried artillery, cargo, ship's stores, and passengers. VOC ships with three continuous decks were certainly known but did not become common until the late eighteenth century.[21] In the early seventeenth century, they generally had two full decks; the lower gun deck and the upper maindeck (Appendix A). In addition, their sterncastles had a quarterdeck than ran from the mainmast to the transom and a poop deck (Figs. IV.4–IV.6). The forecastle had a deck above the upper deck. In between the forecastle deck and quarterdeck was an open space, called the waist, where, among other things, the ship's boat was kept.[22] It is therefore likely that *Batavia* was constructed with two decks, although it is not certain.

In the 1647 edition of Francisco Pelsaert's *The Unlucky Voyage* (published by Jans Jansz), several engravings of the *Batavia* ship are printed with two rows of gunports along the side of its hull, suggesting the ship had three or more decks (Fig. IV.7). These representations are, however, not part of the original journal, and they were made specifically for this 1647 publication of Pelsaert's story.[23] The ship has fourteen gunports per side in these representations, which matches the numbers of cannon that *Batavia* carried. *Batavia* has no topgallant sails in the 1647 engravings. Another representation of *Batavia* appears in the first edition of *The Unlucky Voyage* published by Joost Hartgers in 1648 (Fig. IV.8). Again, the ship is shown with two full rows of gunports and no topgallant sails.

These representations of *Batavia* should be seen as artistic impressions and not true representations of the ship's appearance. First of all, they were made nearly twenty years after the ship's wrecking. Secondly, they are not consistent with more detailed and accurate iconography of Dutch Indiamen dating to the first half of the seventeenth century. Several representations of Dutch East Indiamen dating to the time *Batavia* was built show that they were only fitted with one row of gunports along one deck and, occasionally, with two gunports at a lower level aft (Figs. IV.1–IV.3, IV.9–IV.11). Additionally, some ships have a few small gunports along the ship's waist and quarterdeck (Figs. IV.4, IV.6, IV.10, IV.11). None of the contemporary iconography shows a vessel with two full rows of gunports. The cannon were generally placed at the lower deck, as it was protected from weather influences.

Twenty–eight guns were found on the *Batavia* shipwreck site. They include twenty–one cannon made of iron, five of bronze, and two composite cannon.[24] The ship originally had two more cannon, one iron and one bronze, which were raised by Pelsaert after the ship's wrecking. They are listed in his overview of salvaged good as one iron cannon of 3,310 pounds and one metal (=bronze) cannon of 3,300 pounds.[25] *Batavia*, therefore, originally carried at least 30 cannon. In a decree of the Gentlemen XVII dating to 22 August 1630, the VOC's large Indiamen were ordered to be fitted with thirty–two cannon; twenty–four heavy iron cannon, six bronze cannon, and two mignons of iron or copper. [26] The latter are composite cannon. In comparison to this document, *Batavia* is two iron cannon short.

The large Dutch East Indiamen *Salamander* (1,000 tons) and *Parel* (1,100 tons) were built by the Chamber of Amsterdam in 1639 and 1651, respectively.[27] Although these particular ships were much larger than *Batavia*, they had one row of gunports along each side of the vessel, plus one gunport in the transom on either side of the sternpost (Figs. IV.3 and IV.11). *Batavia* probably had a similar arrangement with fourteen of its cannon on each side of the lower gun deck and two gunports at its transom. It would seem, then, that both publications of *The Unlucky Voyage* feature inaccurate depictions of the vessel.

**Hull structure and wood**

*Batavia*'s existing structural timbers, including hull and ceiling planks, are made of oak.[28] The sheathing on the exterior of the ship's hull, and the subfloor of the ceiling planking and cargo floor on top of the ceiling were made of pine. A detailed discussion of the use of timber in seventeenth–century Holland and the wood study of the *Batavia*'s timbers can be found in Chapter VII.

Information on all timbers discussed below can be found in the scantling list of Appendix B. For this study, only the diagnostic timbers from *Batavia*'s hull were taken into consideration; all non–diagnostic fragments without provenance are excluded.

**Hull planking**

*Batavia*'s lower preserved hull and its transom are double–planked up to the twelfth preserved strake, which may correspond to the ship's waterline (Figs. IV.12–IV.15). The two layers of hull planking have essentially the same thickness; each strake measures 0.080 m to 0.090 m in thickness, with an average thickness of 0.087 m.[29] The

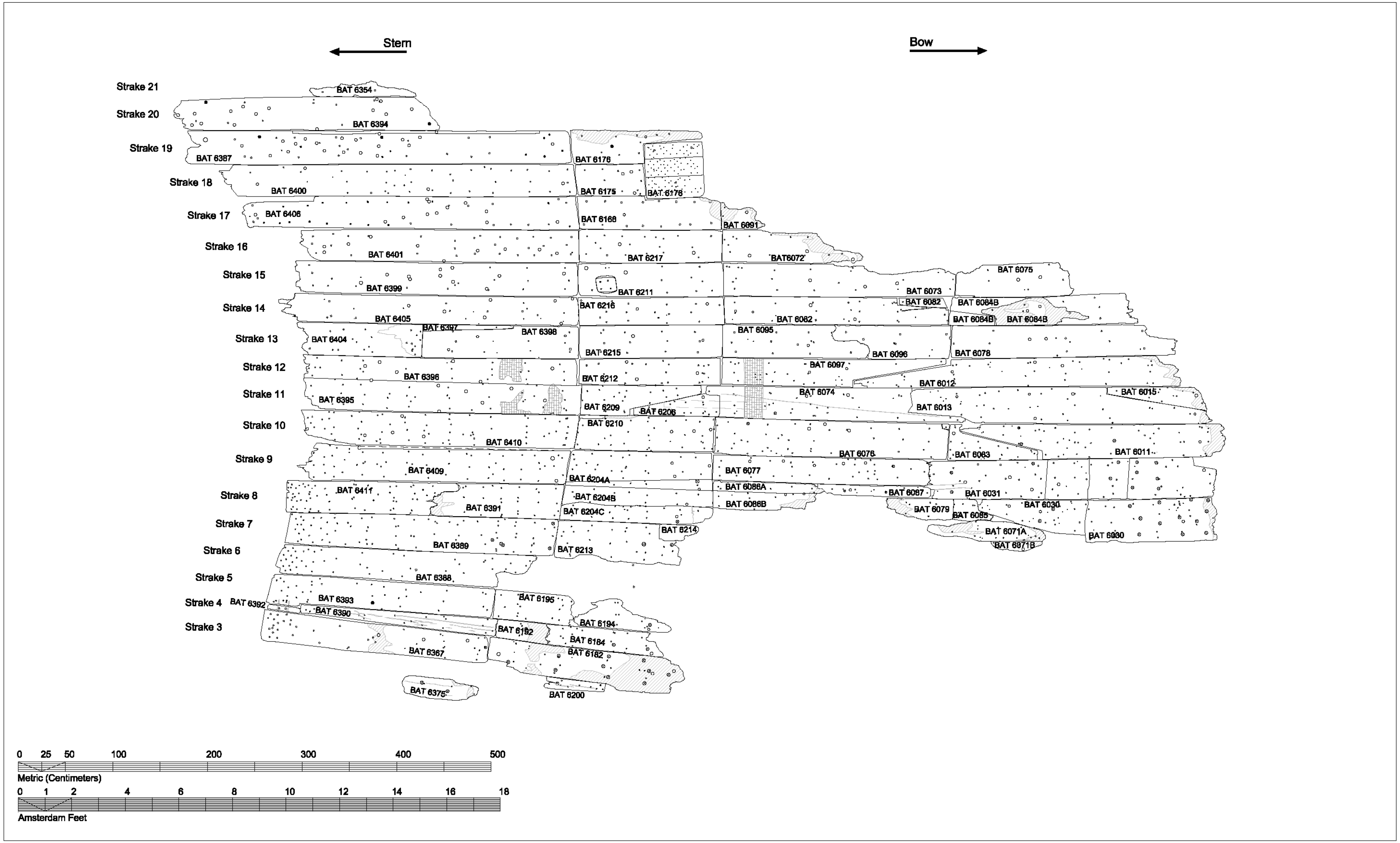


Fig. IV.12 Timber plan of *Batavia*'s inner layer of hull planking, preserved strakes 3–21. Port side, interior surface. Illustration: Wendy van Duivenvoorde.

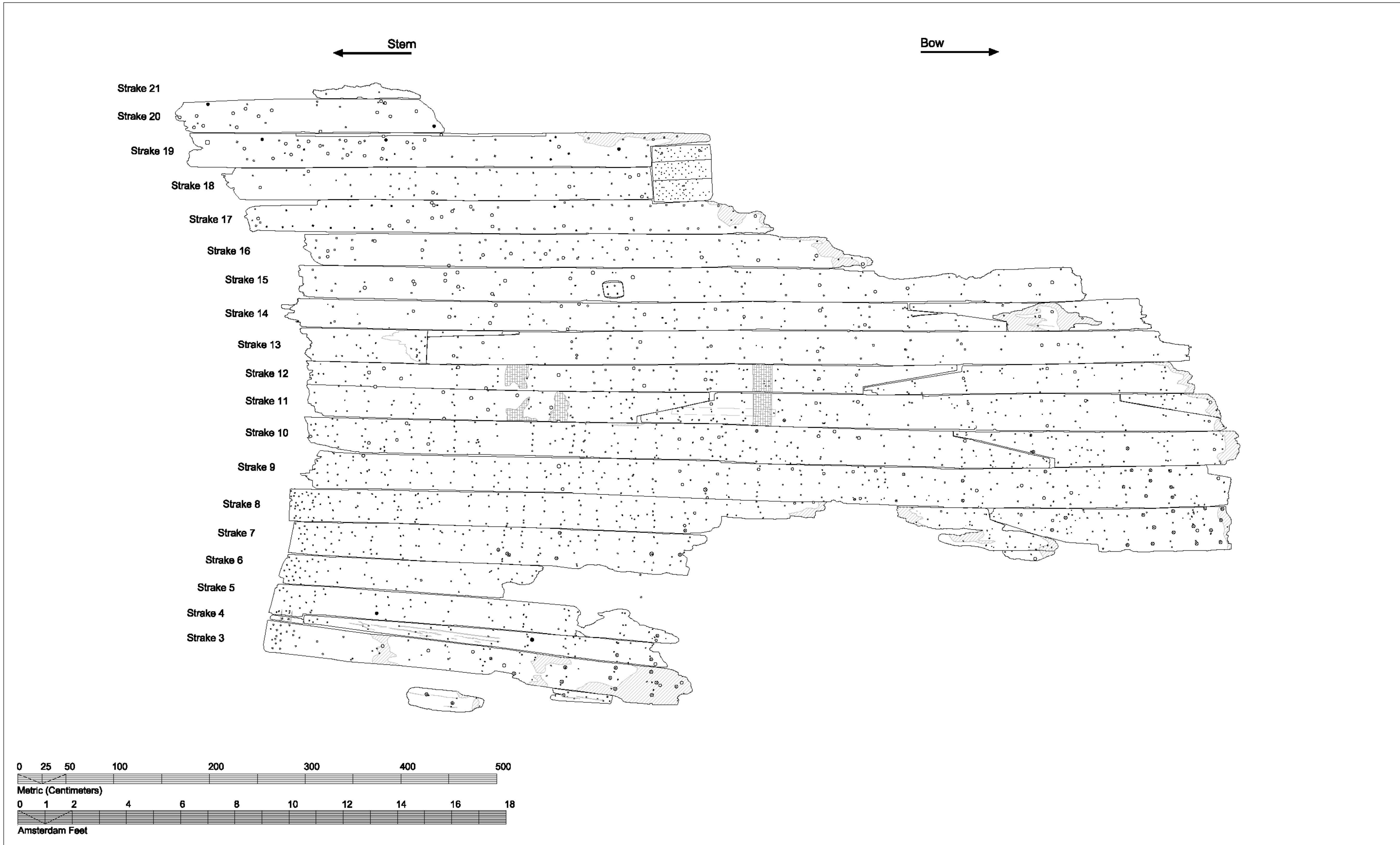


Fig. IV.13 Reconstructed plan of *Batavia*'s inner layer of hull planking, preserved strakes 3–21. Port side, interior surface. Illustration: Wendy van Duivenvoorde.

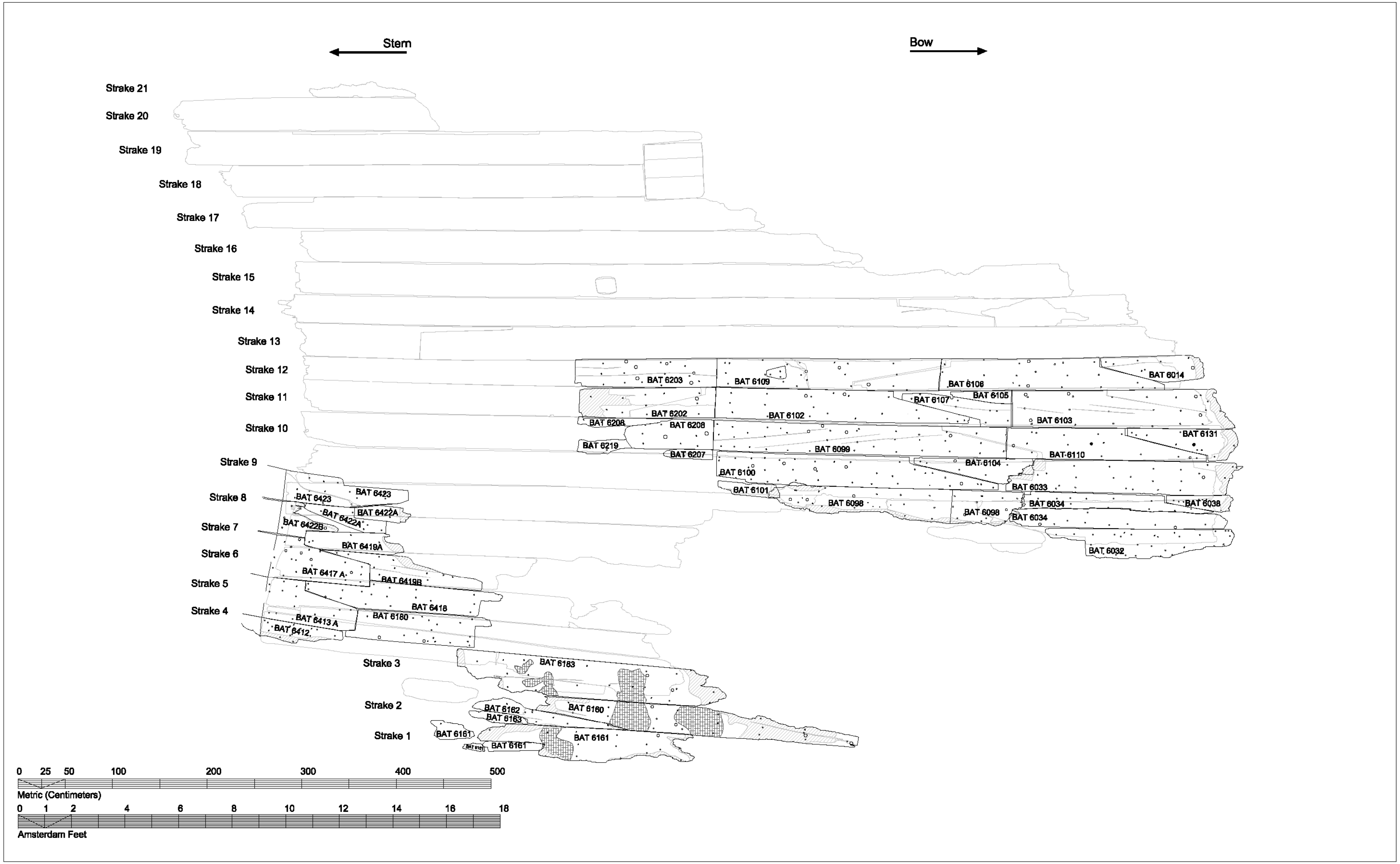


Fig. IV.14 Timber plan of *Batavia*'s outer layer of hull planking, preserved strakes 1–12. Port side, interior surface. The inner layer of hull planking is shown in background, in gray, for orientation. Illustration: Wendy van Duivenvoorde.

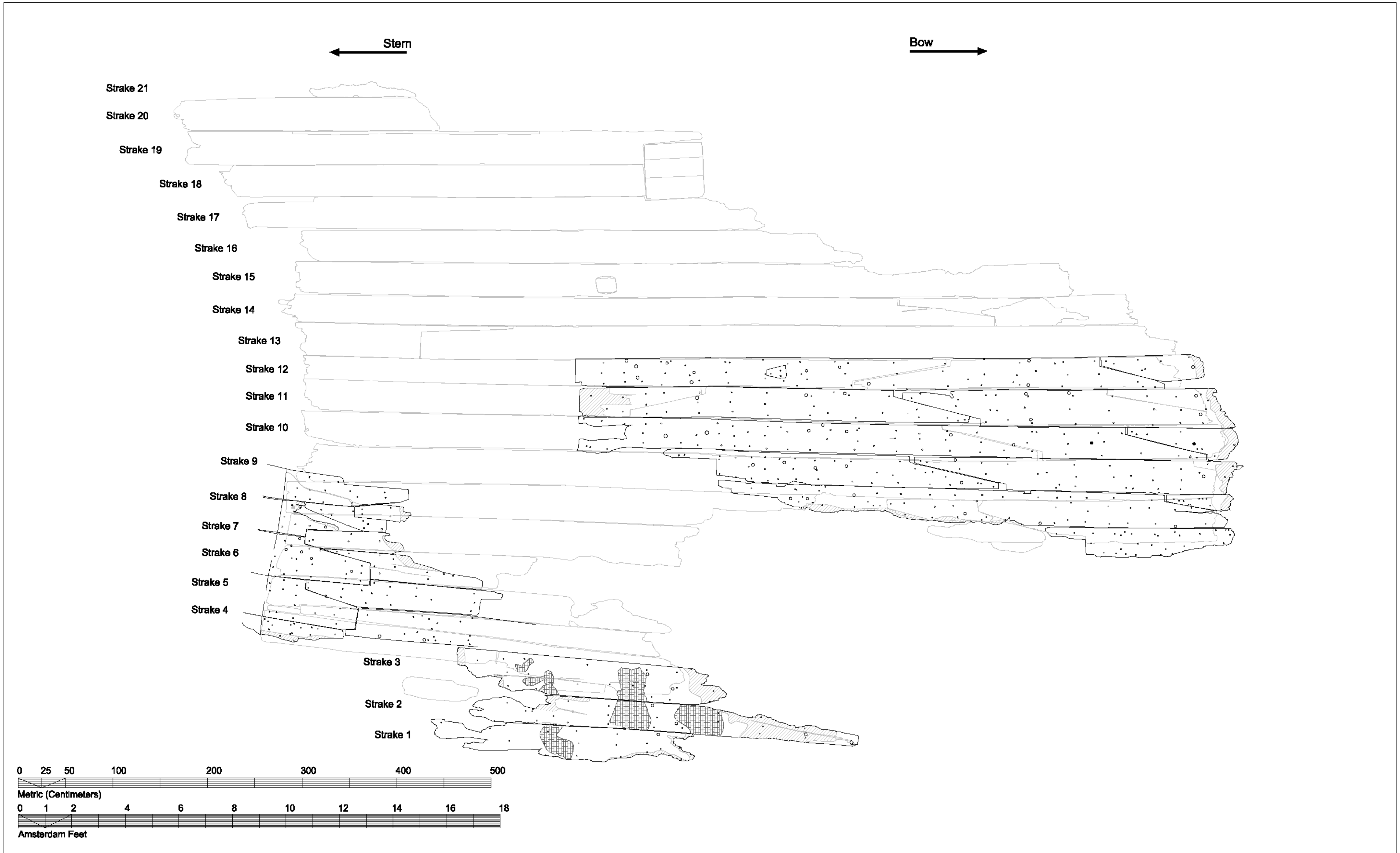


Fig. IV.15 Reconstructed plan of *Batavia*'s outer layer of hull planking, preserved strakes 1–12. Port side, interior surface. The inner layer of hull planking is shown in background, in gray, for orientation. Illustration: Wendy van Duivenvoorde.

maximum hull planking thickness of the ship's bottom is, thus, 0.180 m (7 Amsterdam thumbs). The seams of each plank layer are only offset by a few centimeters, which is probably the result of both layers of planking being rabbeted into the keel (Fig. IV.16). The maximum planking width varies from 0.250 m (strake 4) to 0.451 m (strake 7), with an average width of 0.339 m. The longest preserved hull plank is strake 9 of the inner layer of hull planking, which measures 9.72 m (Fig. IV.13).[30] This plank is, however, not preserved in its entirety as the scarf at its forward end only partially survived.

Strake 13 is the first single–planked layer consisting of two planks that are joined by a vertical flat scarf (Fig. IV.13). It measures 0.359 m in maximum width and has a maximum thickness of 0.180 m. In previous publications, this strake has been referred to as the first wale, which seems incorrect as it has the same thickness as the two layers of all the strakes below.[31] It does, however, function as a "thick strake of planking," which is located at the side of the vessel for the purpose of girding or stiffening the outer hull."[32] Although not physically apparent, it then technically is *Batavia*'s first wale. It also marks the change from the ship's shell–based bottom and frame–based side, and probably indicates the ship's waterline.

Above the thirteenth strake, only one layer of planking is applied, though there is evidence at strake 14 that suggests it was double–planked at its forward end. From strake 14 to strake 21, the planking varies from 0.112 m to 0.130 m in thickness, with an average thickness of 0.125 m. The two planking layers at the forward end of strake 14 are, however, part of a substantial vertical flat scarf that turns into a single layer of planking (Fig. IV.17). The interior end of this scarf comprises two timbers that are joined by a regular flat scarf. The maximum thickness of strake 14 is 0.125 m.

In the aft section of the hull, one drop strake has been preserved in strake 4.[33] It tapers towards the stern and does not run onto the transom. It is preserved over a length of 3.78 m, tapers from 0.25 m to 0.09 m in width, and has a maximum thickness of 0.089 m. Interestingly, the aftermost end of the plank that is placed above the drop strake, BAT 6393, was apparently damaged in the construction process and a small insert, BAT 6392,

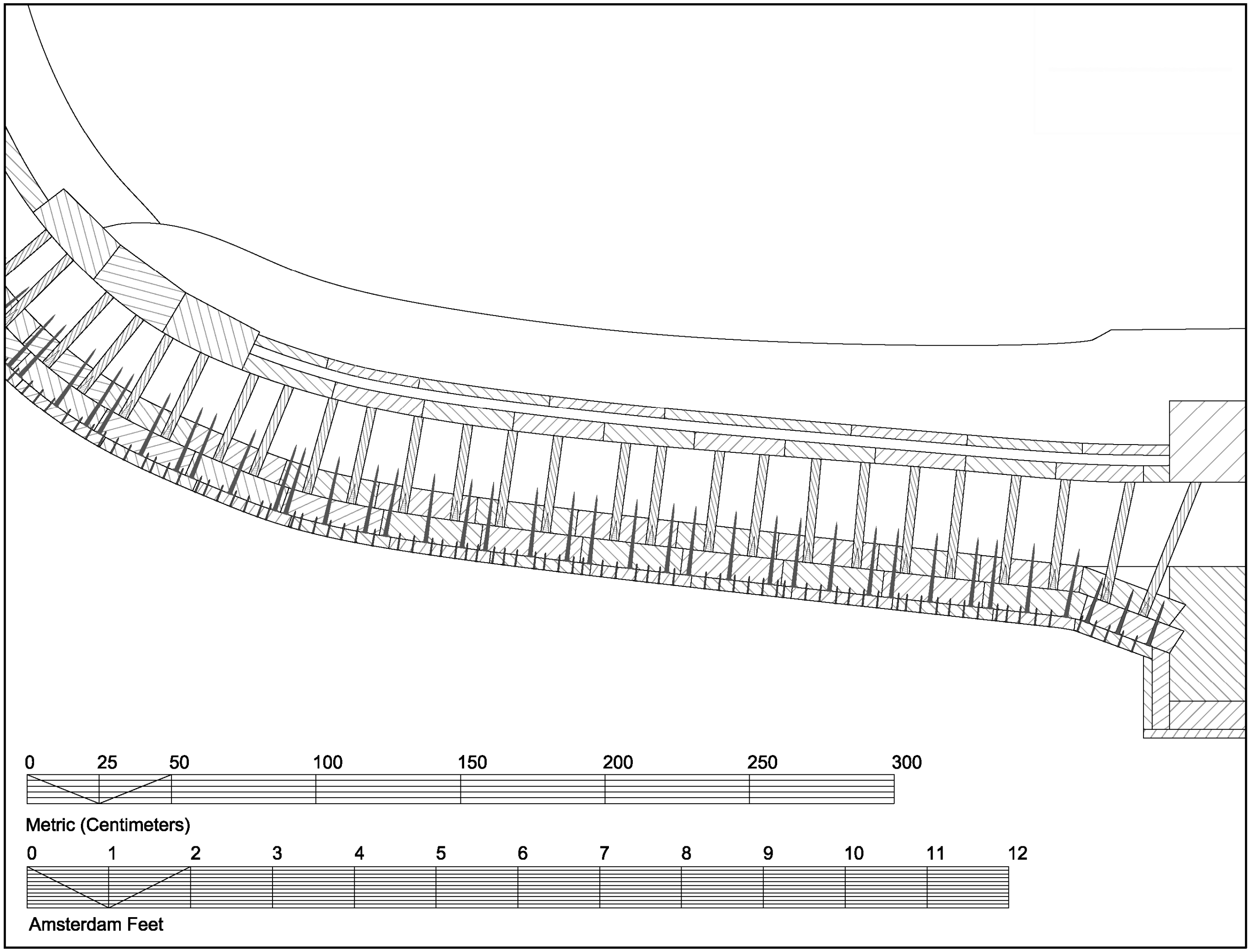


Fig. IV.16 Reconstruction of *Batavia*'s bottom showing assembly of the pine sheathing, two layers of hull planking, floor, ceiling planking, cargo floor planking, and rider. Illustration: Wendy van Duivenvoorde.

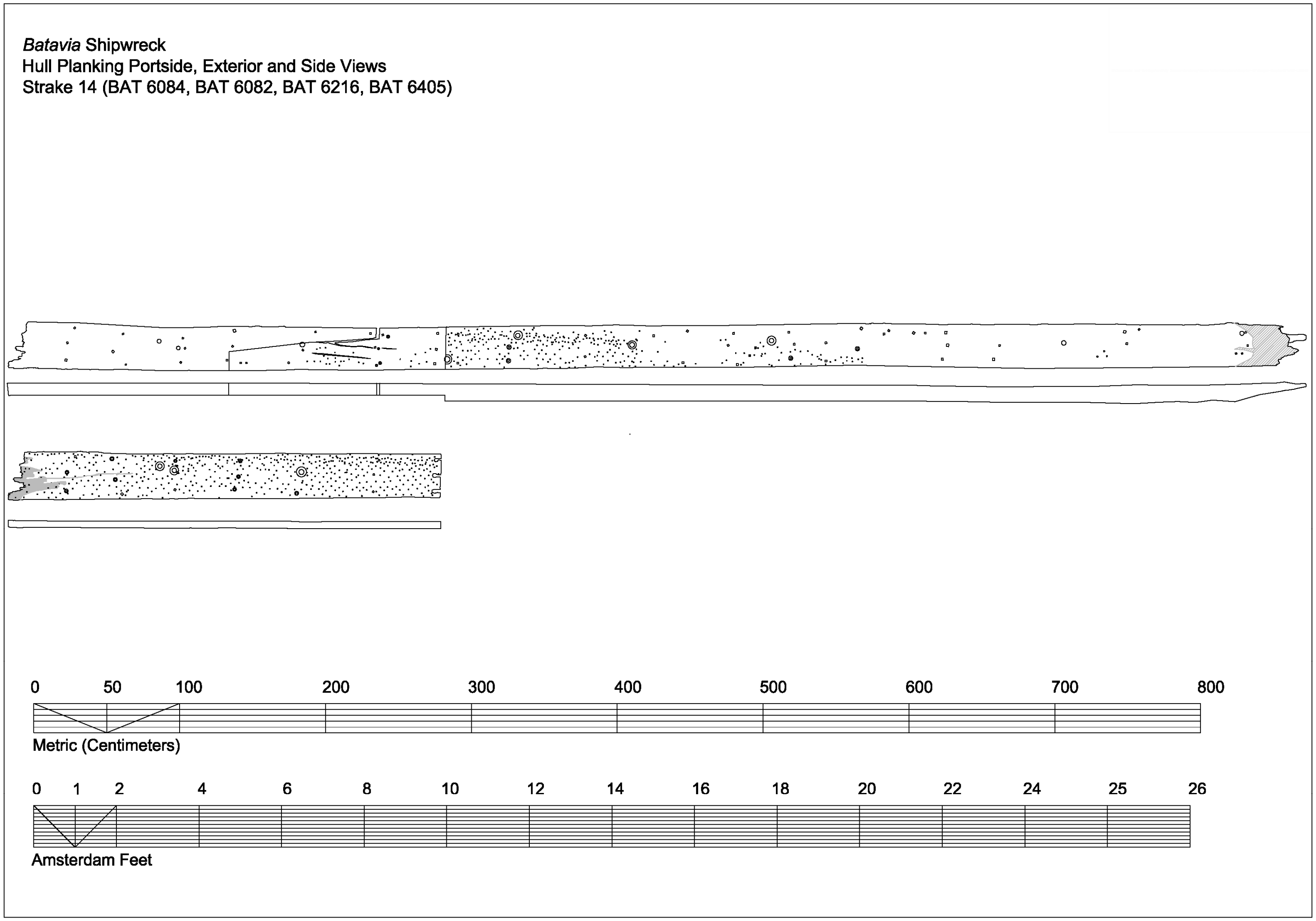


Fig. IV.17 Hull planking strake with flat scarf and partial vertical flat scarf, *Batavia* shipwreck. Illustration: Wendy van Duivenvoorde.

was nailed onto its lower end with two iron nails, so it would fit around the drop strake properly.

The planks of double–planked strakes 1 to 12 and the interior end of the vertical flat scarf in strake 14 are all joined with flat scarfs (Figs. IV.13, IV.15, IV.18). In the foremost preserved area of *Batavia*'s hull seven flat scarfs are preserved in the inner layer of hull planking, and five in the outer layer of hull planking. The close proximity of these scarfs must have created a weakness in the ship's hull. The complete scarfs of the inner layer of hull planking vary in length from 0.818 m (strake 11, aft) to 1.084 m (strake 10). Their nibs measure from 0.051 m (strake 10) to 0.105 m (strake 14) in width, with an average width of 0.076 m. The scarfs in the outer layer of hull planking are slightly smaller and vary in length from 0.71 to 0.962 m. The dimensions of their nibs are similar to those of the inner layer of hull planking, measuring from 0.051 m to 0.102 m, with an average width of 0.070 m.

Fig. IV.18 Flat scarf in planking strake 12, exterior of outer layer of hull planking, *Batavia* shipwreck, BAT 6014 and BAT 6106. Photograph: Patrick Baker, Western Australian Museum (MA4864–34).

At first glance, it seems that no scarfs are present in the aftermost section of the ship's planking above the double–planked strakes but, when taking a closer look at this area, vertical scarfs are found in strakes 13 and 14 (Figs. IV.12, IV.13, IV.17, IV.19). These scarfs are best seen from the inside of the hull planking, which is currently not easily accessible as the inside of the hull planking is primarily covered with frame timbers. These scarfs are used to join the planks of the single–planked strakes of *Batavia*'s surviving hull structure.

The planks of two strakes are thus scarfed together with vertical flat scarfs. Their foremost planks are scarfed onto the outboard surface of the aftermost plank (Figs. IV.17, IV.19–IV.20). One such scarf is present in strake 13, though poorly preserved and no longer complete, and measures 1.456 m in length (Fig. IV.19). This particular scarf end also has a rectangular graving piece which will be discussed in the 'Graving pieces' section of this chapter. The second vertical flat scarf is situated in the fourteenth strake, previously discussed, from which only a vertical seam is visible at the exterior of the ship's hull. The overlying forward part is fastened to the underlying scarf end with three iron nails (Fig. IV.20). This scarf measures 3 m in length. Vertical flat scarfs are typical for northwest European shipbuilding and have been found on the archaeological remains of thirteenth–century and fourteenth–century cog–like vessels, such as NZ43, NZ42, and Q75. They are also visible on iconographic representations of cogs on city seals.[34] The vertical flat scarfs of *Batavia*, however, are much larger and more sophisticated than those of the medieval cog–like vessels, which generally varied between 0.200 m and 0.300 m in length.[35]

The frame timbers of the ship's bottom are fastened to the inner layer of hull planking with wooden treenails. Strake 11 is the highest strake in which treenails have been observed. They are absent in strakes 13 to 18. Strake 12 is the last preserved strake of the ship's bottom that was erected in a shell–based construction method; it may have treenails but they have not been found to date. The treenails, which had an average diameter of 0.032 m, fastened not only the hull planking and frames, but also the ceiling planking.

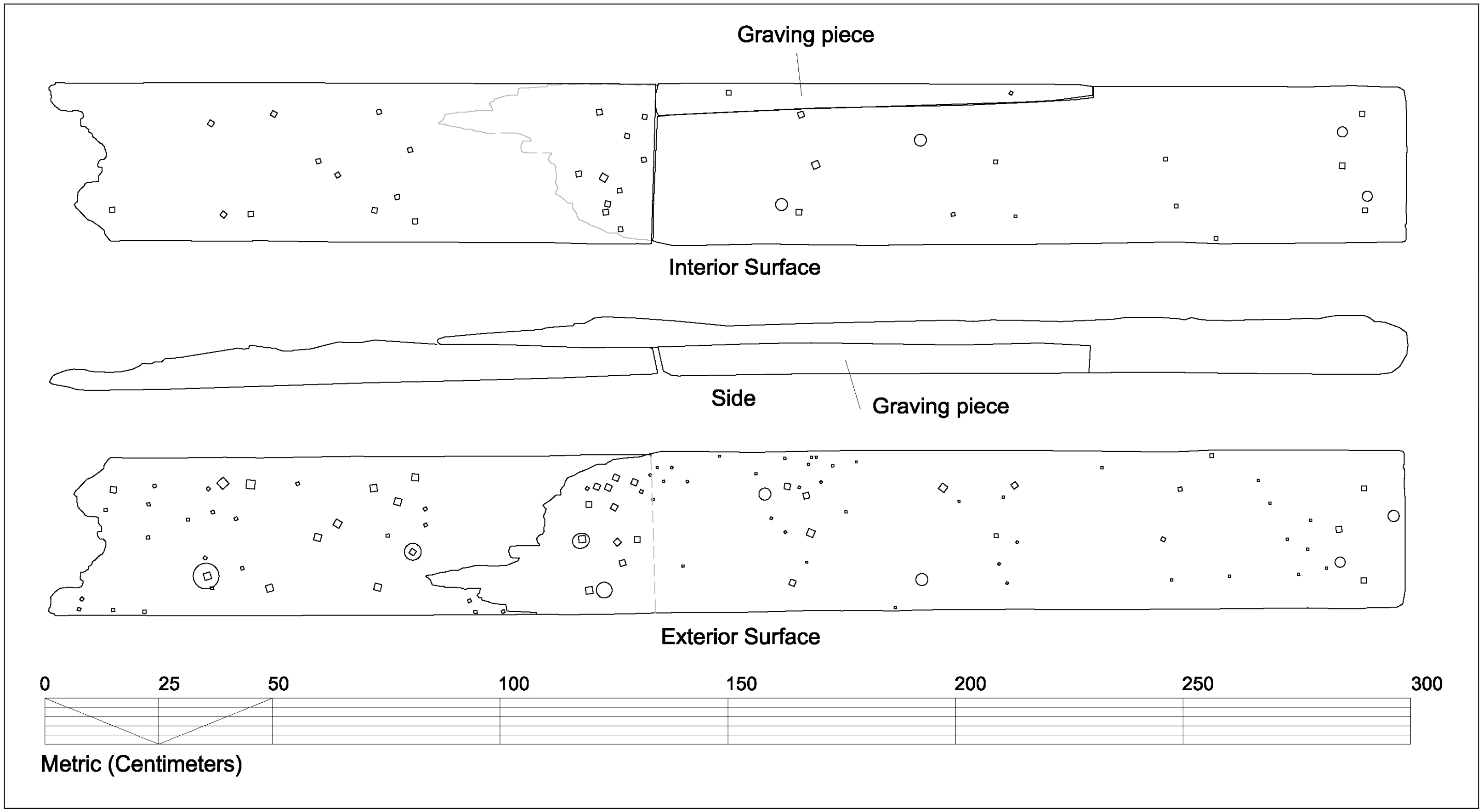


Fig. IV.19 Hull planking strake 13 with vertical flat scarf, *Batavia* shipwreck, BAT 6397, BAT 6398, and BAT 6404. Illustration: Wendy van Duivenvoorde.

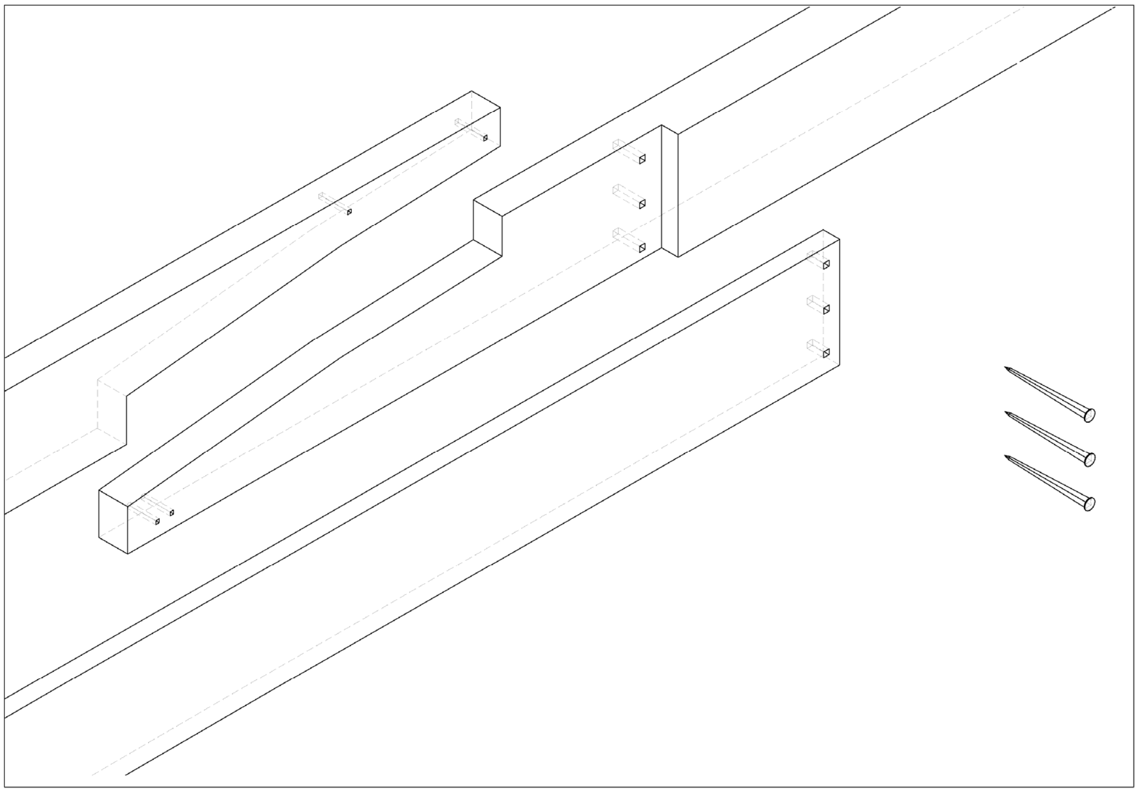

Fig. IV.20 Isometric reconstruction of planking strake 14 with flat scarf and partial vertical flat scarf, *Batavia* shipwreck. Illustration: Wendy van Duivenvoorde.

Treenails that secured the frames and planking in place are pegged with square hardwood pegs on their exterior ends (Figs. IV.21–IV.22). These pegs vary in width from 0.015 m to 0.020 m. In other shipwreck studies, authors have referred to pegged treenails as 'wedged treenails,' which is incorrect.[36] Treenail pegs are seated in the center of the treenails, they are square in section, and taper to a point. Treenail wedges are rectangular and flat inserts that span the entire diameter of a treenail.[37] In addition, treenail pegs are located, in seventeenth–century Dutch ships, at the exterior of the hull planking, whereas wedges are inserted on treenails on the interior of the hull timbers. Due to the poor preservation of *Batavia*'s frame timbers, in particular at the ship's forward end, no wedges have been found to date on the interior ends of the treenails.

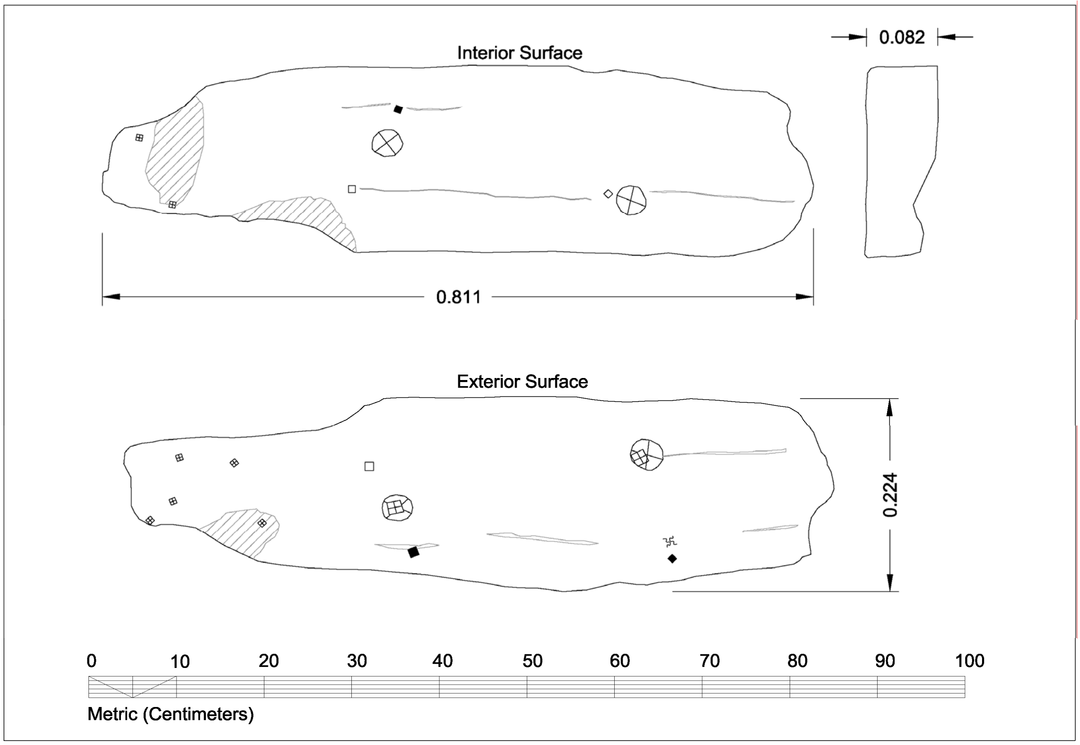


Fig. IV.21 Fragment of inner layer of hull planking showing pegged treenails, nail holes, and nail plugs, *Batavia* shipwreck, BAT 6375. Illustration: Wendy van Duivenvoorde.

Fig. IV.22 Pegged treenail driven from the inner layer of hull planking, as seen on the exterior surface of the plank, *Batavia* shipwreck, BAT 6375. Photograph: Patrick Baker, Western Australian Museum.

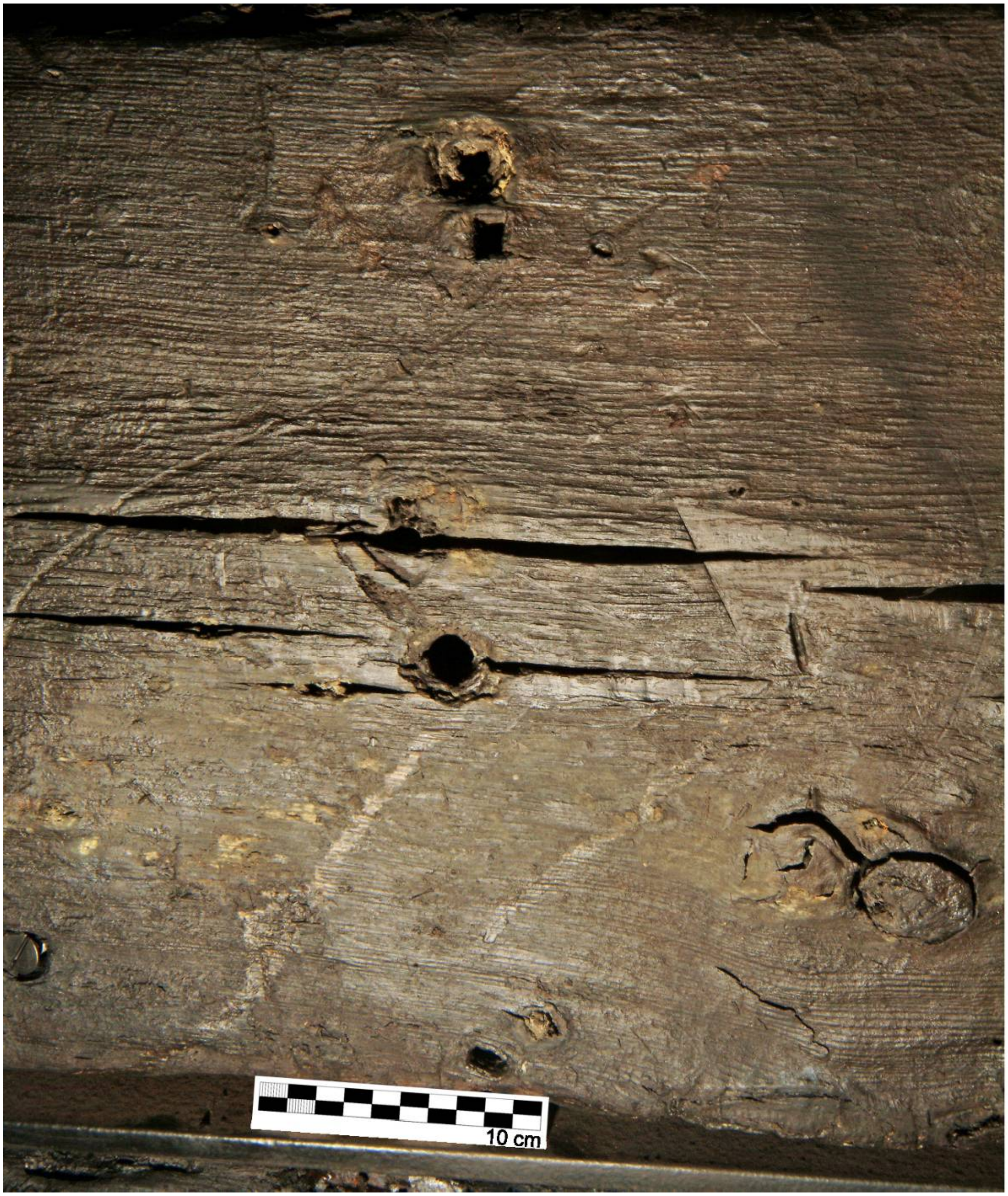


Fig. IV.23 Nail holes on exterior of inner layer of hull planking directly forward of transom. Nail head impressions with nail holes are from fasteners that fixed the inner layer to frames, whereas each nail hole next to them, are from nails that fastened the outer layer of planking to inner layer, *Batavia* shipwreck, BAT 6389. Photograph: Patrick Baker, Western Australian Museum.

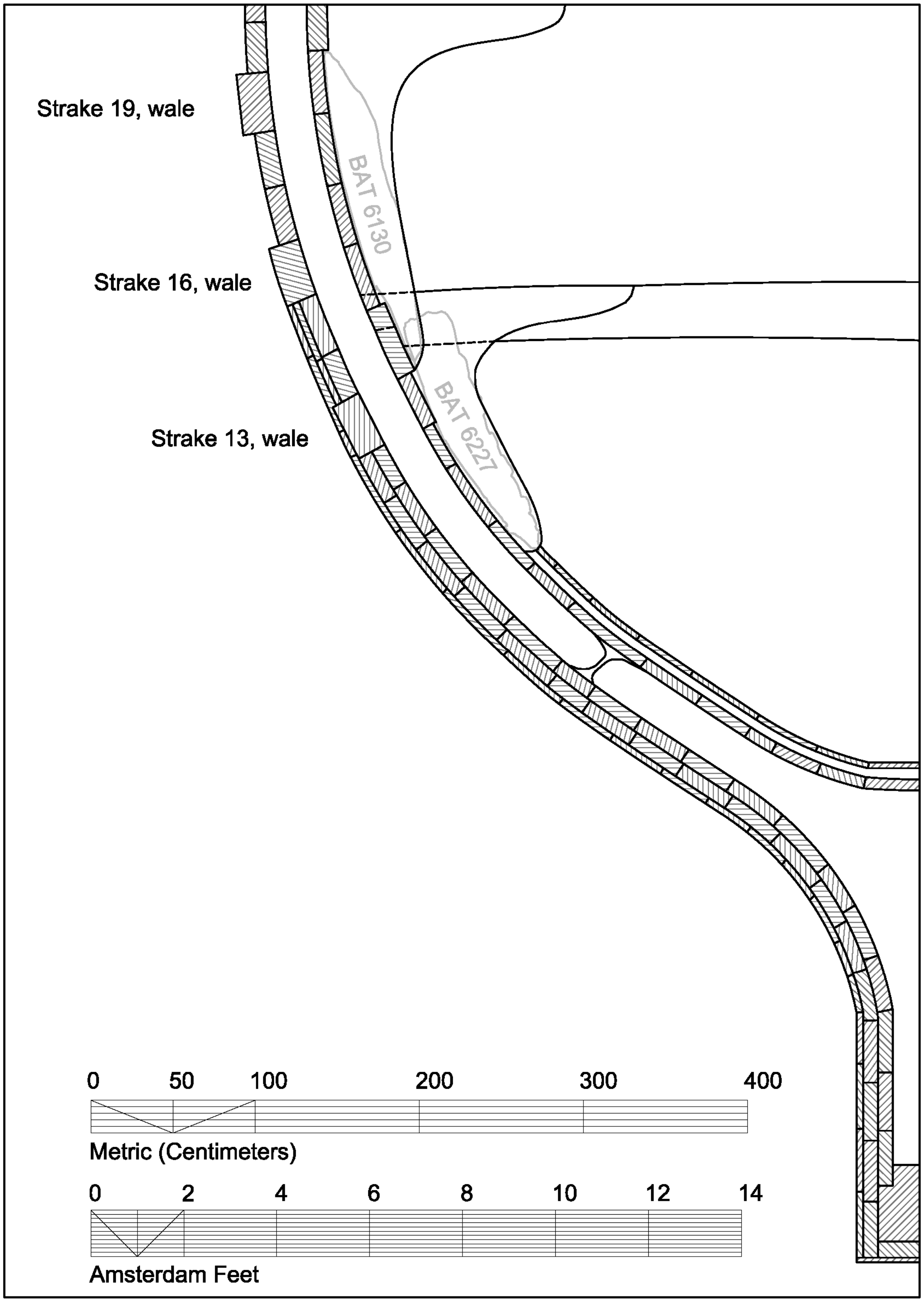


Fig. IV.24 Cross–section of *Batavia*'s hull at frame C31, showing all layers of planking, frames, and hanging knees from lower and upper decks. Illustration: Wendy van Duivenvoorde.

At the aftermost end of the bottom hull planking strakes, over an area of two meters from the transom, frames were not treenailed to the inner layer of hull planking, but instead nailed with iron spikes. Most noticeable are the enormous concentrations of iron fasteners where the plank ends were nailed onto the fashion piece. The aftermost ends of the inner layer of hull planking on the ship's side are beveled where they were nailed onto the fashion piece.

The outer layer of hull planking was nailed to the inner layer, throughout the hull, with iron spikes, with an average of three spikes per plank at an interval of about 0.200 m or basically at each frame. Generally, the nails went through both layers of hull planking into the frames, so their original length must have exceeded 0.160 m (Fig. IV.14). The nailing pattern of these spikes in the aftermost section of *Batavia*'s hull is regular and may have been facilitated by the slight overlap in planking (Fig. IV.23).[38]

The single layer of hull planking at strakes 14 to 21 was also nailed to frames with iron spikes. The shafts of the iron spikes taper slightly in cross–section and measure 0.015 m below their heads. The spike heads vary in size from 0.023 m to 0.030 m, with an average of 0.025 m. No treenails were used in the ship's side planking.

*Batavia*'s planking thickness changes from about 0.180 m at its bottom to 0.125 m on its sides (Fig. IV.24). This change is not gradual but rather abrupt. Strake 14 is about 0.055 m thinner than the thicker strakes below it. The ship's exterior curvature does not continue smoothly at the lower end of this particular strake, but forms a straight interruption, which is a result of this change from a double–planked bottom to the single–planked sides. Furthermore, on the exterior face of strake 14, two layers of pine sheathing were applied, probably to compensate for loss in hull thickness and adjust the ship's interrupted exterior surface. The two layers of pine sheathing will be discussed later in this chapter.

Above the first wale, two additional wales have been preserved of the hull. One can be easily indentified and is located directly above the surviving gunport (Fig. IV.13, strake 19).[39] It measures 5.485 m in length, has a maximum width of 0.361 m, and a thickness of 0.193 m. It may have been slightly thicker originally, as the wale's exterior surface is worn below its original surface. The top of the gunport is cut into the lower forward part of the wale. Strake 16 below the gunport is another wale, although less apparent; it is poorly preserved and worn at its exterior surface (Fig. IV.13, strake 16). It is, however, still slightly thicker than the hull planking next to it and has a more pronounced shape. It is preserved over a length of 5.981 m, and measures 0.361 m in width, and in some places has a maximum thickness of 0.15 m. The original thickness of this second wale may have been the same as that of the ship's first wale, strake 13 (0.180 m, Fig. IV.13, strake 13).

As discussed in Chapter III, the outer layer of hull planking is worn towards the transom. The exterior surface of the hull planking near the stern is eroded away below its original surface due to chafing of the hull against the reef. Nail holes from the pine sheathing have mostly worn away on strakes 8 to 15 aft of the gunport, although the hull was sheathed up to the fifteenth strake (Figs. IV.13–IV.15). The exterior layer of planking has been preserved relatively well for about 2 m directly forward of the transom from strakes 3 to 8, and about 4.5 m from strakes 1 to 3.

**Nail plugs or *spijkerpennen***

Numerous nail plugs, also known as *spijkerpennen*,[40] have been found both on the interior and exterior surfaces of the inner layer of oak hull planking (Figs. IV.21, IV.25–IV.26).[41] Nail plugs have been observed up to strake 10, BAT 6011, of the preserved hull planking. They may occur in strakes 11 and 12 as well, but it has not been possible to record nail plugs in these strakes as they are obscured by other timbers or the surface damage caused by sulphur–reducing bacteria. A substantial number of hull planks do not have their original surfaces preserved due to this bacterial activity. The fastening holes left behind by the temporary cleats on the planking have a cross–sectional size of 0.005 m, similar to that of the nails used to fasten the pine sheathing to the hull planking.

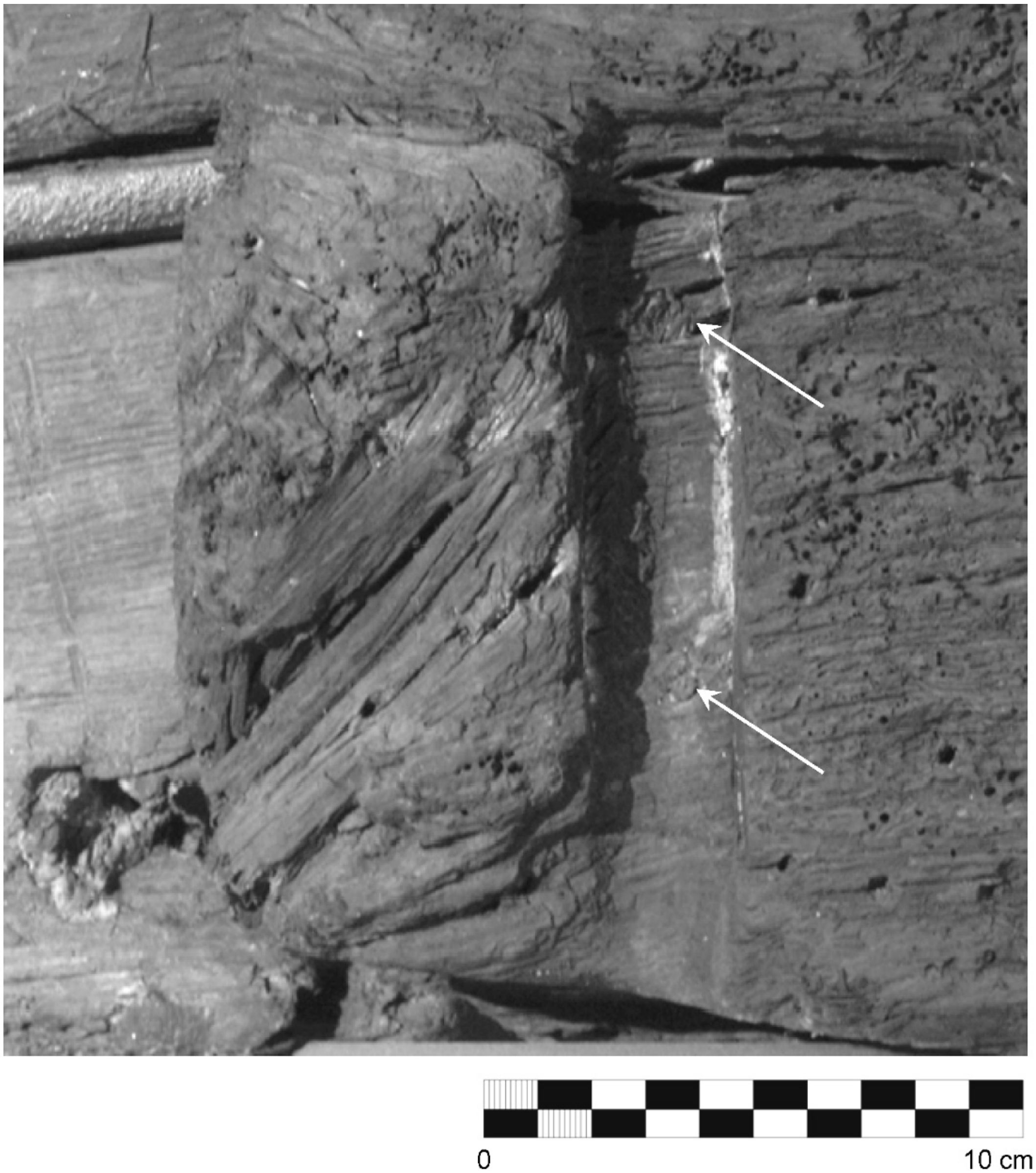


Fig. IV.25 Two *spijkerpennen* or nail plugs inside mortise for temporary cleat on the exterior surface of outer layer of hull planking directly forward of transom, *Batavia* shipwreck, BAT 6413, Strake 4. Photograph: Wendy van Duivenvoorde.

Fig. IV.26 *Spijkerpennen* or nail plugs on the exterior surface of inner layer of hull planking directly forward of transom, *Batavia* shipwreck, BAT 6367, Strake 3, and BAT 6390, Strake 4. Photograph: Wendy van Duivenvoorde.

Additionally, nail plugs have been observed in the outer layer of hull planking on the side of the ship that continues onto the transom (Fig. IV.25, BAT 6413). Here, temporary cleats were probably used to prevent the shoring poles from shifting during the ship's construction (Fig. IV.27).

**Graving pieces**

Dutch shipwrights working on the construction of large oceangoing vessels would remove knots, cracks, or other irregularities in hull planking and fill the cavities with graving pieces. In *Batavia*'s hull planking, five graving pieces have been observed. Two graving pieces were used as inserts after the removal of knots, one to patch up a scarf tip, and two to replace a crack or growth aberration along the upper edges of two planks. Similar graving pieces have been found in the hull planking of the Christianshavn B&W 2, Christianshavn B&W 1, and Angra C ships.[42]

Fig. IV.27 The use of wooden shoring poles on the outside of the ship's hull to support its planking, reconstruction of VOC ship *Duifje*, 1606. Photograph: Patrick Baker, Western Australian Museum.

Two of *Batavia*'s graving pieces, inserted to replace knots, were roughly shaped into a quadrangle and a pentagon. The first was found in the hull planking, BAT 6211, of strake 15. It measures 0.215 m by 0.138 m, and goes through the entire plank thickness of 0.125 m (Figs. IV.13, IV.28–IV.29). It was nailed onto the underlying timber with four square-shafted nails measuring a maximum of 0.015 m in cross–section.

The graving piece in the shape of a pentagon is preserved on the outer layer of hull planking, BAT 6109, in strake 12. It measures 0.203 m over its top length and tapers over its width from 0.132 m to 0.056 m. The foremost corners are chamfered and the lower edge is divided in two faces, measuring 0.139 m and 0.059 m in length (Figs. IV.13, IV.30).

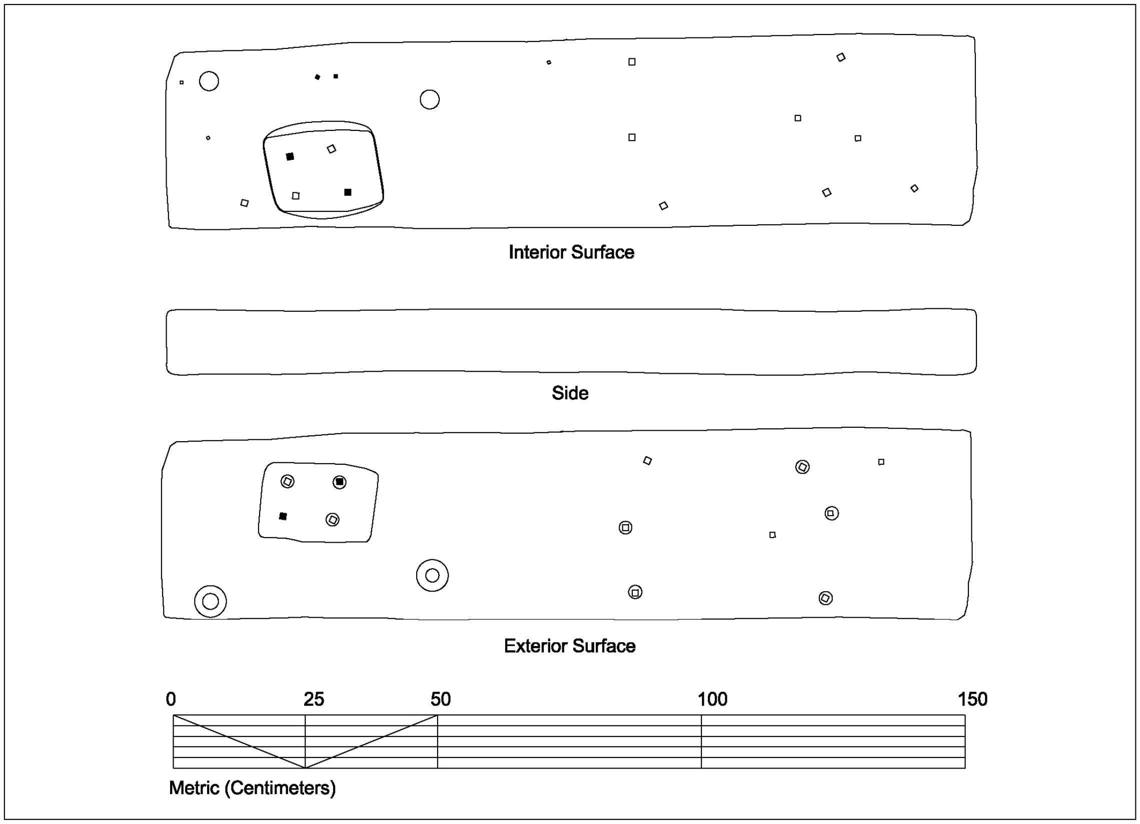


Fig. IV.28 Fragment of hull planking with rectangular graving piece, *Batavia* shipwreck, BAT 6211, Strake 15. Illustration: Wendy van Duivenvoorde.

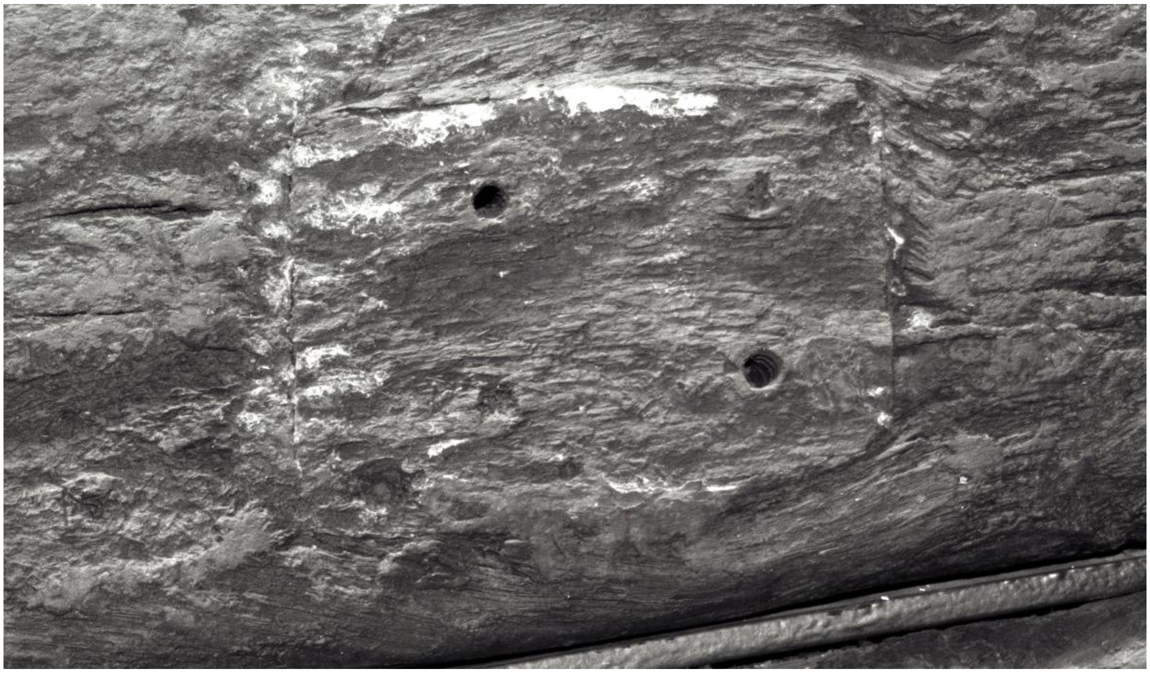

Fig. IV.29 Rectangular graving piece, *Batavia* shipwreck, BAT 6211, Strake 15. Photograph: Patrick Baker, Western Australian Museum (MA4864–27).

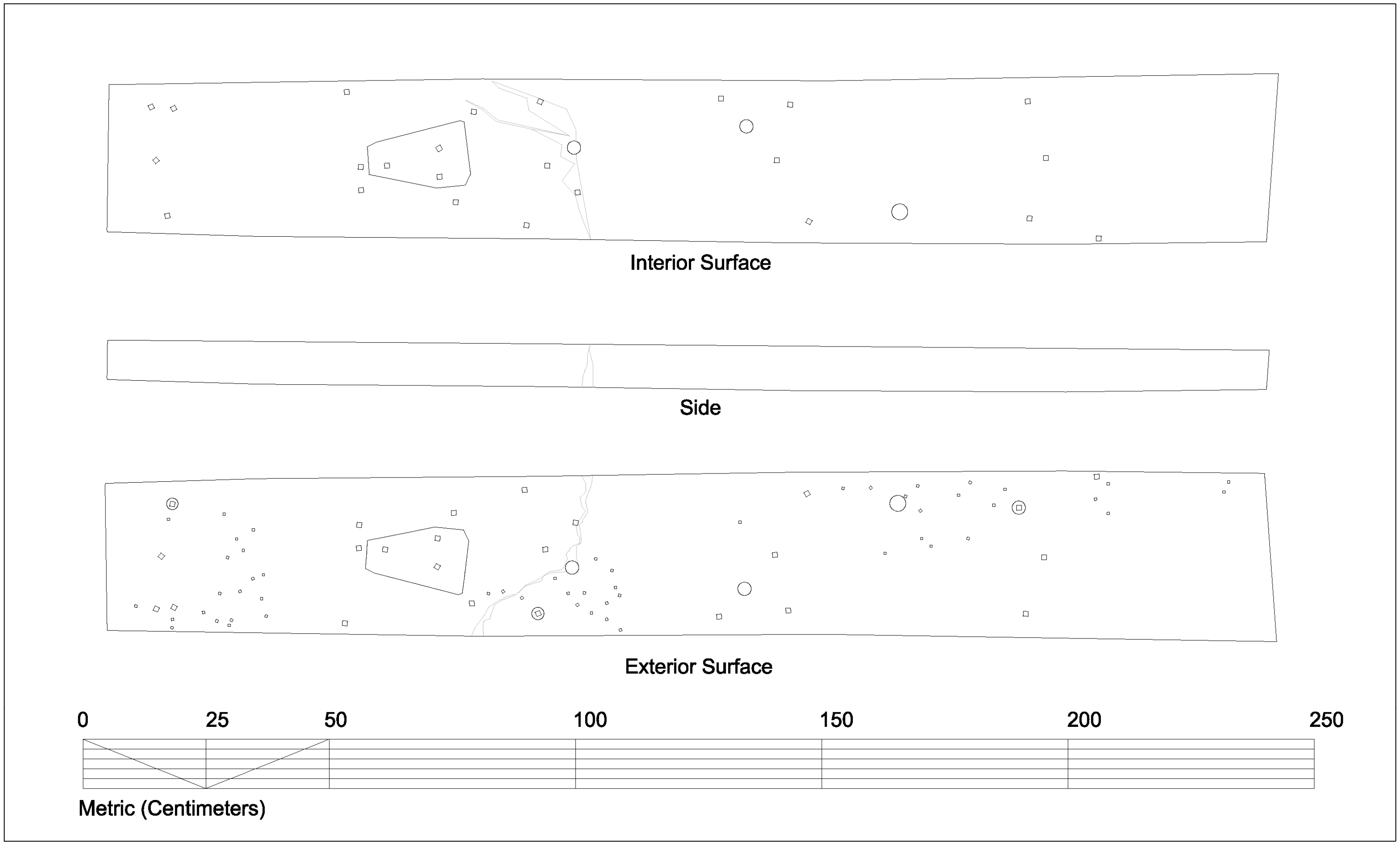


Fig. IV.30 Fragment of hull planking with pentagonal graving piece, *Batavia* shipwreck, BAT 6109, Strake 12. Illustration: Wendy van Duivenvoorde.

The third graving piece, not visible today, is preserved at the scarf tip on the exterior surface of the inner layer of hull planking of strake 11, seven strakes below the gunport (Fig. IV.31–32, BAT 6206 and BAT 6074). The rectangular wooden insert was probably used to replace a crack or growth irregularity in the scarf tip, because it is too long and narrow to have been used in replacing a knot in the timber. It measures 1.080 m in length and 0.077 m in width. It does not replace the entire thickness of the inner layer of hull planking as it is only evident on the exterior.[43] It was nailed to the inner layer of hull planking with five square-shafted nails (Figs. IV.13 and IV.31–IV.32).

Lastly, rectangular strips of wood are found on the top surface of *Batavia*'s third wale, BAT 6367, and on the top surface of the vertical scarf end in the first wale strake 13, BAT 6397. On the edge of the third wale, a possible splinter along the timber's edge was removed and two long wooden strips were inserted that are joined together with a small vertical flat scarf joint. The two strips together measure 2.520 m in length, 0.032 m in width, and 0.060 m in thickness (Fig. IV.13). On the forward side of the vertical scarf in strake 13, another wooden strip, BAT 6397, was inserted to repair a crack or growth aberration in the planking. It was secured in place with two iron nails, and measures 0.961 m in length, 0.071 m in width, 0.067 m in thickness (Fig. IV.19).

**Gunport and lid**

The gunport preserved on the side of *Batavia*'s hull structure is more or less square in shape and is located in the upper part of strake 17, strake 18, and lower two–thirds of strake 19 —the ship's third wale. It is simply cut into the ship's hull planking; no remnants of framing or sills have been observed that would have reinforced and shaped the port and its lid. The remains of a second gunport were found on the lower face of the wing transom, which is discussed in detail in the 'Wing transom' section of this chapter.

The gunport on the side of the ship still has its lid preserved, which is consists of a complex assembly of three layers of wood. It measures 0.586 m in height and 0.615 m in width, and fits tightly into the port. The innermost layer of the lid consists of a pine

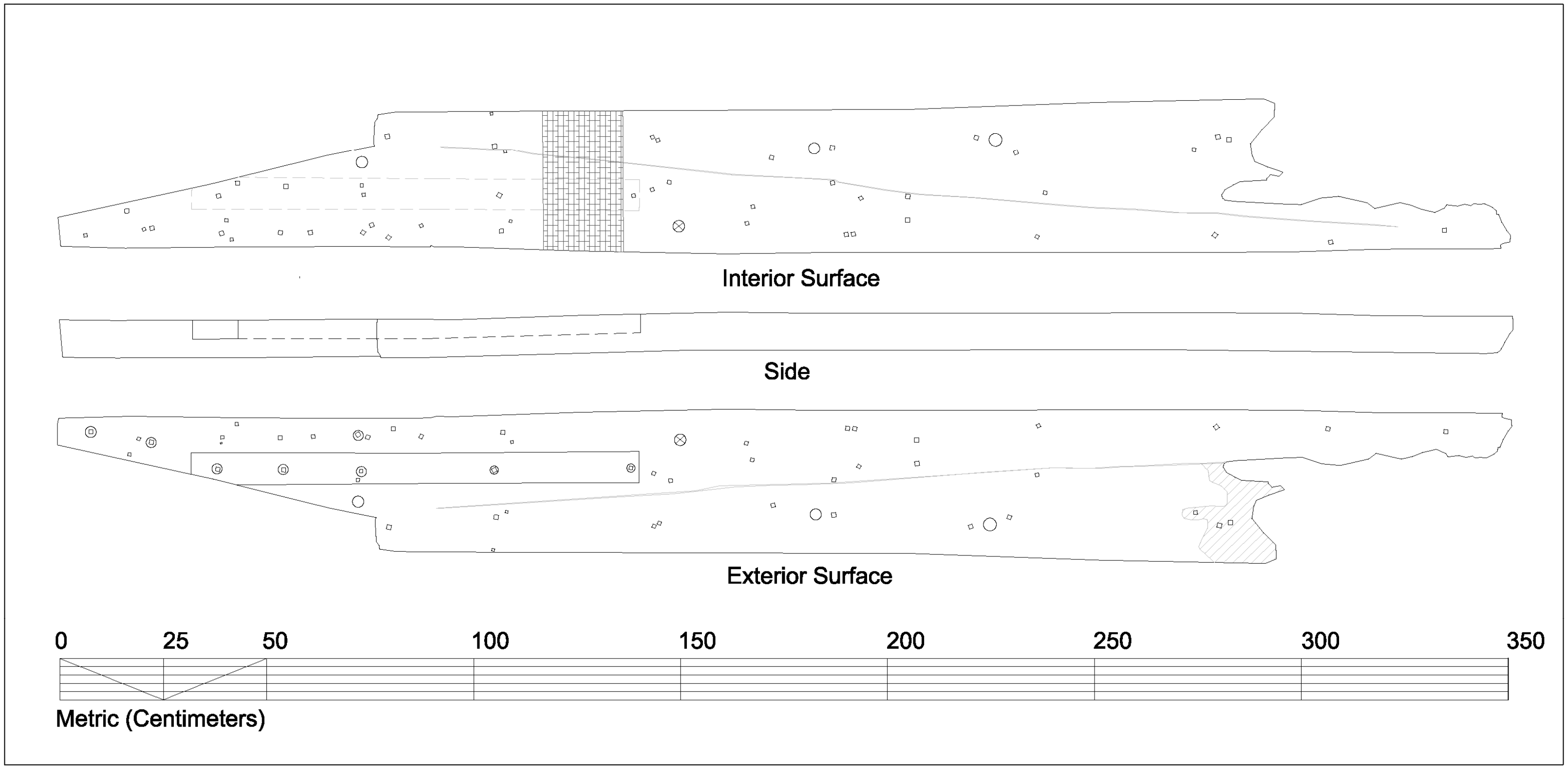


Fig. IV.31 Fragment of hull planking with rectangular graving piece, *Batavia* shipwreck, BAT 6206 and BAT 6074, Strake 11. Illustration: Wendy van Duivenvoorde.

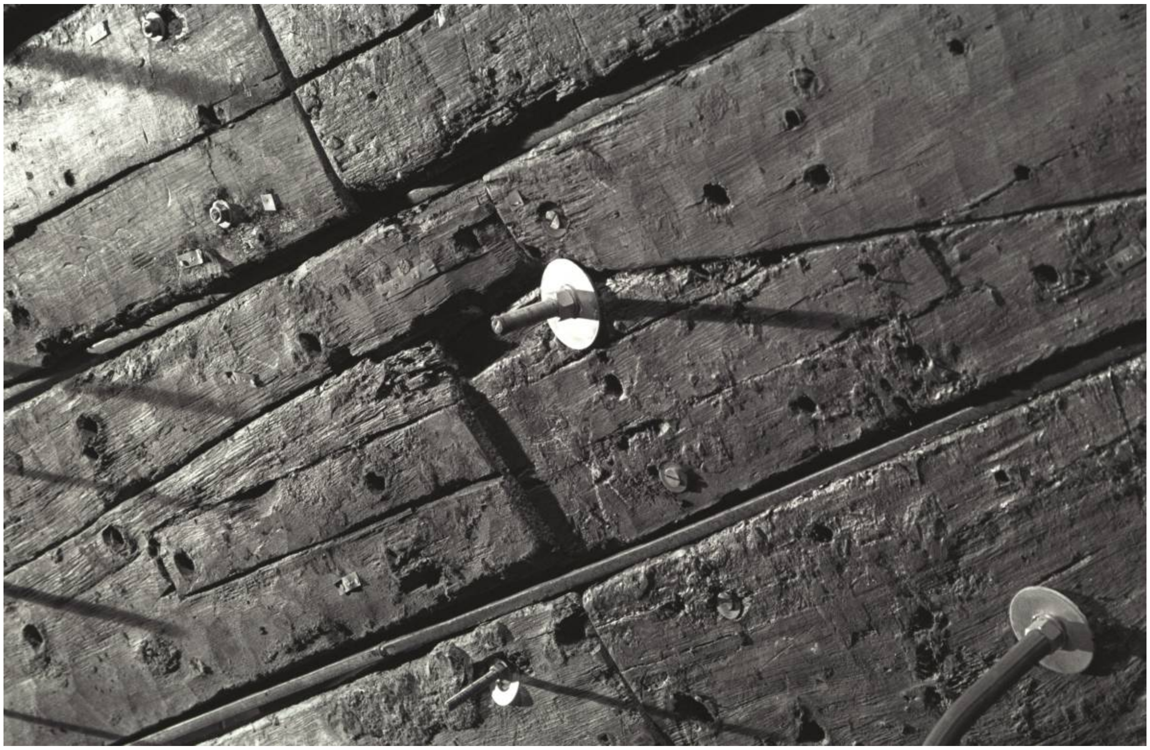

Fig. IV.32 Rectangular graving piece forward of scarf end on exterior of inner layer of hull planking, sawn in two sections during excavation, *Batavia* shipwreck, BAT 6206 and BAT 6074, Strake 11. Photograph: Patrick Baker, Western Australian Museum (MA4068–10).

sheathing board that covers the entire area of the lid (Fig. IV.33). It measures 0.057 m in thickness. The board was fastened to the lid's second layer with closely–spaced iron nails, with rounded heads and square shafts, in a quincunx pattern (Fig. IV.33). It was applied in exactly the same method as the layer of pine sheathing to the exterior of the hull planking. The circular impressions of the iron nail heads have an average diameter of 0.015 m, and the nail shafts measure 0.006 m square in section directly below the nail head, and taper to a point.

The second layer of the lid, which sits flush within the strakes of hull planking, consists of three thick oak planks fitted horizontally. They measure 0.099 m in thickness and were held together by the sheathing board on the interior. As the gunport is located at the bottom of *Batavia*'s third wale, one additional horizontal plank was fastened to the

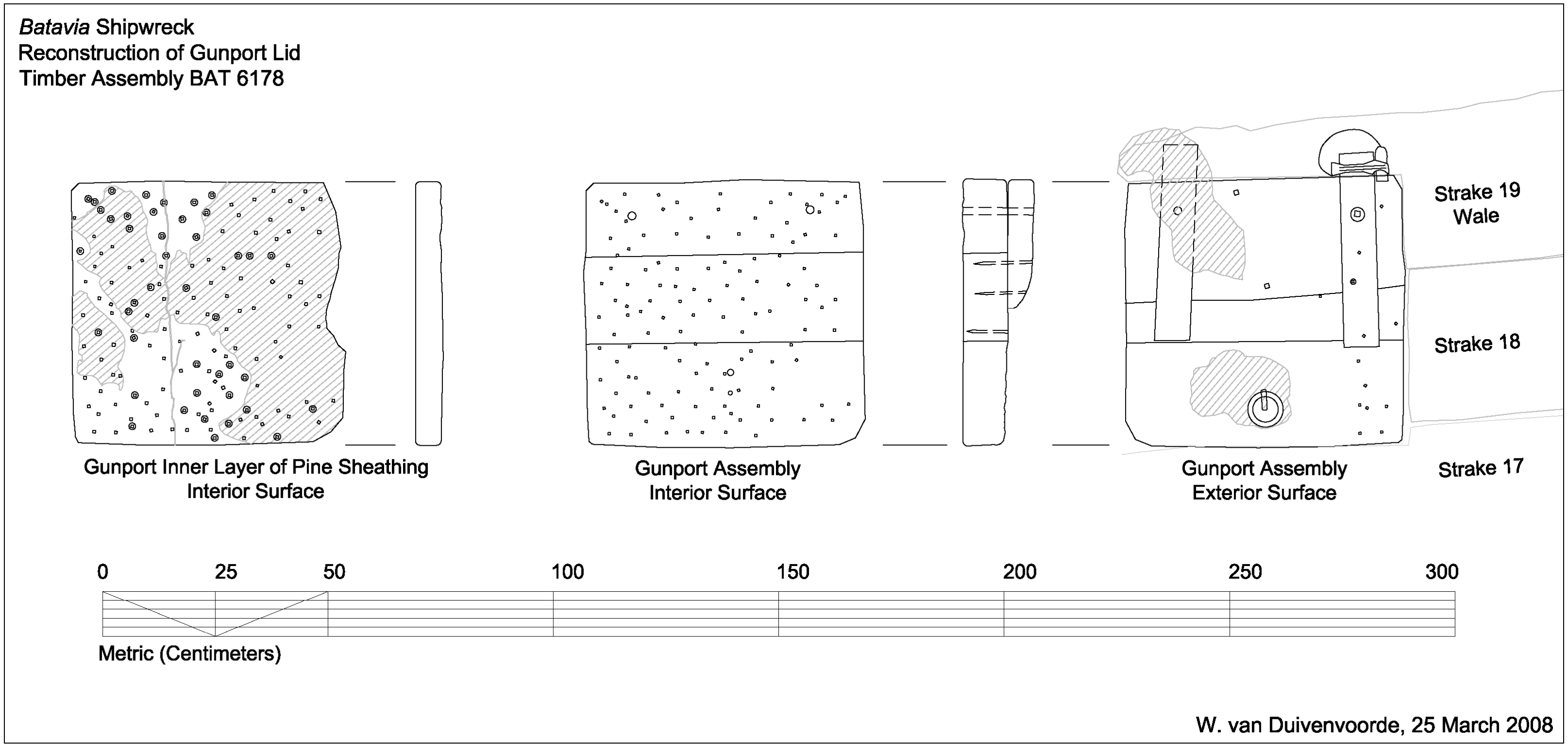


Fig. IV.33 Gunport lid assembly from hull planking strakes 17–19, *Batavia* shipwreck, BAT 6178. Illustration: Wendy van Duivenvoorde.

top exterior surface of the lid in order to create a continuation of the ship's wale. This top plank, although eroded, measures 0.060 m in thickness and 0.243 m in width. It was fastened to the gunport lid with two large spikes or bolts that ran from the lid's hinges on the exterior to its interior face.

Three concretions were found on the lid's exterior surface; two contained impressions of hinges on the upper half, and one covered the staple and its ring in the center of the lid's lower half. Unfortunately, these concretions are no longer available for study. They were, however, photographed and sketched in the field directly after excavation from which the reconstruction could be made in figure IV.33. The hinges followed the profile of the exterior surface of the lid and were bent to accommodate the transition between the extra plank on top and the lower half of the lid. A large spike or bolt at the top of each hinge ran through the two layers of oak below. In addition, the hinges were nailed to the lid's exterior surface with a few iron nails.

This particular gunport is most likely associated with iron cannon BAT 8722, which was found next to it, broken in three sections. Its starboard side counterpart, BAT 8723, was found nearby.[44] Both cannon have the same size, 2.78 m in length, and molding.

**Transom planking**

The transom planks of *Batavia*'s hull are not perfectly straight and curve in both transverse and longitudinal planes (Fig. IV.34). They are not distorted but were cut to create this convexity as was the wing transom which follows this transverse curvature. Furthermore, the scant remains of the sternpost's rabbet line show this curvature in longitudinal direction on the ship's starboard side.

The transom was planked, like the ship's bottom, with two layers of oak hull planking (Figs. IV.34–IV.37). These two layers are, more or less, equal in thickness, like the double layers of hull planking. The inner layer of transom planking varies between 0.090 m and 0.104 m in thickness, averaging 0.095 m. The outer layer is slightly thinner; the thickness varies from 0.080 m to 0.094 m, averaging 0.089 m. Van IJk mentions that

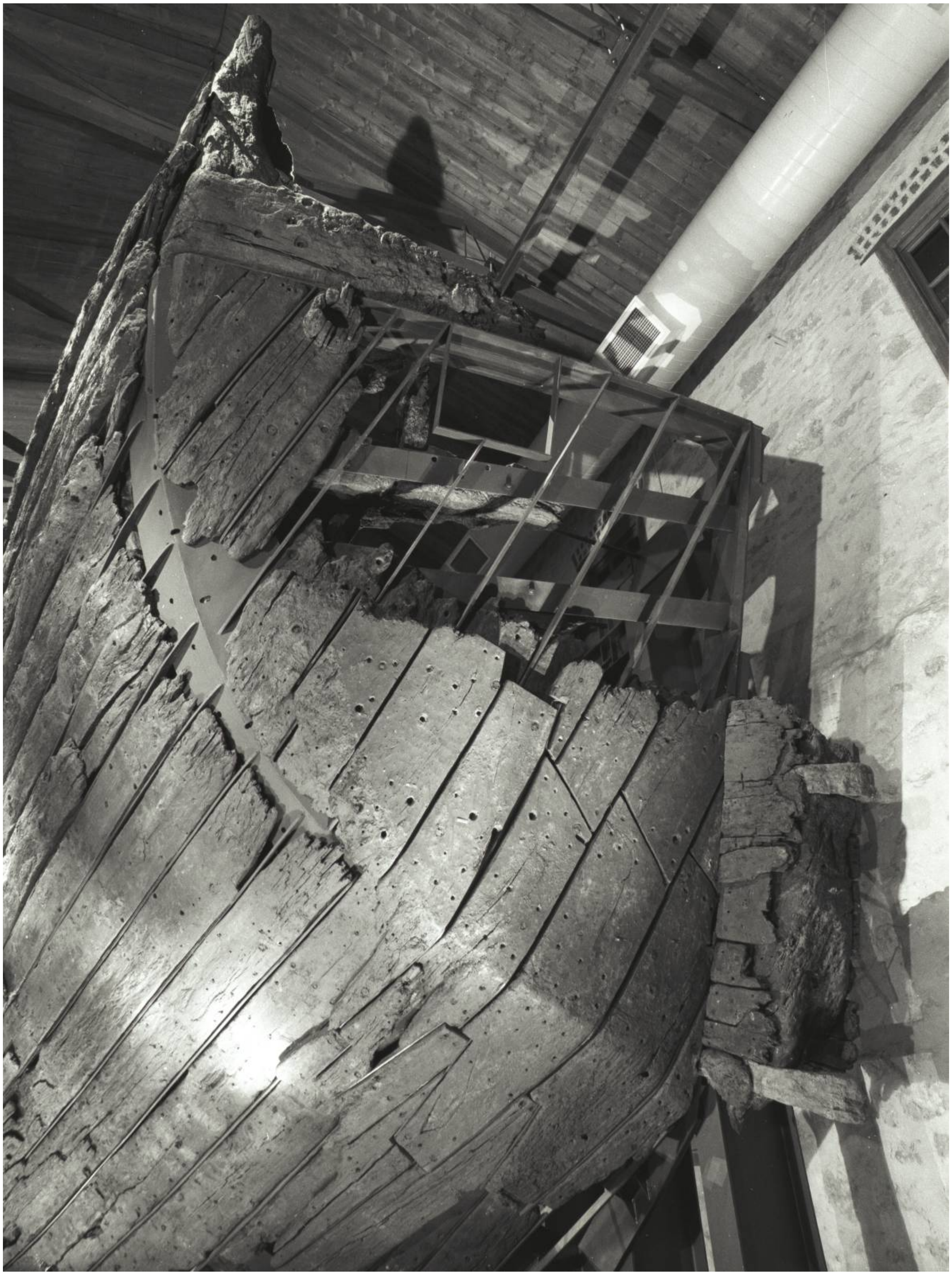

Fig. IV.34 *Batavia*'s port side transom planking and sternpost. Photograph: Patrick Baker, Western Australia Museum (MA5048–30).

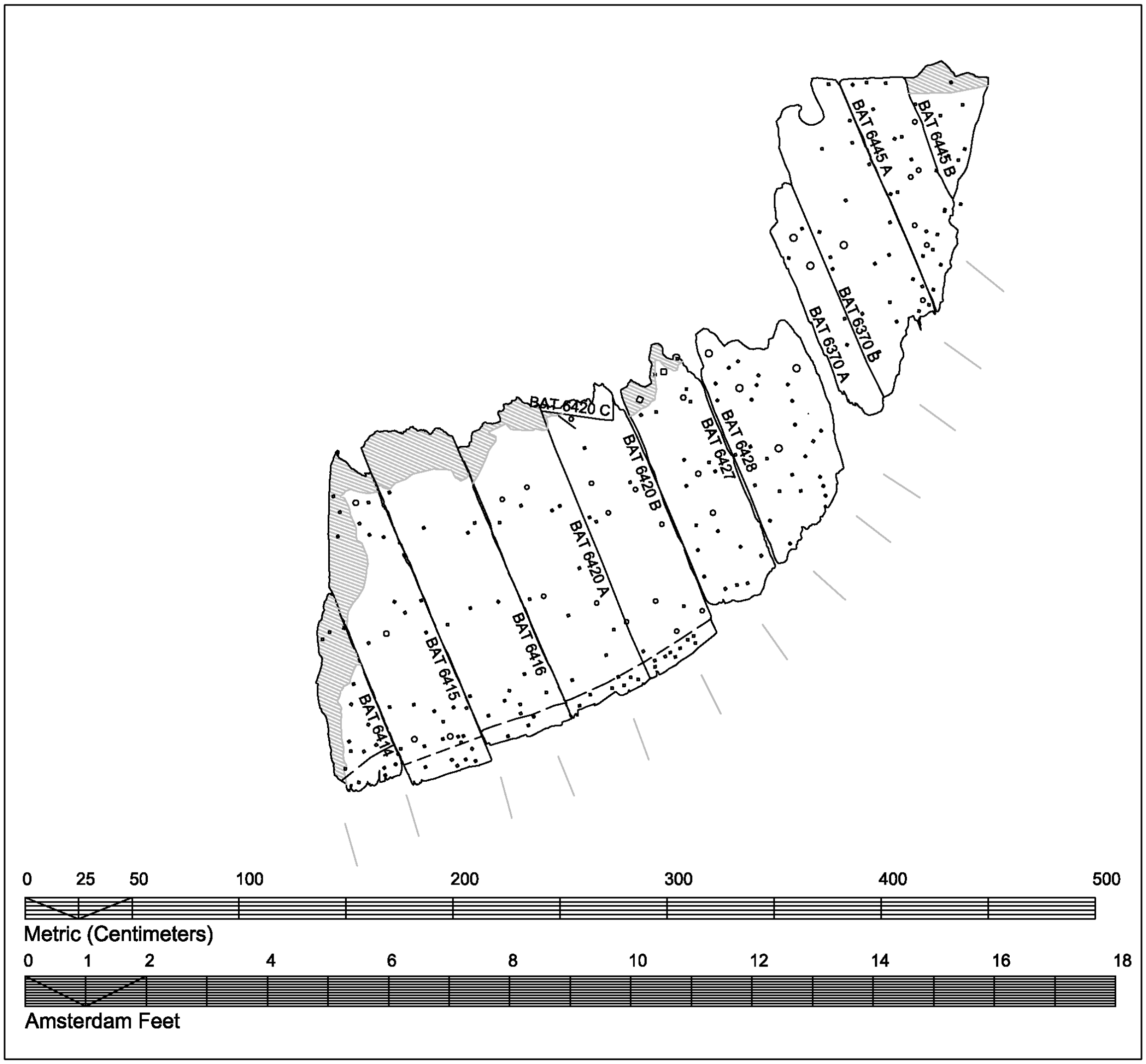


Fig. IV.35 Inner layer of *Batavia*'s transom planking, interior face, port side, corresponding to preserved outer hull strakes 3–16, *Batavia* shipwreck. Illustration: Wendy van Duivenvoorde.

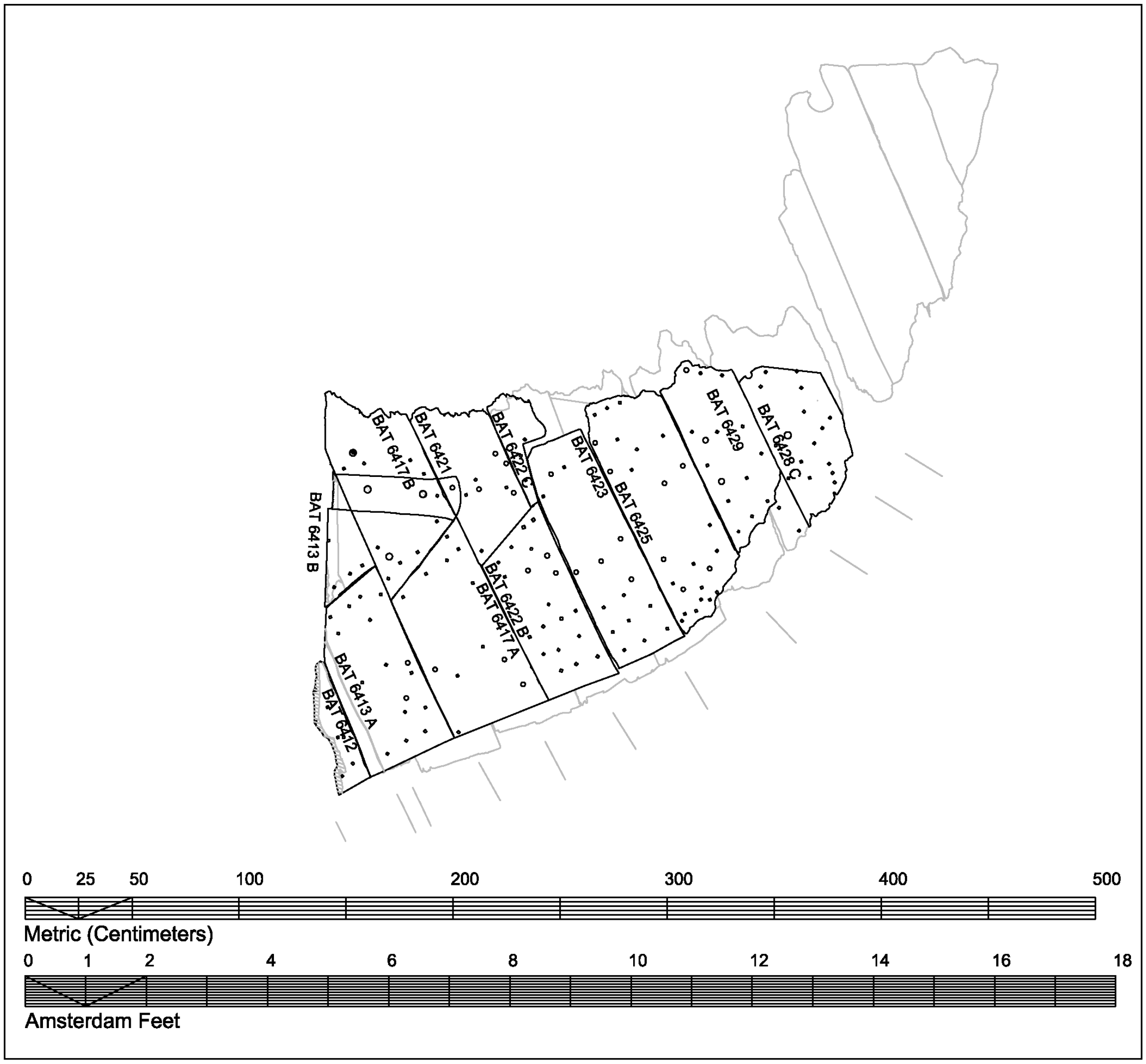


Fig. IV.36 Outer layer of *Batavia*'s transom planking, interior face, port side, corresponding to preserved outer hull strakes 3–12, *Batavia* shipwreck. The inner layer of transom planking is shown in background, in gray, for orientation. Illustration: Wendy van Duivenvoorde.

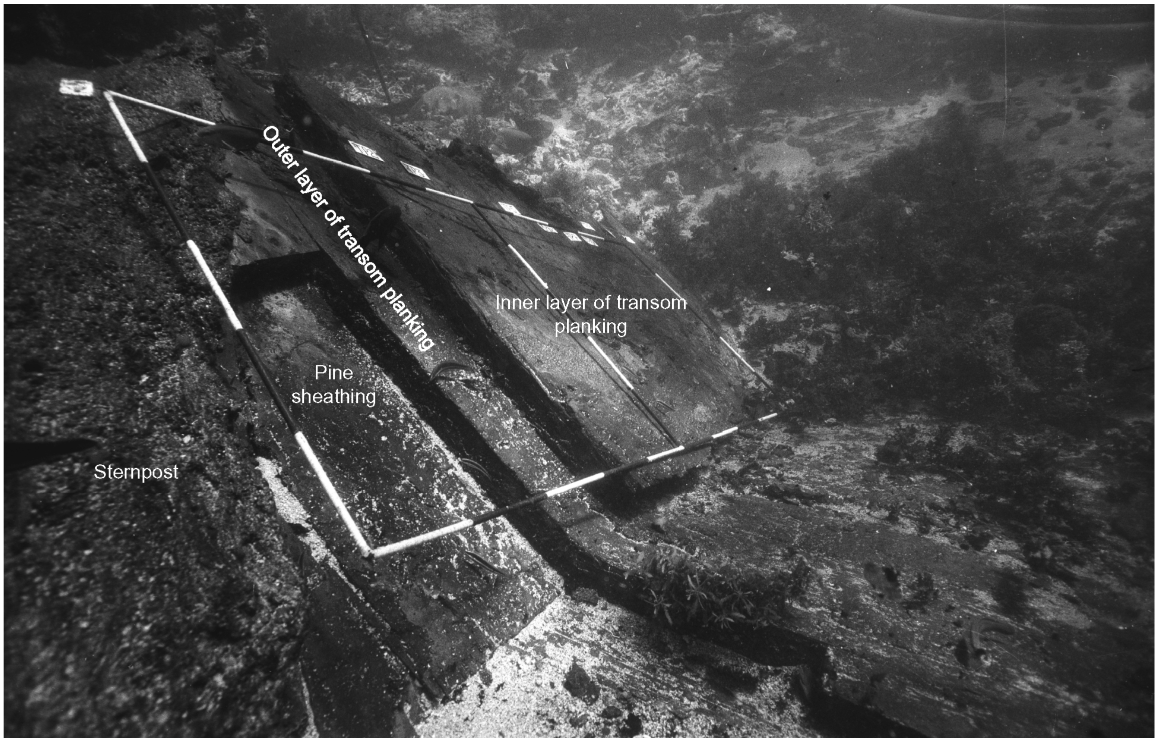


Fig. IV.37 Inner and outer layer transom planking on the seabed. *Batavia* shipwreck. Photograph: Jeremy Green, Western Australian Museum (MA0412–22).

transom planking was allowed to be one–third thinner than hull planking.[45] The *Batavia* transom planking, however, does not confirm this practice. The transom planking is joined with diagonal scarfs. Both layers were fastened in place with iron spikes.

The most unusual feature is the outer layer of transom planking at the corner between the transom and ship's side. Here, the outer layer of planking was roughly cut at an obtuse angle to fit around the inner layer of transom planking and the planking of the ship's side (Fig. IV.34). These curved planks run from the transom over the fashion piece to the ship's side and are scarfed to the side strakes with flat scarfs and to the transom planking with diagonal scarfs (Figs. IV.14, IV.15, IV.36–IV.38). Directly forward of the transom, a concentration of five flat scarfs is evident in the lower strakes of *Batavia*'s outer layer of hull planking (Fig. IV.14–15, IV.34).

Eight strakes of outer transom planking survived, of which only the lowest five are curved. These curved corner planks vary from 0.996 m to 2.360 m in length and from 0.224 m to 0.476 m in width.  Their angles, between the ship's transom and side, becomes progressively smaller from the stern upwards.  The lowest corner transom plank, BAT 6412, has an angle of 152 degrees between two plank ends on its interior surface, whereas the highest, BAT 6423, has an angle of 140 degrees.  All tool marks found on these five transom planks, from adzes and saws, indicate that they were carved to create a corner plank (Figs. IV.38–IV.40).  The diagonal direction and spread of the adze marks, particularly on the interior surfaces around the plank's bend, clearly indicate that the roughly sawn timber was adzed into shape (Figs. IV.38–IV.39).  Saw marks run in diagonally opposing directions towards the bends in the planks (Fig. IV.40).  These tool marks do not provide any evidence to suggest that the sharp angles were a result of bending the planks to create an extreme angle in their centers.


Fig. IV.38 Axe and adze marks on interior surface of transom planking, *Batavia* shipwreck, BAT 6423.  Photograph: Patrick Baker, Western Australian Museum (MA0422–26).

Fig. IV.39 Adze marks on interior surface of transom plank, *Batavia* shipwreck, BAT 6413. Photograph: Patrick Baker, Western Australian Museum (MA0422–21).

This is in concordance with Van IJk who recommended the carving of transom planking. Good, smooth pieces of oak were to be sawn into a curved shape with the help of a special mold in order to avoid the aggravation of burning and bending transom planking to achieve the correct curvature as the transom planking had to be sturdily built. Van IJk had seen this practice in shipyards on occasion and valued it highly.[46]

Fig. IV.40 Saw marks on edge of transom plank, *Batavia* shipwreck, BAT 6417. Photograph: Patrick Baker, Western Australian Museum (MA0422–32).

Eleven strakes of *Batavia*'s inner layer of transom planking have survived; they were not carved to fit around the fashion piece. The lowest five of these planking strakes still have beveled or slanting ends on their exterior surfaces, similar to the beveled ends of inner layer of hull planking on the ship's side, and all were fastened to the fashion piece with iron spikes. The planks of this layer vary from 0.192 m to 1.616 m in length and from 0.155 m to 0.513 m in width.

In transom plank 9, a circular hawse hole was cut through which a cable ran that towed the ship's boat or was used for mooring the ship.[47] It measures 0.103 m in diameter (4 Amsterdam thumbs). The hawse hole, its outboard bolster, and its bung are discussed in the 'Hawse hole, cardinal's hat, and bung' section of this chapter.

On the interior surface of the outer layer of transom planking a shallow rectangular mortise was cut to receive the starboard end of the gudgeon (Figs. IV.36 and IV.41). This mortise measures 0.632 m in length, 0.167 m (6.5 Amsterdam thumbs) in width, and 0.038 m (1.5 Amsterdam thumbs) in depth, and flares out, about 0.10 m from its end, to 0.201 m in width. A thick layer of goat hair and tar was found in the mortise that provided extra waterproofing. The ends of the gudgeons thus extended outwards from the sternpost to underneath the outer layer of transom planking, where they were nailed in place with two iron spikes per side. The impressions of the spike heads are clearly visible in the outer layer of transom planking and measure 0.032 m (1.25 Amsterdam thumbs) in diameter. This demonstrates that the outer layer of transom planking was applied after the sternpost's gudgeons were installed, most likely in the final stage of construction. The outer layer of transom planking around the gudgeon ends was therefore added much later in the construction process than the outer layer of hull planking, which was installed after the frames were inserted. Transom planks BAT 6413 B, BAT 6417 B, and BAT 6421 were probably pre–assembled before they were placed over the gudgeon ends and fastened to the inner layer of transom planking, as three transverse nails were found along the edges of plank BAT 6417 B.


Fig. IV.41 Interior surface of outer layer of transom planking, laid out on museum's gallery floor during reassembly. *Batavia* shipwreck. Photograph: Brian Richards, Western Australian Museum (BT–T–0201).

**Hawse hole, cardinal's hat, and bung**

As mentioned, a circular hole was cut in transom plank 9 to create a hole through with a cable was passed to tow the ship's boat or to moor the ship.[48] It measures 0.103 m in diameter (4 Amsterdam thumbs). This hole was reinforced with a bolster on its exterior surface that was nailed to the transom planking with spikes (Fig. IV.34). This decorative reinforcement, called a *kardinaalsmuts* or cardinal's hat, eased the run of the line and protected it against chafing.[49] The outer diameter of the bolster measures 0.322 m (12.5 Amsterdam thumbs), whereas the inner diameter is equivalent to that of the cylindrical opening.

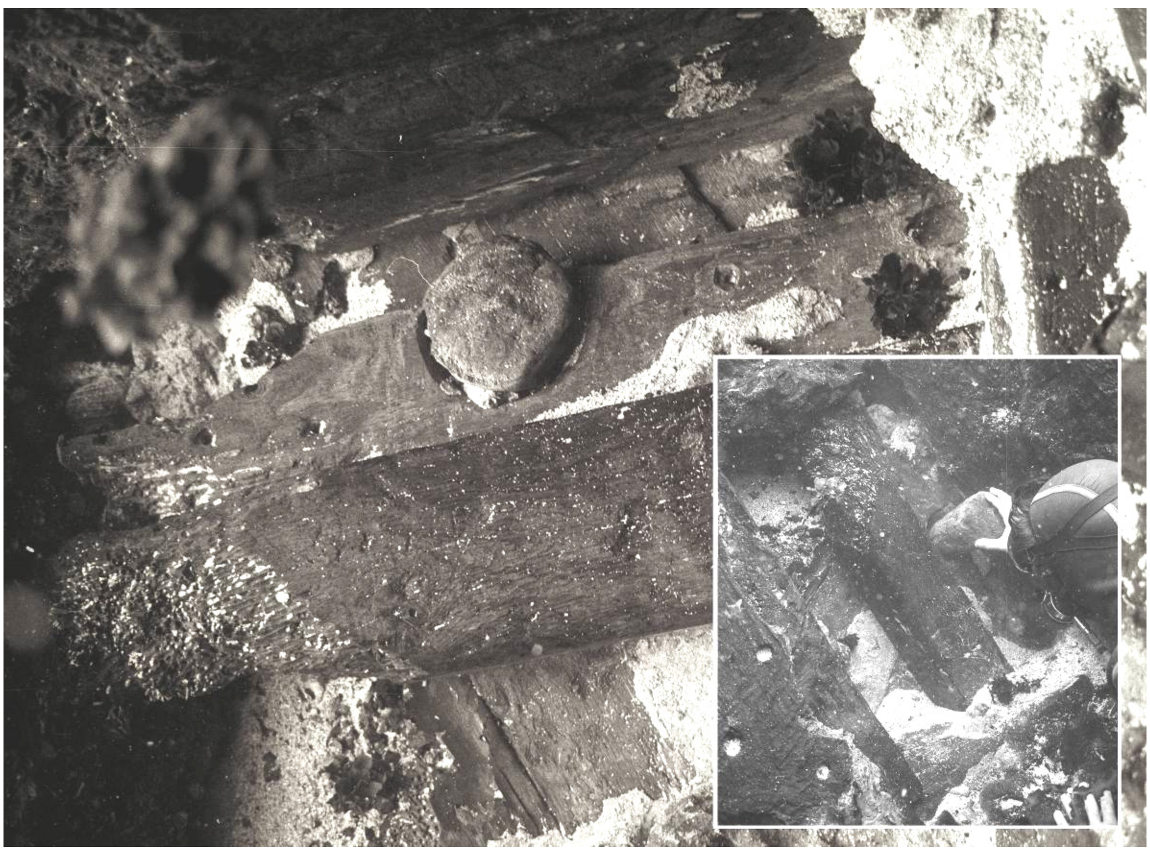

Fig. IV.42 Bung from hawse hole in transom, interior face, port side, *Batavia* shipwreck, BAT 6235. Photograph: Patrick Baker, Western Australian Museum (MA0287–17/MA0289–23).

Since *Batavia* was under full sail and was not towing a boat at the time of its sinking, the hawse hole was plugged with a bung on its interior (Fig. IV.42, BAT 6235). This bung was still in place during the ship's excavation. It measures 0.248 m in length, is round in section, and tapers from 0.130 m to 0.081 m in diameter.

**Pine sheathing**

*Batavia*'s hull was sheathed with pine planking, up to at least its fifteenth preserved strake (Figs. IV.43–IV.44). The pine sheathing has a maximum thickness of 0.040 m.[50] Some poorly preserved fragments of pine sheathing have been preserved at the forward ends of strakes 12 to 15. These fragments, some originally belonging to the same plank, vary from 0.277 m to 2.550 m in length and from 0.125 m to 0.536 m in width. The pattern of the sheathing nail holes preserved on the exterior of the outer layer of hull planking clearly shows the edge fastenings of the pine sheathing planks. No pine sheathing has been preserved from the after two–thirds of the hull. Furthermore, the poorly preserved remnants of closely–spaced nail holes from the pine sheathing nails in the exterior surface of hull planking in this area of the hull, indicate that the original exterior surface of the hull planking is no longer present. It is unknown up to what strake *Batavia*'s hull was sheathed in pine, but no pine sheathing or associated nail holes in the hull planking have been observed above strake 15.

On the exterior surface of strake 14, two layers of pine sheathing were applied; most likely to compensate for loss of 0.055 m of hull thickness between strakes 13 and 14. It adjusts discontinuity in the ship's exterior surface. The inner layer of pine was 0.040 m in thickness, whereas the outer layer did not have an even thickness over its width and tapered in thickness from the center to its seams (Figs. IV.43–IV.44).

The pine sheathing was attached to the exterior of the outer layer of planking with iron nails that were closely spaced to produce an iron rust layer which protected the hull against marine organisms.[51] The square nail holes in the pine sheathing and on the hull planking indicate that the nails were fastened at intervals of about 0.050 m, in quincunx

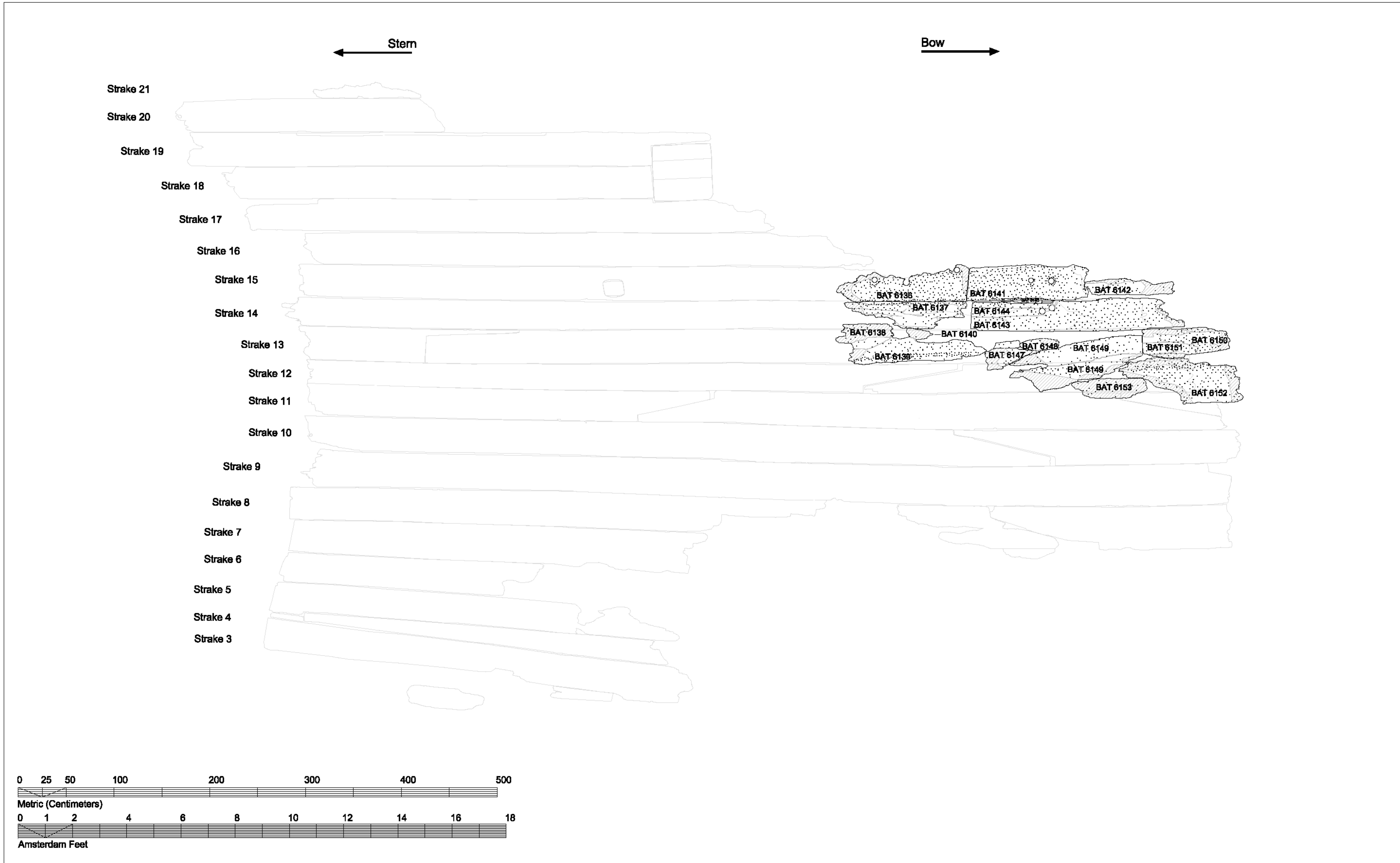


Fig. IV.43 Timber plan of *Batavia*'s inner layer of pine sheathing, preserved strakes 12–15. Port side, interior surface. The inner layer of hull planking is shown in background, in gray, for orientation. Illustration: Wendy van Duivenvoorde.

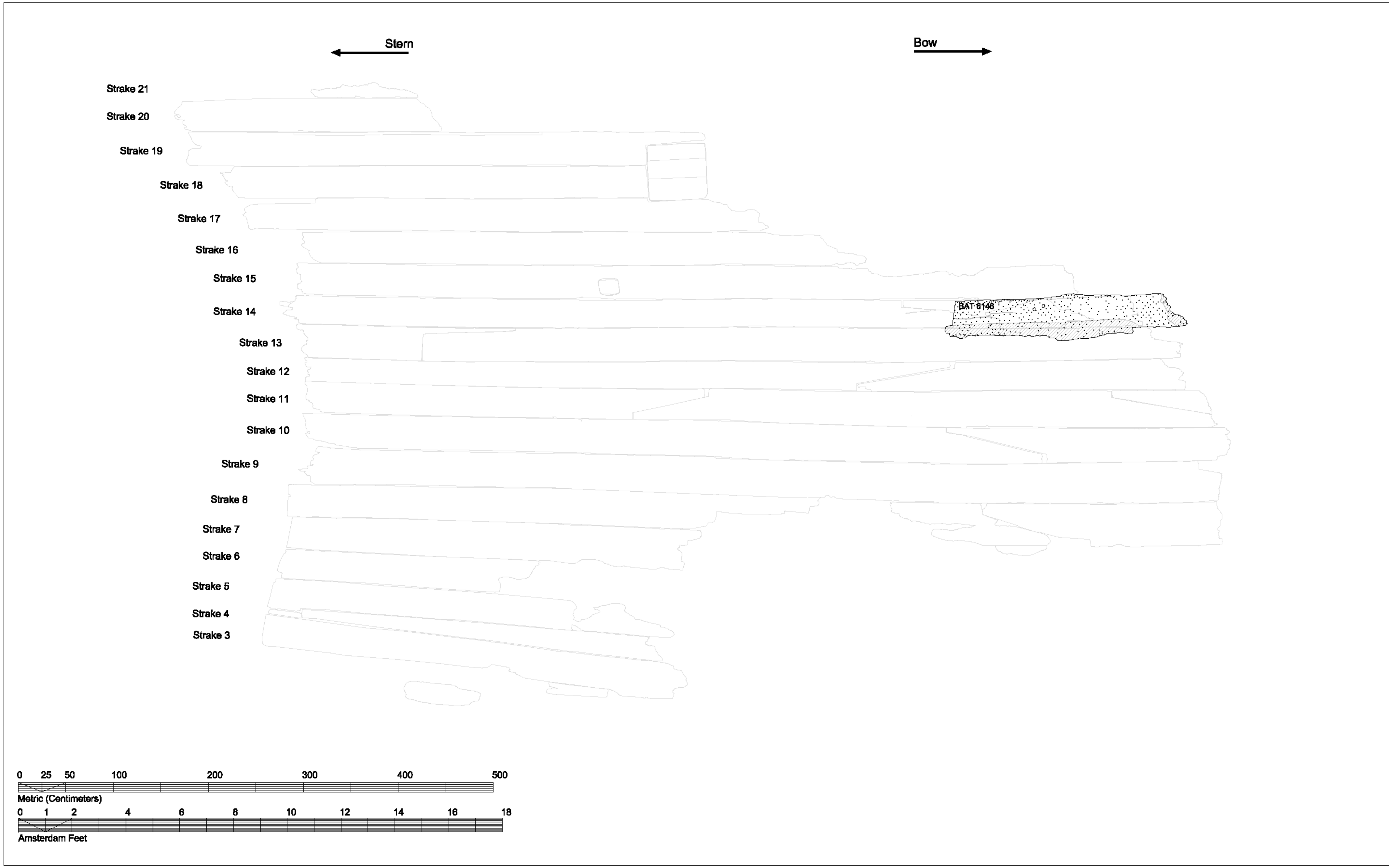


Fig. IV.44 Timber plan of *Batavia*'s outer layer of pine sheathing, preserved strakes 13–14. Port side, interior surface. The inner layer of hull planking is shown in background, in gray, for orientation. Illustration: Wendy van Duivenvoorde.

Fig. IV.45 Nail holes with nail head impressions and some goat hair on exterior surface of pine sheathing, *Batavia* shipwreck, BAT 6241. Photograph: Wendy van Duivenvoorde.


Fig. IV.46 Interior surface of pine sheathing plank. Note sheathing nails spaced neatly around bolt head holes, *Batavia* shipwreck, BAT 6141, Strake 15. Photograph: Patrick Baker, Western Australian Museum (MA0199–27).

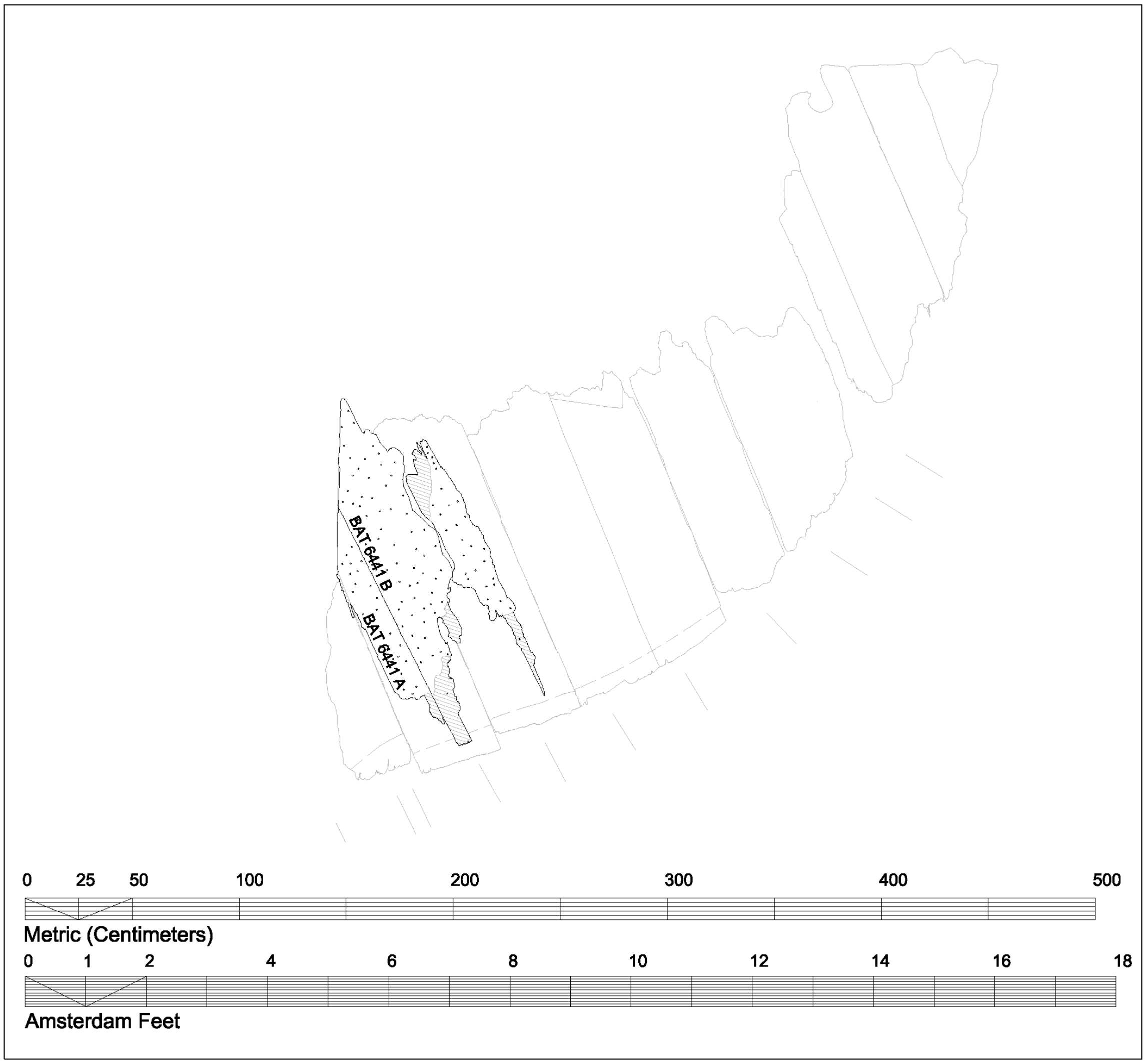


Fig. IV.47 Layer of pine sheathing on transom planking, interior face, port side, *Batavia* shipwreck. Inner layer of transom planking is shown in background, in gray, for orientation. Illustration: Wendy van Duivenvoorde.

pattern (Fig. IV.45). The circular impressions of the iron nail heads have an average diameter of 0.015 m. They, therefore, do not have particularly large heads.

The pine sheathing remnants at strakes 14 and 15 show that round holes were cut in the planks, varying from 0.051 m to 0.064 m in diameter, to fit the sacrificial planking neatly around the heads of large iron bolts that probably fastened the ship's rider frames to the ceiling planking, frames and hull planking (Figs. IV.43, IV.44, and IV.46). Iron sheathing nails were spaced neatly around the holes that seat the bolt heads (Fig. IV.46).

Numerous pine sheathing planks were found on top of the well–preserved transom planks. The nail holes on the exterior of the transom planks indicate that the iron sheathing nails were 0.06 m to 0.07 m in length, their nail shafts were 0.005 m in cross–section, and their heads measured 0.015 m diameter. The heads of all sheathing nails were slightly rounded at their tops. Although most of the pine sheathing planks from the transom were not recorded or mapped *in situ*, they ran diagonally like the transom planking (Fig. IV.47). Their dimensions are similar to the pine sheathing of the ship's side.

**Layers of goat hair**

Thin layers of animal hair, approximately 0.005 m in thickness, were applied to the outboard surfaces of the two layers of *Batavia*'s hull planking (Figs. IV.45 and IV.48). Some hair was also found on the outboard surface of the pine sheathing on the sternpost (Fig. IV.47). Excavators tentatively identified and published that the layers of *Batavia* hair consisted of "cow hair" payed on the ship's hull with tar.[52] Recently, six samples of hair from this layer have been identified as goat hair (Table IV.1).

This layer will simply be referred to as hair to be consistent with the terminology used in nautical documents dating to the seventeenth century.[53] The layer of animal hair between the planking and sheathing was mainly intended as a bulking agent for the tar, to deter wood rot, and to keep teredoes from getting at the bottom planking. Hair added to the ship's waterproofing will be discussed in the 'Caulking' section below.

Hair samples from BAT 4123 and BAT 6249, plus four additional samples, were sent in 2007 for species identification to the Research and Consultancy Service for Biological Archaeology and Environmental Reconstruction in the Netherlands (BIAX Consult, Table IV.1). These specialists are trained in the identification of archaeological animal hairs from northwestern Europe and are also equipped to obtain micrographs of


Fig. IV.48 Sample of goat hair from the hair layer between the inner and outer layer of hull planking. *Batavia* shipwreck, BAT 4123. Photo: Patrick Baker, Western Australian Museum (BT–46–23).

Table IV.1 Results of hair identification from *Batavia* timbers.

| Catalog Nr. | Hair Sample Taken From | Species |
|---|---|---|
| BAT 4123 | Frame area, aft most hull section | *Capra hircus* |
| BAT 6240 | Sternpost sheathing (inside), starboard side | *Capra hircus* |
| BAT 6241 | Sternpost sheathing (outside), starboard side | *Capra hircus* |
| BAT 6249 | Sternpost cover planking (inside), starboard side | *Capra hircus* |
| BAT 6439 | Sternpost cover planking (inside), port side | *Capra hircus* |
| BAT 6441 | Sheathing from transom (sacrificial planking) | *Capra hircus* |
| BAT 6442 | Tar and hair from shipwreck site (loose find) | *Capra hircus* |

Identification by Henk van Haaster, BIAX Consult.

the hairs that can be verified by other biological archaeologists or specialists. All hairs from these two samples were identified as goat hair (Figs. IV.49–IV.51). The diagnostic features of goat hair are clearly visible, and some of the six samples are remarkably well–preserved considering that they were on the seabed for more than three hundred years. The cross–sectional outline of the hair is dumbbell shaped, characteristic of goat, rabbit, and hare hair. Goat hair, however, also has a distinct medulla pattern. This pattern is referred to as 'scalloped' or a 'honeycomb lattice', which is clearly visible in figures IV.50 and IV.51. This medulla nearly fills the entire hair, which results accordingly in a thin cortex.[54]

Animal coats consist of two types of hairs: guard hairs that form the outer coat, and fur or wool hairs that form the inner coat. The basic make up of an animal coat, thus, consists of a mixture of both types of hair. Hair specialist Henk Van Haaster explains that only guard hairs have diagnostic features that allow for identification of a particular animal, whereas the so–called fur hairs have no diagnostic markers.[55] Under hairs from one animal can easily be mistaken for the hair of another if not examined by an experienced or trained specialist.

The *Batavia* hair samples are mainly comprised of tufts of fur and diagnostic guard hairs, indicating that these hairs derive from one and the same animal (Fig. IV.50).[56] This also indicates that the goat hair was used in its entirety, including the underwool. In general, the preserved goat hair found on the *Batavia* ship's timbers seems to have come from black or dark brown goats.

In addition to goat hair, a moss–like material was found between the ends of a vertical flat scarf of hull plank BAT 6404, the after most end of strake 13 (approximately 0.80 m forward of transom). Most of the original overlying exterior end of this scarf had disintegrated on the seabed, exposing on the exterior face of the inner scarf what could have been moss as luting or coating in between the two scarf ends. The material was not sampled before conservation for species identification.

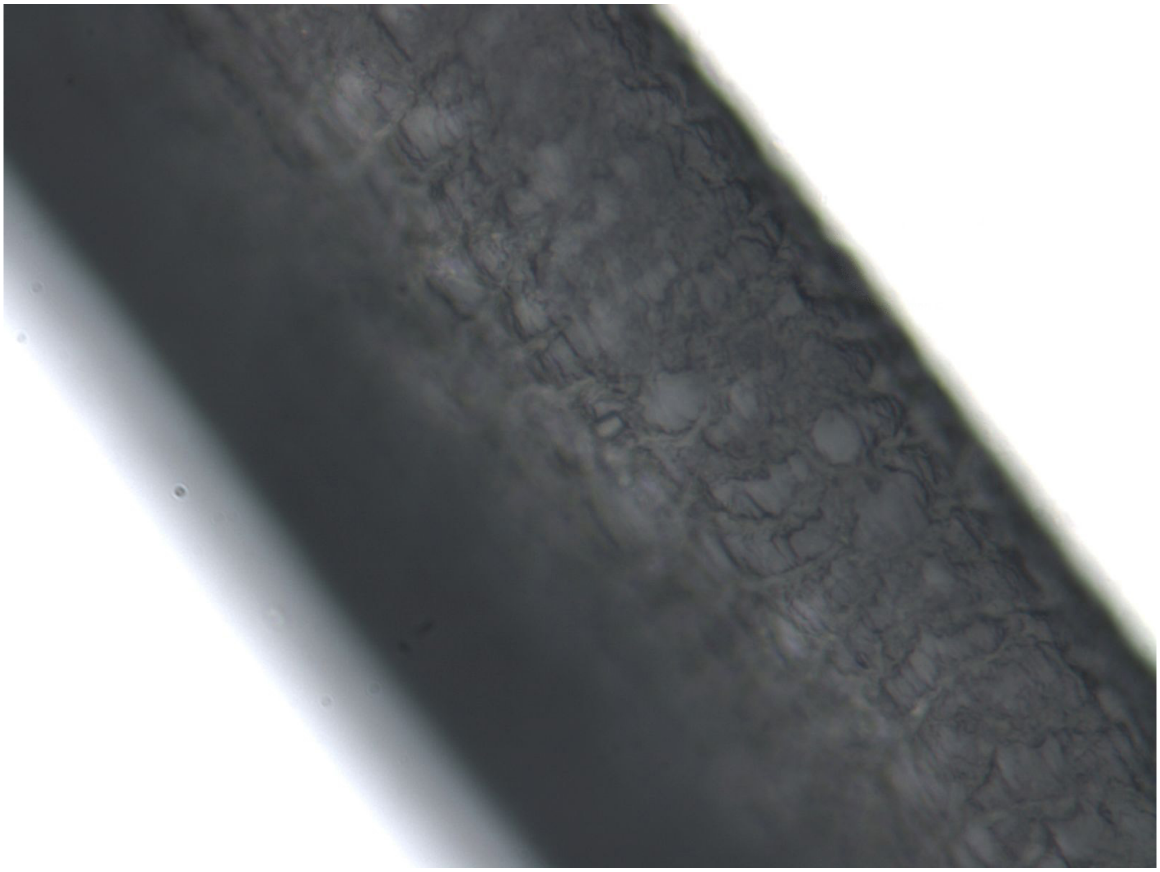

Fig. IV.49 Example of 'honeycomb lattice' or 'scalloped type' medulla of hair sample. *Capra hircus* (common goat), reference collection Cargille. Not to scale. Micrograph: Dawn Marshall, Archaeobotany Laboratory Texas A&M University.

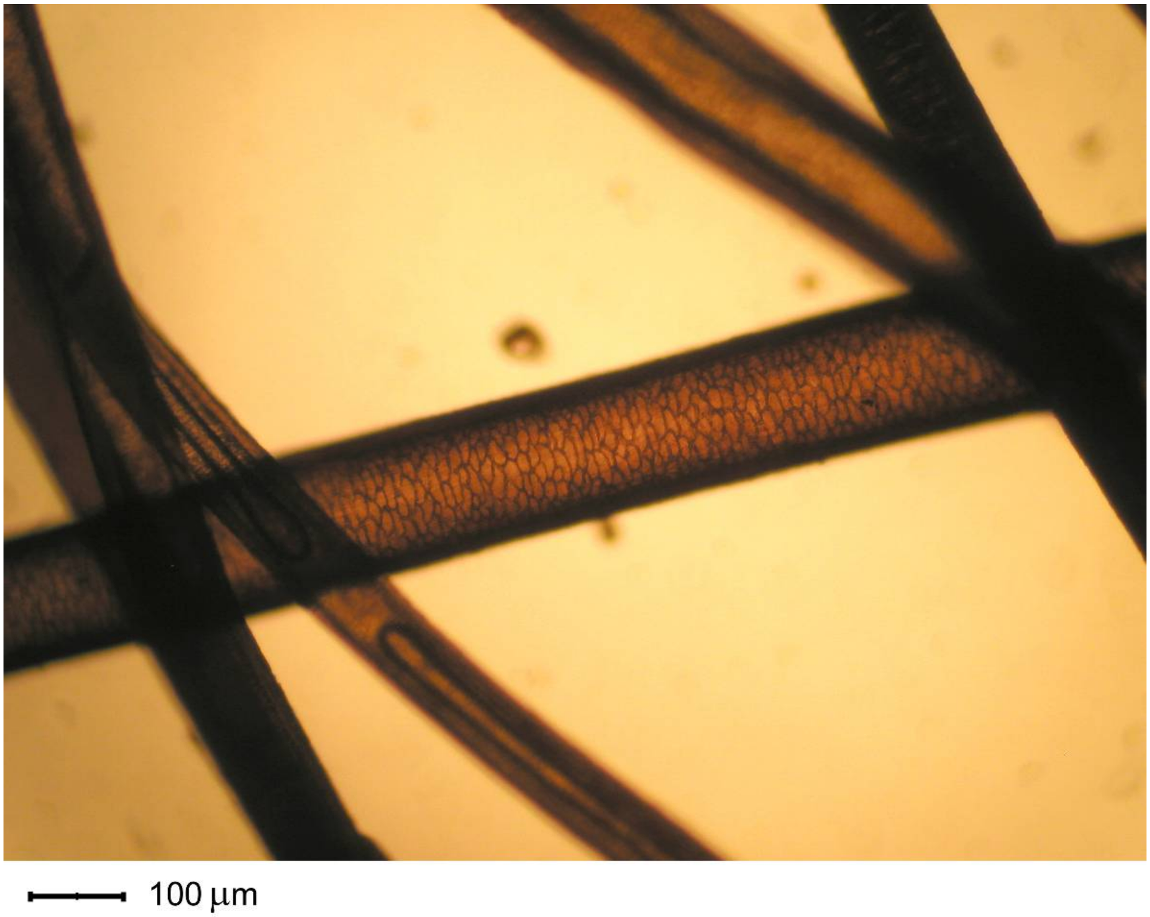


Fig. IV.50 ‘Honeycomb lattice’ or ‘scalloped type’ medulla of hair sample. Goat hair, *Batavia* shipwreck, BAT 6240. Dissecting microscope, magnification x100. Micrograph: Mark van Waijjen, BIAX Consult.

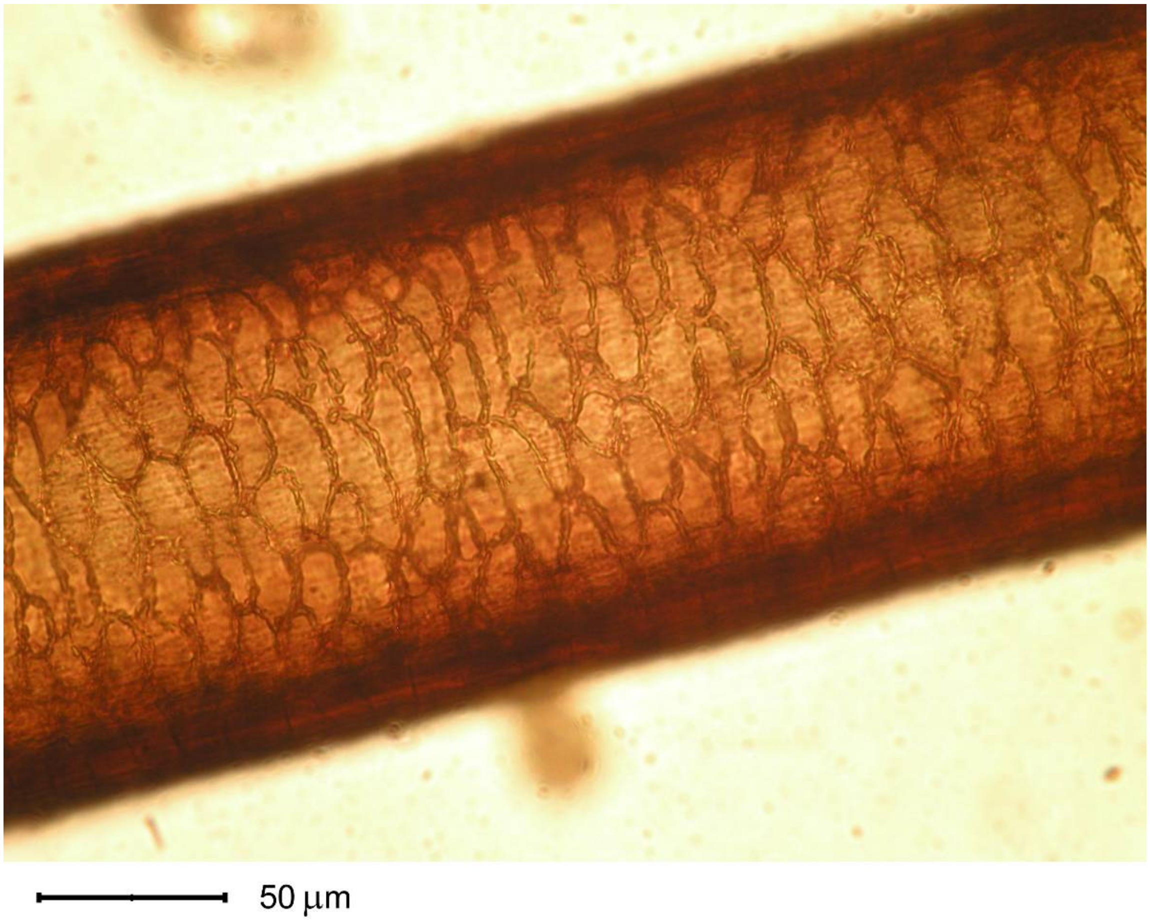


Fig. IV.51 Detail of 'honeycomb lattice' or 'scalloped type' of medulla of hair sample. Goat hair, *Batavia* shipwreck, BAT 6240. Dissecting microscope, magnification x400. Micrograph: Mark van Waijjen, BIAX Consult.

Unfortunately, it was not preserved during the timber's conservation treatment and is, therefore, no longer present for further investigation and analyses (Figs. IV.19 and IV.52).

Although several ships from the Medieval period have been found with waterproofing of goat hair, *Batavia* is the first–known archaeological example of a post–medieval ship with layers of goat–hair. The ship of Newport, for example, built pre–1445, is waterproofed with tar and a mixture of animal hair, including goat, cattle, horse hair, and sheep wool.[57]

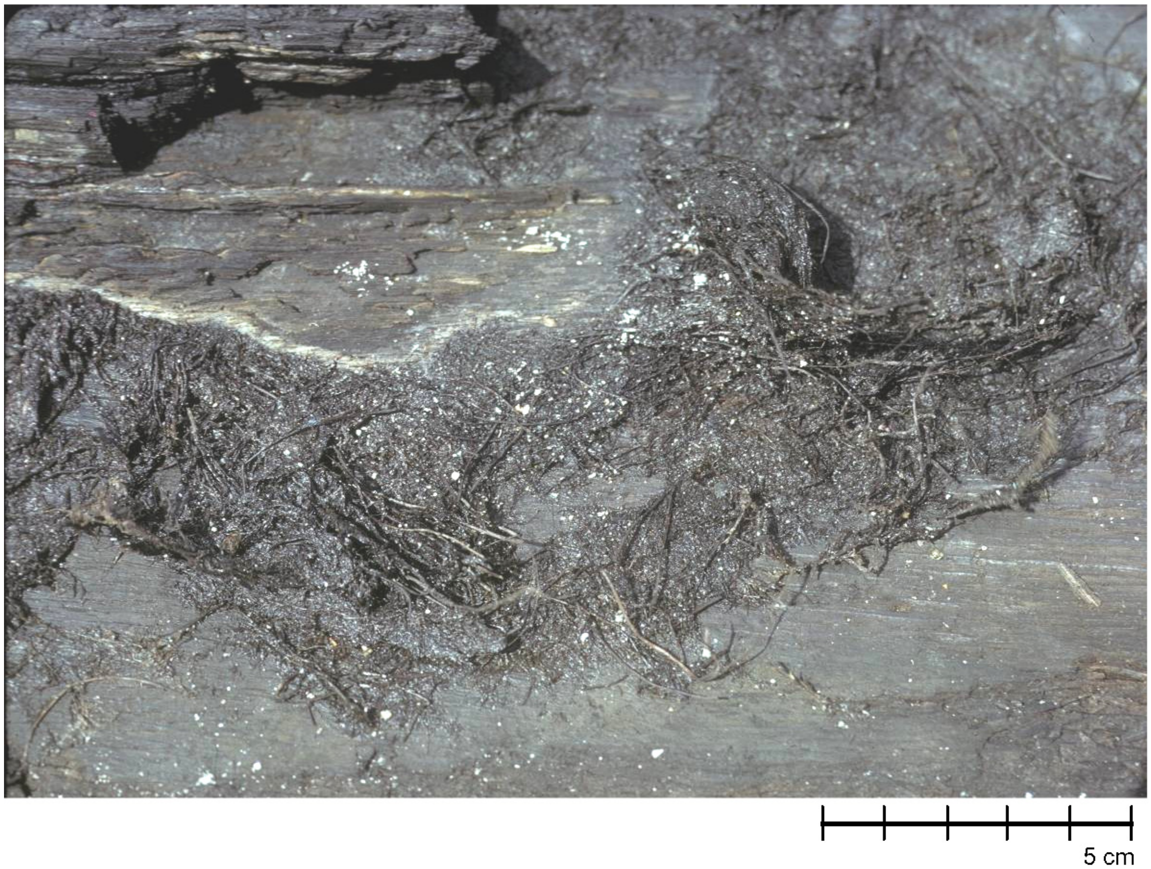


Fig. IV.52 Moss layer on exterior surface of inner layer of a vertical scarf, *Batavia* shipwreck, BAT 6404. Photo: Patrick Baker, Western Australian Museum (BT–67–09).

An extensive study was published in 1998 by Michael Ryder on 200 samples of animal hair from caulking found on Medieval–ship timbers found in England; most of which were re–used as quay revetments. Ryder's study indicates that cattle hair was the most common hair for caulking in the twelfth century, while goat hair predominates in the fourteen and fifteen centuries.[58] The most common fibrous material used for caulking in the sixteenth century is wool.[59] Ryder's work contrasts a similar study on caulking material from Norway that shows a steady change from wool in the twelfth century to cattle and goat hair in the fifteenth century.[60]

Another study on ship's caulking material by Cappers *et al.* indicates the predominant use of mosses to caulk Dutch ships dating to the later Middle Ages. Their study was based on 182 caulking samples from 98 different shipwrecks.[61] In addition to moss, some samples from shipwrecks, dating to the medieval and post–medieval periods, consisted of only hair or a mixture of hair and moss. Other than the observation that this hair is of considerable length and, thus, probably originates from horses and cattle, no efforts were made to identify the hair from caulking samples in this study.[62]

The application of goat–hair in *Batavia* is noteworthy, as cattle hair has been found between the hull planking of other European shipwrecks such as Monte Cristi (1650s), and possibly *Zeewijk* (1727) and *Nieuwe Rhoon* (1776).[63] Layers of animal hair may have been observed in many wrecks of VOC ships but no scientific study has been conducted on this material to identify it. In most cases, cattle hair seems to be the material assumed based on historical research, as seen in the early publications of the *Batavia* ship itself and, more recently, VOC ships *Mauritius* (1609), *Kampen* (1627), and *Buitenzorg* (1760).[64] This assumption probably follows Witsen and Van IJk, who both mention explicitly the use of cattle hair.[65] The earliest VOC shipbuilding charter of 1603 simply refers to hair, not the hair of any specific animal (Appendix A). Nonetheless, cattle and goat were the largest populations in Dutch animal husbandry since the early medieval period, which, for example, is demonstrated by the leather used to manufacture shoes from the eleventh century onwards. Leather shoe remnants found in archaeological contexts in the Netherlands are made primarily from cattle or goat hides.[66]

Although the VOC purchased goat hair or wool for high–quality fabrics, such as mohair, in Kirman from 1658, or in Gamron (modern–day Bandar Abbas, Iran), goat hair for caulking its ships was almost certainly acquired locally.[67] It is known that the VOC purchased substantial quantities of cattle hair in the eighteenth century. For the Chamber of Amsterdam, this consignment was acquired annually in bulk, usually during butchering season. In October 1742, for example, 22,248 pounds of cattle hair were purchased for 440 guilders and in October 1748 16,158 pounds for 343 guilders.[68] Both batches of hair were purchased from the sole supplier in that period, Geert Oetses.[69] It is unknown whether similar procedures applied to the seventeenth century.

Layers of animal hair were also applied to the Christianshavn B&W 2 ship (1620s) and VOC–ship *Amsterdam* (1748), but no analytical study has been made to identify animal species.[70] Although layers of animal–hair between the hull planking and pine sheathing have been found on the hull timbers of many VOC and contemporaneous shipwrecks, few studies on the nature of the fibrous matter have been made to date.

**Tar coating**

The goat hair was payed on to *Batavia*'s hull with a mixture of sulfur and tar. It is difficult, however, to establish an accurate analysis of this tarry material because of the high sulfur content of corrosion products from the ship's iron fasteners. These corrosion products are likely to have diffused into the hair and tar mixture between the planks. Samples of the hair from the *Mauritus* and Monte Cristi shipwrecks indicate that they were mixed with tar and sulfur.[71] In the coating of the Christianshavn B&W 2 ship tar and hair was also mixed in with finely–ground glass.[72]

**Caulking material**

No strands of animal hair or other caulking material have been found in the planking seams of the *Batavia*. The seams were apparently fitted so tightly that no additional caulking was needed. This is similar to the Dutch–built Indiaman found at Christianshavn.[73]

*Batavia*'s only caulking was comprised of goat hair that was inserted to fill up the cavities between poorly fitting joints, such as the scarf tips of the outer layer of hull planking of strakes 9 and 11 (Figs. IV.14–IV.15). Here, wads of hair were simply stuck into the significant gaps between the scarf tips. It is unknown whether these wads of hair were payed with tar.

**Frames**

Forty–six remnants of *Batavia*'s framing have been preserved, mainly comprising first, second, and third futtocks (Figs. IV.53–IV.55, numbered C1 to C46). The only possible remnant of a floor timber is a small timber fragment, BAT 6289, found at C37 over hull planking strake 4 (Figs. IV.53–IV.55). Looking at *Batavia*'s frames it becomes evident that the efforts of the shipbuilders were not focused on its frames as their arrangement and shape have a haphazard and rough appearance in comparison to the hull planking (Fig. III.30). They obviously were a secondary focus, and not primary in the design philosophy of the shipwrights.

All frame remnants excavated in the first excavation season, C1 to C10, in the foremost section of the preserved hull have worm–eaten and eroded surfaces. Most frames in this section were sitting on the seabed, fractured along their lengths into smaller adjoining fragments.

Field numbers C1 to C46 were only given to frame remnants that were physically present on the seabed. Originally a first futtock was situated between C16 and C17, for example, but no field number was given as no actual remains were found *in situ*. Then, two frame fragments, C11 and C12, were mistaken on the seabed for two different frames. They turned out to be fragments of the same second futtock.

*Batavia*'s first and third futtocks have only been partially preserved at the bottom and top of the ship's hull structure, whereas the large sections of the second futtocks have been preserved over the entire preserved hull section. The first and second futtocks and second and third futtocks are not interconnected or transversally fastened but overlap each other at their ends to form an irregular band of timber (Fig. IV.55).

The frame timbers are preserved over lengths varying from 0.513 m to 3.972 m, with an average length of 1.755 m. Their average sided dimension measures 0.207 m and average molded dimension 0.191 m. The room and space between the second futtocks varies from 0.353 m to 0.482 m, with an average of 0.414 m (Fig. IV.55).

As mentioned previously, no signs of lateral fastening have been observed between the overlapping futtocks of each frame timber.[74] The frames were fastened to

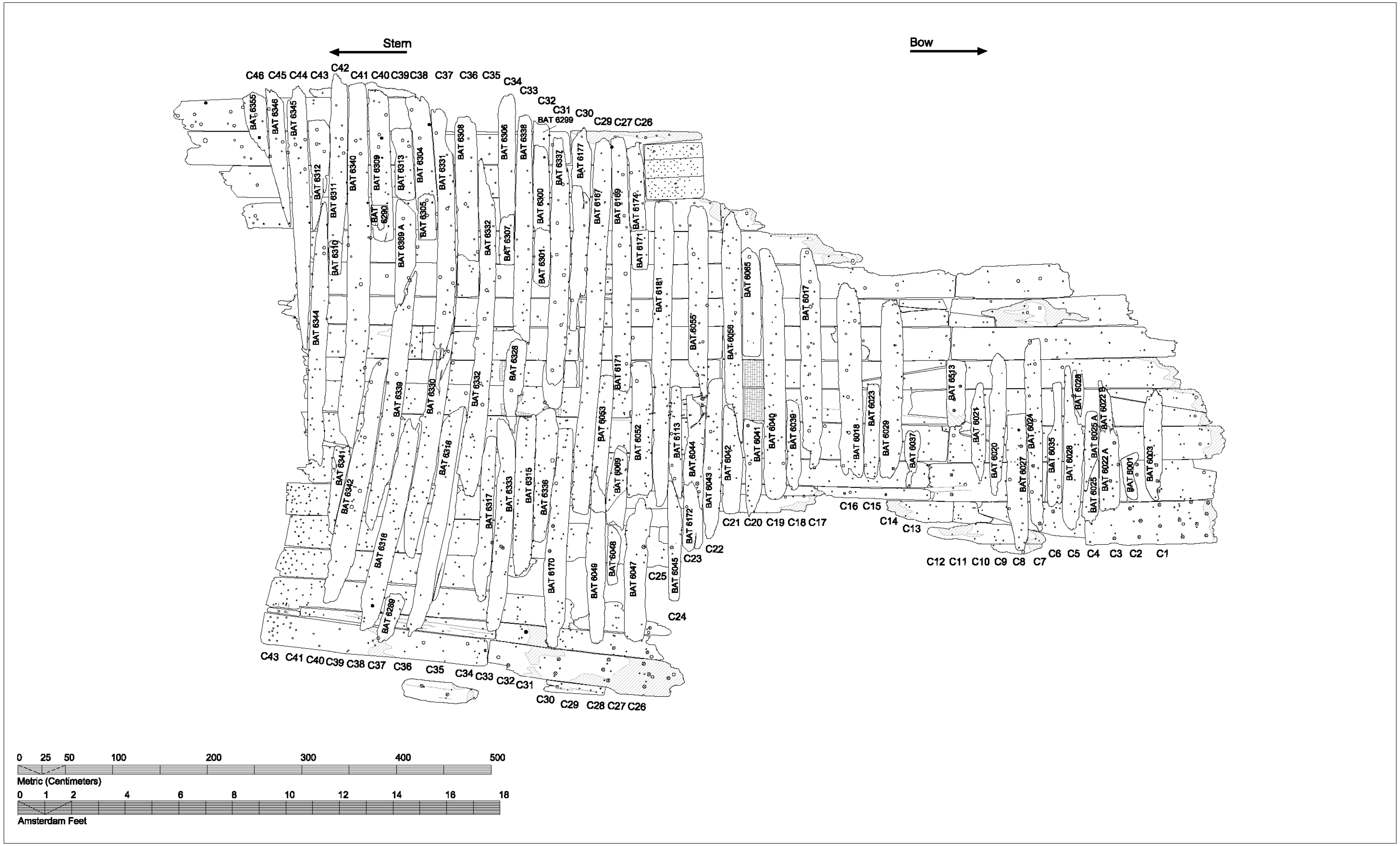


Fig. IV.53 Timber plan of *Batavia*'s frame timbers. Illustration: Wendy van Duivenvoorde.

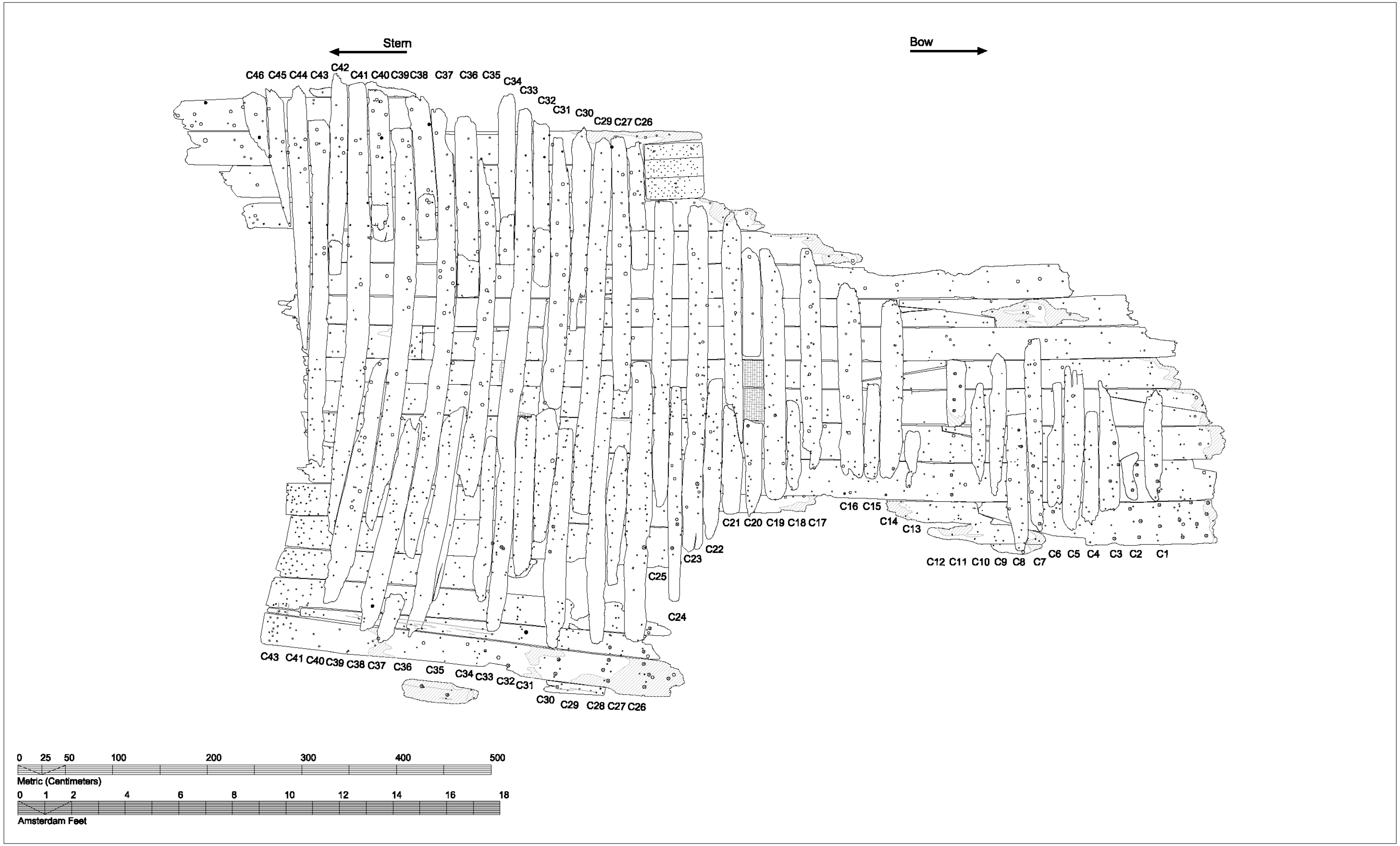


Fig. IV.54 Reconstructed plan of *Batavia*'s frame timbers. Illustration: Wendy van Duivenvoorde.

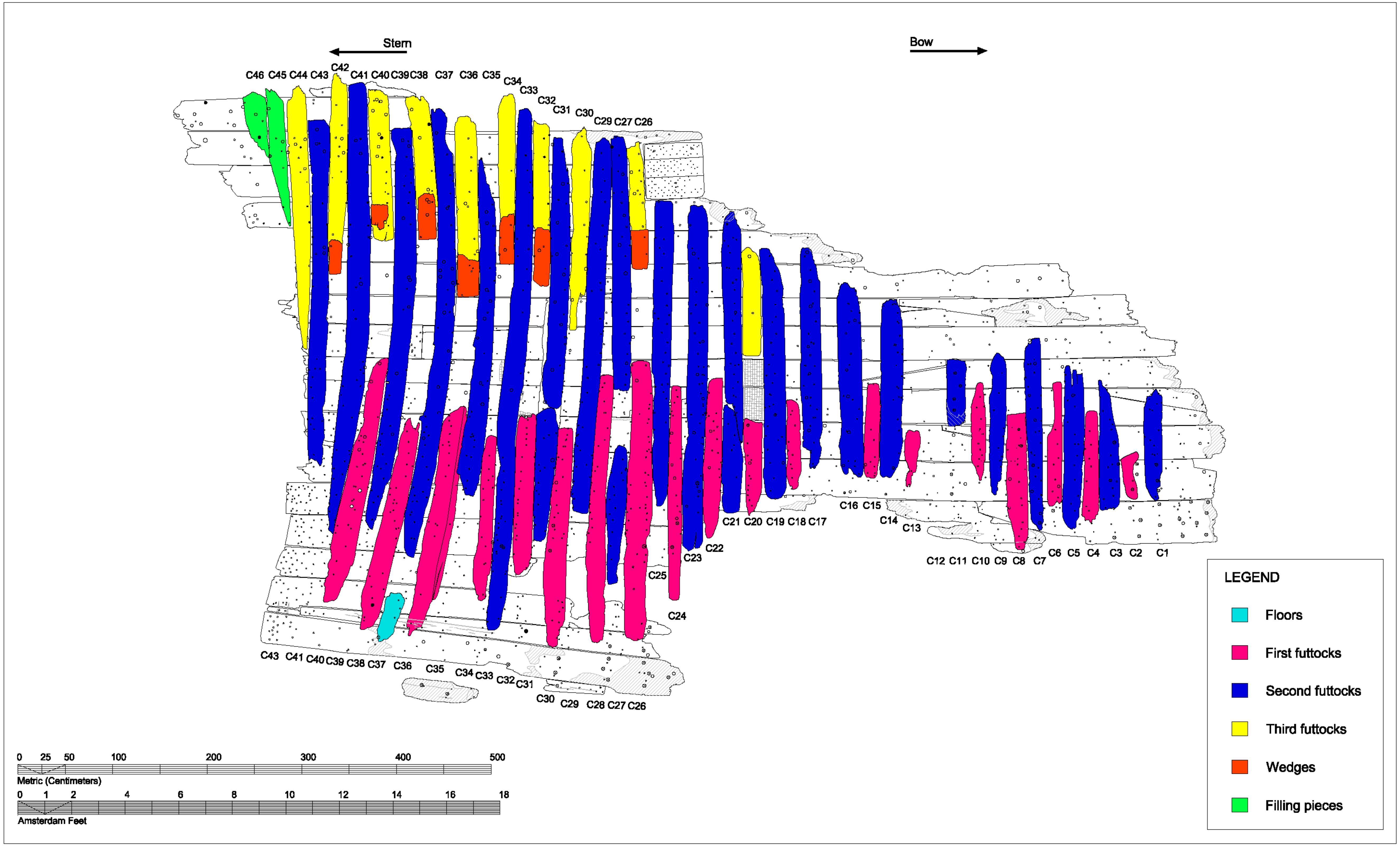


Fig. IV.55 Reconstructed plan showing types of frame timbers found in *Batavia*’s preserved hull structure. Illustration: Wendy van Duivenvoorde.

the ship's bottom planking with treenails and the planking was nailed to the frames of ship's sides and the aftermost ends of the bottom planks. Only the lower futtocks, up to at least hull planking strake 11 in transverse direction and from C1 to 34 in longitudinal direction, have treenails preserved. All frame timbers above strake 14 and from C35 to C46 show that the planking was fastened exclusively with iron spikes.

Wedges were nailed over the lower ends of the third futtocks to fill the space between the beveled frame ends and the ceiling planks above the shelf clamp (Fig. IV.55). Seven of these preserved wedges are triangular in cross–section and vary from 0.184 m to 0.616 in length and from 0.145 m to 0.264 m in width (Fig. IV.56). Their maximum thickness measures between 0.090 m and 0.175 m on their lower ends from which they taper to a point at their top ends where they sit over their respective frames.


Fig. IV.56 Various sizes of wedges from the lower ends of the third futtocks, *Batavia* shipwreck, BAT 6310, BAT 6307, and BAT 6305. Photograph: Patrick Baker, Western Australian Museum (MA0422–04/MA0422–05/MA0423–09/MA0423–10).

**Ceiling planking and shelf clamp**

Twelve strakes of ceiling planking and a shelf clamp were found atop the frames, and fastened to the frames with iron nails (Fig. IV.57). The ceiling planking is well preserved in the aftermost section of the hull, which was excavated in the last excavation season, whereas its state of preservation directly forward of this section, below the gunport, is fragmentary. Here, the planks have nearly completely decayed.

The lowest six strakes of preserved ceiling planking vary in thickness from 0.060 m to 0.071 m, with an average of 0.064 m. The strakes above strake 7 show a definite increase in thickness. Strakes 7 and 9–13 vary in thickness from 0.080 m to 0.090 m, with an average of 0.087 m, which is similar to the strakes of hull planking of the ship's bottom. It is noteworthy that exactly where the ceiling planking becomes 0.020 m thicker, the ship's hull planking becomes 0.055 m thinner. Ceiling planking strake 7 corresponds to hull planking strake 13, which is the first single–planked layer, and is situated one strake below hull planking strake 14, which is the first strake that measures 0.125 m in thickness. The preserved ceiling planks of the *Batavia* are joined with diagonal scarfs and were nailed onto approximately every other frame with a maximum of three iron spikes. The preserved fragments of ceiling planking vary in length from 0.415 m to 2.911 m, with an average length of 1.650 m. The ceiling strakes measure from 0.245 m to 0.619 m in width.

The eighth strake comprises the shelf clamp of *Batavia*'s lower deck. It is much thicker than the ceiling planking and has two preserved notches to seat the deck beams (Fig. IV.57). The shelf clamp has been preserved over a total length of 3.9 m, although it was cut in two sections during excavation (BAT 6322 and BAT 6185). It measures 0.428 in width and 0.12 m in thickness. In addition, the ninth ceiling strake has one notch on its bottom face to sit over the forwardmost surviving deck beam notch.

Originally, a pine cargo floor covered the ceiling planking up to the lower deck (Fig. IV.58). Three fragmentary planks of this cargo floor have been well preserved on strakes 1 to 3. These planks measure from 1.713 m to 1.896 m in length, and from 0.352 m to 0.56 m in width. Their maximum thickness varies from 0.026 m to 0.036 m. Two

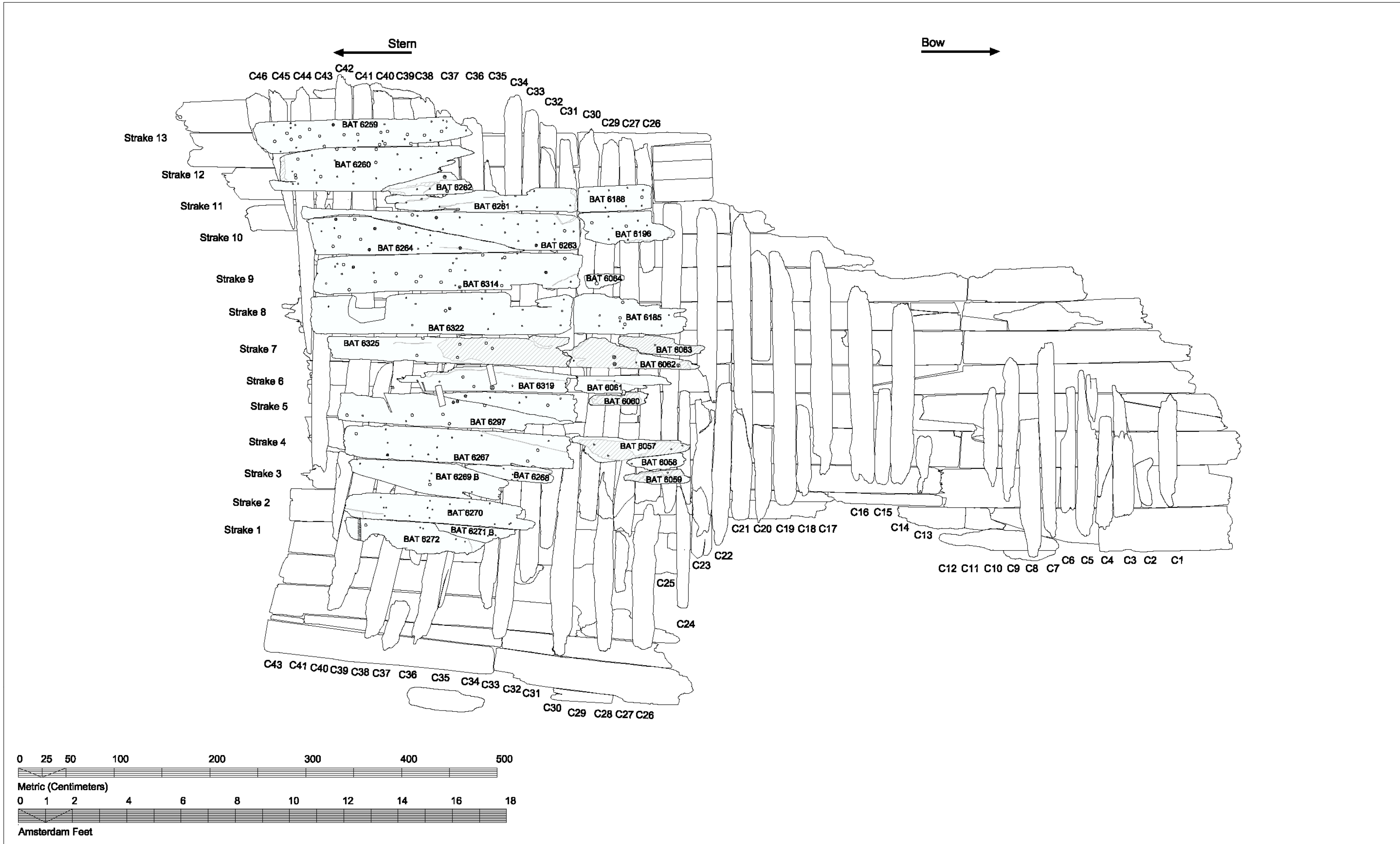


Fig. IV.57 Timber plan of *Batavia*'s ceiling planking. Illustration: Wendy van Duivenvoorde.

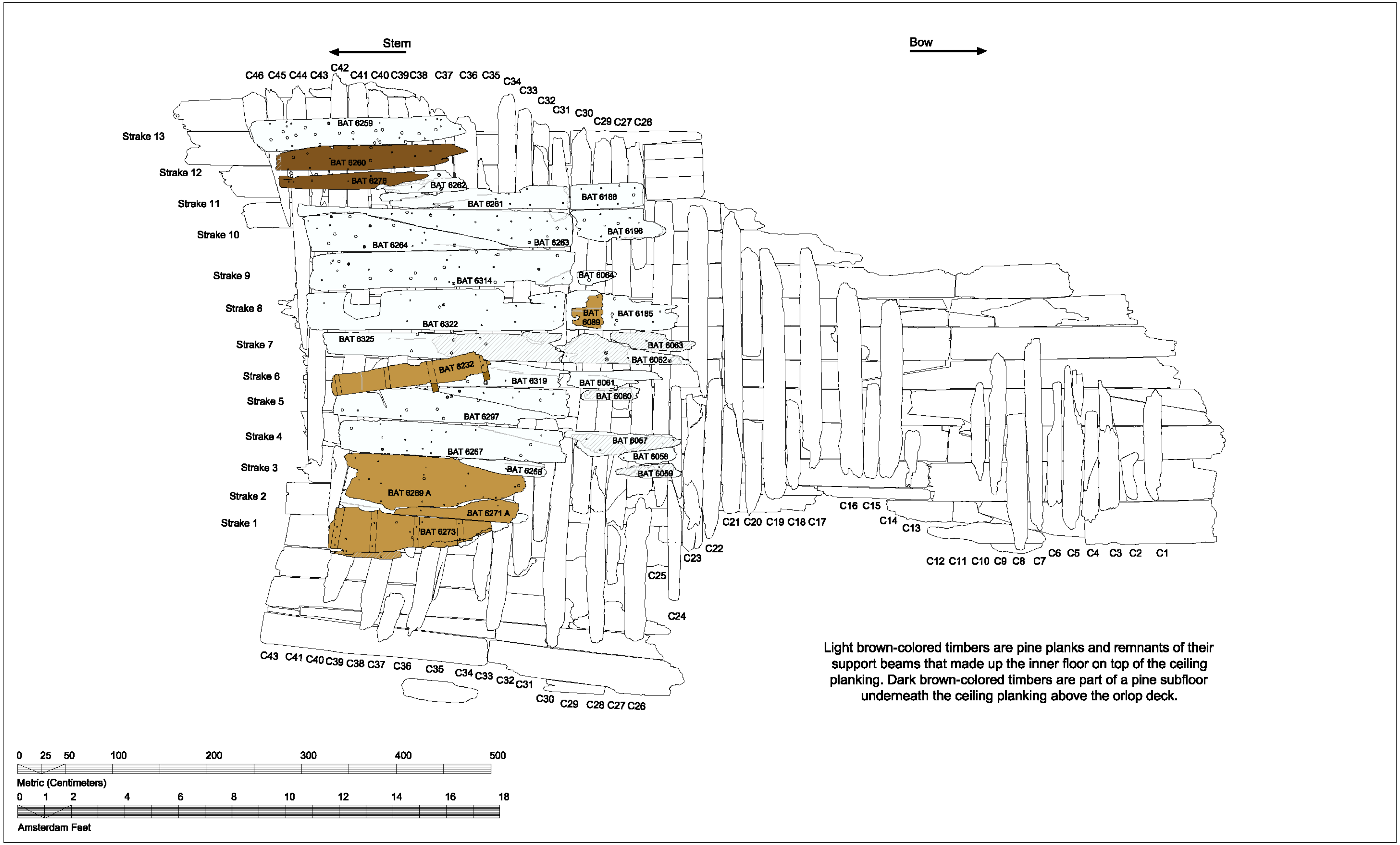


Fig. IV.58 Timber plan of *Batavia*’s pine inner floor on top of ceiling planking and subfloor below pine ceiling planks. Illustration: Wendy van Duivenvoorde.

more fragmentary planks were found on the forward end of the shelf clamp (BAT 6089) and below ceiling planking strake 7 (BAT 6232). This pine floor was supported by small vertical laths that were nailed onto the ceiling planking. These laths were found underneath the preserved floor boards (Figs. IV.57–IV.60). Most laths measure about 0.063 m in width and one measures 0.077 m in width. Their preserved lengths vary from 0.217 m to 0.451 m, and their thicknesses are only a few centimeters due to their poor state of preservation. Their room–and–space on plank BAT 6273 varies from 0.374 m to 0.465 m (Fig. IV.60), and on strakes 5 and 6 it measures 0.577 m.

Over the cargo floor boards on top of the lowest three strakes of ceiling planking, a large iron concretion of cannon balls was found. This concreted conglomerate was encountered during the last excavation season of the *Batavia* shipwreck site. It created an anaerobic environment over the ship's hull and measured 2.8 m in length and 1 m in width. The concretion was removed by using picks and hammers, and eventually by small quantities of explosives.[75] The surface of the cargo floor planks, found directly underneath the concretion, is covered with a smooth and thin concretion layer (Fig. IV.60). This layer could also be the result of the iron corrosion products leaching from the iron concretion into the surface of the pine planks. It has been suggested that the


Fig. IV.59 Fragments of small laths to support a pine inner floor on top of the ceiling planking, BAT 6297 and BAT 6319, directly below transom beam. *Batavia* shipwreck. Photograph: Patrick Baker, Western Australian Museum (MA0388–15).

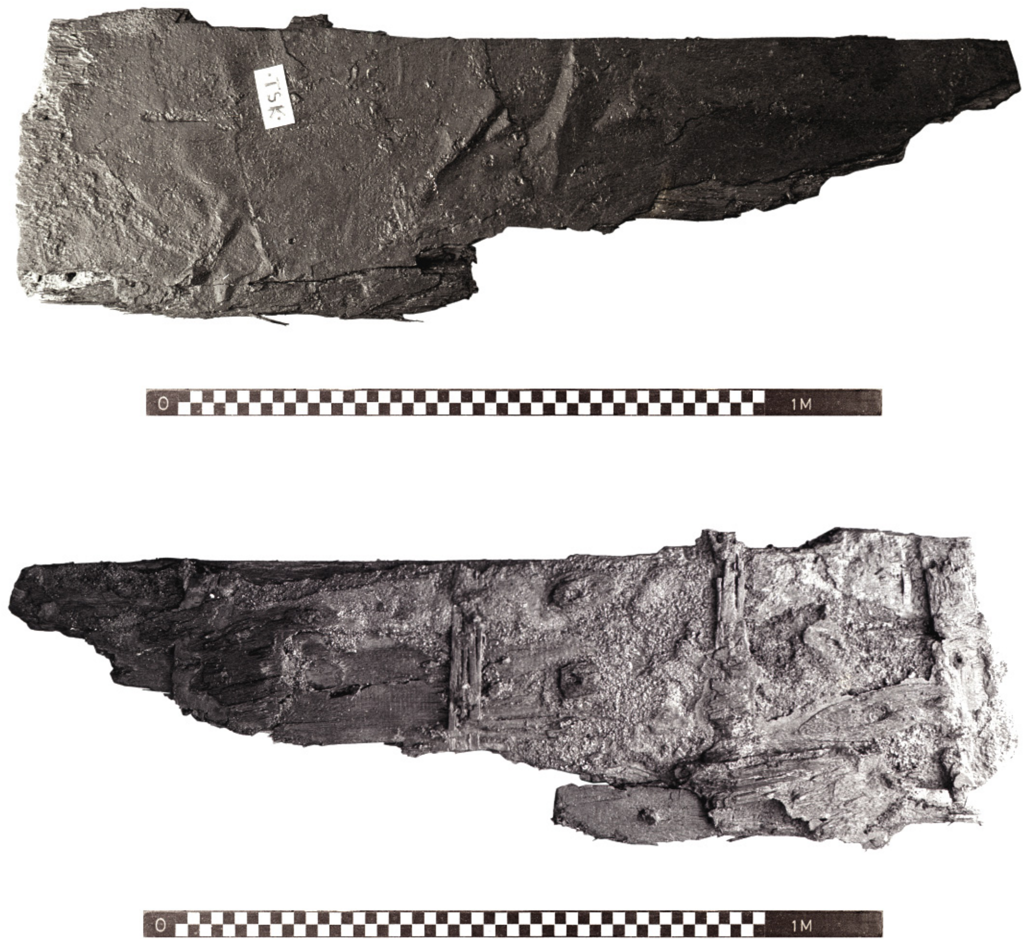


Fig. IV.60 Internal (top) and outboard surfaces of pine plank from cargo floor. Note vestiges of laths on outboard surface, *Batavia* shipwreck, BAT 6273. Photograph: Catherina Ingelman–Sundberg, Western Australian Museum (MA0399–11/12).

thin layer could have been part of a lead sheathing, purposely applied to the pine floor during *Batavia*'s construction.[76] This was a known practice for the shot lockers of VOC ships. There were no remnants of small fasteners, however, to suggest that metal sheets were nailed onto the pine planks. Recently, the interior and exterior surfaces of floor plank, BAT 6273, were analyzed by Kalle Kasi and Vicki Richards of the Department of Materials Conservation of the Western Australian Museum, using a 'Bruker AXS Handheld XRF' apparatus. The chemical analysis was conducted on seven different spots on the planking's surface. The results mainly show high concentrations of iron and

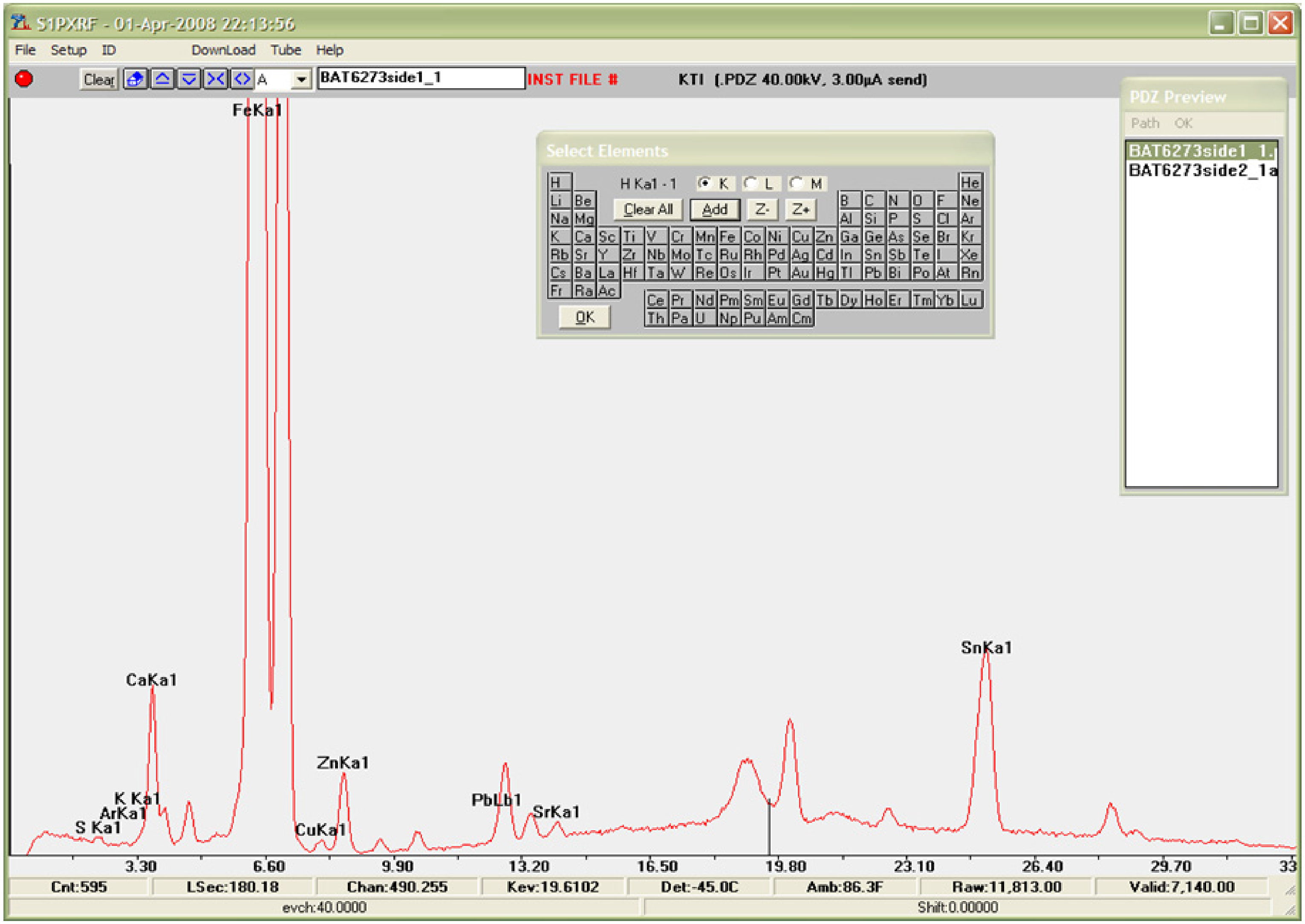


Fig. IV.61 Result of XRF spot test on pine floor plank, *Batavia* shipwreck, BAT 6273. Illustration: Bruce Kaiser.

corrosion in the form of iron corrosion products, and insignificant amounts of lead (Fig. IV.61). If the cargo floor was covered with lead sheathing, the amount of lead and lead corrosion products preserved on its surface would have been much higher due to the anaerobic conditions prevalent under the dense concretion. It is, therefore, more likely that the surface layer is a combination of anaerobic concretion and iron corrosion products formed due to the corroding cannon balls.

A pine subfloor was found above the lower deck in alignment with the gunport underneath ceiling strakes 11 and 12 (which correspond to hull planking strakes 18 and 19). A plank of this subfloor found underneath strake 12 measures 2.15 m in length, 0.471 m in width, and 0.035 m in thickness (BAT 6260). Another one situated underneath strake 11 is somewhat smaller and measures 1.58 m in length, 0.183 m in width, and 0.05 m in thickness (BAT 6276). It is not known what the precise function of this subfloor would have been, but it may relate to the reinforcement of the gunports.

Other contemporaneous Dutch–built ships, such as the Scheurrak SOI and Christianshavn B&W 2, have ceiling planking that is treenailed through frames into the inner layer of oak hull planking (see Chapter V). No evidence of treenail fastening of the strakes of ceiling planking on *Batavia* exist. As previously discussed, the aftermost hull planking of the ship's bottom was nailed and not treenailed to the fashion piece and frames. The ceiling planking has mainly been preserved in this particular area and it could simply have been fastened in concordance with the fastening method used for the planking.

**Riders**

No riders have survived on the *Batavia* shipwreck, but similar practice is seen in the construction of the Christianshavn B&W 2 ship.[77] Round bolt holes of riders and hanging deck knees are primarily found in *Batavia*'s preserved hull remains from frame C31 forwards (at frames C30, C27, C24/C23/C22, C17, C16, C14, C11, C7, and the foremost edge of the preserved hull), indicating that the rider frames had an irregular room–and–space varying from 0.46 m to 1.73 m.

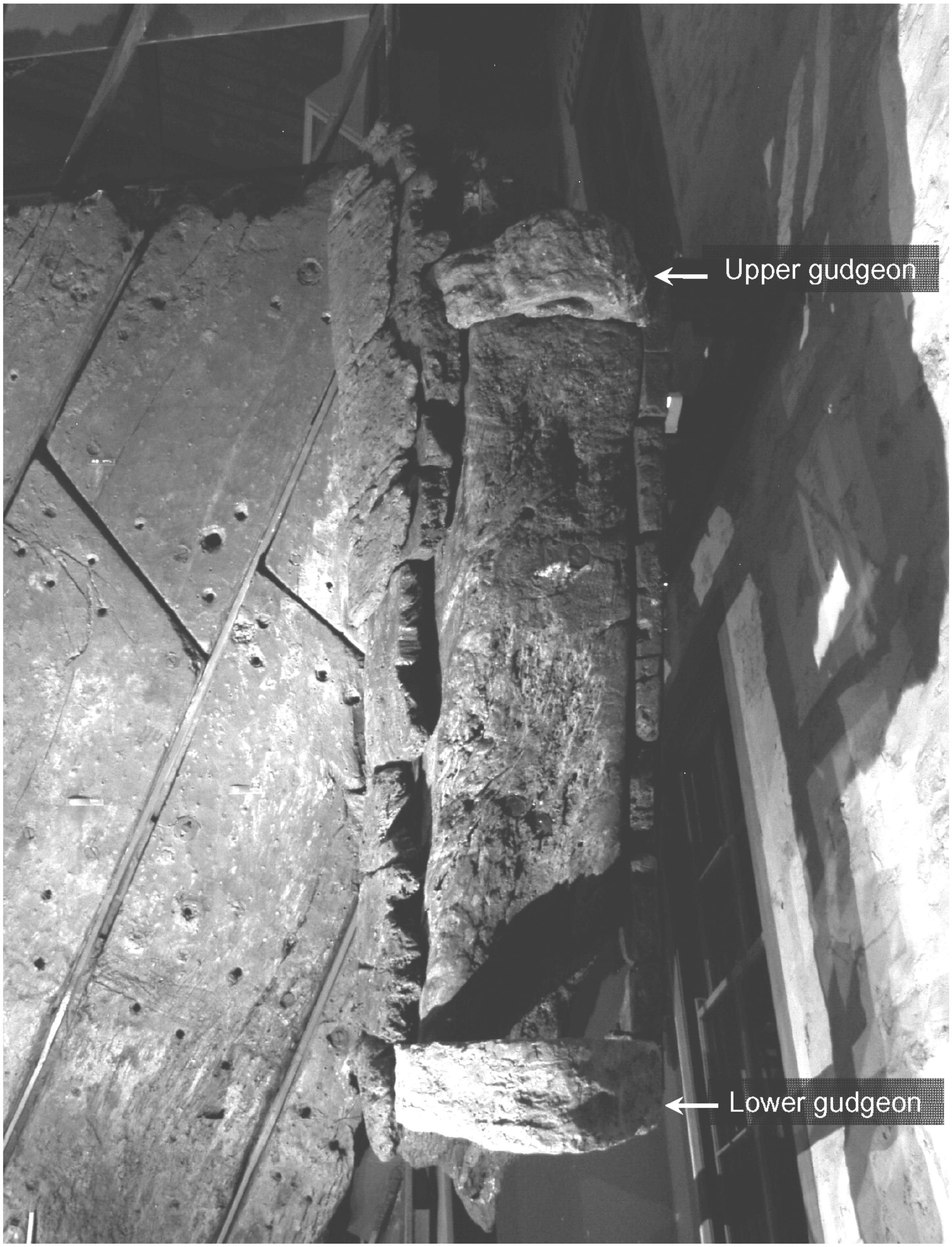


Fig. IV.62 After face of sternpost with layer of oak cover planking and pine sheathing on starboard and port sides. *Batavia* shipwreck. Photograph: Wendy van Duivenvoorde.

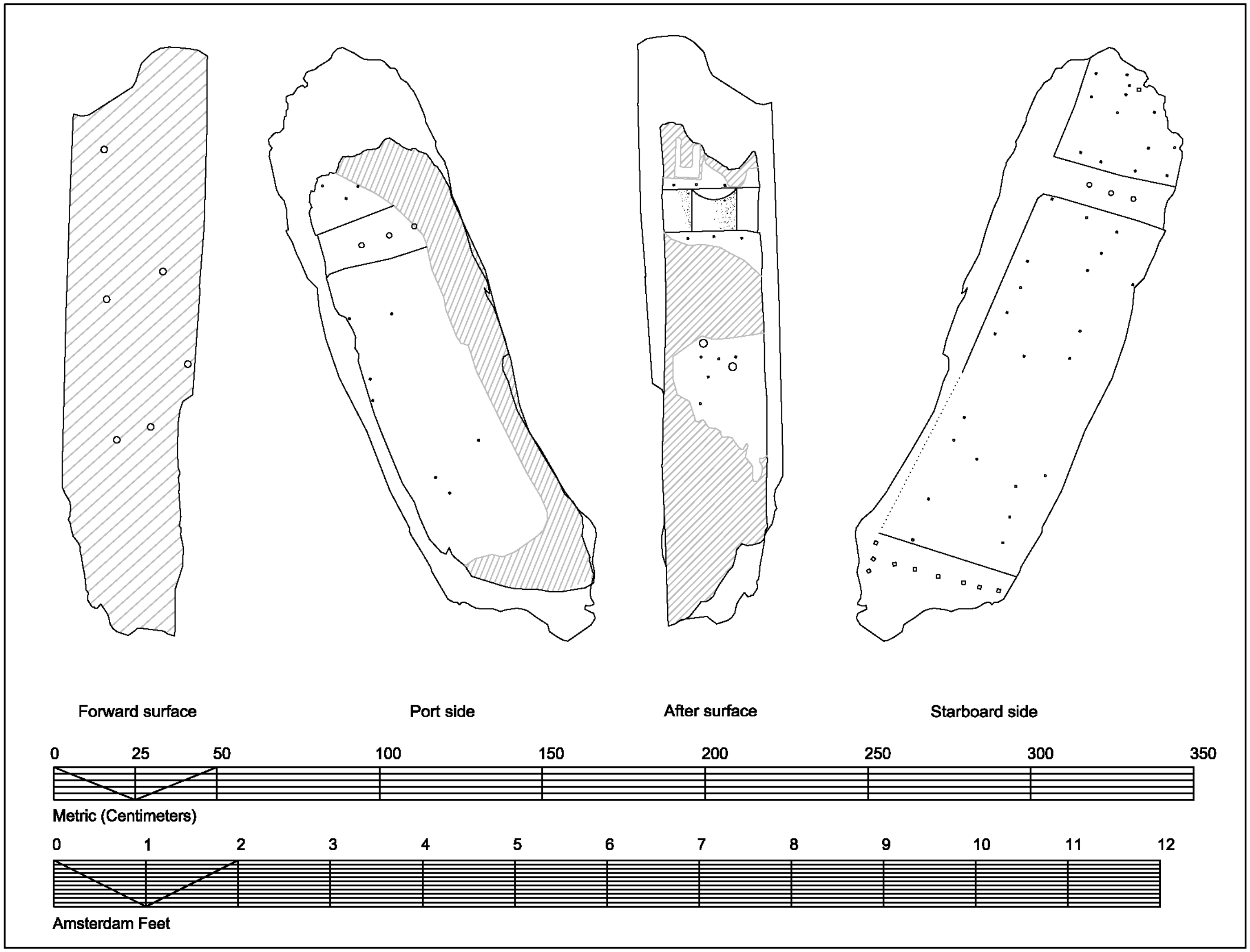


Fig. IV.63 Sternpost, *Batavia* shipwreck, BAT 6434. Illustration: Wendy van Duivenvoorde.

**Sternpost**

As displayed in the museum, the after face of *Batavia*'s sternpost has an inclination of 107.5 degrees to the keel, whereas it has an angle of approximately 114 degrees to the keel where it meets the transom planking. The sternpost was originally covered on each outboard side with several layers of material for additional reinforcement and protection (Fig. IV.62). The innermost layer, nailed to the sternpost, was comprised of oak planking on top of which thin sheets of copper sheathing were added. A layer of pine sheathing was then fastened over the copper sheathing.[78] A thin layer of goat hair and tar was applied to the inner and outer surfaces of the pine sheathing.

The preserved section of sternpost measures 1.544 m in length over its aftermost face and 1.815 m over its foremost face (Fig. IV.63). It measures 0.528 m in molded dimension and tapers in sided dimension from 0.419 m forward to 0.329 m aft. An impression of the sternpost rabbet, preserved on its portside only, shows that the rabbet line was curved (Fig. IV.63). As discussed previously, the transom planking was not flat and straight but had a curvature to it, which is clearly shown by the rabbet line (Fig. IV.63). In addition, the sternpost was notched on its after face and on either side of the post to receive the rudder gudgeons (Figs. IV.62–IV.63).

The concretions of two iron rudder gudgeons were found, but one, upper gudgeon BAT 80104, is still in wet storage and not available for study. Interestingly, the preserved transom planking indicates that the ends of this gudgeon flared on each side of the transom planking, where they were fastened between the two layers of transom planking on each side of post (Figs. IV.36 and IV.41). This practice provided strong lateral support for the gudgeons and its fasteners. The gudgeon arms were secured to the inner layer of transom planking by two iron spikes. The upper gudgeon was secured to the sternpost with large iron bolts, whereas the lower preserved gudgeon was fastened with smaller bolts or large iron spikes. The heads of the bolts from the upper gudgeon have left perfectly rounded circular impressions on the interior surface of the upper cover planking (head diam. 0.045 m, Figs. IV.64–IV.65).

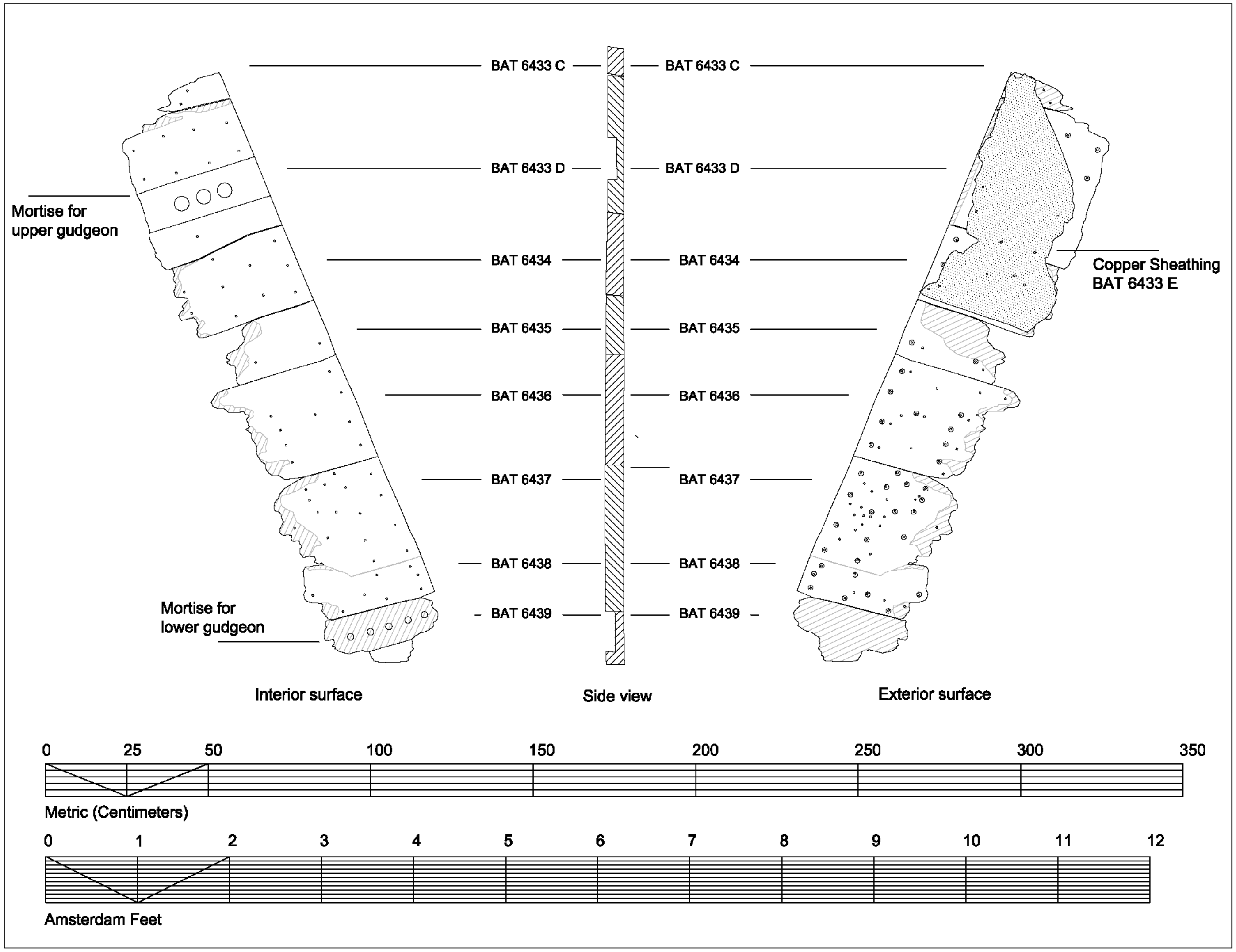


Fig. IV.64 Cover planking on port side of sternpost, *Batavia* shipwreck, BAT 6433 C–BAT 6439. Illustration: Wendy van Duivenvoorde.

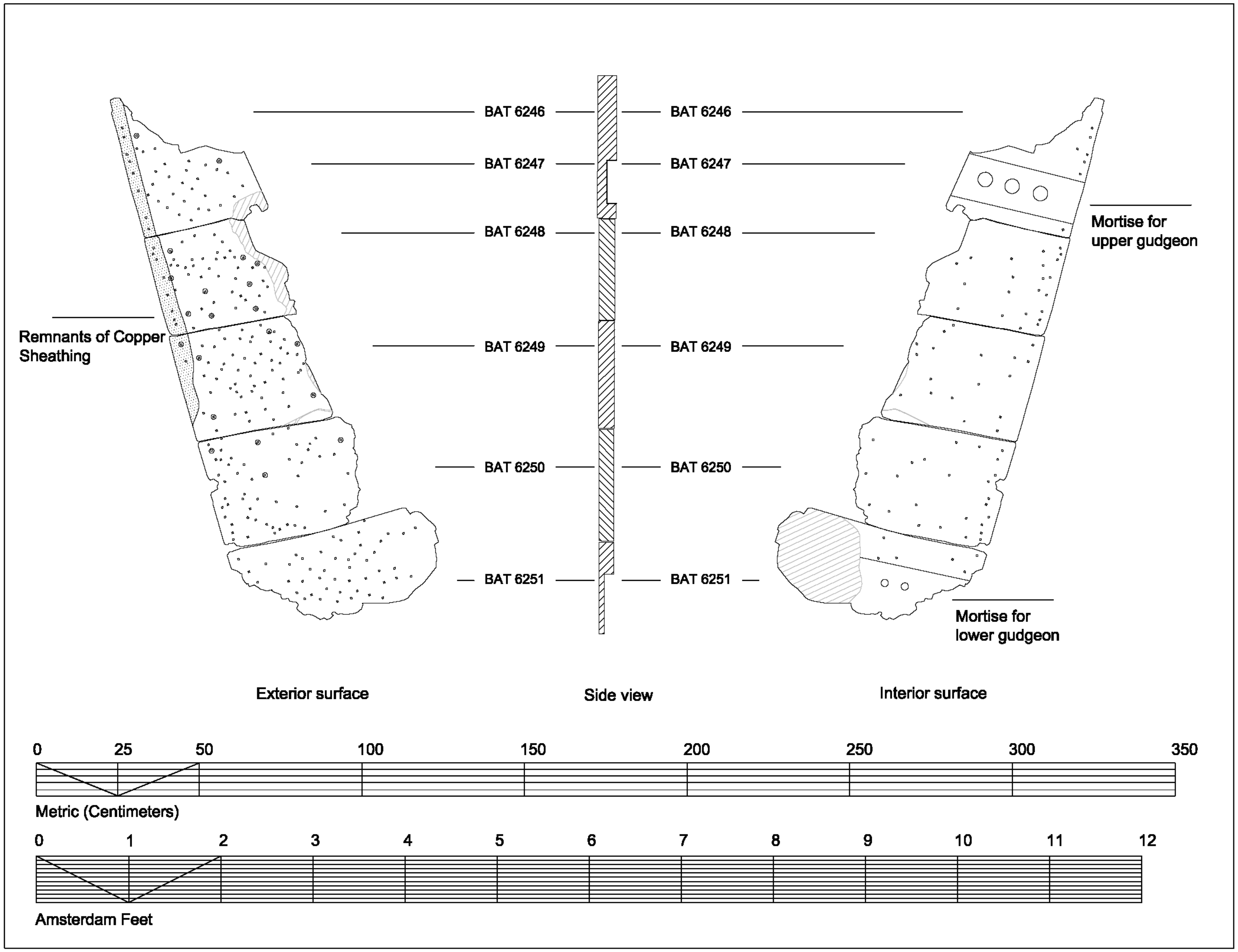


Fig. IV.65 Cover planking on starboard side of sternpost, *Batavia* shipwreck, BAT 6246–BAT 6251. Illustration: Wendy van Duivenvoorde.


Fig. IV.66 Casting of lower preserved gudgeon from iron concretion, *Batavia* shipwreck, BAT 80395 R. Photograph: Jon Carpenter, Western Australian Museum.

The second rudder gudgeon, BAT 80395, is the lower one from the preserved sternpost. This concretion has been cast for replication purposes and museum display (Figs. IV.62 and IV.66. Note: the upper gudgeon shown in Fig. IV.62 is a replica of the lower gudgeon). It was fastened to the sternpost with seven iron bolts or large spikes per side. The preserved gudgeon measures 0.36 m in length, and tapers in width from 0.155 m at its aftermost end to 0.114 m where it runs in between the sternpost and the cover planking. It measures 0.038 m in thickness, although it is slightly thicker, 0.055 m, at its aftermost end where it seated the pintle. The hole for the pintle measures 0.085 m in diameter.

Seven fragmentary covering planks have been preserved from the sternpost's outboard port side and five on its starboard side (Figs. IV.67–IV.68). They vary in maximum length from 0.322 m to 0.643 m and in maximum width from 0.183 m to 0.477

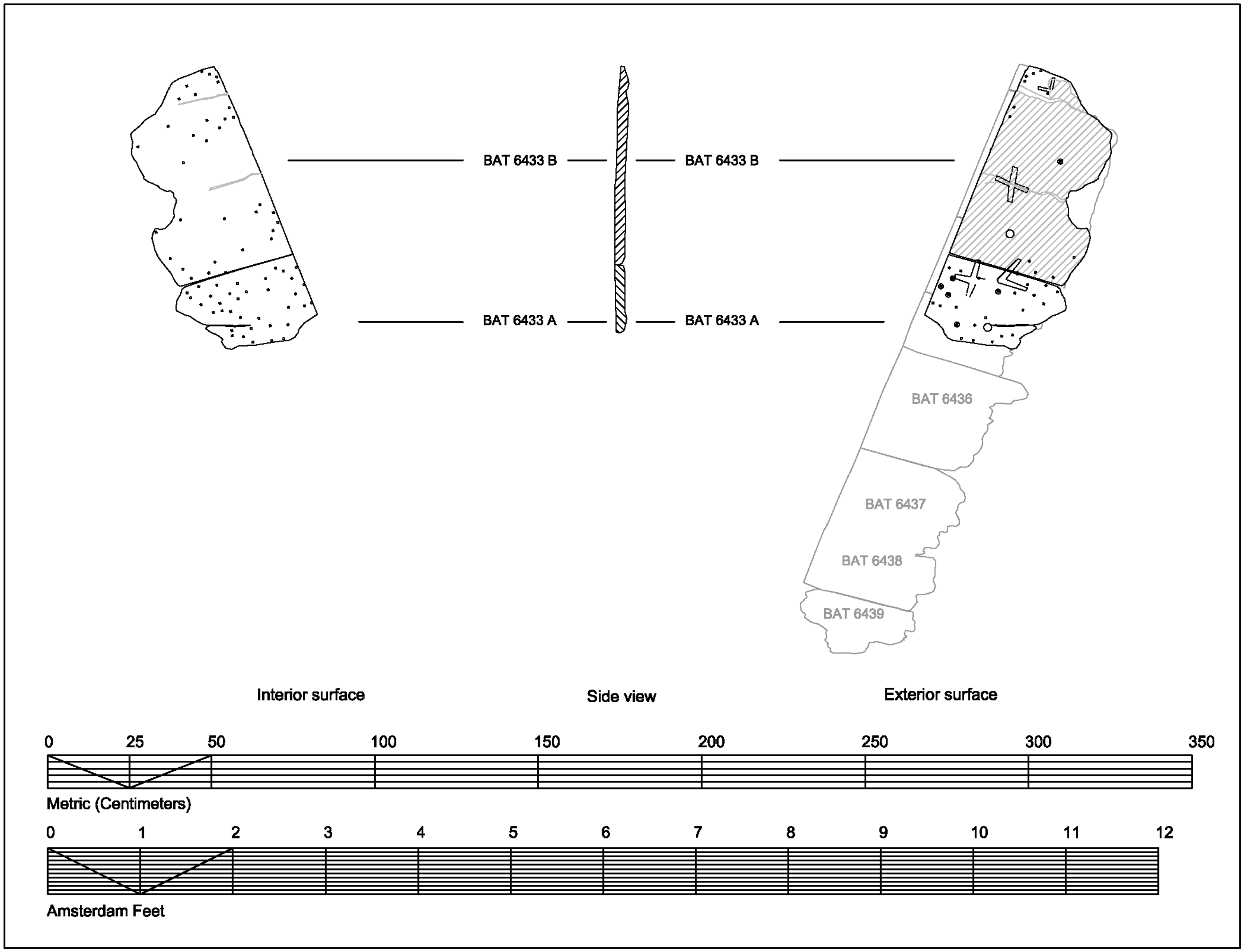


Fig. IV.67 Pine sheathing planks, port side of sternpost, *Batavia* shipwreck, BAT 6433 A–BAT 6433 B. Illustration: Wendy van Duivenvoorde.

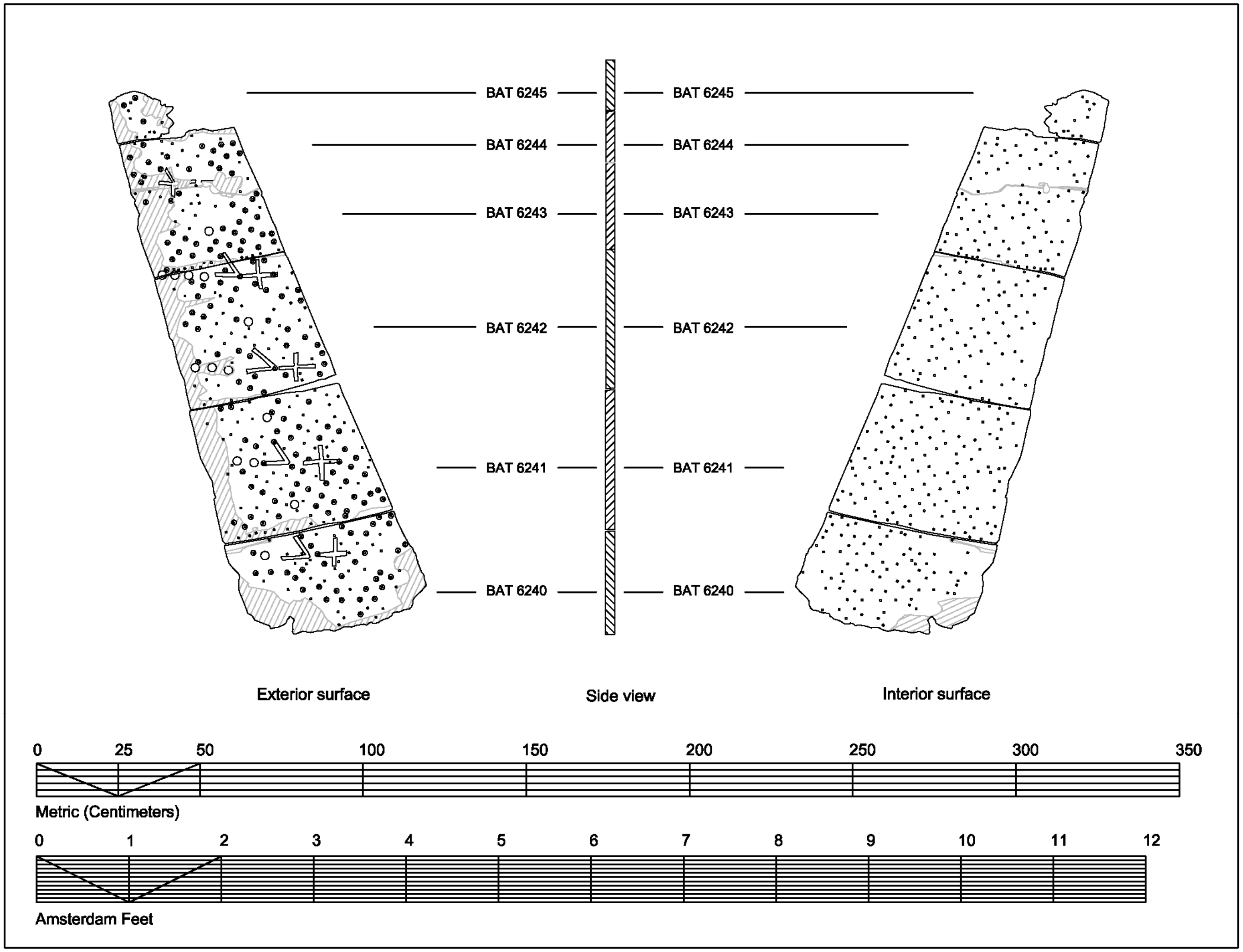


Fig. IV.68 Pine sheathing planks, starboard side of sternpost, *Batavia* shipwreck, BAT 6240–BAT 6245. Illustration: Wendy van Duivenvoorde.

m. The thicknesses of the planks measure from 0.045 m to 0.058 m, with an average thickness of 0.053 m.

The inner layer oak cover planking on the sternpost has shallow mortises cut out to receive the ship's gudgeons. The smaller fasteners of the lower gudgeon have left a rounded impression with an average diameter 0.022 m. The lower gudgeon mortises have not preserved well, although the starboard mortise measured 0.12 m in width, and the port mortise 0.114 m. The upper mortise measures 0.14 m in width on both starboard and port sides. The notches are 0.029 m deep.

Six planks of pine sheathing have been preserved that were nailed onto the cover planking on the starboard side and two on the portside (Figs. IV.67–IV.68). They vary in maximum length from 0.193 m to 0.566 m and in maximum width from 0.159 m to 0.619 m. The thicknesses of the planks measure from 0.027 m to 0.035 m, with an average thickness of 0.029 m. The two layers of planking that protect the sides of the sternpost do not have the same thickness, for the cover planking is slightly thicker than the sheathing.

The pine sheathing planking on the starboard side of the sternpost show Roman numerals representing draft marks numbered from XVI to XX (Fig. IV.68).[79] On the port side, numbers XVIIII to XXI have only partially survived (Fig. IV.67). The Roman number "I" is indicated by a single round dot, as are half values. The letters are maximum 0.120 m tall. On the starboard side, these marks read from right to left (mirrorwise), whereas on the port side they read from left to right. Roman number XIX is represented as XVIIII. The numbers are carved into the wood parallel to each other at distances varying from 0.28 m to 0.303 m, with an average of 0.2943 m. They are, therefore, not perfectly in concordance with the Amsterdam foot of 0.2831 m. Witsen mentions in his manuscript that numbers were applied on the sternpost so a ship's draught could be read.[80]

The pine sheathing planks were fastened to the inner cover planking with iron nails closely–set in a quincunx pattern. These nails had the same dimensions and spacing as those of the pine sheathing nailed to *Batavia*'s hull planking, discussed previously. A layer of tar and goat hair was applied to exterior and interior surfaces of the pine sheathing, in addition to a layer of copper sheathing in between the cover planking and pine sheathing (discussed below).

From the waterline markings on *Batavia*'s sternpost sheathing, it is possible to determine the position of the bottom of the keel. From these calculations, it is known that 4.1 m is missing from the sternpost below its preserved section (including the thickness of keel).

**Copper sheathing**

*Batavia*'s sternpost was partially coppered with thin copper sheets fastened to the oak cover layer with copper tacks. Only small parts of the copper sheathing survived together with the sternpost. The copper sheathing was, however, not recorded in detail underwater or directly after excavation. From observations made in the field and from recent study, it is known that the copper sheets were nailed over the inner layer of oak cover planking —underneath the pine sheathing— and copper strips over the hood ends of this cover planking. Toolmarks indicate that these strips of copper were hammered around the corners of the post's sides and aftermost face. It is possible that the entire aftermost surface of the sternpost was sheathed with copper, but no evidence has been found to support this. One large fragment of copper sheet was found between the oak cover planking and pine sheathing of the port side sternpost (Fig. IV.64, BAT 6433 E). Other bits of copper sheets that were raised from the seabed represent fragments of the strips that were folded over the cover planking's sides and after hood ends (Figs. IV.65, IV.69–IV.70).

The fragments of copper sheathing are poorly preserved and have an average thickness of 0.003 m. Their preserved length varies from 0.134 m to 0.746 m, and their width from 0.060 m to 0.423 m. Some still retain copper sheathing tacks, others only their holes. The tack holes are square and average 0.006 m in section.


Fig. IV.69 Fragments of copper sheathing and tacks from sternpost, *Batavia* shipwreck. Photograph: Patrick Baker, Western Australian Museum.

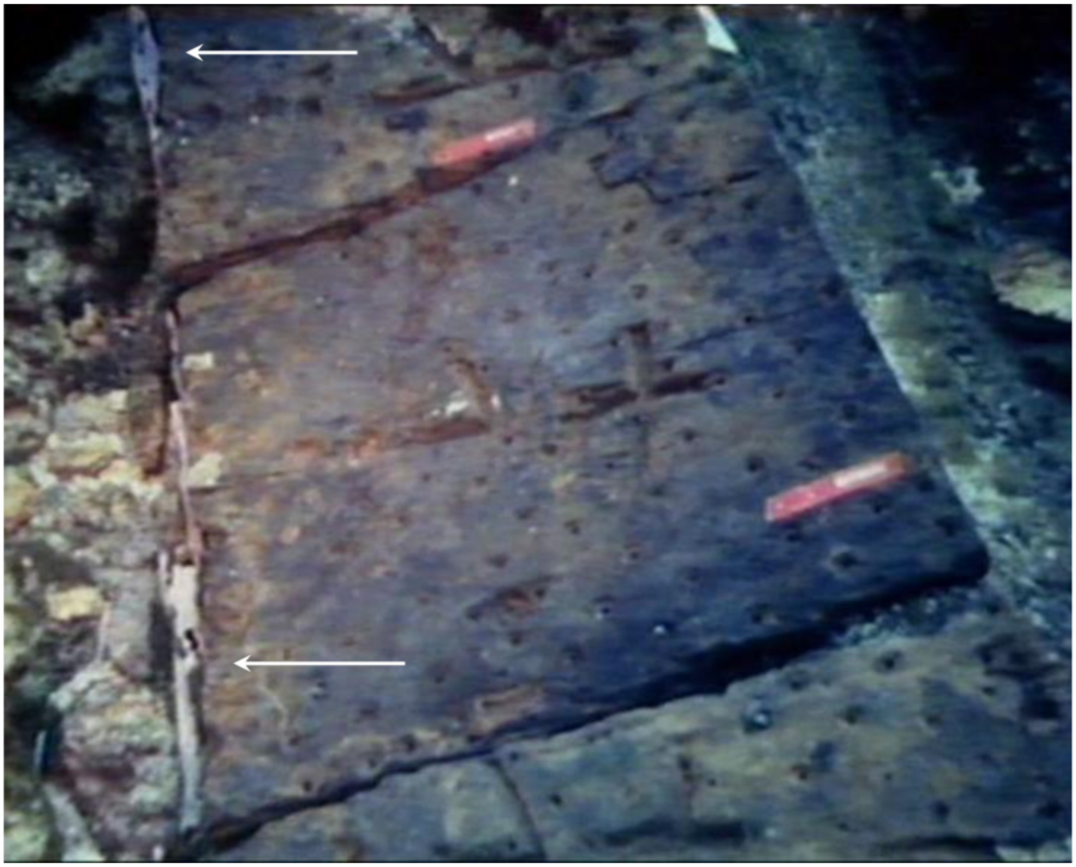

Fig. IV.70 Fragments of copper sheathing protruding along the edge (left) from underneath the starboard pine sheathing of the sternpost, *Batavia* shipwreck. Photograph: ABC Peach's Australia, *The Unlucky Voyage*, 1990.

The preserved copper tacks have irregular flat heads indicating that the soft metal was flattened and deformed when driven into the wood (Fig. IV.71). Their shanks are square in section (0.006 m) from below their heads to the tips, and taper in thickness to about 0.002 m. Their distal ends are pointed. The copper tacks have an average length of 0.031 m. Their heads vary in diameter from 0.011 m to 0.023 m, and their head thickness generally tapers from 0.003 m in the centers to 0.001 m at the edges.

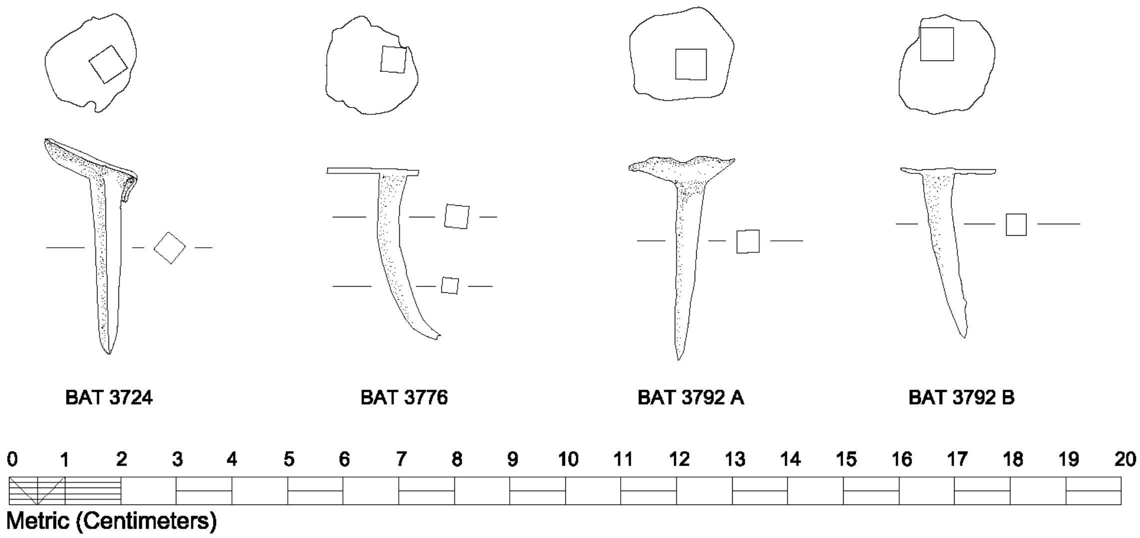


Fig. IV.71 Copper tacks for fastening copper sheets to the sternpost, *Batavia* shipwreck. Illustration: Wendy van Duivenvoorde.

A semi–quantitative chemical analysis of the material was conducted on six fragments of copper sheathing and four tacks in order to approximate their composition (Table IV.2). The copper purity in the fragments and tacks varies between 96.16% and 99.49%. The concentrations of natural trace elements found in the copper, such as arsenic, iron, lead, nickel, and zinc, were generally found to be less than 1%.

From 1613, the Dutch had gained control over the transport of Swedish copper. The raw material was shipped in large annual shipments from Sweden to Amsterdam, which had become Europe's staple market for Swedish copper.[81] Historic studies indicate that Sweden was, in fact, the principal supplier of copper used by the Dutch in general and the VOC in particular.[82] Therefore, samples from five fragments of copper sheets and six copper tacks were sent to the Laboratory for Isotope Geology, Swedish Museum of Natural History, for lead isotope analysis.[83] The samples were analyzed in four individual sessions by an Isoprobe ICP–MS, after which all data were normalized

Table IV.2 Results EDAX analysis of *Batavia* sternpost sheathing and tacks.

| | | Wt % | | | | | | | | | At % | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sample** | **From** | **SiK** | **SbL** | **SnL** | **FeK** | **NiK** | **CuK** | **AsK** | **PbL** | **Total** | **SiK** | **SbL** | **SnL** | **FeK** | **NiK** | **CuK** | **AsK** | **PbL** | **Total** |
| BAT 0582 | Sheathing | 0.82 | 0.31 | 0.14 | 0.24 | 0.19 | 97.35 | 0.00 | 0.94 | 100 | 1.86 | 0.16 | 0.08 | 0.28 | 0.20 | 97.13 | 0.00 | 0.29 | 100 |
| BAT 0582 | Sheathing | 0.71 | 0.00 | 0.00 | 0.19 | 0.16 | 98.28 | 0.00 | 0.66 | 100 | 1.61 | 0.00 | 0.00 | 0.21 | 0.17 | 97.81 | 0.00 | 0.20 | 100 |
| BAT 0582 | Sheathing | 0.52 | 0.12 | 0.10 | 0.28 | 0.07 | 98.40 | 0.00 | 0.51 | 100 | 1.17 | 0.06 | 0.05 | 0.31 | 0.08 | 98.17 | 0.00 | 0.16 | 100 |
| BAT 0582 | Sheathing | 0.46 | 0.12 | 0.09 | 0.15 | 0.06 | 98.58 | 0.00 | 0.54 | 100 | 1.04 | 0.06 | 0.05 | 0.18 | 0.07 | 98.44 | 0.00 | 0.16 | 100 |
| BAT 3149 | Sheathing | 0.09 | 0.00 | 0.00 | 0.06 | 0.40 | 99.33 | 0.00 | 0.12 | 100 | 0.19 | 0.00 | 0.00 | 0.07 | 0.43 | 99.27 | 0.00 | 0.04 | 100 |
| BAT 3149 | Sheathing | 0.08 | 0.00 | 0.00 | 0.08 | 0.42 | 99.33 | 0.09 | 0.00 | 100 | 0.19 | 0.00 | 0.00 | 0.09 | 0.45 | 99.20 | 0.07 | 0.00 | 100 |
| BAT 3149 | Sheathing | 0.08 | 0.00 | 0.00 | 0.08 | 0.32 | 99.47 | 0.05 | 0.00 | 100 | 0.17 | 0.00 | 0.00 | 0.09 | 0.34 | 99.36 | 0.04 | 0.00 | 100 |
| BAT 3438 | Sheathing | 0.26 | 0.00 | 0.00 | 0.12 | 0.14 | 97.45 | 0.13 | 1.90 | 100 | 0.59 | 0.00 | 0.00 | 0.13 | 0.15 | 98.43 | 0.11 | 0.58 | 100 |
| BAT 3438 | Sheathing | 0.15 | 0.00 | 0.00 | 0.10 | 0.10 | 96.16 | 0.38 | 3.11 | 100 | 0.34 | 0.00 | 0.00 | 0.11 | 0.11 | 98.12 | 0.33 | 0.97 | 100 |
| BAT 3649 | Sheathing | 0.06 | 0.00 | 0.00 | 0.11 | 0.22 | 99.49 | 0.00 | 0.12 | 100 | 0.13 | 0.00 | 0.00 | 0.13 | 0.24 | 99.46 | 0.00 | 0.04 | 100 |
| BAT 3724 | Tack | 0.10 | 0.11 | 0.00 | 0.10 | 0.35 | 99.25 | 0.09 | 0.00 | 100 | 0.22 | 0.06 | 0.00 | 0.12 | 0.38 | 99.14 | 0.08 | 0.00 | 100 |
| BAT 3724 | Tack | 0.04 | 0.02 | 0.00 | 0.08 | 0.40 | 99.37 | 0.00 | 0.09 | 100 | 0.09 | 0.01 | 0.00 | 0.09 | 0.44 | 99.34 | 0.00 | 0.03 | 100 |
| BAT 3724 | Tack | 0.32 | 0.65 | 0.12 | 0.12 | 0.30 | 98.07 | 0.00 | 0.42 | 100 | 0.72 | 0.34 | 0.06 | 0.14 | 0.32 | 98.29 | 0.00 | 0.13 | 100 |
| BAT 3724 | Tack | 0.47 | 0.56 | 0.16 | 0.15 | 0.21 | 97.78 | 0.00 | 0.67 | 100 | 1.07 | 0.29 | 0.09 | 0.17 | 0.23 | 97.94 | 0.00 | 0.21 | 100 |
| BAT 3754 | Sheathing | 0.20 | 0.30 | 0.00 | 1.17 | 0.34 | 96.66 | 0.00 | 1.32 | 100 | 0.46 | 0.16 | 0.00 | 1.34 | 0.38 | 97.25 | 0.00 | 0.41 | 100 |
| BAT 3754 | Sheathing | 0.04 | 0.07 | 0.03 | 0.58 | 0.26 | 98.26 | 0.00 | 0.76 | 100 | 0.09 | 0.04 | 0.02 | 0.67 | 0.28 | 98.66 | 0.00 | 0.23 | 100 |
| BAT 3754 | Sheathing | 0.23 | 0.25 | 0.08 | 1.18 | 0.16 | 96.91 | 0.00 | 1.18 | 100 | 0.53 | 0.13 | 0.04 | 1.36 | 0.17 | 97.40 | 0.00 | 0.37 | 100 |

Table IV.2 Continued.

| | | Wt % | | | | | | | | | At % | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sample** | **From** | **SiK** | **SbL** | **SnL** | **FeK** | **NiK** | **CuK** | **AsK** | **PbL** | **Total** | **SiK** | **SbL** | **SnL** | **FeK** | **NiK** | **CuK** | **AsK** | **PbL** | **Total** |
| BAT 3776 | Tack | 0.53 | 0.47 | 0.08 | 0.13 | 0.26 | 98.14 | 0.00 | 0.39 | 100 | 1.20 | 0.24 | 0.04 | 0.15 | 0.28 | 97.97 | 0.00 | 0.12 | 100 |
| BAT 3776 | Tack | 0.48 | 0.44 | 0.12 | 0.12 | 0.17 | 98.26 | 0.00 | 0.41 | 100 | 1.09 | 0.23 | 0.06 | 0.14 | 0.19 | 98.17 | 0.00 | 0.12 | 100 |
| | | | | | | | | | | | | | | | | | | | |
| BAT 3792 A | Tack | 0.40 | 0.67 | 0.13 | 0.14 | 0.22 | 97.66 | 0.06 | 0.72 | 100 | 0.90 | 0.35 | 0.07 | 0.16 | 0.24 | 98.01 | 0.05 | 0.22 | 100 |
| BAT 3792 A | Tack | 0.39 | 0.25 | 0.12 | 0.08 | 0.13 | 98.65 | 0.00 | 0.38 | 100 | 0.88 | 0.13 | 0.07 | 0.09 | 0.14 | 98.57 | 0.00 | 0.12 | 100 |
| BAT 3792 A | Tack | 0.27 | 0.82 | 0.15 | 0.10 | 0.17 | 96.79 | 0.06 | 1.63 | 100 | 0.62 | 0.43 | 0.08 | 0.12 | 0.19 | 97.99 | 0.05 | 0.51 | 100 |
| | | | | | | | | | | | | | | | | | | | |
| BAT 3792 B | Tack | 0.21 | 0.40 | 0.11 | 0.11 | 0.26 | 98.63 | 0.00 | 0.28 | 100 | 0.48 | 0.21 | 0.06 | 0.13 | 0.28 | 98.75 | 0.00 | 0.09 | 100 |
| BAT 3792 B | Tack | 0.08 | 0.17 | 0.00 | 0.11 | 0.31 | 99.14 | 0.09 | 0.10 | 100 | 0.18 | 0.09 | 0.00 | 0.12 | 0.34 | 99.16 | 0.08 | 0.03 | 100 |
| BAT 3792 B | Tack | 0.50 | 0.49 | 0.10 | 0.11 | 0.14 | 98.44 | 0.06 | 0.16 | 100 | 1.13 | 0.25 | 0.05 | 0.12 | 0.15 | 98.19 | 0.05 | 0.05 | 100 |
| BAT 3792 B | Tack | 0.38 | 0.33 | 0.13 | 0.11 | 0.21 | 98.63 | 0.21 | 0.00 | 100 | 0.86 | 0.17 | 0.07 | 0.13 | 0.22 | 98.37 | 0.18 | 0.00 | 100 |
| | | | | | | | | | | | | | | | | | | | |
| BAT 3827 | Sheathing | 0.58 | 0.22 | 0.12 | 0.19 | 0.33 | 97.27 | 0.12 | 1.17 | 100 | 1.31 | 0.12 | 0.07 | 0.22 | 0.36 | 97.46 | 0.10 | 0.36 | 100 |
| BAT 3827 | Sheathing | 0.36 | 0.12 | 0.07 | 0.14 | 0.35 | 97.69 | 0.06 | 1.21 | 100 | 0.82 | 0.06 | 0.04 | 0.16 | 0.38 | 98.12 | 0.05 | 0.37 | 100 |

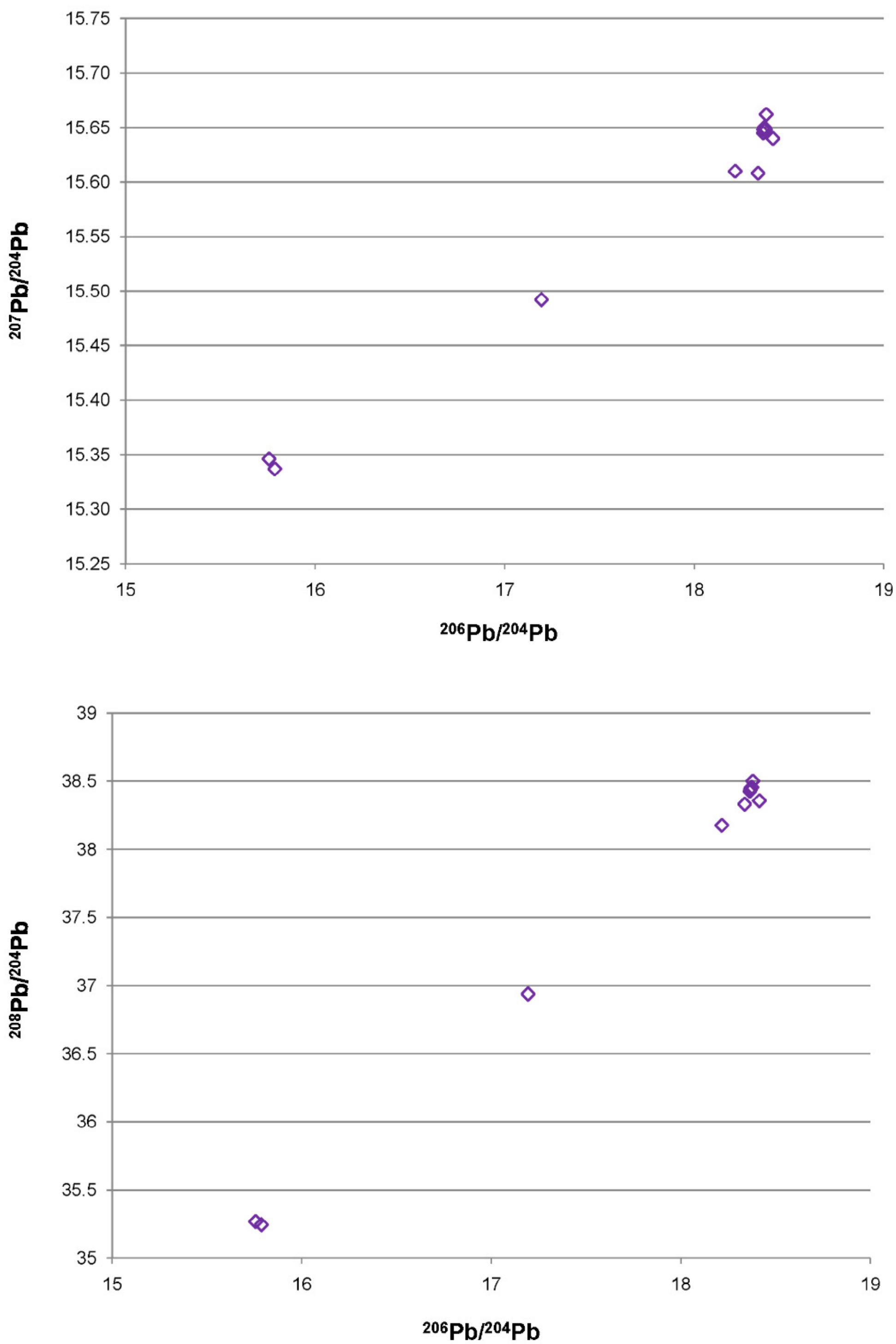


Fig. IV.72 Charts plotting lead isotope values of copper tacks and sheathing, *Batavia* shipwreck. Illustration: Kjell Billström.

to the standard reference value for NBS981.[84] Comparison of the *Batavia* data with the ores of Swedish mining areas reveals that only two samples of sheathing, BAT 3827 and BAT 3438, yield a typical Swedish Bergslagen lead isotope signature. The lead–isotope signatures of eight *Batavia* samples form a cluster in Figure IV.72, which is distinctly different from the lead isotope ratios that characterize the mines in central Sweden. The lead of these samples is isotopically "more evolved" as it has higher $^{206}Pb/^{204}Pb$, $^{207}Pb/^{204}Pb$, and $^{208}Pb/^{204}Pb$ ratios than lead from Bergslagen (Table IV.3).

Table IV.3 Lead isotope data of copper tacks and sheathing from *Batavia*'s sternpost.

| **Catalog Nr.** | **Description** | **$^{206}Pb/^{204}Pb$** | **$^{207}Pb/^{204}Pb$** | **$^{208}Pb/^{204}Pb$** |
|---|---|---|---|---|
| BAT 0582 | Sheathing | 18.216 | 15.610 | 38.175 |
| BAT 3149 | Sheathing | 17.194 | 15.492 | 36.937 |
| BAT 3232 | Sheathing | 18.380 | 15.662 | 38.501 |
| BAT 3438 | Sheathing | 15.787 | 15.337 | 35.244 |
| BAT 3484 | Tack | 18.364 | 15.645 | 38.425 |
| BAT 3724 | Tack | 18.375 | 15.648 | 38.455 |
| BAT 3776 | Tack | 18.367 | 15.648 | 38.439 |
| BAT 3792 A | Tack | 18.415 | 15.640 | 38.357 |
| BAT 3792 B | Tack | 18.370 | 15.650 | 38.450 |
| BAT 3827 | Sheathing | 15.757 | 15.346 | 35.267 |
| BAT 3831 | Tack | 18.337 | 15.608 | 38.332 |
| Bergslagen | Copper Mines | 15.7 | 15.3 | 35.4 |

Analyses by Kjell Billström, Laboratory for Isotope Geology, Swedish Museum of Natural History. The analytical uncertainty for all of these results is 0.1 % (error 2s).

The latter, which displays a very homogeneous isotopic composition, was formed in the early Proterozoic, at around 1890 Ma (million years) ago.[85] Ores utilized for most of *Batavia*'s copper fasteners must have formed at a much more recent time, given their evolved isotopic signatures and their formation during the Phanerozoic, roughly from present to 545 million years ago, is suggested.[86] Many world–wide ore beds are characterized by Phanerozoic ores, including areas in eastern Asia and around the Mediterranean Sea. The isotopic signatures of the evolved *Batavia* samples straddle those of Japanese ore fields, and to a lesser extent Iberian ore leads (Fig. IV.72).[87] Both regions are well–known for their copper mining industries since antiquity.[88] Interestingly, the VOC gained a monopoly over trade with Japan in 1640 and started trafficking Japanese copper in 1646, mainly for the Southeast Asian market.[89]

One intermediate signature occurred (BAT 3149) which could hypothetically constitute a mixture of two lead components, involving, for example, a Japanese and a Bergslagen ore, or may, alternatively, come from a third, unidentified, mining area.[90] As the lead isotope composition of the BAT 3149 sample plots on binary mixing trends (end–compositions defined by Bergslagen and Japanese leads) in both the $^{206}Pb/^{204}Pb$ versus $^{207}Pb/^{204}Pb$ and $^{206}Pb/^{204}Pb$ versus $^{208}Pb/^{204}Pb$ diagrams, it is suggested that this lead represents a mixture of lead from two ore districts.

It must be noted that when it comes to the comparison of the *Batavia* lead isotope data with other mining areas, no extensive research has been conducted, as the primary objective was to check its consistency with Swedish ores. Although general features of the data and copper mining areas have been compared, some specific source areas cannot be completely ruled out, nor can they be claimed to be 100% consistent with the *Batavia* data.

A noteworthy feature is that the copper tacks define a rather narrow range of lead isotopic compositions, whereas the copper sheets reflect a larger isotopic heterogeneity. Although the analyzed samples are few in number, they suggest that the sheets were prepared independently from the tacks, as different metal sources were involved.

The copper ores used to manufacture *Batavia*'s tacks and sheets appear to originate from at least two different regions, one of these is most likely the Bergslagen ore district in central Sweden.[91] The lead isotope analyses of *Batavia*'s copper sheathing and tacks demonstrate, however, that it was certainly not the only source, and both Japan and the Iberian copper ores should be taken into consideration. The first would, however, be an early occurrence as a trading relationship between the VOC and Japan was not officially established until 1640. Spain was one of the markets to which the Dutch sold Swedish copper.[92]

**Transom assembly**

*Batavia*'s port transom timbers and their assembly are similar to those of a galleon.[93] The preserved timbers include a fashion piece, an upper fashion piece, the wing transom, and five transom beams (including a deck transom and four transom beams, Fig. IV.73). One gunport has been found between the wing transom and the transom beam below it (Fig. IV.73). All measurements listed for the transom timbers are approximate as they are taken from the field drawings. The actual timbers currently on display are largely inaccessible. The large size also posed a problem during the shipwreck's excavation as they are poorly recorded. Tracings of these timbers are incomplete, and the photography set up on Beacon Island used to record most of the timbers was not suitable for large structural elements.

**Fashion piece**

On each side of the stern, the corner of the transom and side of the hull was reinforced by a fashion piece and transom knees, five of which were preserved. The fashion piece, BAT 6444, is the single largest timber raised intact from the seabed, measuring about 4.6 m in length, 0.60 m sided, and 0.32 m molded (Fig. IV.74). The after surface of the fashion piece has a maximum preserved sided dimension of 0.469 m as it was chamfered to accommodate the angle between *Batavia*'s transom and port side. The fashion piece terminates at the top of the wing transom.

The fashion piece has a flat scarf on top of its after face to receive the wing transom and four large dovetails, spaced at set intervals, along its length on its forward face. These dovetails receive the ends, each vertically flat scarfed, of four transom beams, BAT 6358, BAT 6361, BAT 6364, and BAT 6365. The flat scarf at the fashion

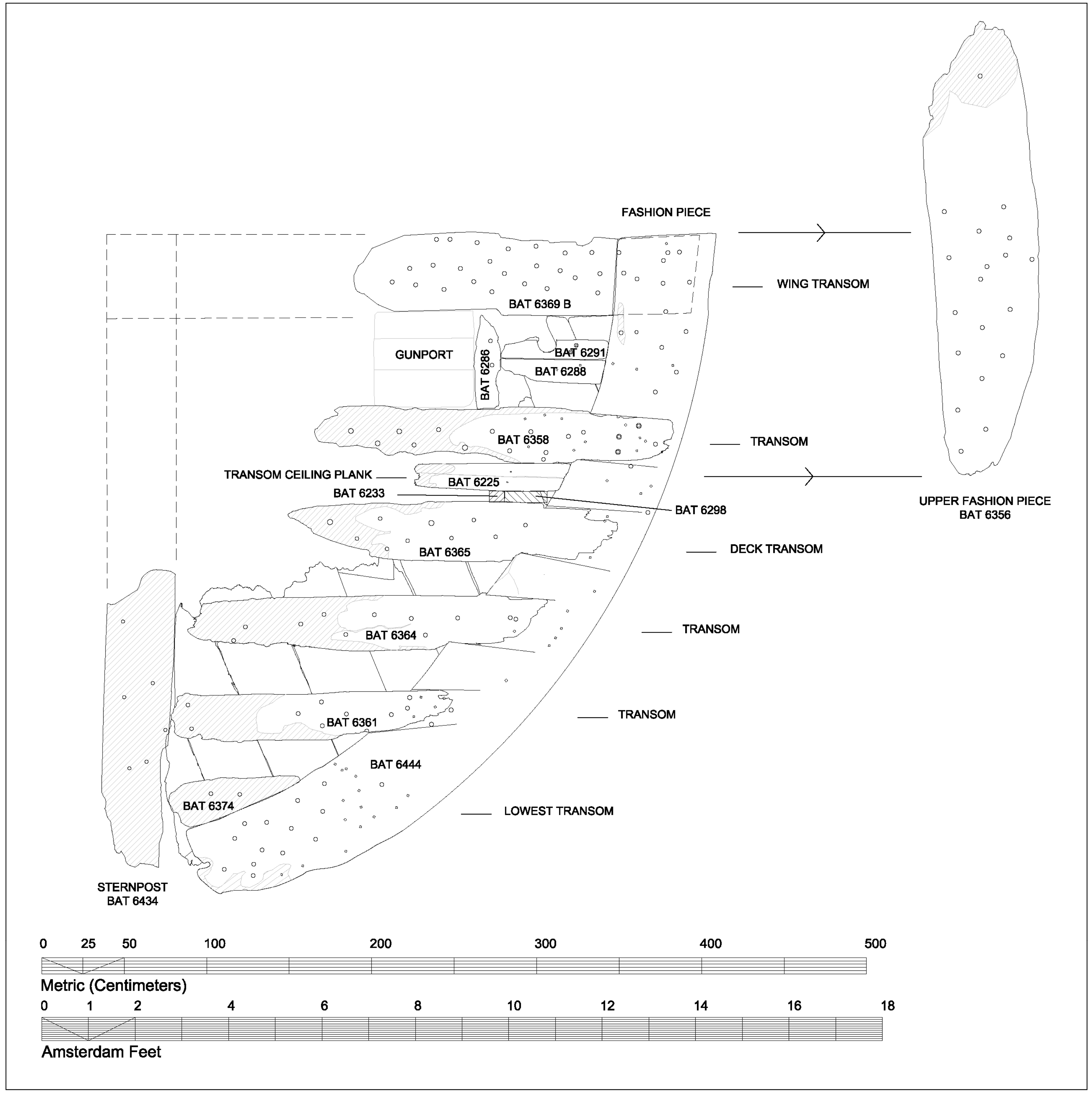


Fig. IV.73 Transom timbers, looking aft, *Batavia* shipwreck. Illustration: Wendy van Duivenvoorde.

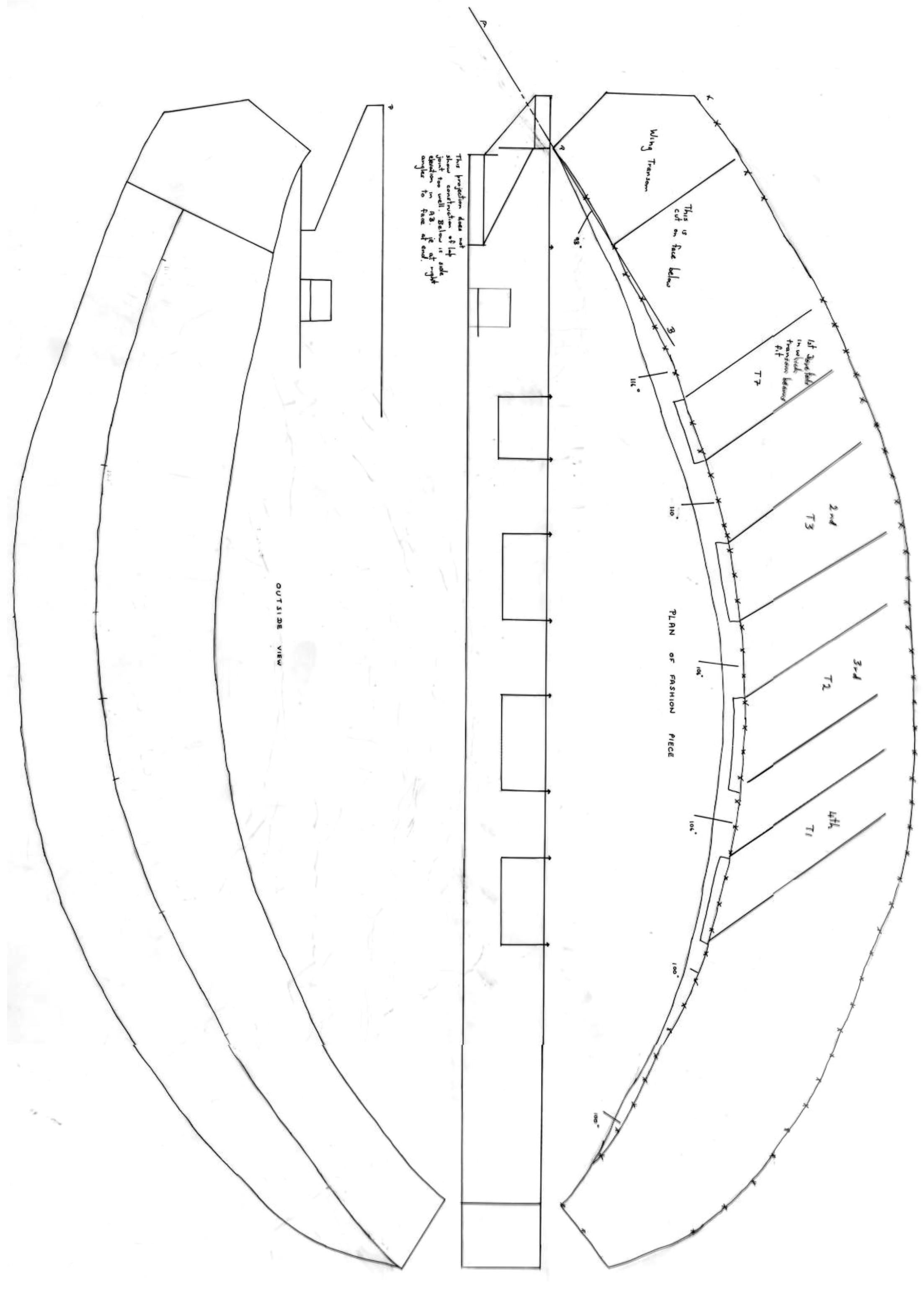


Fig. IV.74 Sketch of fashion piece, BAT 6444, *Batavia* shipwreck. Illustration: Jeremy Green.

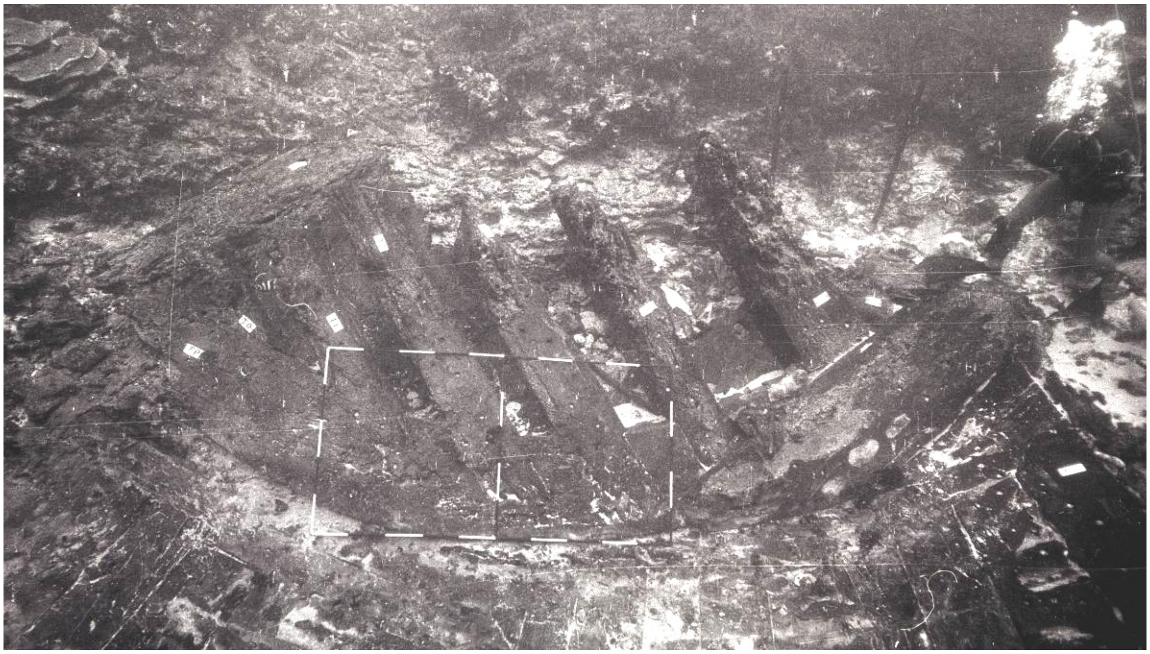

Fig. IV.75 Transom timber assembly *in situ*, *Batavia* shipwreck. Photograph: Patrick Baker, Western Australian Museum (MA0410–28).

piece's top end is nibbed for 0.036 m and then measures 0.494 m in length and spans the entire molded dimension of the fashion piece.

The transom beams were slotted into the dovetail joints on the forward face of the fashion piece; the notches vary between 0.28 m and 0.38 m in width, and from 0.129 m and 0.194 m in depth where they receive the transom beams. The dovetails become shallower over the fashion piece's forward face until they disappear towards the exterior edge. The transom beams and wing transom were secured to the fashion piece by iron bolts. The upper fashion piece was bolted on its top forward end where it sits flush over the highest transom beam, BAT 6358 (Fig. IV.73).

**Upper fashion piece**

The upper fashion piece was only partially preserved over a length of about 2.80 m (Figs. IV.73–IV.75). It measures roughly 0.68 m sided and 0.24 m molded. It was bolted onto the fashion piece with at least 18 iron bolts.

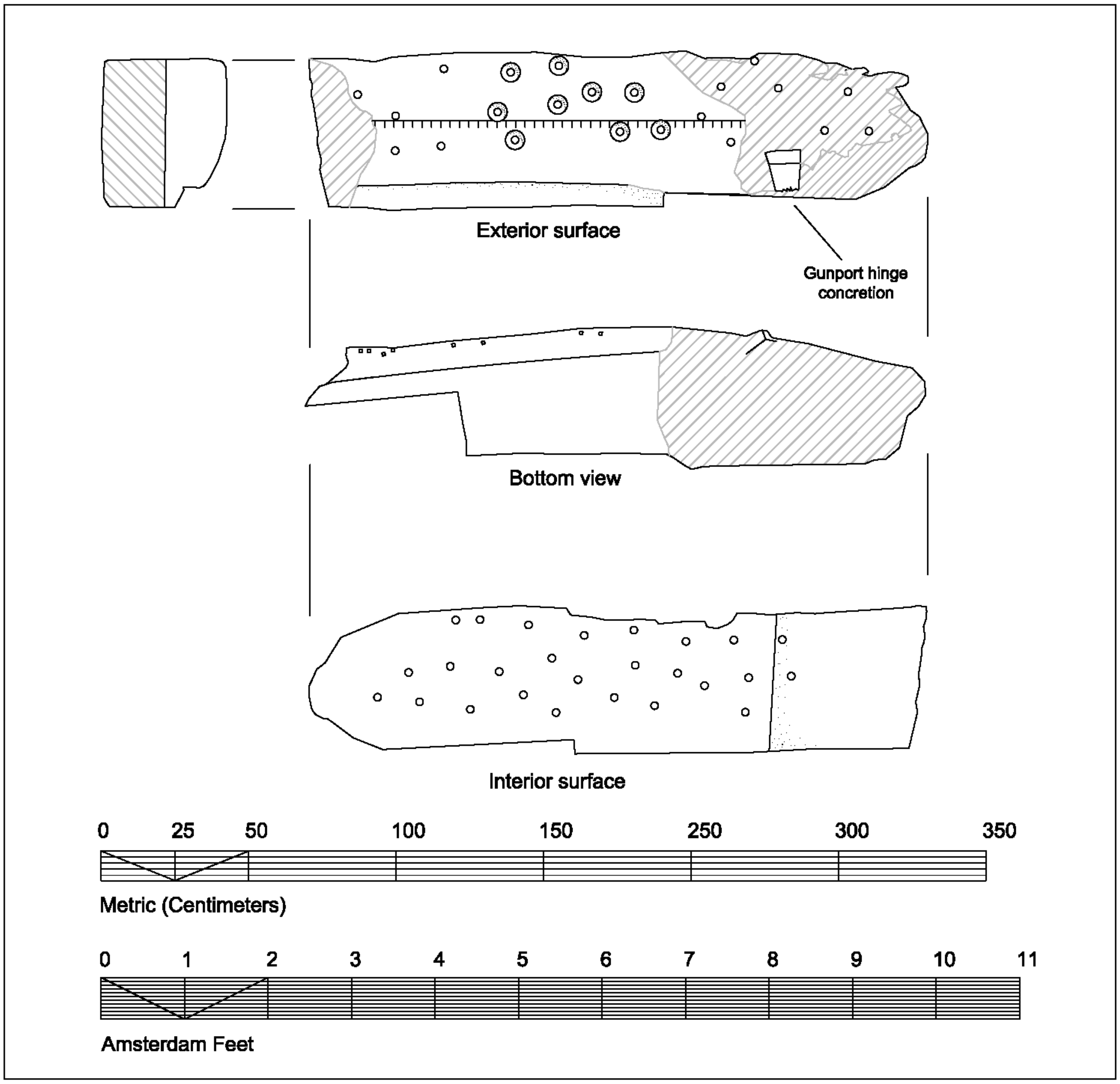


Fig. IV.76 Schematic drawing of wing transom, *Batavia* shipwreck, BAT 6369 B. Illustration: Wendy van Duivenvoorde.

## Wing transom and gunport

The upper ends of *Batavia*'s diagonal transom planking terminated at a wing transom (Fig. IV.76). The partially–preserved port side of this piece was found on the seabed with a concreted hinge fitting for a gunport. Wing transom BAT 6369 B is only preserved on the transom's exterior face where its scarfs over the aftermost face of the fashion piece. Its preserved dimensions are approximately 2.10 m in length, 0.50 m sided, and 0.43 m molded. The scarf end is nibbed 0.04 m and measures 0.51 m in length. At the aftermost lower end a rabbet was cut to receive one layer of transom planking (0.10 m in width) (Fig. IV.77).

Fig. IV.77 Chamfered after surface of wing transom with rabbet to receive transom planking (timber is lying upside down), *Batavia* shipwreck, BAT 6369. Photograph: Patrick Baker, Western Australian Museum (MA0414–15).

The forward face of the wing transom has a flat surface, whereas the aftermost face is chamfered towards the rabbet. The aftermost face of the wing transom and its rabbet are also curved over their lengths to follow the curvature of the transom planking.

The concretion of a gunport hinge and a notch for the port have been preserved, though poorly, on the lower face of the wing transom. The notch measures about 0.615 m in width; it delineates the width of the transom gunport. The distance between the lower face of the wing transom and the upper face of the transom beam below is 0.586 m (exactly 2 Amsterdam feet). The transom gunport, therefore, had the same width and height as the gunport preserved on the port side of the hull. The gunport is centered between the transom edge and the port side edge of the sternpost. On the interior face of transom assembly, two small horizontal beams have been preserved that reinforce the gunport and the hawse hole next to it (Fig. IV.73, BAT 6288 and BAT 6291). The hinge concretion contains remnants of the iron strap of the hinge mechanism, which is preserved over a length of 0.150 m and varied in width from 0.058 to 0.098 (BAT 80041). The strap was about 0.026 m in thickness. The hinge mechanism itself did not survive.

The transom gunport is probably associated with iron cannon BAT 8721, which was found lying on top of it. This cannon measures 2.78 m in length and had a bore diameter of 0.125 m. On the starboard side, one additional iron cannon was found which is probably its starboard side counterpart, BAT 8720.[94] Both cannon have the same length and shape.

**Transom beams**

*Batavia*'s transom was reinforced by five transom beams below the wing transom, all of which were placed parallel to one another at intervals of roughly 0.25 m (nearly one Amsterdam foot). Only the three lowest transom beams BAT 6374, BAT 6261, and BAT 6262 have been preserved from the transom's exterior edge to the sternpost. Bolt holes at the forward end of the sternpost suggest that these transom beams were notched on their after faces to fit over the sternpost (Fig. IV.73).

The lowest transom, BAT 6374, was not seated in the fashion piece but was fastened on top of its lower end, and is thus wedged between the fashion piece and sternpost. It is preserved 0.796 m in length, 0.0269 sided, and 0.269 molded.

As described above, the four transom beams between the lower transom and wing transom were dovetailed into the fashion piece (Fig. IV.78). They are preserved over

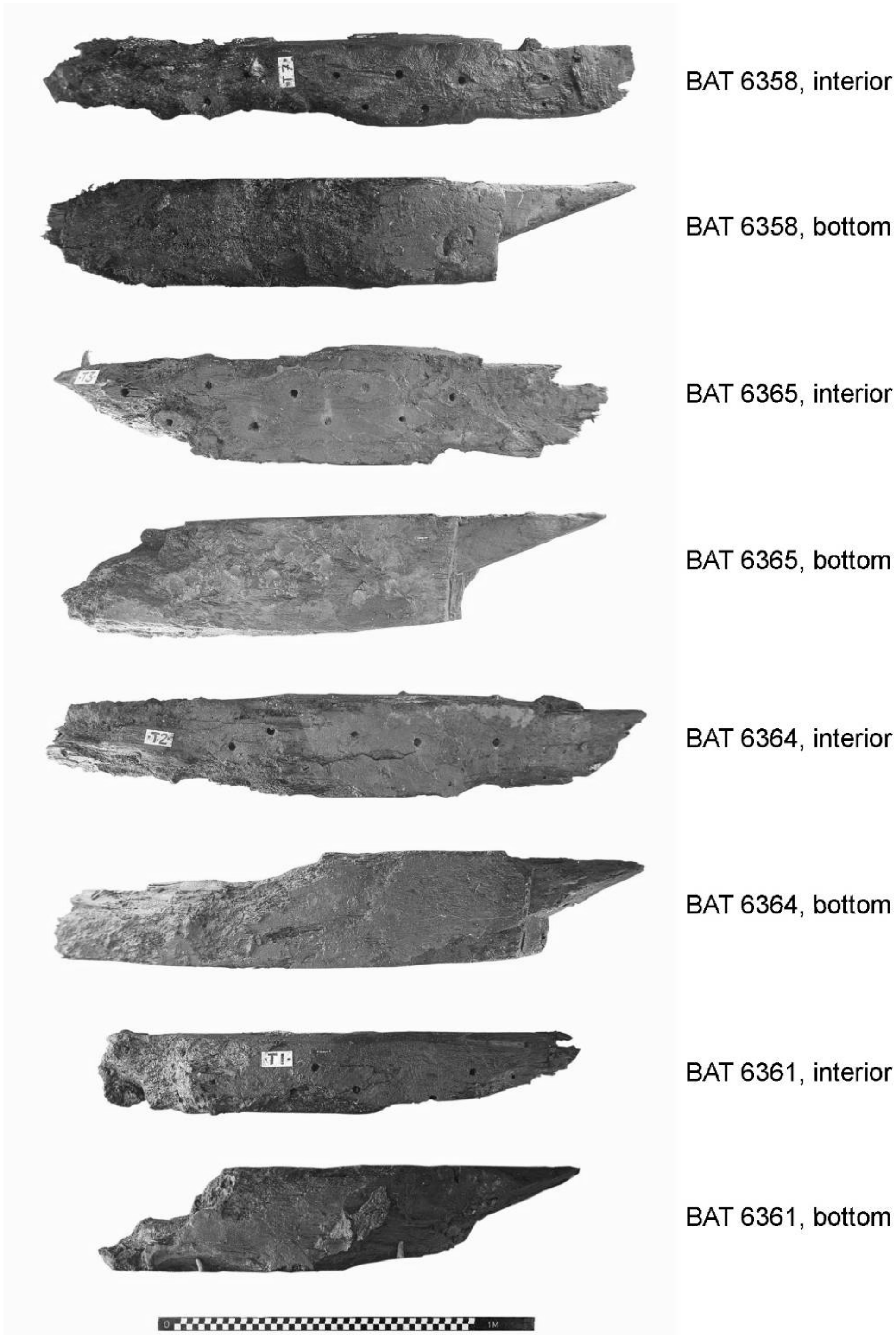


Fig. IV.78 Transom beams, *Batavia* shipwreck, BAT 6361, BAT 6364, BAT 6365, BAT 6358. Photographs: Patrick Baker, Western Australian Museum (MA0415–35, MA0415–36, MA0416–05, MA0416–06, MA0416–067, MA0416–12, MA0416–13, MA0415–31, MA0415–34).

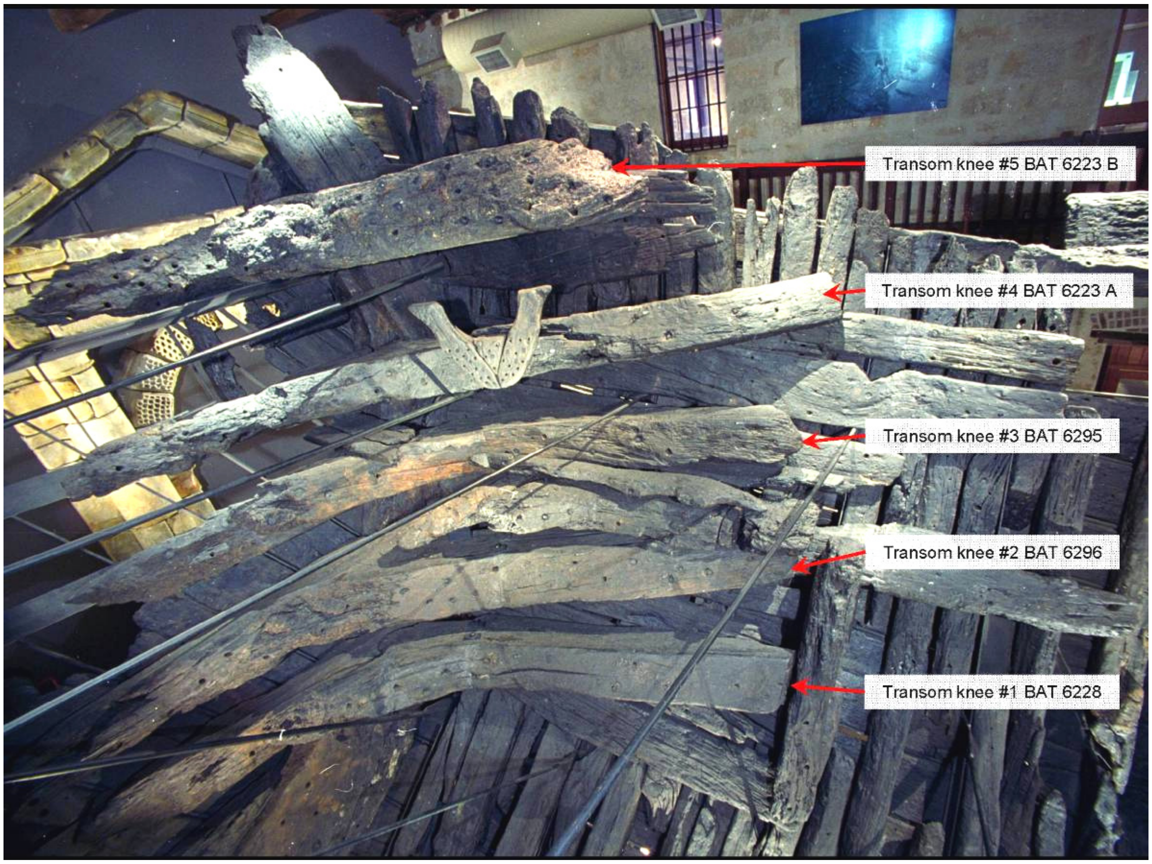


Fig. IV.79 Five transom knees as displayed, *Batavia* shipwreck, BAT 6228, BAT 6296, BAT 6295, BAT 6223 A, and BAT 6223 B. Photograph: Patrick Baker, Western Australian Museum (MA5049–30).

lengths varying from 1.71 m to 2.19 m, measure between 0.32 m and 0.41 m sided, and 0.36 m and 0.41 m molded. The second transom beam below the wing transom, BAT 6365, comprises the deck transom beam (Fig. IV.73).

**Transom knees**

Five large lodging knees, called transom knees, reinforce *Batavia*'s transom assembly. The uppermost knee was fastened to the wing transom, and the four below it to the transom beams (Fig. IV.79). They are placed on top of the ceiling planking on the side of the ship's hull, which means they were installed after the frames and ceiling planks were inserted. Only the lowest transom was not reinforced with a knee. The transom knees were fastened to the transom beams and to the ship's side timbers with large iron bolts. None of the transom knees has been preserved in its entirety, and all are worm–eaten on either end.

The measurements for the length of the transom knees were aligned between the tips of their ends, which, unlike all other timbers, are not linear (Fig. IV.80). Furthermore, their thickness is measured from their exterior corner, where the two arms intersect, to their inner corner. They vary in preserved length from 2.65 m to 3.60 m, from 0.35 m to 0.36 m in width, and from 0.31 m to 0.62 m in thickness.

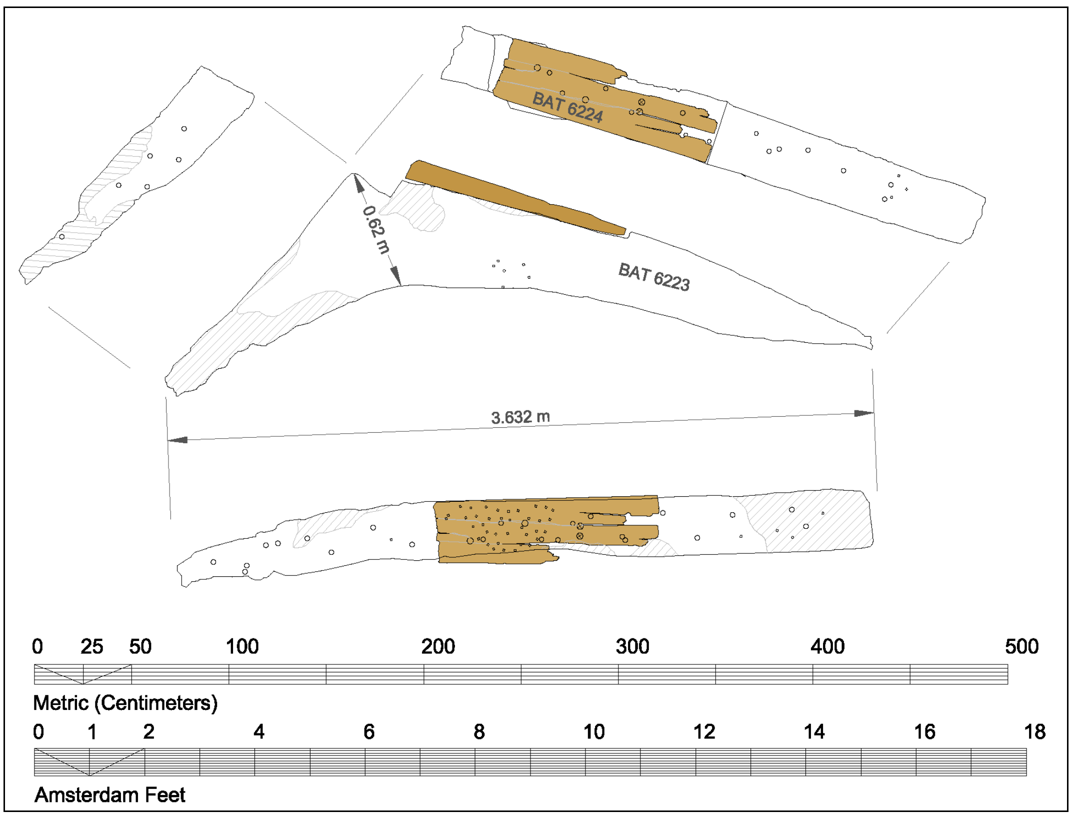


Fig. IV.80 Transom knee #4 and its wedge (highlighted in brown), *Batavia* shipwreck, BAT 6223 A and BAT 6224. Illustration: Wendy van Duivenvoorde.

Fig. IV.81 View of top surface of uppermost preserved transom knee and its wedge, *Batavia* shipwreck, BAT 6223 B. Not to scale. Photograph: Brian Richards, Western Australian Museum (MA3294–01).

The transom knees were notched at the exterior intersection of their arms to fit over the fashion piece and upper fashion piece. Additionally, the shipwrights adjusted the shape of the uppermost transom knees, as the exterior arm faces of both knees did not follow the curvature of the ship's hull and, therefore, large wedges were inserted between the knee ends and ceiling planking to ensure a tight fit (Figs. IV.80–IV.81).

**Kevel**

One kevel or belaying cleat has been preserved attached to uppermost transom knee on the after lower deck directly below the wing transom, where it was fastened to the interior corner of transom knee BAT 6223 A with iron spikes (Fig. III.29, IV.79, and IV.82). The kevel, BAT 6220, is made up of three oak sections, and the entire assembly measures 0.86 m in length, 0.55 m in width, and 0.088 m in thickness. It was mainly used to belay the stern mooring line or tow line for *Batavia*'s boat.

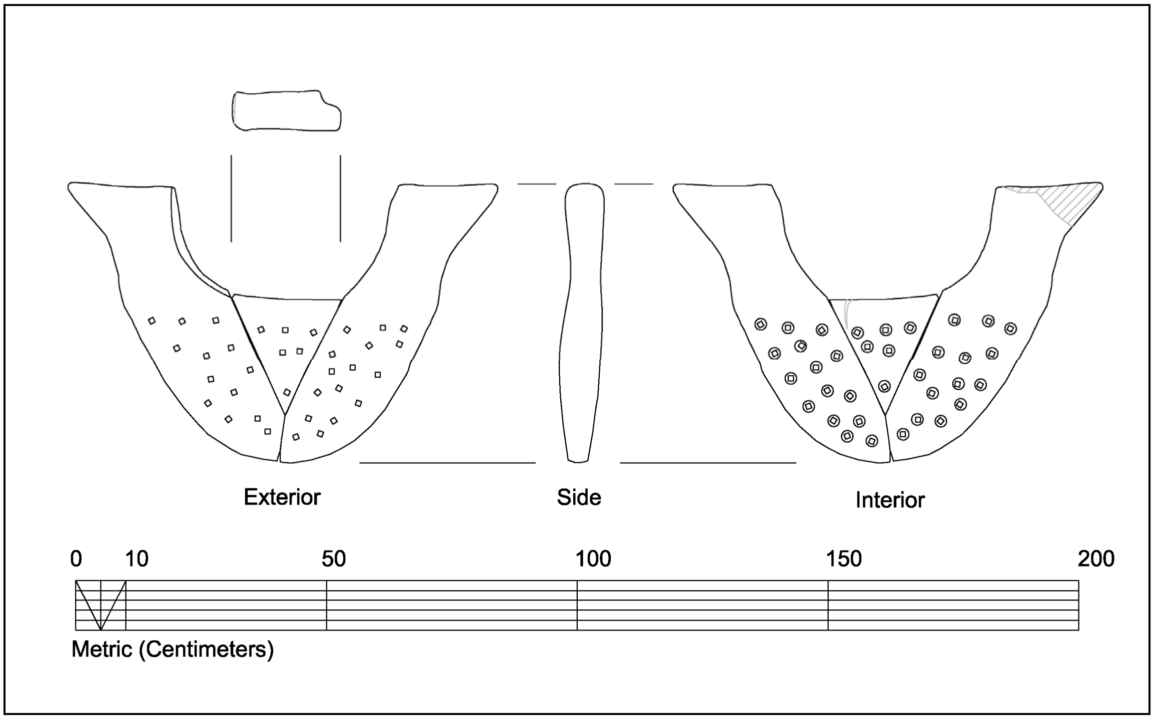


Fig. IV.82 Kevel or belaying cleat at aftermost end of lower deck. *Batavia* shipwreck, BAT 6220. Illustration: Wendy van Duivenvoorde.

**Deck beams, knees, and planking**

Only fragmentary timbers from *Batavia*'s lower deck and one remnant of a hanging knee from the upper deck have survived. The timbers of the lower deck include one fragment of a hanging knee, a lodging knee, waterway, possibly a margin plank, and two fragmentary deck beams (Fig. IV.83).

The hanging knee, BAT 6227, is poorly preserved and is missing its upper horizontal arm (Fig. IV.24). It measures 1.52 m in length, 0.24 m sided, and 0.30 m molded. Directly above and forward of BAT 6227, the lower vertical arm of a hanging knee from *Batavia*'s upper deck was found (BAT 6130, not on display). It measures 1.965 m in length, 0.276 m sided, and 0.305 m molded. The lower end of the upper hanging knee slightly overlaps with the horizontal arm of the lower hanging knee (Fig. IV.24). Aft of the lower hanging knee, BAT 6227, the remaining stump of the foremost deck beam, BAT 6230, protrudes from the shelf clamp. This deck beam was notched at its lower end and slotted into the shelf clamp, like the aftermost preserved remnant of a deck beam BAT 6324. Between the two deck beams, one lodging deck knee, BAT 6229, has been preserved. The knee measures 1.49 m in length, 0.49 m sided, and 0.28 m molded (Fig. IV.84). The timber was beveled on the exterior and aftermost edge of its top surface, probably to receive the waterway along the ship's side and transom. The knee was bolted to the ship's side, and its ends were fastened longitudinally to the deck beams (Fig. IV.84). The forward end of this lodging knee rests on the forward arm of the transom knee below, BAT 6296, whereas the after end of the transom knee above, BAT 6295, rested its aftermost face on the after deck beam.

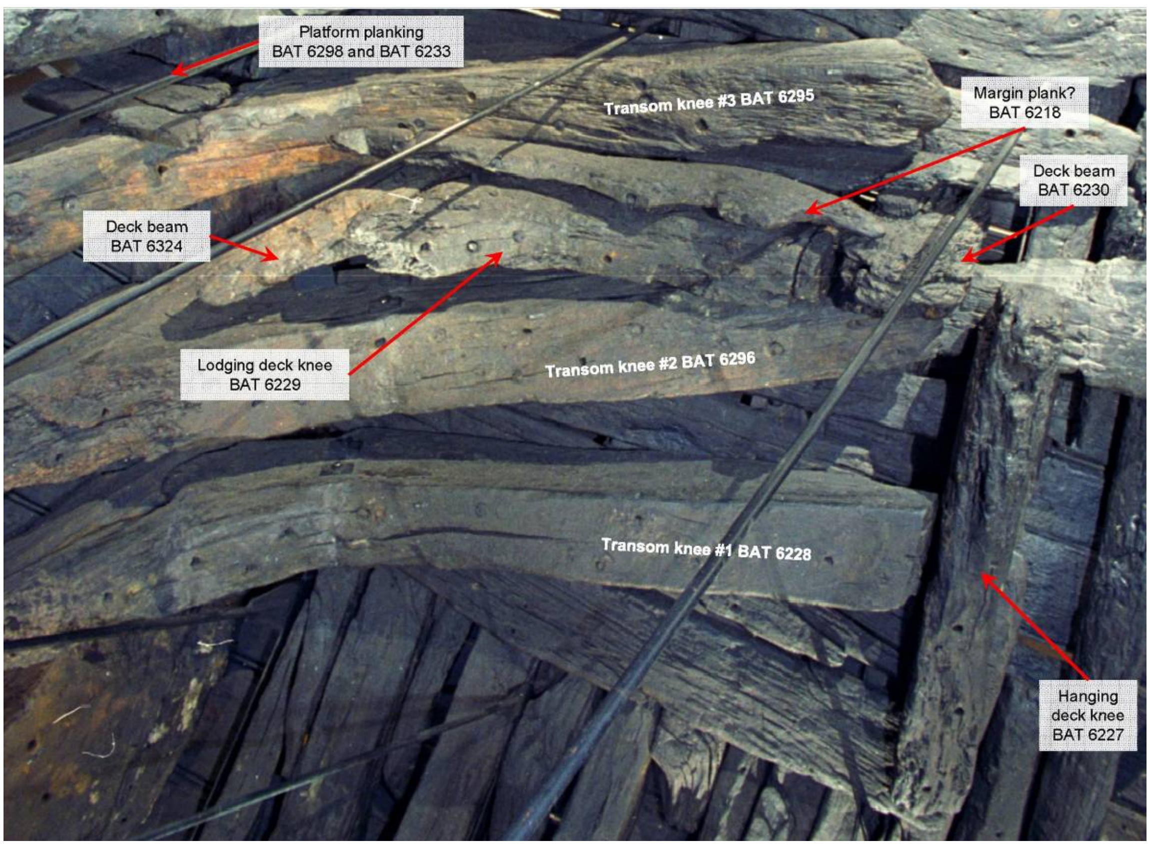


Fig. IV.83 Deck timbers as displayed. *Batavia* shipwreck. Photograph: Patrick Baker, Western Australian Museum (MA5049–30).

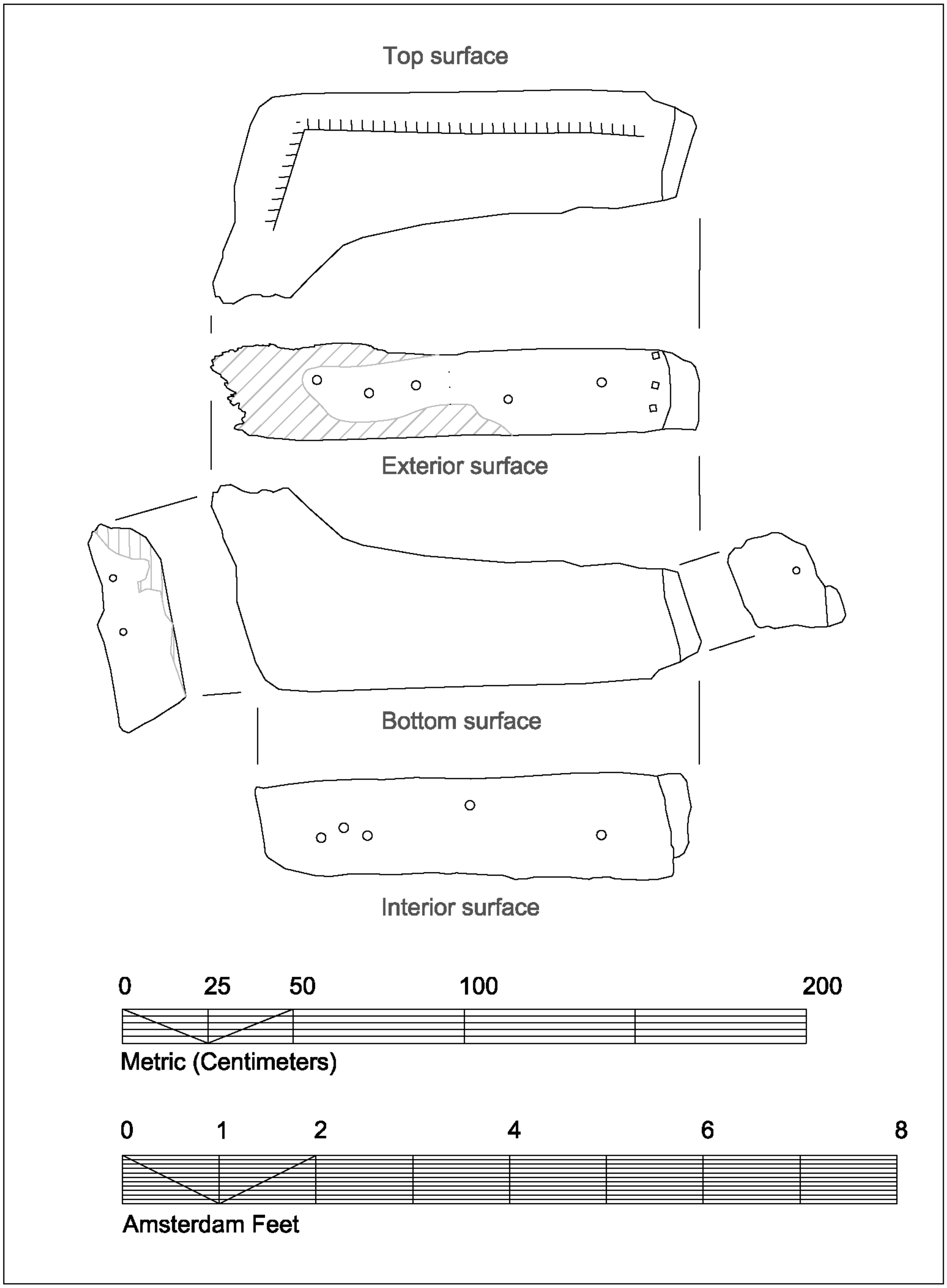


Fig. IV.84 Lodging deck knee. *Batavia* shipwreck, BAT 6229. Illustration: Wendy van Duivenvoorde.

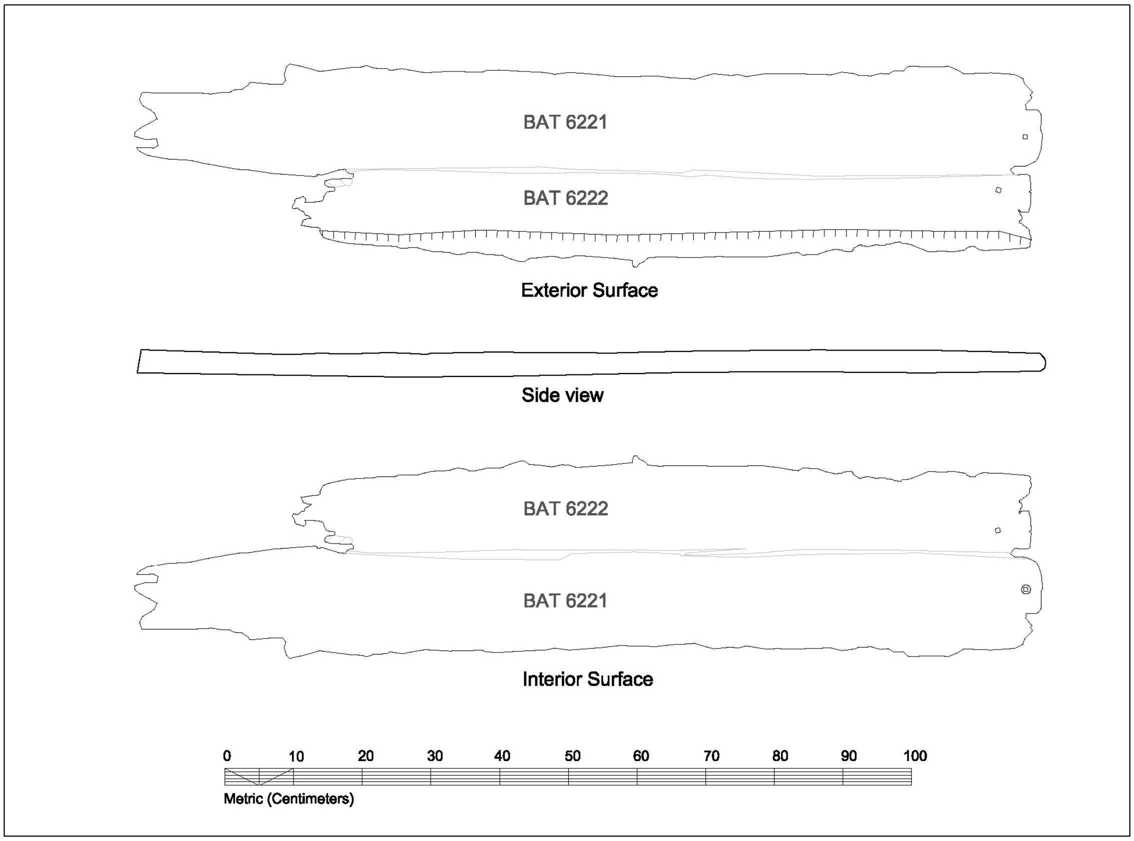


Fig. IV.85 Planking from area in between transom knees #3 and #4. *Batavia* shipwreck, BAT 6221 and BAT 6222. Illustration: Wendy van Duivenvoorde.

Little of the lower deck's waterway has been preserved. One fragment, BAT 6231, demonstrates that it was merely a thick deck plank against the side of the ship. It is preserved over 1.174 m in length, 0.229 m in width, and 0.107 m in thickness. In addition, a fragment of a possible margin plank, BAT 6218, or other type of timber survived parallel to the waterway and the ship's side (Fig. IV.83). It was fastened to the waterway with iron bolts (0.023 m in diameter). If a margin plank, its function was to prevent the straight deck planks from being tapered to a fine angle where they met the curvature of *Batavia*'s side at the after end of the hull. A margin plank is fashioned to receive the after or fore deck planking ends. The timber on *Batavia* has the same thickness as the waterway (0.107 m). The preserved fragment measures 1.70 m in length and 0.31 m in width. No deck planking has survived of *Batavia*'s lower deck, and it may as well be that the after end of the lower deck was not planked but raised to create the platform above it with spacing blocks on top of the deck beams, as also seen on *Vasa*.[95]

In addition, two fragments of one pine plank, BAT 6221 and BAT 6222, have survived. The fragments were found near the deck timbers during the shipwreck's excavation, albeit between transom knees #3 and #4 and, therefore, they were not part of the deck (Fig. IV.85). As their exact location and orientation were not recorded, their function cannot be determined; they might be part of the ceiling planking's cargo floor above transom knee #4. The preserved plank measures 1.320 m in length, 0.290 m in width, and 0.036 m in thickness (Fig. IV.85).

On top of the after arm of the third transom knee, BAT 6295, parallel to the transom, two oak planking remains run in a longitudinal direction. They are not deck planking but planks of a platform that rested this transom knee and probably supported the two transom cannon (Figs. IV.73 and IV.83). The oak planking fragments vary in thickness between 0.070 m and 0.075 m.

**Fastenings**

Fastenings found in the construction of *Batavia* were made of wood, iron, and copper. Most of the wooden and copper fasteners are still present whereas the majority of the iron fasteners did not survive. The inner layer of hull planking and the frame timbers of the ship's bottom were assembled by treenails that were driven in from the exterior and pegged in place with square tapering wooden pegs (Figs. IV.21–IV.22). These treenails were probably also wedged on their interior, although no evidence of this practice has been found to date. The treenails have an average diameter of 0.032 m, although they tend to be 0.001 m or 0.002 m larger in diameter on the planking's external face than on the interior. Treenail pegs vary in width from 0.015 m to 0.020 m in width and taper to a point. Generally, three treenails were inserted in a staggered pattern along each plank. This fastening pattern can be seen clearly on inner hull planks BAT 6030, 6031, and 6192 (Fig. IV.12).

Iron spikes were mainly used to fasten the outer layer of hull planking to the inner planking, and the upper strakes of hull planking, ceiling planking, and aftermost two meters of the inner layer of hull planking to the frames. The ceiling planks and hull planks were generally fastened with three staggered iron spikes along the planking width; the ceiling planks were nailed down with spikes at every other frame, whereas the hull planking was fastened to each frame timber. The planks with narrow widths only were fastened with only one or two spikes. As discussed in the 'Hull planking' section of this chapter, the after end of the double–layer of hull planking showed that the slight overlap between the inner and outer layers of hull planking facilitated a staggered nailing pattern at a regular interval along the planking's width. All iron spikes had square shafts that tapered to a point. Their shafts averaged 0.015 m in section below the heads. The precise length of these fasteners is unknown, but they could have easily been 0.160 m or more.

Impressions of the spike heads were visible in the countersunk holes in the timbers, showing they were roughly circular in section. The diameters of the spike heads vary from 0.023 m to 0.030 m, with an average of 0.025 m. Few square spike heads have been found on the exterior of the surface of the hull planking, but the function of these particular nails is unknown.

The largest fasteners used for *Batavia*'s construction are iron bolts. They were mainly used to secure rider frames to the ceiling, frames, and hull planking. As discussed at the end of the 'Pine sheathing' section of this chapter, no rider frames have been preserved but the bolt holes to fasten them are still present in other timbers. Round bolt holes are primarily found in *Batavia*'s second futtocks, indicating that the rider frames had the same average room–and–space of 0.414 m. These bolts could easily have measured over 0.600 m in length, tallying *Batavia*'s planking thickness, molded frame dimension, and ceiling planking thickness. The shafts of the bolts were round in section with consistent diameters of approximately 0.020 m (Fig. IV.86). They were inserted from the exterior of the hull where their large heads rested on the exterior of the hull planking. The bolt heads were roughly circular in section and peened at their tops.

Generally, one or two bolts were used in each hull plank for every second futtock. The pine sheathing planks had cut–outs to accommodate the large bolt heads. The diameter of the bolt heads seems to vary between 0.030 m and 0.064 m.


Fig. IV.86 Top view (with wood attached) and side view of replica from iron bolt concretion, *Batavia* shipwreck, BAT 3550 R. Photograph: Patrick Baker, Western Australian Museum (MA0241–32/33).

Additionally, bolts were employed to fasten the knees, transom beams, fashion piece timbers, and the upper gudgeon of the sternpost. The bolts used for the assembly of the transom timbers vary in diameter; they generally measure 0.02 m or 0.032 in diameter. Their heads have left countersunk impressions that are similar in diameter to those of the rider frames

Iron sheathing or filling nails, all similar in dimension and fastening pattern, were used to fasten the pine sheathing to the exterior of *Batavia*'s hull planking, to the interior of the gunport lid, and to the ship's sternpost. The square nail holes left behind in the pine sheathing and underlying hull planking indicate that the nails were fastened at intervals of about 0.050 m, in a quincunx pattern (Fig. IV.45). These closely–set nails do however not have a particularly large head, for the circular counter–sink impressions of the nail heads have an average diameter of 0.015 m. The nail shafts were square in section, measured 0.006 m in cross–section directly below the nail head and then narrowed to 0.005 m. Their distal ends tapered to a point. The sheathing nails measured about 0.06 m to 0.07 m in length, and were therefore too large to be considered tacks.[96]

Copper sheathing tacks were exclusively used to fasten the copper sheathing around *Batavia*'s sternpost. Their shape and dimensions are discussed in the 'Copper sheathing' section of this chapter.

Fig. IV.87 Saw marks of framed pit saw on interior surface of outer hull planking, *Batavia* shipwreck, BAT 6106, Strake 12. Photograph: Patrick Baker, Western Australian Museum (MA0188–26).

**Tool marks**

Saw and adze marks were well preserved on the interior and exterior surfaces of numerous planking strakes on *Batavia*'s hull. They were most evident directly after the timbers were raised from the seabed.

Irregular saw marks seen in the excavation timber photographs and on the conserved hull planking clearly indicate that all planks were hand–sawn with a framed pit saw, and not cut mechanically by a wind–driven sawing mill (Figs. IV.39, IV.87–IV.88). It is not surprising that the *Batavia* ship's timbers were sawn by hand, given the resistance of the Amsterdam hand–sawyers guilds in the early seventeenth century against the introduction of wind–driven sawing mills as discussed in Chapter II.

Fig. IV.88 Outer hull planking with saw marks of framed pit saw, *Batavia* shipwreck, BAT 6078 (top), Strake 13. Photograph: Patrick Baker, Western Australian Museum.

Some of *Batavia*'s timbers seem to have nice regular saw cuts that can easily be misinterpreted as being sawn by a wind–driven sawmill (Fig. IV.89). If the distance between the saw cuts is measured, they demonstrate to have been fed through the mill in a tempo creating a cut of 0.005 m to 0.009 m cut. This tempo is actually too fast and beyond the capacity of a seventeenth–century sawmill.[97] Furthermore, when the lines of the saw cuts are traced on paper and continued with a pencil, they are not parallel. They are, therefore, sawn by hand. A well–trained pit sawyer could saw smaller timbers easily with a speed that creates saw cuts with distance between 0.005 m and 0.009 m.[98]

Fig. IV.89 Regular saw marks of framed pit saw on (l) side of an inner transom plank, *Batavia* shipwreck, BAT 6414. Photograph: Patrick Baker, Western Australian Museum (MA0420–06).

On a map of Amsterdam by Cornelis Anthonisz dating to 1544, two teams of sawyers working a pit saw in the Amsterdam shipyards depict this method of sawing (Fig. IV.90). Another example is a print on lottery tickets, dating to 1558, issued to fund construction work on the choir of the Old Church in Amsterdam (Fig. IV.91).[99] In the second half of the seventeenth century, timber was apparently still sawn manually even though the wind–driven wood sawing mills had taken over, as can be seen on a contemporaneous drawing by Reinier Nooms (Fig. IV.92).

Fig. IV.90 Detail of Amsterdam map, *Die vermaerde Coopstadt van Amstelredam*. Map: Cornelis Anthoniszoon Schilder, 1544, National Maritime Museum Amsterdam (A.3540-01).

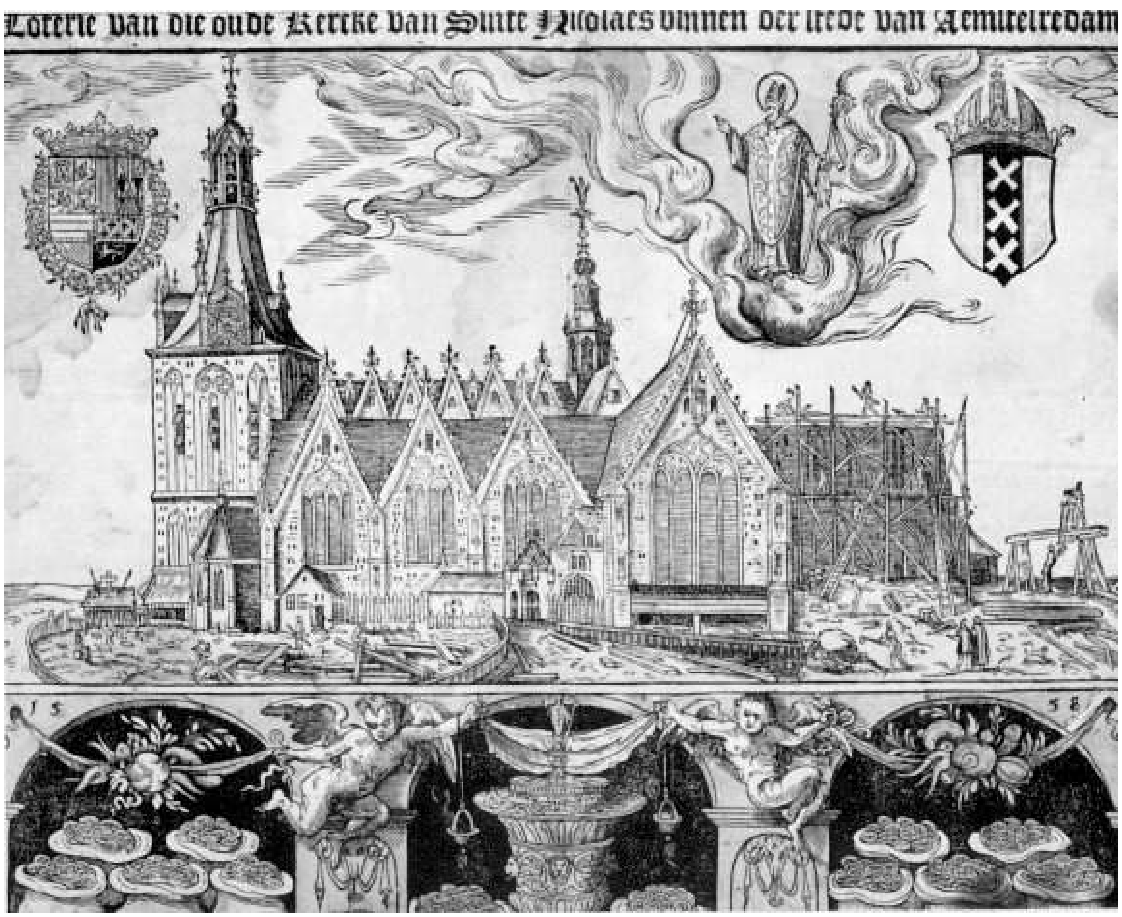


Fig. IV.91 Two sawyers working a framed pit saw. Lottery ticket, Old Church Amsterdam, 1548.

Fig. IV.92 Sketch of shipyard. Engraving: Reinier Nooms, 1650–1664, Rijksmuseum Amsterdam (RP–P–1881–A–4735).

Some hull planking surfaces show well–preserved saw marks, whereas others were deliberately smoothed by adzes (Fig. IV.93). The latter had their final shape established with adzes; adze marks are evident on all layers of hull planking (Figs. IV.37–38, IV.93). The adze marks vary in size between 0.059 m and 0.114 m, with an average of 0.092 m. The specifics of the adze and saw marks on the curved transom planking have already been discussed in the 'Transom planking' section of this chapter. Toolmarks also show that the futtocks were shaped and finished with adzes.


Fig. IV.93 Outer layer of hull planking with saw marks of framed pit saw (top) and adze marks (bottom), *Batavia* shipwreck, BAT 6078 (top), Strake 13, and BAT 6106 (bottom), Strake 12. Photograph: Patrick Baker, Western Australian Museum.

**Conclusion**

The construction features of *Batavia*'s hull remains demonstrate clearly that its shipwrights focused primarily on the ship's strength, waterproofing, and providing the utmost protection against teredo worms. The ship's bottom hull is remarkably thick as shown by the thicknesses and the multiple layers of hull planking and pine sheathing. These multiple layers must not only have provided enormous strength, but also added extra waterproofing as their seams had a slight offset, like overlapping roof shingles. The same can be said for *Batavia*'s ceiling planking which was sealed off with an inner pine floor up to the lower deck. The multiple layers of the ship's planking, laminated together, would also have greatly strengthened the hull longitudinally.

Layers of goat hair were applied with tar to all outboard surfaces of the hull planking, and some hair was also found on the outboard surfaces of the pine sheathing, to provide extra protection against teredo worms in addition to the nails of the pine sheathing. The sternpost was encased in layers of oak, pine, copper, and hair, basically any application available, to protect it against teredo worms and against impact damage, thereby, reducing the risk of injury to this vital element. The galvanic corrosion caused by the iron nails of the protective planking and copper sheathing must have been problematic, despite the layers of goat hair in between. All measures, known or available, seem to have been taken reducing any chance of the ship being weakened on its lengthy voyage to the Indies. The graving pieces and other construction features, such as the attachment of the sternpost's gudgeon to the transom, also indicate that *Batavia*'s shipwrights were meticulous and skilled craftsman; very capable of making the vessel's assembly shipshape.

In the following chapters, *Batavia*'s construction features are compared to archaeological examples of similar ships and to textual evidence from the late sixteenth and early seventeenth centuries. This provides a better understanding on what was considered standard practice by the VOC in the early seventeenth century and whether other VOC ships from this period were similar in construction to *Batavia*.

*Batavia*'s hull structure also demonstrates that the strengthening or reinforcement of the ship's bottom was largely carried by the thick, multiple–layered skin, whereas the frames played a secondary role. This is concurrent with a bottom–based construction philosophy, in which the bottom shell forms the foundation of the ship's structure. *Batavia*'s bottom–based construction method and building sequence is further delineated in Chapter VIII.

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1 National Archives (NA) of the Netherlands, The Hague*, Archieven van de Verenigde Oostindische Compagnie, 1602 – 1795*, reference code 1.04.02, item number 147 (Resoluties van de ordinaris en extraordinaris vergaderingen van de Heren XVII, 29 March 1626).

2 National Archives (NA) of the Netherlands, The Hague, *Archieven van de Verenigde Oostindische Compagnie*, 1602 – 1795, reference code 1.04.02, item number 147 (Resoluties van de ordinaris en extraordinaris vergaderingen van de Heren XVII, 29 March 1626); Porsius and De Munck, "Over hout, de herkomst, de kwaliteitseisen en de bewerking daarvan," 146; Witsen, *Architectura navalis et reginem nauticum*, 112 and 133; and Van IJk, *De Nederlandsche scheeps–bouw–konst open gestelt*, 68, 128, 147, 152, and 168.

3 National Archives (NA) of the Netherlands, The Hague*, Archieven van de Verenigde Oostindische Compagnie, 1602 – 1795*, reference code 1.04.02, item number 229 (Resoluties van de ordinaris en extraordinaris vergaderingen van de kamer Amsterdam, 29 June 1628).

4 Bruijn, Gaastra, and Schöffer, *Dutch Asiatic Shipping in the 17th and 18th Centuries: Introductory Volume*, 37–38.

5 Bruijn, Gaastra, and Schöffer, *Dutch Asiatic Shipping in the 17th and 18th Centuries: Introductory Volume*, 27.

6 National Archives (NA) of the Netherlands, The Hague*, Archieven van de Verenigde Oostindische Compagnie, 1602 – 1795*, reference code 1.04.02, item number 229 (Resoluties van de ordinaris en extraordinaris vergaderingen van de kamer Amsterdam, 18 November 1627).

7 National Archives (NA) of the Netherlands, The Hague*, Archieven van de Verenigde Oostindische Compagnie, 1602 – 1795*, reference code 1.04.02, item number 229 (Resoluties van de ordinaris en extraordinaris vergaderingen van de kamer Amsterdam, 25 May 1628).

8 Tristan Mostert and Lodewijk Wagenaar, letter to author, 5 February 2008.

9 National Archives (NA) of the Netherlands, The Hague*, Archieven van de Verenigde Oostindische Compagnie, 1602 – 1795*, reference code 1.04.02, item number 229 (Resoluties van de ordinaris en extraordinaris vergaderingen van de kamer Amsterdam, 29 June 1628).

10 National Archives (NA) of the Netherlands, The Hague*, Archieven van de Verenigde Oostindische Compagnie, 1602 – 1795*, reference code 1.04.02, item number 229 (Resoluties van de ordinaris en extraordinaris vergaderingen van de kamer Amsterdam, 18 July 1628).

11 National Archives (NA) of the Netherlands, The Hague*, Archieven van de Verenigde Oostindische Compagnie, 1602 – 1795*, reference code 1.04.02, item number 7345 (Kopie–resoluties van de ordinaris en extraordinaris vergaderingen van de Heren XVII, Kamer Zeeland, 18 July 1628), point 8.

12 National Archives (NA) of the Netherlands, The Hague*, Archieven van de Verenigde Oostindische Compagnie, 1602 – 1795*, reference code 1.04.02, item number 7345 (Kopie–resoluties van de ordinaris en extraordinaris vergaderingen van de Heren XVII, Kamer Zeeland, 18 July 1628), point 8.

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[13] National Archives (NA) of the Netherlands, The Hague, *Archieven van de Verenigde Oostindische Compagnie, 1602 – 1795*, reference code 1.04.02, item number 147 (Resoluties van de ordinaris en extraordinaris vergaderingen van de Heren XVII, July 1628), point 7.

[14] National Archives (NA) of the Netherlands, The Hague*, Archieven van de Verenigde Oostindische Compagnie, 1602 – 1795*, reference code 1.04.02, item number 229 (Resoluties van de ordinaris en extraordinaris vergaderingen van de kamer Amsterdam, August–October 1628).

[15] National Archives (NA) of the Netherlands, The Hague*, Archieven van de Verenigde Oostindische Compagnie, 1602 – 1795*, reference code 1.04.02, item number 147 (Resoluties van de ordinaris en extraordinaris vergaderingen van de Heren XVII, 29 March 1626).

[16] National Archives (NA) of the Netherlands, The Hague*, Archieven van de Verenigde Oostindische Compagnie, 1602 – 1795*, reference code 1.04.02, item number 147 (Resoluties van de ordinaris en extraordinaris vergaderingen van de Heren XVII, 29 March 1626) and item number 7345 (Kopie–resoluties van de ordinaris en extraordinaris vergaderingen van de Heren XVII, Kamer Zeeland, 28 July 1628), point 8.

[17] National Archives (NA) of the Netherlands, The Hague, *Archieven van de Verenigde Oostindische Compagnie, 1602 – 1795*, reference code 1.04.02, item number 147 (Resoluties van de ordinaris en extraordinaris vergaderingen van de Heren XVII, 29 March 1626).

One last equals 4000 Amsterdam pounds or 1976 kg. For convenience sake, one last is then considered to be about two metric tons. This conversion can only be applied to VOC ships until 1636, after which the *lasten* of a ship no longer means anything as the VOC kept the figures artificially low for fiscal reasons. From 1636 onwards, the volume was calculated on the basis of the measurements of the ship. The volume in *lasten* was calculated by a simple formula (length x breadth x depth in Amsterdam feet, divided by 200). For more information on this method and the problems regarding the ships' volumes, see, Bruijn, Gaastra, and Schöffer, *Dutch Asiatic Shipping in the 17th and 18th Centuries: Introductory Volume*, 42–44.

[18] Bruijn, Gaastra, and Schöffer, *Dutch Asiatic Shipping in the 17th and 18th Centuries: Introductory Volume*, 38.

[19] Green, "The Planking-first Construction of the VOC Ship *Batavia,*" 70.

[20] These nail plugs were initially observed by Dr. Thijs Maarleveld, Institute of History and Civilization, Center for Maritime and Regional Studies, University of Southern Denmark, Denmark. Maarleveld, *Archaeological Heritage Management in Dutch Waters*, 126.

[21] In 1779, the VOC's master shipwright Willem Udemans and ship's surgeon Ezechiel Lombard convincingly managed to explain in a letter to the VOC Chamber of Zeeland what the technological and medical advantages of three-decked ships were. As a result, the VOC finally decided to connect the quarterdeck and the forecastle deck, by adding walkways (also called a spar deck) along either side of the waist or by decking this open area. This connection was mainly a social breakthrough as it coupled the officers' quarters with that of the crew, a change that was not appreciated by everyone. This advancement did not lead to the construction of a true three-decker, as generally no cannon were placed on the walkways or the connecting deck. The same can be said about the three-deckers constructed by Dutch admiralties.

Bruijn, Gaastra, and Schöffer, *Dutch Asiatic Shipping in the 17th and 18th Centuries: Introductory Volume*, 48-49; Ab J. Hoving, and Alan A. Lemmers, *In tekening gebracht: De achttiende-eeuwse scheepsbouwers en hun ontwerpmethoden* (Amsterdam: De Bataafse Leeuw, 2001), 111.

[22] Bruijn, Gaastra, and Schöffer, *Dutch Asiatic Shipping in the 17th and 18th Centuries: Introductory Volume*, 48.

[23] Roeper, *De schipbreuk van de* Batavia*, 1629*, 49–52.

[24] Bronze cannon were expensive and, generally, only placed in areas in the direct vicinity of the compass (on the quarterdeck fore of the cabin). Two bronze Rotterdam Admiralty cannon, BAT 3640 and BAT 3627, and two composite cannon, BAT 3742 and BAT 3641, were recovered in *Batavia*'s stern area, whereas the three remaining bronze cannon, BAT 3637, BAT 3638 and BAT 3639, were found in the bow area. The first is a Rotterdam Admiralty cannon, and the latter two were Amsterdam Admiralty cannon. It is likely that the bronze cannon, recovered by Pelsaert, was the counterpart for the Rotterdam Admiralty cannon in the ship's bow.

Green, *The Loss of the Verenigde Oostindische Compagnie Retourschip* Batavia*, Western Australia 1629*, 25-54.

[25] Roeper, *De schipbreuk van de* Batavia*, 1629*, 219.

[26] Van Dam, *Beschrijvinge van de Oostindische Compagnie*, 507.

[27] Bruijn, Gaastra, and Schöffer, *Dutch–Asiatic Shipping in the 17th and 18th Centuries: Outward–bound Voyages from the Netherlands to Asia and the Cape (1595–1794)*, nos. 553.1, 593.2, 643.3, 696.4, 734.5, 772.6, 829.7; Bruijn, Gaastra, and Schöffer, *Dutch–Asiatic Shipping in the 17th and 18th Centuries: Homeward–bound Voyages from Asia and the Cape to the Netherlands (1597–1795)*, nos. 5290.1, 5320.2, 5343.3, 5377.4, 5400.5, 5414.6.

[28] Green, "The VOC Ship *Batavia* Wrecked in 1629 on the Houtman Abrolhos, Western Australia," 52–53; and Green, "The Planking-first Construction of the VOC Ship *Batavia,*" 70.

[29] All average measurements listed in this chapter have been taken from the original edges of the timbers. Hull planks, for example, that are eroded below their original surfaces are omitted for calculating average dimensions.

[30] This plank was raised in sections and comprises of BAT 6409, BAT 6204, BAT 6077, BAT 6086 A, BAT 6087, and BAT 6031.

[31] Green, "The Planking-first Construction of the VOC Ship *Batavia,*" 70.

[32] Steffy, *Wooden Shipbuilding and the Interpretation of Shipwrecks*, 281.

[33] This drop strake consists of timber sections BAT 6390, BAT 6192, and BAT 6184.

[34] Aleydis van de Moortel, *A Cog–like Vessel from the Netherlands* (Lelystad: Rijkswaterstaat, Directie Flevoland, 1991), 51–52.

[35] Van de Moortel, *A Cog–like Vessel from the Netherlands*, 52.

[36] Michael McCarthy, *Ships' Fastenings: from Sewn Boat to Steamship* (College Station: Texas A&M University Press, 2005), 66-68; and Lemée, *The Renaissance Shipwrecks from Christianshavn*, 205.

[37] McCarthy, *Ships' Fastenings*, 68.

[38] Adriaan de Jong, conversation with author, 21 April 2007.

[39] The wale comprises of timber sections BAT 6387 and BAT 6176.

[40] The word *spijkerpennen* has been translated by Christian Lemée as "spike plugs." The use of the word "spike" to define spike plugs is, however, problematic. In general, there has been quite some discussion on what size a nail needs to have for it to be called a true "spike." Although the *International Maritime Dictionary* stated that the length at which nails become spikes is approximately 3 inches (0.075 m), some authors, including Michael McCarthy, prefer to categorize large square–sectioned nails over four inches as spikes.

As fasteners of the temporary cleats are no longer present, it is not known how long the nails or spikes would have been although they probably did not exceed 4 inches (0.1 m) in length. Their size does certainly not correspond to the cross–sectional size of the spikes that were used to fasten the outer layer to the inner layer of hull planking, which taper to a point from a width of 0.015 m. Furthermore, the Dutch word *spijker* literally means nail. Therefore, the wooden pegs used to plug up the nail holes of the temporary cleats, after their removal, should preferably be called "nail plugs" or "nail pegs" and not "spike plugs." Lemée, *The Renaissance Shipwrecks from Christianshavn*, 119–20; McCarthy, *Ships' Fastenings*, 176–77.

[41] Examples of hull planks of the inner layer of planking that show these nail plugs very clearly are BAT 6375 (loose find), BAT 6068 (loose find, not on plan), BAT 6068, strake 3, and BAT 6390, strake 4.

[42] Lemée, *The Renaissance Shipwrecks from Christianshavn*, 204, 242, Fig. 4.3.22; and Erik Phaneuf, "Angra C, une épave hollandaise en contexte Açoréen du XVIIe siècle" (M.Sc. thesis, Université de Montréal, 2003), 64.

[43] The thickness has not been remeasured, as this part of the timber is not accessible being on display in the museum.

[44] Green, *The Loss of the Verenigde Oostindische Compagnie Retourschip* Batavia*, Western Australia 1629*, 27, 46, 47, and 49.

[45] Van IJk, *De Nederlandsche scheeps–bouw–konst open gestelt*, 90.

[46] Van IJk, *De Nederlandsche scheeps–bouw–konst open gestelt*, 90.

[47] Hoving and De Weerdt, *Nicolaes Witsens scheeps-bouw-konst open gestelt*, 210.

[48] This was first identified by Ab Hoving.

[49] Hoving and De Weerdt, *Nicolaes Witsens scheeps-bouw-konst open gestelt*, 210.

[50] Baker and Green, "Recording Techniques Used during the Excavation of the *Batavia*," 148.

[51] Coolhaas, *Generale missiven van gouverneurs–generaal en raden aan Heren XVII der Verenigde Oostindische Compagnie*, 478–79.

[52] Baker and Green, "Recording Techniques Used during the Excavation of the *Batavia*," 148.

In 1983, two hair samples from *Batavia*'s timbers, BAT 4123 and BAT 6249, were identified as a mixture of predominantly horsehair and some goat hair. The identification was based on a microscopic examination of distinguishing features such as the shape of the medulla, which are "commonly interrupted in the cattle hair and often with [a] 'serrated edge' in the horsehair," and "the absence of the large, spindle–shaped aggregations of pigment granules found scattered throughout the cortex of a cattle hair." Horsehair is, however, not easily identified with certainty, as is exemplified by an FBI–report, published in 2004, which states that their specialists have difficulties with the determination of horsehair. In order to distinguish between cattle and horse, it is usually necessary for the root to be present. It is, therefore, essential to be critical of a positive identification that differentiates between one and the other, especially as the condition of the hair from the *Batavia* planking is expected to be relatively poor.

Douglas W. Deedrick and Sandra L. Koch, "Microscopy of Hair Part II: A Practical Guide and Manual for Animal Hairs," *Forensic Science Communications* 6.3 (2004): http://www.fbi.gov/hq/lab/fsc/backissu/july2004/research/2004_03_research02.htm; Nancy R. Mills, unpublished report for Department of Material Conservation and Restoration, Western Australian Museum, 8 June 1983; Nancy R. Mills, unpublished report for Department of Material Conservation and Restoration, Western Australian Museum, 13 June 1983.

[53] It may also be correct to call it "felt" as this term does comply with the description defined in the Oxford English Dictionary. In the latter the following definitions are given for the word felt: "1. Skin, felt, or hide of a beast; 2. to mat or press together, or a thickly matted mass of hair or other fibrous substance." It can, however, be argued that the term is not commonly used until the eighteenth century when it occurs in nautical jargon to refer specifically to a compressed layer of hair applied underneath copper sheathing. Christian Lemée refers to this layer of animal hair as "matting" which suggests a weave. It is, therefore, not correct to refer to the layer of hair between hull planking and sheathing as matting.

William Falconer, Falconer's Marine Dictionary (1780) (Newton Abbot: David & Charles, 1970); Lemée, *The Renaissance Shipwrecks from Christianshavn*, 203; Witsen, *Architectura navalis et reginem nauticum*, 91; Erik A.R. Ronnberg, Jr., "The Coppering of Nineteenth Century American Merchant Sailing Ships; Some Historical Background with Notes for Modelmakers," *Nautical Research Journal* 26.3 (1980): 137; Royal Society of London, "An Extract of a Letter, Written from Holland, about Preserving of Ships Being Worm–Eaten," *Philosophical Transactions* vol. 1.11 (1665–1666): 190–91; and Andrew Ure, *A Dictionary of Arts, Manufactures, and Mines: Containing a Clear Exposition of their Principles and Practice* (London: Longman, Brown, Greene & Longmans, 1846), 454-55.

[54] Hans Brunner and Barbara Triggs, *Hair ID: An Interactive Tool for Identifying Australian Mammalian Hair* (CSIRO Publishing: Collingwood, Victoria, 2002).

[55] Henk van Haaster, letter to author, 7 March 2007.

[56] Henk van Haaster, letter to author, 29 March 2007.

[57] Toby Jones, letter to author, 13 March 2008.

[58] Michael L. Ryder, "Animal Hair in Medieval Ship Caulking Throws Light on Livestock Types," *Environmental Archaeology* 2 (1998): 61.

[59] Ryder, "Animal Hair in Medieval Ship Caulking Throws Light on Livestock Types," 62.

[60] Ryder, "Animal Hair in Medieval Ship Caulking Throws Light on Livestock Types," 62.

[61] René T.J. Cappers et al., "The Analysis of Caulking Material in the Study of Shipbuilding Technology," *Palaeohistoria* 39–40 (2000): 577.

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62 Cappers et al., "The Analysis of Caulking Material in the Study of Shipbuilding Technology," 585.

63 Jerome L. Hall, "A Seventeenth–century Northern European Merchant Shipwreck in Monte Cristi Bay, Dominican Republic" (Ph.D. diss., Texas A&M University, 1996), 70; Robert A. Lightley, "An 18th Century Dutch East Indiaman Found at Cape Town, 1971," *IJNA* 5:4 (1976): 309; and Kevin D. Rittenhouse, "Mitochrondrial DNA Control Region Sequences Used for Identification of Species in Two Forensic Science Case Studies: the Monte Cristi Shipwreck and a Homicide Case" (M.A. thesis, Texas A&M University, 1996), 11.

A hair sample of matting found on pine sheathing of theVOC ship *Zeewijk* was analyzed as possibly cattle or horsehair by Henk van Haaster, BIAX Consult, Research and Consultancy Service for Biological Archaeology and Environmental Reconstruction. Henk van Haaster, letter to author, 7 March 2007.

64 Baker and Green, "Recording Techniques Used during the Excavation of the *Batavia*," 148; Arjan den Braven et al., *De* Buytensorgh*: Onderzoek, restauratie, presentatie van een 18e eeuws VOC schip* (Amsterdam: Amsterdams Archeologisch Centrum, University of Amsterdam, 2003), 62, 159, and 162; Michel l'Hour, Luc Long, and Eric Rieth, *Le Mauritius: la mèmoire engloutie* (Paris: Casterman, 1989), 215; and Richard Larn, ed., "The Wreck of the Dutch East Indiaman *Campen* on the Needles Rocks, Isle of Wight, 1627—Part 1," *IJNA* 14:1 (1985): 15.

65 Witsen, *Architectura navalis et reginem nauticum*, 334; and Van IJk, *De Nederlandsche scheeps–bouw–konst open gestelt*, 91.

66 Puck Meijer, *Leer in beeld: En toen was er een schoen* (Waalwijk: Nederlands Leder en Schoenen Museum, 1992), 26.

67 Rudolph P. Matthee, *The Politics of Trade in Safavid Iran: Silk for Silver, 1600-1730*, (Cambridge and New York: Cambridge University Press, 1999), 164; and Willem M. Floor, "Dutch Presence in the Persian Gulf (1623-1766)" (paper presented at the International Congress on Siraf Port: Interaction of Industry, Technology and Cultural Heritage, Bushehr, Iran, 14-16 November, 2005).

68 Jerzy H.G. Gawronski, *De equipage van de* Hollandia *en de* Amsterdam*: VOC–bedrijvigheid in 18de–eeuws Amsterdam* (Amsterdam: De Bataafsche Leeuw, 1996), 276 and 278.

69 Gawronski, *De equipage van de* Hollandia *en de* Amsterdam, 276 and 278.

70 Lemée, *The Renaissance Shipwrecks from Christianshavn*, 203; and Peter Marsden, "The Wreck of the Dutch East–Indiaman *Amsterdam* near Hastings, 1749: An Interim Report," *IJNA* 1 (1972): 82.

71 Van Beylen, *Schepen van de Nederlanden, van de late middeleeuwen tot het einde van de 17e eeuw*, 42; Hall, "A Seventeenth–century Northern European Merchant Shipwreck in Monte Cristi Bay, Dominican Republic," 70; and Rittenhouse, "Mitochrondrial DNA Control Region Sequences Used for Identification of Species in Two Forensic Science Case Studies," 8.

72 Lemée, *The Renaissance Shipwrecks from Christianshavn*, 203.

73 Lemée, *The Renaissance Shipwrecks from Christianshavn*, 205.

74 Green, "The Planking-first Construction of the VOC Ship *Batavia,*" 70.

75 Green, *The Loss of the Verenigde Oostindische Compagnie Retourschip* Batavia*, Western Australia 1629*, 12; Green, "The VOC Ship *Batavia* Wrecked in 1629 on the Houtman Abrolhos, Western Australia," 43-63; and Ingelman-Sundberg, "The VOC Ship *Batavia* 1629: Report on the Third Season of Excavation," 47.

76 Green, *The Loss of the Verenigde Oostindische Compagnie Retourschip* Batavia*, Western Australia 1629*, 12.

77 Lemée, *The Renaissance Shipwrecks from Christianshavn*, 213-14.

78 Van IJk referred to the usage of copper sheets placed around the sternpost and stem to provide extra protection. Van IJk, *De Nederlandsche scheeps–bouw–konst open gestelt*, 289.

79 Baker and Green, "Recording Techniques Used during the Excavation of the *Batavia*," 151 and 153; and Green, *The Loss of the Verenigde Oostindische Compagnie Retourschip* Batavia*, Western Australia 1629*, 19.

80 Witsen, *Architectura navalis et reginem nauticum*, 111.

[81] Jonathan I. Israel, *Dutch Primacy in World Trade 1585-1740* (Oxford: Clarendon Press, 1989), 96.

[82] Remmelt Daalder, Els van Eyck, J. Thomas Lindblad, Peter Rogaar, and Peter Schonewille, *Goud uit graan: Nederland en het Oostzeegebied 1600-1850* (Zwolle: Waanders Uitgevers, 1998), 13.

[83] Samples were taken by Glenn Grieco and Wendy van Duivenvoorde, using new titanium drill bits (1/16") to get un–corroded copper from the tacks shaft from their heads. A new bit was used for each nail to avoid sample contamination, and the shavings of the first few millimeters were discarded to avoid interference of corrosion products with the test results.

[84] This reference value is specified in: Joel Baker, David Peate, Tod Waight and Christine Meyzen, "Pb Isotopic Analysis of Standards and Samples Using a 207Pb-204Pb Double Spike and Thallium to Correct for Mass Bias with a Double-Focusing MC-ICP-MS," *Chemical Geology* 211 (2004): 275-303.

[85] K. Sundblad, "A Genetic Reinterpretation of the Falun and Åmmeberg Ore Types, Bergslagen, Sweden," *Mineralium Deposita* 29.2 (1994), 170.

[86] Kjell Billström, report to author, 16 October and 6 December 2007.

[87] Kjell Billström, report to author, 16 October and 6 December 2007.

[88] Israel, *Dutch Primacy in World Trade 1585-1740*, 177, 180, 250, 255, 256, 392, and 407; Christopher F.E. Pare, *Metals Make the World Go Round: The Supply and Circulation of Metals in Bronze Age Europe: Proceedings of a Conference Held at the University of Birmingham in June 1997* (Oxford: Oxbow, 2000); and Ryuto Shimada, *The Intra-Asian Trade in Japanese Copper by the Dutch East India Company during the Eighteenth Century* (Leiden and Boston: Brill, 2006), 67-84.

[89] Israel, *Dutch Primacy in World Trade 1585-1740*, 172; Shimada, *The Intra-Asian trade in Japanese Copper by the Dutch East India Company during the Eighteenth Century*, summary.

[90] Kjell Billström, report to author, 6 December 2007.

[91] Kjell Billström, report to author, 16 October and 6 December 2007.

[92] Israel, *Dutch Primacy in World Trade 1585-1740*, 90.

[93] Steffy, *Wooden Shipbuilding and the Interpretation of Shipwrecks*, 139, 295.

[94] Green, *The Loss of the Verenigde Oostindische Compagnie Retourschip* Batavia*, Western Australia 1629*, 27, 46, 47, and 49.

[95] Fred Hocker, letter to author, 15 April 2008.

[96] McCarthy, *Ships' Fastenings*, 101, 174-75.

[97] Simon Jellema, letter to author, 4 April 2008.

[98] Simon Jellema, letter to author, 4 April 2008.

[99] Herman Janse, "Bouwbedrijf en houtgebruik in het verleden: eikehout en naaldhout als bouwmateriaal," *Houtvoorlichting* (October 1960): 43.

# CHAPTER V
# THE ARCHAEOLOGY OF DUTCH OCEANGOING SHIPS

## Introduction

The expansion of overseas trade and shipping during the sixteenth and seventeenth centuries increased the demand for the construction of ships in the Lowlands, particularly large, oceangoing vessels. A comprehensive understanding of the Dutch shipbuilding tradition relating to these large seagoing ships during this period is difficult to achieve due to the limited contemporary written evidence, as discussed in Chapter II, but also due the lack of well–researched (*and* published) archaeological data.

Generally, historical technological synthesis of shipbuilding can be achieved if a substantial body of shipwrecks from the same cultural origin, period or region can be studied and compared. The archaeological study of hull structures from large oceangoing Dutch ships is, however, not easy for a number of reasons.

Typically, only a small portion of the hull structure is preserved on shipwreck sites. If fortunate, archaeologists find part of the ship's bottom up to the turn of the bilge; therefore, a full understanding of a ship's construction sequence from its keel to caprail is unrealistic to begin with, making ship reconstruction studies partially conjectural.

Nevertheless, the most complete data for late sixteenth– and early seventeenth–century Dutch shipbuilding is likely to be found in the remains of the ships themselves. As J. Richard Steffy and Frederick van Doorninck have demonstrated in the last decennia, an in–depth study of a seemingly insignificant amount of hull wood can provide ample evidence to broaden our understanding of hull construction and shipbuilding tradition.[1]

Unfortunately, this is exactly where study of Dutch ships becomes complicated as valuable information has been destroyed over the last fifty years. Most post–medieval Dutch shipwrecks have been systematically plundered, by looters or treasure hunters searching for artifacts with market value. The number of shipwrecks that have been found and excavated by archaeologists is small. The number of archaeological excavations that have been fully published in a scholarly manner is even smaller (Appendix C).

Approximately 47 VOC ships wrecked between 1606 and 1795 have been located to date (Table V.1). This number does not include any wrecks from, for example, the West India Company or Amsterdam Admiralty, such as Piet Heyn's *Hollandia* (West India Company, 1627), *Utrecht* (Amsterdam Admiralty, 1648) or *Curaçao* (Amsterdam Admiralty, 1727), all of which, incidentally, have been salvaged and their recovered artifacts sold by auction at Christie's in Amsterdam and Sotheby's in London. All that remains of the salvage of *Hollandia* and *Utrecht* are their auction catalogs.[2] Many VOC shipwrecks have been plundered for saleable artifacts.

Of the VOC shipwrecks listed in Table V.1 (see for bibliographic reference Appendix C), at least twenty–nine have been systematically destroyed by commercial salvagers; most *with* permission of the Dutch Government. According to article 247 of the Dutch constitution from 1789, the Dutch Government became the legal heir of the VOC after it was declared bankrupt in 1795, and, thus, owns all former assets of the company.[3] The Domain Directorate of the Dutch Ministry of Finance deputizes the ownership of the government in all buildings, land, objects, and real estate.[4]

This Ministry of Finance has issued about fifty salvage permits for VOC shipwrecks around the globe since 1967.[5] This number is only an estimate, however, since no consistent documentation or filing system was kept that could have provided a precise number of shipwrecks and their identification.[6] Since the early 1980s, thanks to the efforts of Thijs Maarleveld, former Director of the Department of Underwater Archaeology of the Dutch Ministry of Welfare, Health and Cultural Affairs, no *new* salvage permissions have been granted by the Ministry of Finance for shipwrecks within Dutch territorial waters (a zone of 12 nautical miles or 22.3 km from the coastline).[7] This agreement, however, did not apply to salvage permits for shipwrecks outside Dutch

Table V.1 VOC shipwrecks around the world.

| | Name VOC Ship | Wrecking Location | Date | Tonnage | Output |
|---|---|---|---|---|---|
| 1. | *Adelaar* | Barra, Hebrides, U.K. | 1728 | 810 | CS |
| 2. | *Akerendam* | Ålesund, Norway | 1725 | 850 | CS |
| 3. | *Amsterdam* | Hastings, U.K. | 1748 | 1150 | AR |
| 4. | *Avondster* (yacht) | Galle, Sri Lanka | 1659 | 360 | AR |
| 5. | *Banda* | Mauritius | 1615 | 600–800 | CS |
| 6. | *Batavia* | Houtman Abrolhos, Australia | 1629 | 600 | AR |
| 7. | *Bennebroek* | Mtana River, South Africa | 1713 | 800 | CS |
| 8. | *Boot* | Salcombe, Prawle Point, U.K. | 1738 | 650 | CS |
| 9. | *Bredenhof* | Strait Mozambique | 1753 | 850 | CS |
| 10. | *Buitenzorg* | Waddenzee, Netherlands | 1760 | 880 | AR |
| 11. | *Kampen* (yacht) | Isle of Wight, U.K. | 1627 | 300 | CS |
| 12. | *Dolfijn* (yacht) | Galle, Sri Lanka | 1663 | 520 | AR |
| 13. | *Domburg* | Meob Bay, Namibia | 1748 | 850 | CS |
| 14. | *Geldermalsen* | Riau Archipelago | 1752 | 1150 | CS |
| 15. | *Geünieerde Provinciën* | Mauritius | 1615 | 700 | CS |
| 16. | *Hercules* (yacht) | Galle, Sri Lanka | 1661 | 540 | AR |
| 17. | *Hollandia* | Scilly Isles, U.K. | 1743 | 1150 | CS |
| 18. | *Hoorn* (yacht) | Patagonia, Argentina | 1615 | 110 | AR |
| 19. | *Huis te Kraaiestein* | Oude Kraal Bay, South Africa | 1698 | 1154 | CS |
| 20. | *Kennermerland* | Shetland Islands, U.K. | 1664 | 950 | CS |
| 21. | *Lastdrager* (flute) | Shetland Islands, U.K. | 1653 | 640 | CS |
| 22. | *Leimuiden* | Cape Verde | 1770 | 1150 | CS |
| 23. | *Lelie* (galliot) | Texel, Netherlands | 1654 | – | AR |
| 24. | *Liefde* (frigat) | Shetland Islands, U.K. | 1711 | 1009 | CS |
| 25. | *Mauritius* | Gabon, Guinea | 1609 | 700 | AR |
| 26. | *Merestein* (pinas) | Jutten Island, South Africa | 1702 | 826 | CS |
| 27. | *Middelburg* | Cape Rachado, Malaysia | 1606 | 600 | CS |
| 28. | *Middelburg* | Saldanha Bay, South Africa | 1781 | 1150 | CS |
| 29. | *Nassau* | Cape Rachado, Malaysia | 1606 | 320 | CS |
| 30. | *Nieuwerkerk* | Sulawesi, Indonesia | 1748 | 1135 | – |
| 31. | *Nieuw Rhoon* | Cape Town, South Africa | 1776 | 1150 | AR |
| 32. | *Oosterland* | Cape Town, South Africa | 1697 | 1123 | AR |
| 33. | *Prinses Maria* | Scilly Isles, U.K. | 1686 | 1140 | CS |
| 34. | *Ravestein* | Maldives | 1726 | 800 | – |
| 35. | *Reigersdaal* | Springfontein, South Africa | 1747 | 850 | CS |
| 36. | *Risdam* (flute) | Mersing, Malaysia | 1727 | 520 | CS |
| 37. | *Rooswijk* | Goodwin Sands, U.K. | 1740 | 850 | CS |
| 38. | *Slot ter Hoge* | Madeira | 1724 | 850 | CS |
| 39. | *Vergulde Draak* (yacht) | Western Australia, Australia | 1656 | – | AR |
| 40. | *Vis* | Tafelbaai, South Africa | 1740 | 650 | CS |
| 41. | *Vliegend Hert* | Zeeland, Netherlands | 1735 | 850 | CS |
| 42. | *Waddinxveen* | Cape Town, South Africa | 1697 | 751 | AR |
| 43. | *Witte Leeuw* (yacht) | Saint–Helena | 1613 | 540 | CS |
| 44. | *Zeelelie* | Scilly Isles, U.K. | 1795 | 1150 | CS |
| 45. | *[Zee]rob* | Texel, Netherlands | 1640 | – | AR |
| 46. | *Zeewijk* | Houtman Abrolhos, Australia | 1727 | 850 | AR |
| 47 | *Zuiddorp* | Western Australia, Australia | 1712 | 1152 | AR |

* Commercial Salvage (CS) or Archaeological Research (AR). If the shipwreck was salvaged commercially in the past and archaeological research has been conducted since or it is now protected by a local cultural heritage act, it will still be referred to as CS, because the shipwreck has lost part of its intrinsic historic and archaeological value.

territorial waters. In April 2002, the Ministry of Finance finally agreed to comply with specific archaeological standards when issuing new salvage permits or extending existing permits.[8]

This agreement was violated three years later, in 2005, when the Ministry of Finance issued a salvage permit issued to Rex Cowan's salvage company for *Rooswijk.* This large Dutch East–Indiaman (850 tons) sank on its second voyage to the Indies on 8 January 1740 on the Goodwin Sands near Kent in the U.K.[9]

Unfortunately, the precise extent of VOC shipwrecks worldwide will never be known as an indefinite number have been lost to future generations by for–profit discovery and salvaging. Dutch East Indiamen are a desirable finds for commercial ventures as they were bulk carriers of bullion such as coins and ingots. For this reason, they are seldom random discoveries as they are specifically sought after by treasure–hunters. Historic documentation has been a vital tool in aiding such ventures. Furthermore, shipwrecks of Dutch East Indiamen are often found in territorial waters of countries that have no legislation in place to protect their underwater cultural heritage, which makes them vulnerable to looters and salvagers. This is a sad state of affairs as these shipwrecks had the potential to add to our knowledge of ships and shipping in the late sixteenth to eighteenth centuries, information that cannot be found by archival or iconographic studies alone.

Although our current knowledge of Dutch shipbuilding in late sixteenth and early seventeenth centuries is limited due to reasons explained in Chapter II and above, a particular Dutch shipbuilding tradition *did* exist for oceangoing ships traveling long distances over the seven seas. As will be shown in the following chapters, such a tradition can be better understood through a combined study of contemporary written sources and archaeological data.

This study of the Dutch shipbuilding tradition focuses primarily on large merchant ships from the late sixteenth century to the mid–seventeenth century, and includes the vessels of the Dutch long–distance trading companies, *voorcompagnieën,* and the VOC. Analysis of their archaeological remains provides information about the bottom–based construction method, the use of double hull planking, and how the Dutch prepared their ships for voyages to distant and tropical waters.

Unfortunately two well–preserved shipwrecks from this period, the yachts *Nassau* (1606) and *Witte Leeuw* (1613) have been commercially salvaged. The latter was salvaged in 1976 by Robert Sténuit in the waters of St. Helena. The yacht sank there after an encounter with two Portuguese carracks in 1613.[10] Covered by three meters of sand, the ship's well–preserved hull structure comprised of the bow (about a third of original hull) up to the lower deck with parts of keelson, and about half of the keel intact.[11] Although most artifacts were sold via Christie's auction house, Sténuit did seem to have the intention to apply an archaeological approach to the shipwreck's salvage. In the earliest publication on *Witte Leeuw*, printed in the *Rijksmuseum Bulletin* of 1977, Sténuit mentions that the hull remains were recorded by photogrammetry and were being studied.[12] A later publication on the ceramic cargo of *Witte Leeuw* stated that the study of the ship's hull was ignored due a lack of workforce during five months of excavation —there were only four team members. It also stated that "the visibility on the site complicated photogrammetry," suggesting this method to record the hull remains was abandoned as well.[13]

There is little published on the *Witte Leeuw*'s hull other than what can be seen in the *National Geographic Society Magazine* of October 1978, where hull fragments, broken off, are cast over the edge of a large crater dug into the seabed by the salvagers in search of valuable items such as Chinese blue and white porcelain, guns, diamonds, and gems.[14] Furthermore, the visibility on the wreck site seems to be more than favorable for recording hull remains. The hull structure was, thus, not only ignored for study, but also destructively removed.[15] Salvagers seeking artifacts with a market value, generally find the excavation, conservation, and study of hull timbers to be expensive, cumbersome, and time–consuming. This appears to have been the case with *Witte Leeuw*'s structural remains.

The hull remains of eight oceangoing vessels provide us with representative examples of late sixteenth– and early seventeenth–century Dutch shipbuilding. These ships range from small yachts of no more than 100 tons to large Indiamen of up to 700 tons. They are arranged first in chronological order and second by attributes, beginning with Dutch–built merchantmen *not* in service of the VOC, followed by those that may have been built by the Dutch or that have northwestern European construction features, and finally by ships in VOC service.

The oldest example is the fragmentary hull of a small yacht that sailed for one of the Dutch *voorcompagnieën* or long–distance trade companies (1595 to 1602), which is also the only example of a ship belonging to the *voorcompagnieën* discovered to date. It was one of two unnamed ships used by Willem Barents in an attempt to sail to Indies through the northern route in 1596.[16] The names of both ships are unknown.[17] Other well–preserved examples of shipwrecks of seagoing merchantmen are the Scheurrak SOI (1590s) and Angra C (early seventeenth century) ships. The hull remains of these shipwrecks will be discussed according to their Dutch and non–Dutch origin first, and then in their chronological order.

In addition to *Batavia*, one Indiaman and three yachts, all in service of the VOC, are subject to comparative study: *Mauritius* (1609), *Nassau* (1606), *Vergulde Draak* (1656), and *Avondster* (1659).[18] These shipwrecks comprise the entire corpus of VOC shipwrecks dating before the second half of the seventeenth century of which at least some information is available on their hull remains. As it is not known precisely when all these ships were built, the dates of sinking are provided instead.

One additional Indiaman will be discussed, although it was in service of the Danish India Company. The Christianshavn B&W 2 ship was presumably built in a Dutch shipyard sometime after 1606 and was in the service of the Danish East India Company until scuttled in Christianshavn around 1630.[19]

This study is limited to shipwrecks with reliable information on their hull structure or fragmentary hull timbers that have been published or are otherwise available for comparison.[20]

**Yacht of Willem Barents (1596)**

The remains of a 100–ton yacht abandoned in 1596 were discovered in 1979 on the beach of Nova Zembla (modern–day Novaya Zemlya, an archipelago in the Arctic Ocean in the north of Russia) by amateur–archaeologist and engineer Dimitri Kravtsjenko. Kravtsjenko was conducting research near the remains of a house built by Dutch seamen who wintered on Nova Zembla in the winter of 1596/97 after their ship had become icebound. He uncovered a small section of the ship's hull after his metal detector indicated a high concentration of metal in the soil. Kravtsjenko only had time to make a quick and not–very–detailed drawing of the remains, then left the timbers exposed to the elements.[21] Thirteen years later, they were transported to Moscow after an archaeological fieldwork campaign under the direction of Peter V. Boyarsky from the Russian Research Institute of Cultural and Natural Heritage.[22]

The Dutch sailors stranded on the northeast coast of Nova Zembla had set sail to the Indies via the Open Polar Sea on 10 May 1596. It was the third Dutch attempt to open up this route to the Indies under command of Willem Barents and Jacob van Heemskerck. Their flotilla consisted of two ships, whose names are unknown. Barents and Van Heemskerck sailed on a yacht of 100 tons, and their companion Jan Corneliszoon Rijp on a slightly smaller yacht of 60 tons. They were to open up the passage to the Indies that was thought to run straight through four islands around the North Pole.[23] As they could not find this passage, Rijp returned to Holland where he arrived in the fall of 1596, whereas Barents and Van Heemskerck continued searching for another route. After a tough, cold winter on Nova Zembla, the crew of the 100–ton yacht returned in the ship's boats on 29 October 1597.

The remains of the ship's hull are 3.85 m by 0.93 m in size, and consist of two fragmented strakes of hull planking and remnants of seven floors (Figs. V.1–V.3). The ship's hull planking is made up from two layers, which are roughly 0.40 to 0.45 m in width and 0.040 m in thickness (for a total thickness 0.080 m); the outer layer is fastened to the inner layer with iron nails.[24]

Fig. V.1 Hull remains of Barents' ship (1597), Nova Zembla. Photograph: Jerzy Gawronski.

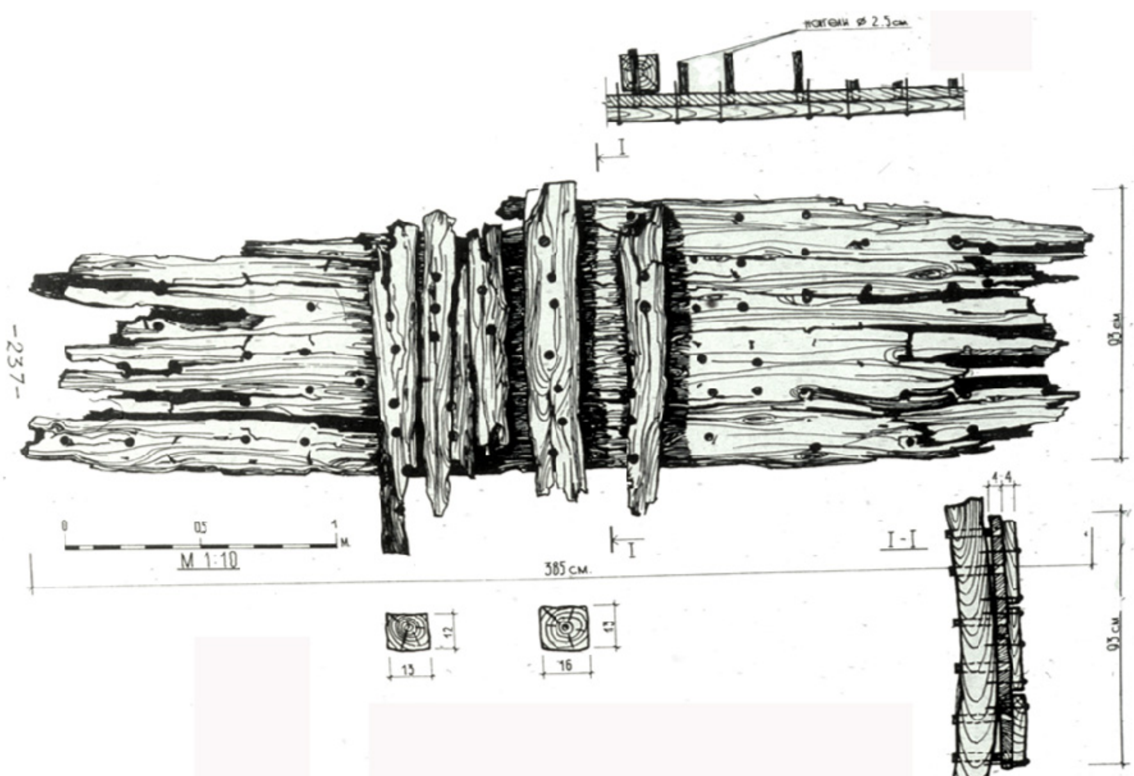


Fig. V.2 Hull remains of Barents' ship (1597). Illustration: after Russian Research Institute of Cultural and Natural Heritage, Moskou.

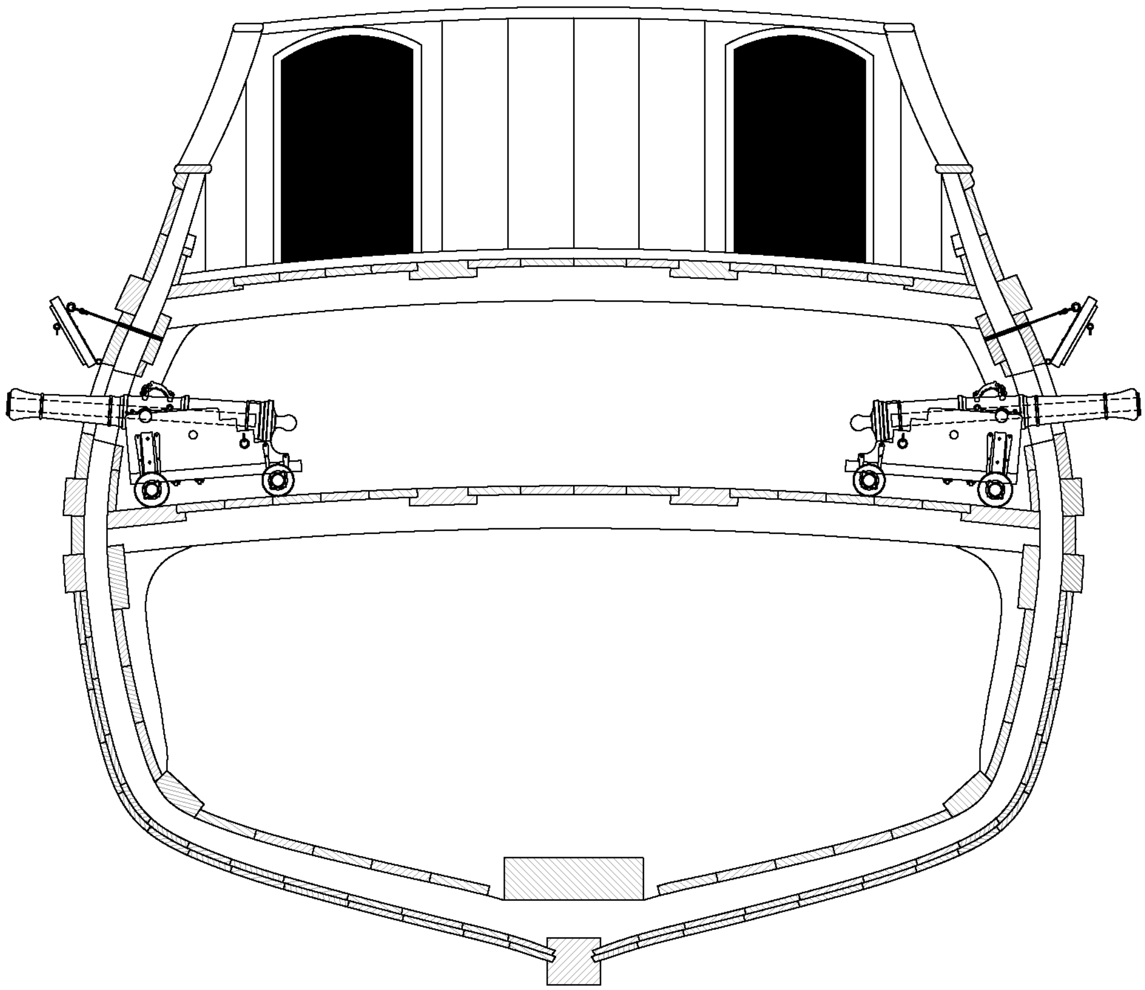

Fig. V.3 Reconstruction of Barents' ship (1597). Illustration after Cor Emke (WB–1004.dwg).

The floors are fastened to the first layer of hull planking with wooden treenails (Figs. V.1–V.2).[25] No traces of an additional layer of pine sheathing were found, although this yacht was destined to sail to the Indies. Archaeologists suspect that additional remains of the ship's hull may be preserved under water, several meters from the tide line against a longitudinal embankment close to where the remains were found.[26]

**Merchantman Scheurrak SOI (1590s)**

The Scheurrak SOI shipwreck was discovered in 1984 in the Wadden Sea, and excavated between 1989 and 1997 by the *Nederlands Instituut voor Scheeps– en onderwaterArcheologie*.[27] The large merchantman sank sometime after 1590, perhaps on 24 December 1593.[28] On this particular Christmas Eve, around 150 ships were caught in a southwesterly storm on the Wadden Sea.[29] That night, more than 40 merchant vessels sank and over 1,000 persons on board those ships lost their lives.[30] The location and orientation of the Scheurrak SOI ship are in concordance with a lee–shore created by this storm. In addition, several artifacts date the ship to the 1590s, such as a trumpet engraved with "Lissandro Milanese Fecit Genoa 1589", and a linstock engraved with a poem signed by a gunner named Cornelis Claeszoon from Westblokker in the year 1590.[31]

The hull of the Scheurrak SOI ship is well preserved, and includes most of the lower starboard hull up to the turn of the bilge, bottom planking, and parts of the bow and stern (Fig. V.4).[32] Part of the hull's starboard side, although separated from the lower hull, is preserved up to the bulwarks.[33] The total length of the vessel is more than 30 m (105 Amsterdam feet), which indicates the remains are of a large merchantman.[34] The hull of the Scheurrak SOI ship consists of a double layer of oak planking. Both layers of planking were rabbeted into the keel and have a total thickness measuring over 0.14 m (five Amsterdam thumbs).[35] The thickness of the two layers of planking is more or less equal (Fig. V.5). The floors and futtocks were fastened to the first layer of hull planking with wooden treenails and are not fastened to each other.[36] Unlike the inner layer of hull planking, which was erected in a bottom–based construction method, the outer layer was added after the frames were inserted. It was temporarily fastened to the inner layer of hull planking with iron fasteners (approximately two per meter) and then securely fastened in place with treenails.[37] These treenails were wedged on the interior and pegged on their exterior surfaces.[38] The oak ceiling planking was fastened to the

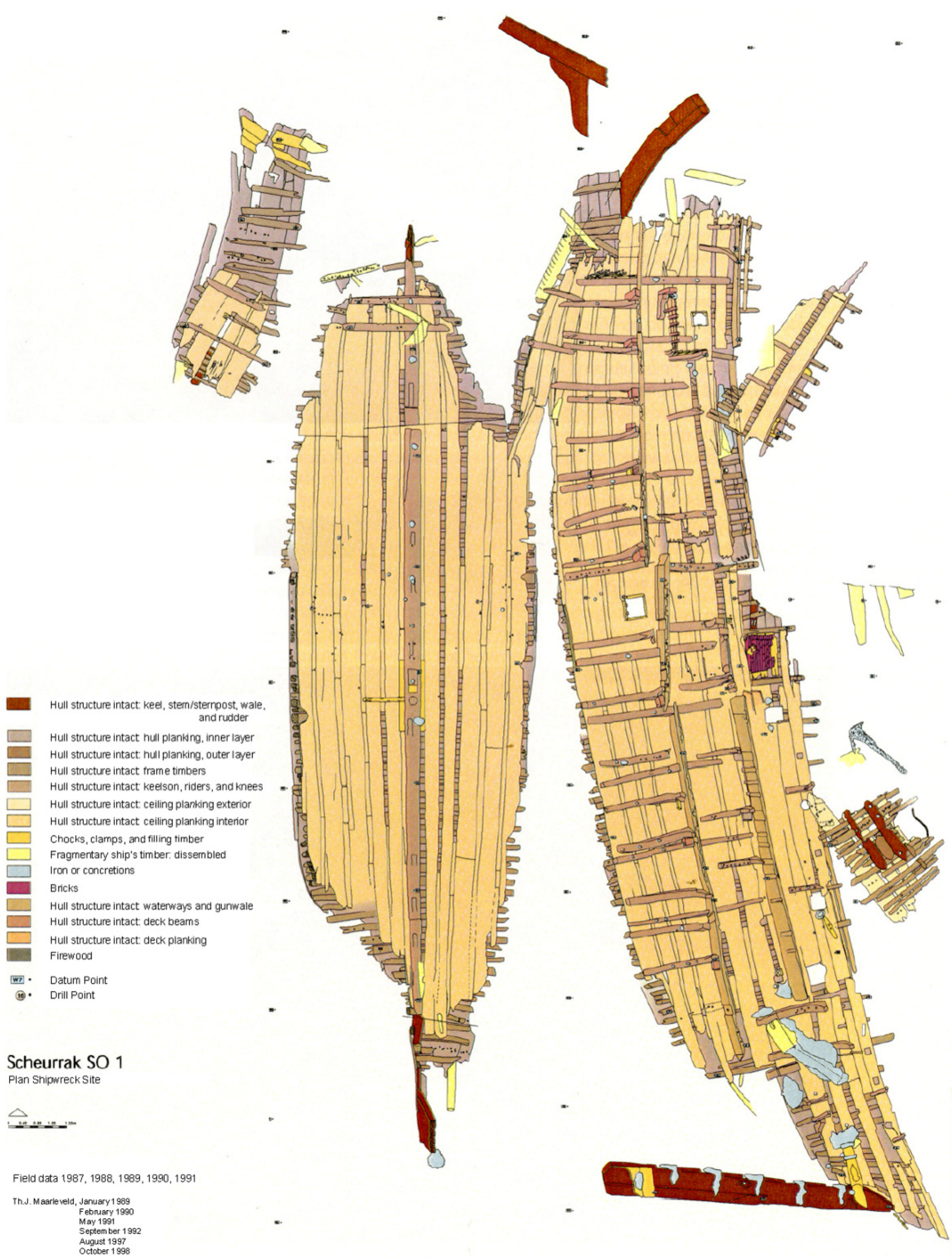


Fig. V.4 Site plan of Scheurrak SOI shipwreck, Wadden Sea. Illustration: Thijs J. Maarleveld, courtesy of National Service for Archaeology, Cultural Landscape and Built Heritage (RACM, Lelystad).

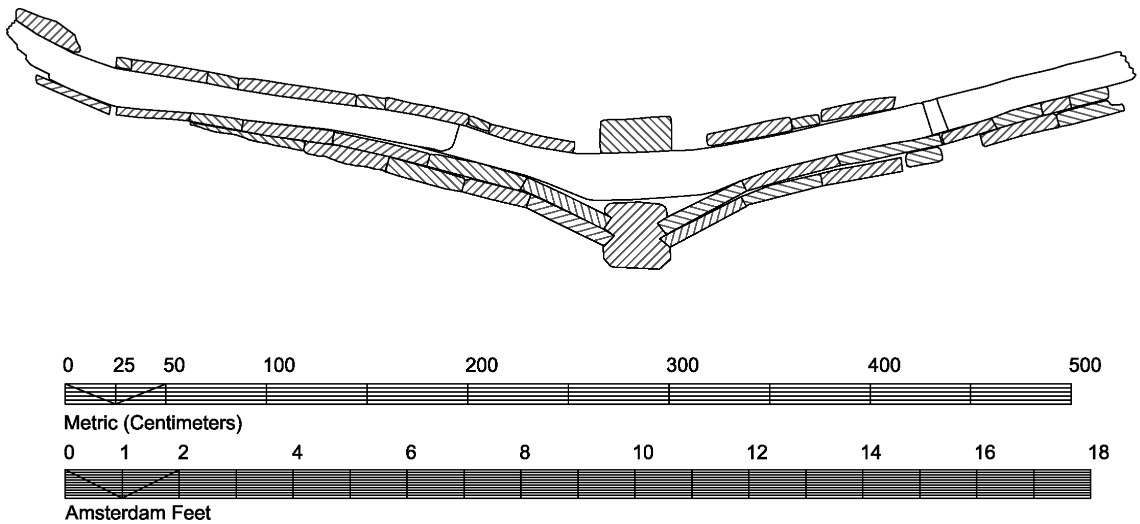


Fig. V.5 Section of Scheurrak SOI ship's hull. Illustration: After Thijs J. Maarleveld, courtesy of National Service for Archaeology, Cultural Landscape and Built Heritage (RACM, Lelystad).

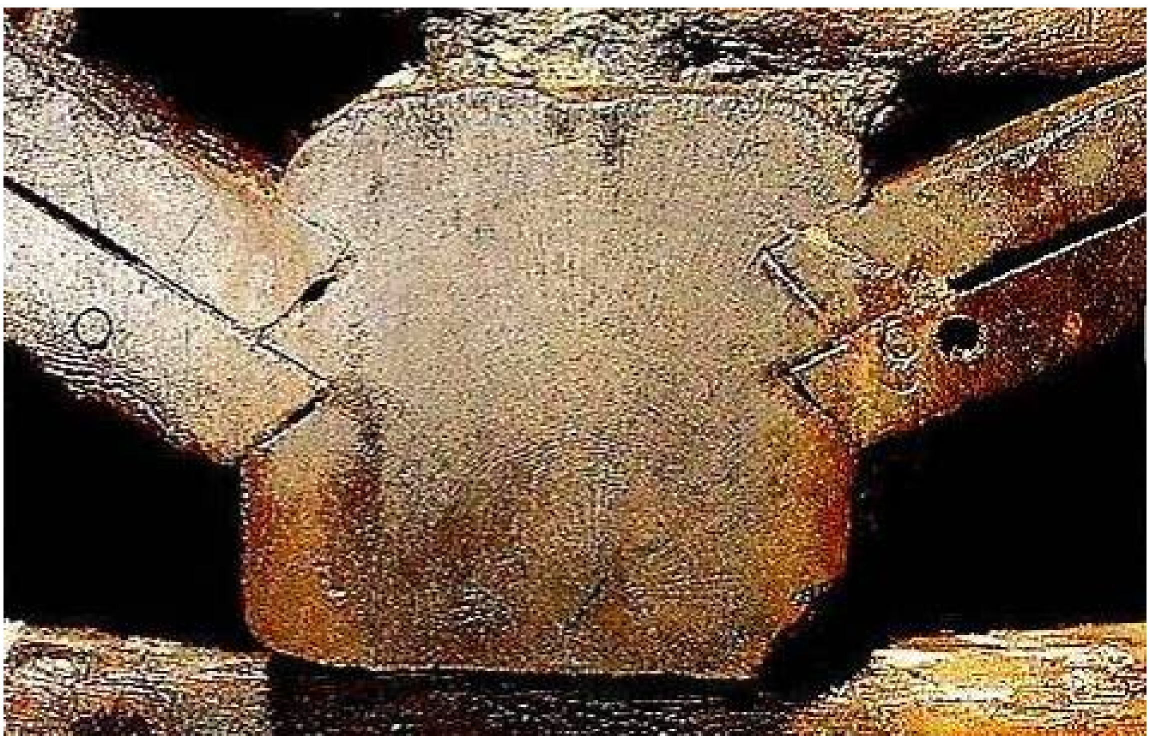

Fig. V.6 Cross–section of keel with double rabbet to seat the garboard strakes, Scheurrak SOI shipwreck, Wadden Sea. Photograph: Jan Pauptit, National Service for Archaeology, Cultural Landscape and Built Heritage (RACM, Lelystad).

frames and the first layer of oak hull planking with wooden treenails.[39] The double–rabbeted keel consisted of at least three flat–scarfed timbers and has a total length of 24 meters (85 Amsterdam feet) (Fig. V.6).[40]

**Danish East Indiaman Christianshavn B&W 2, Dutch–built (1630)**

On the former location of the Burmeister & Wain (B&W) ship engine factory in the area of Christianshavn in Copenhagen, Denmark, the remains of eight ships were recorded and excavated in 1996 and 1997.[41] The subsequent study of the ships has been published in the book *The Renaissance Shipwrecks from Christianshavn* by Christian P.P. Lemée. Of the eight ships, six were dismantled and scuttled some time before 1750 to form the foundation of a careening wharf.[42] One of these ships, the so–called B&W 2 shipwreck, an early–seventeenth Dutch–built East Indiaman, is of particular interest to this study.

The remains of the Christianshavn B&W 2 ship basically comprise the after half of the ship's wooden hull over an area of 14.5 m in length and 7.5 m in width, from abaft the main mast step to its stern.[43] The construction of this particular ship is dated to some time after time after 1606 by dendrochronology.[44] It was built in a bottom–based construction method in the same manner as *Batavia*.

Lemée's study of the Christianshavn B&W 2 ship does not include a reconstruction of the ship with an estimated tonnage and proposed hull shape. He does indicate that the ship's hull must have had an overall length of 27.5 m and a maximum breadth of 7.5 m.[45]

The Christianshavn B&W 2 ship's double–rabbeted keel timber, false keel, and keelson are all joined together with long iron bolts (diam. 0.020–0.022 m). Its floors, futtocks, and first futtocks are not interconnected or transversally fastened but overlap each other at their ends to form a solid band of timber.[46]

The Christianshavn B&W 2 ship has two layers of oak hull planking of approximately the same thickness (max. th. 0.079 m for the inner layer, and 0.070 m for its outer layer) and an additional layer of pine sheathing (max. th. 0.025 m) on their exterior.[47] In between the three layers, a coating of animal hair and finely–ground glass was applied to deter teredo worms; they were mixed in with tar to help with sealing the planking seams and to improve the ship's water tightness.[48]

Like *Batavia* and all ships discussed in this chapter, the frames of the Christianshavn B&W 2 ship were fastened to the inner layer of hull planking with treenails that were pegged on their exterior faces.[49] The outer layer of hull planking was secured to the inner layer of hull planking with iron nails.[50] Like *Batavia*, each plank was fastened with rows of three staggered spikes across the planks at intervals of 0.4–0.5 m along the strakes.

The outer layer of hull planking of the Christianshavn B&W 2 ship, however, may have been a later addition to the ship based on its dendrochronology and its fastening to the inner layer by iron nails.[51] The timber for the ship was felled in 1606, whereas the planking of the outer layer of hull planking was added between 1618 and 1625.[52] This use of iron spikes to fasten the outer layer of hull planking to the inner layer is evident in the Barents', *Mauritius*, and *Batavia* ships. Lemée adds that the outer layer of *Mauritius* and *Batavia* has no structural function, which is incorrect as the second layer has the same thickness as the inner one and, as the *Mauritius* ship shows, was seated in the ships' keel rabbet.

The application of iron spikes to fasten the outer layer of oak hull planking was common practice by Dutch shipbuilders for long–distance trading ships as clearly indicated by Barents', *Mauritius*, and *Batavia* ships. In fact, *Batavia* was originally constructed with a second layer of oak planking fastened to the ship's inner layer of planking by iron spikes. As will be discussed in more detail in Chapter VI, the outer layer of oak hull planking was often replaced several times over the lifespan of ships in service of the VOC. This may also have applied to the Christianshavn B&W 2 ship.

Based on historic research and the Christianshavn B&W 2's bottom–based construction method, Lemée suggests that the ship may originally have been constructed in the Dutch *Noorderkwartier*—the region of Holland north of the river IJ and the city of Amsterdam.[53] Unlike *Batavia*'s hull planking, which was sawn manually, the

Christianshavn B&W 2's hull planking was sawn mechanically. This excludes an Amsterdam shipyard as the place of construction as the city had no wind–driven sawmills before 1630. However, the Christianshavn B&W 2 ship could very well be constructed in the Zaan region of the *Noorderkwartier* where ship timber was sawn by wind–driven sawmills since the late sixteenth century.[54]

Regardless, the Christianshavn B&W 2 and *Batavia* ships have many similarities, such as the occurrence of nail plugs (*spijkerpennen*) on both interior and exterior surfaces of the hull planking. The exterior nail plugs indicate the use of shoring posts placed underneath the ships' hulls during their construction.[55]

Even though no riders of the *Batavia* ship have been preserved (Chapter IV), the remnants of large iron bolts in the ship's hull planking indicate that its riders, like those of Christianshavn B&W 2, were fastened by bolts (diam. shafts 0.020 m).[56] Another similarity between the *Batavia* and Christianshavn B&W 2 ships is the use of copper sheathing on the aftermost end of the sternpost. This copper sheathing, fastened by copper tacks, was applied to avert marine organism attack of the hood ends of the sternpost planking or covering.[57]

**Dutch–built (?) merchantman Angra C**

Another early seventeenth–century merchantman built in the bottom–based construction method with a double layer of hull planking was found during construction of a marina in the port of Angra in the Azores. This shipwreck, named Angra C, was one of two contemporaneous shipwrecks that were excavated in about 7 m of water in this marina by the Centro Nacional de Arqueologia Náutica e Subaquática (CNANS) in 1998. After the excavation of the Angra C and D shipwrecks was completed, their hull remains were dismantled and removed from the marina development area.[58] The hull remains of the Angra C shipwreck were recorded and mapped under the direction of Kevin Crisman of the Nautical Archaeology Program of Texas A&M University in the summer of 2000.[59] The structural remains of the Angra C ship were preserved over a length of 14.75 m and a width of 6 m.[60] They include part of the ship's bottom hull and consists of the remains of the keel, keelson, rising deadwood, six strakes of inner hull planking and five of outer hull planking on the port side, seven strakes of inner hull planking on the starboard, twenty floor timbers and 36 futtocks (18 on either side of the keel), two strakes of limber boards, four strakes of ceiling planking, and two bilge stringers (Fig. V.7).[61]

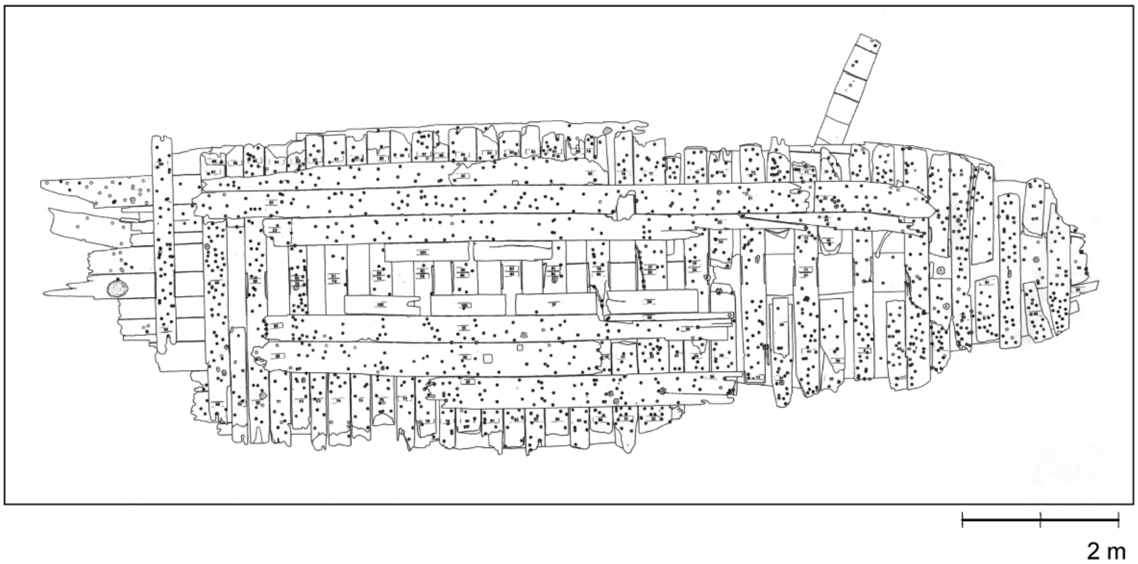


Fig. V.7 Plan of the Angra C ship's hull remains. Illustration: Colin O'Bannon.

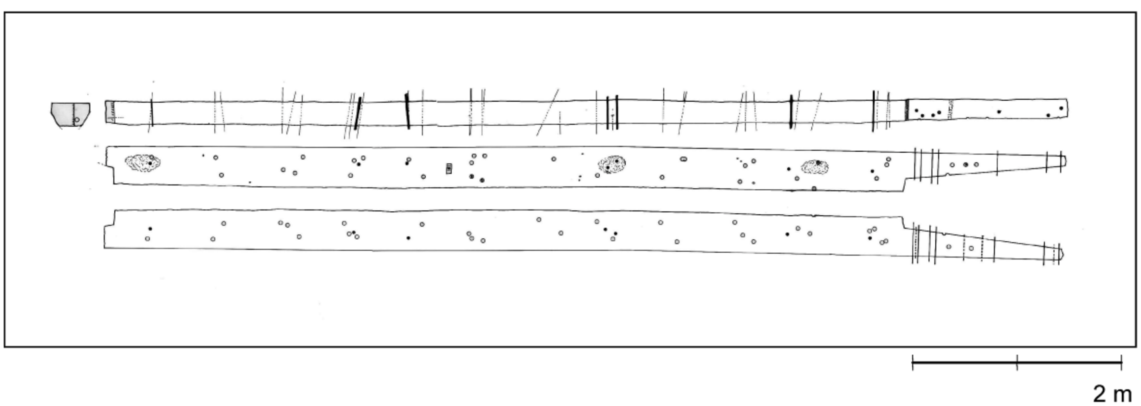


Fig. V.8 Preserved keel timber, Angra C ship. Illustration: Erik Phaneuf.

Although the research of this vessel is far from complete and detailed hull drawings and scantling lists have yet to be published, Eric Phaneuf's master thesis on the ship's hull remains, titled: *Angra C, une épave Hollandaise en contexte Açoreen du XVIIe siècle,* has produced some important and detailed information. Although Phaneuf has specified a bow and stern orientation in his thesis, it is uncertain whether this identification is correct.[62] For clarity, Phaneuf's orientation is used in the following discussion but it must be kept in mind that the preserved bow area may as well be the ship's stern area.

Angra C's keel was made of several timbers, of which only one was preserved (Fig. V.8). Its present length is 8.4 m, which is not its original length, as the scarf tip at its after end is only partially preserved, provides a reconstructed length of 9.85 m for this keel timber. At its forward end, it joined the stem with a 1.4–m–vertical scarf that was fastened transversely with 11 metal bolts (diam. shafts 0.02 m).[63] This keel timber has no rabbets to receive the ship's garboard strakes but has chamfered edges that correspond with the thickness of the garboard strake (0.07 m, Figs. V.8–V.9).[64] The keel was molded 0.35 m, and sided 0.2 m on its top surface.[65] The endposts of the Angra C ship have disappeared. The shape of the keel is not similar to the other shipwrecks discussed here, such as the Scheurrak SOI, Christianshavn B&W 2, and *Mauritius*, and is not characteristic for Dutch shipbuilding of the early seventeenth century. However, *spijkerpennen* or nail–plugs found on the top of Angra C's keel and on the ship's hull planking indicate the ship was assembled in a bottom–based construction method.

The hull of the Angra C ship consists of a double layer of planking, which is only preserved on the ship's port side (Fig. V.9). Both layers of planking have a total thickness of approximately 0.14 m (five Amsterdam thumbs). Like Barents', the Scheurrak SOI, and Christianshavn B&W 2 ships, the thickness of the two layers of hull planking is more or less equal (0.07 m, Fig. V.9).

The inner layer of hull planking has been preserved on either side of the keel (six strakes on port, seven on starboard). The planks vary in width between 0.25 m and 0.5

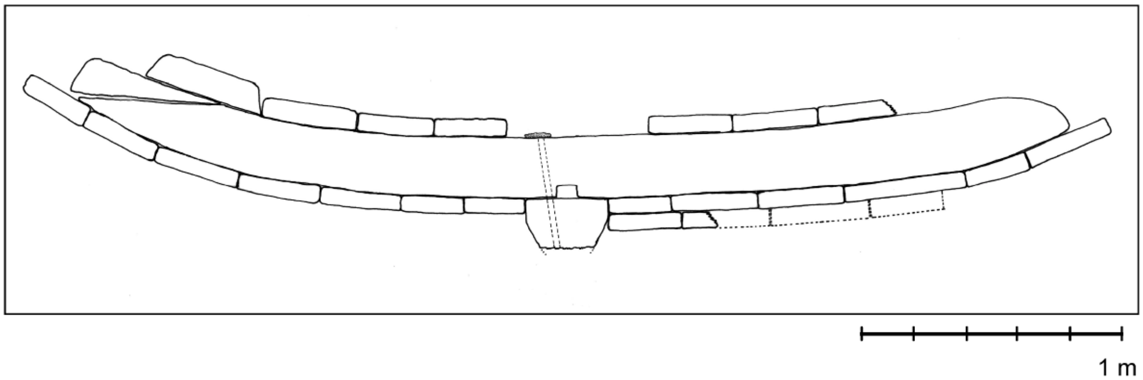


Fig. V.9 Cross–section showing inner and outer layers of hull planking, Angra C shipwreck. Illustration: Erik Phaneuf.

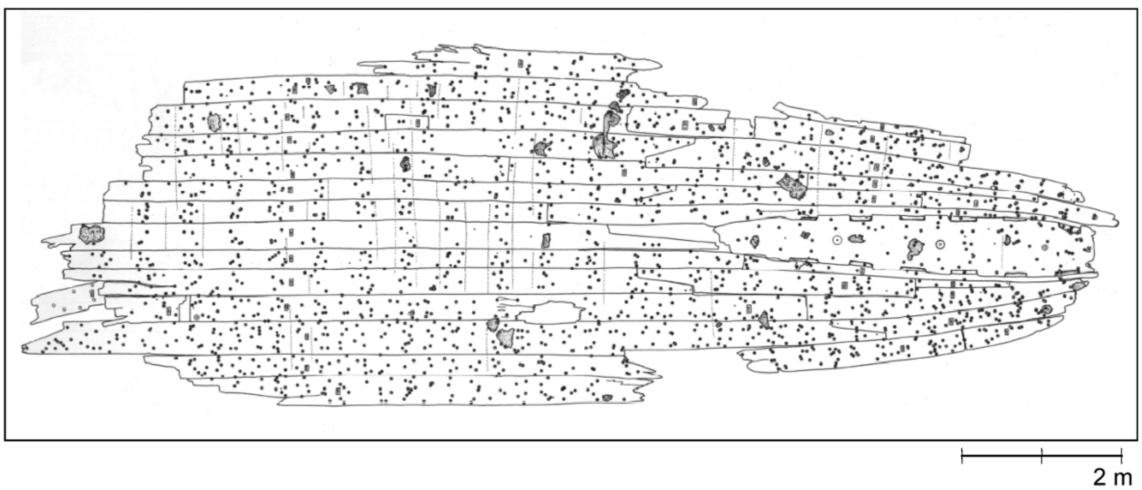


Fig. V.10 Plan of inner layer of hull planking, Angra C shipwreck. Illustration: Erik Phaneuf.

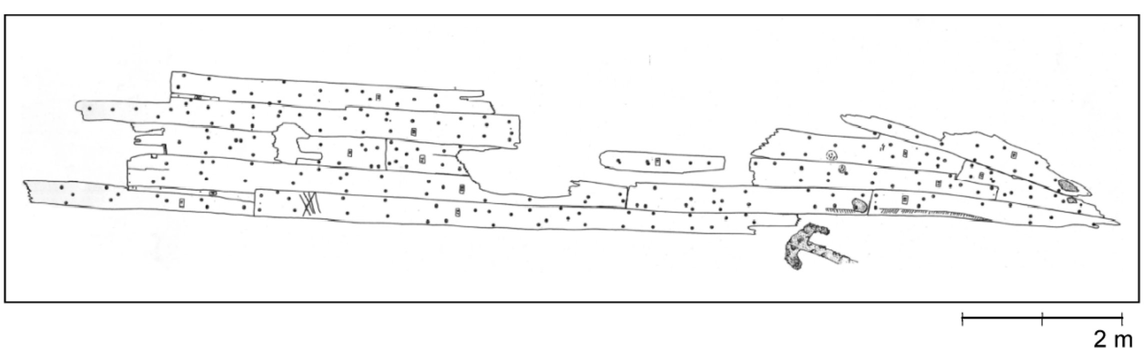


Fig. V.11 Plan of outer layer of hull planking, Angra C shipwreck. Illustration: Erik Phaneuf.

m, and between 0.06 m and 0.08 m in thickness. The only complete plank with a flat scarf on either end measures 11 m in length (strake 4 on the port side).[66] The ends of the hull planking were joined together with flat scarves or butt joints, although the latter predominate on the outer layer of hull planking (Figs. V.10–V.11). Planks were fastened to the frames with treenails having a diameter between 0.025 m and 0.035 m. Only two examples of wedged treenails were observed.[67] Although the outer layer of planks were primarily fastened with treenails (two to three treenails per plank, per frame, like the Scheurrak SOI ship), the plank ends were fastened to the inner layer with iron nails.[68]

Twenty preserved floor timbers cross over the ship's keel, eighteen of which are still accompanied by first futtocks on either side of the keel. The room and space of the floor timbers measured between 0.5 m and 0.7 m.[69] Floor timbers were sided between 0.24 m and 0.55 m, with an average of 0.32 m. Their average molded dimension is 0.25 m. The length of the floor timbers varies between 1.46 m and 4.4 m.[70] Ten floor

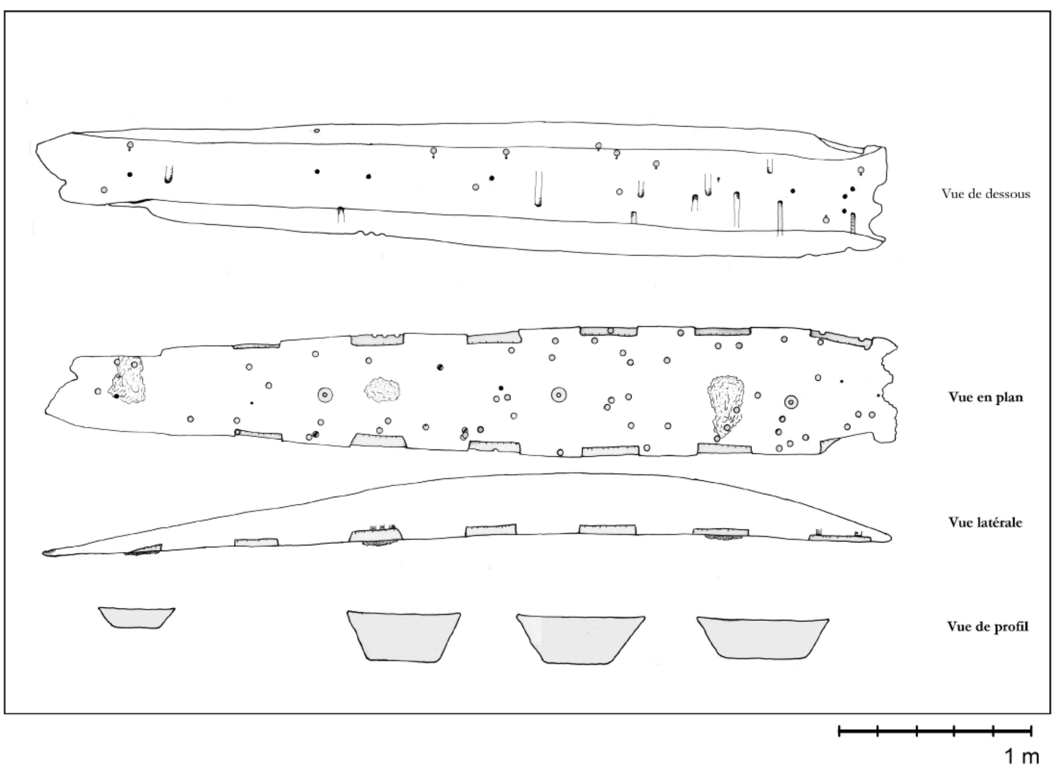


Fig. V.12 Rising deadwood, Angra C shipwreck. Illustration: Erik Phaneuf.

timbers were fastened to the keel and deadwood with iron bolts.[71] The first seven frames from the bow were seated in notches in the rising deadwood. This substantial timber measures 4.75 m in length, 0.75 m in width, and had a maximum thickness of 0.37 m (Fig. V.12).[72]

The spaces between the ends of the floors were filled with the lower ends of the futtocks, forming a solid band of timber at the bilges. The average preserved length of the futtocks on both port and starboard is 1.32 m. The molded and sided dimensions of the futtocks differ between the two sides of the ship. Most futtocks on the port side were sided between 0.17 m and 0.34 m and molded 0.24 m. On the starboard side, the sided dimension varies between 0.21 m and 0.31 m, and the molded dimension is 0.22 m.[73]

Most floors and futtocks, like those of the *Batavia* and Scheurrak SOI ships, are not fastened to each other but are fastened to the hull planking with wooden treenails. Two floor timbers, however, were joined to the futtocks with two lateral treenails, in addition to being securely locked with dovetail joints on the side of the timbers (floor 4 from the stern and 12 from the bow, Figs. V.13–V.14). Frame 12 had a double–dovetail joint of which the dovetail mortises were cut from the forward side of the floor timber and the fixed dovetail tenons from the side of the futtock.[74] The fixed dovetail tenon of frame 4 was cut from the aft face of the floor timber.[75]

All floors had a central limber hole and were notched on the top of one or both sides to receive the keelson (Fig. V.15).[76] A small fragment of the keelson was found underneath the ship's hull remains and was preserved over a length of 2.4 m. It averaged 0.34 m sided. The lower end of the keelson is notched to fit over the ship's floor timbers and fastened to the floors with wooden treenails and iron nails. Its four preserved notches fit over frames 13 to 16 (counted from the vessel's stern).[77]

The Angra C ship's ceiling consisted of one row of short removable ceiling or limber boards on either side of the keelson. This row of limber boards was followed on either side by two strakes of ceiling planking and a bilge stringer. The two strakes of ceiling planking were fastened to the frames with wooden treenails and iron nails (Fig. V.16).[78] The ceiling has the same thickness as the hull planking (averaging 0.07 m) and

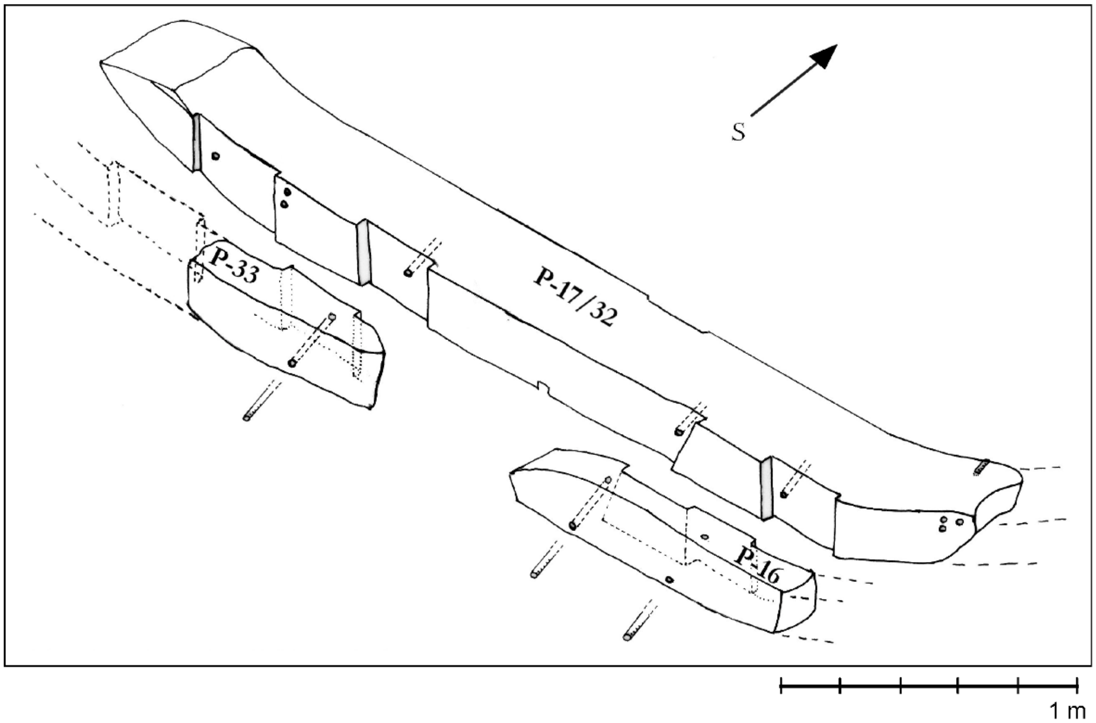


Fig. V.13 Pre–assembled frame, floor 12 from the stern, Angra C shipwreck. Illustration: Erik Phaneuf.

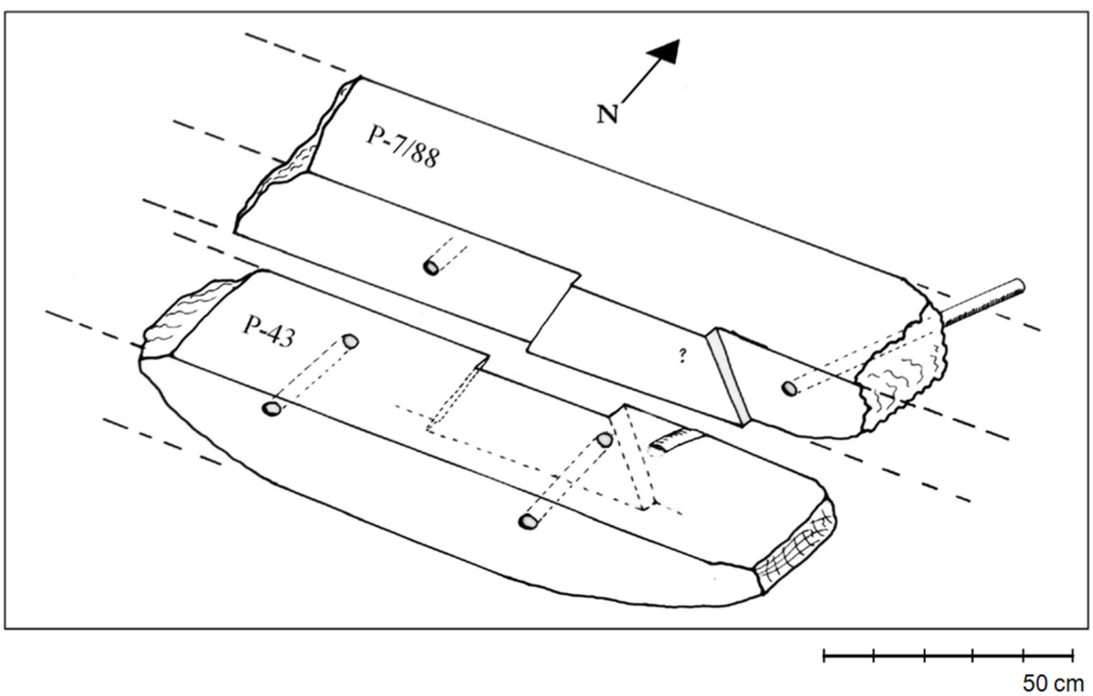


Fig. V.14 Pre–assembled frame, floor 4 from the bow, Angra C shipwreck. Illustration: Erik Phaneuf.

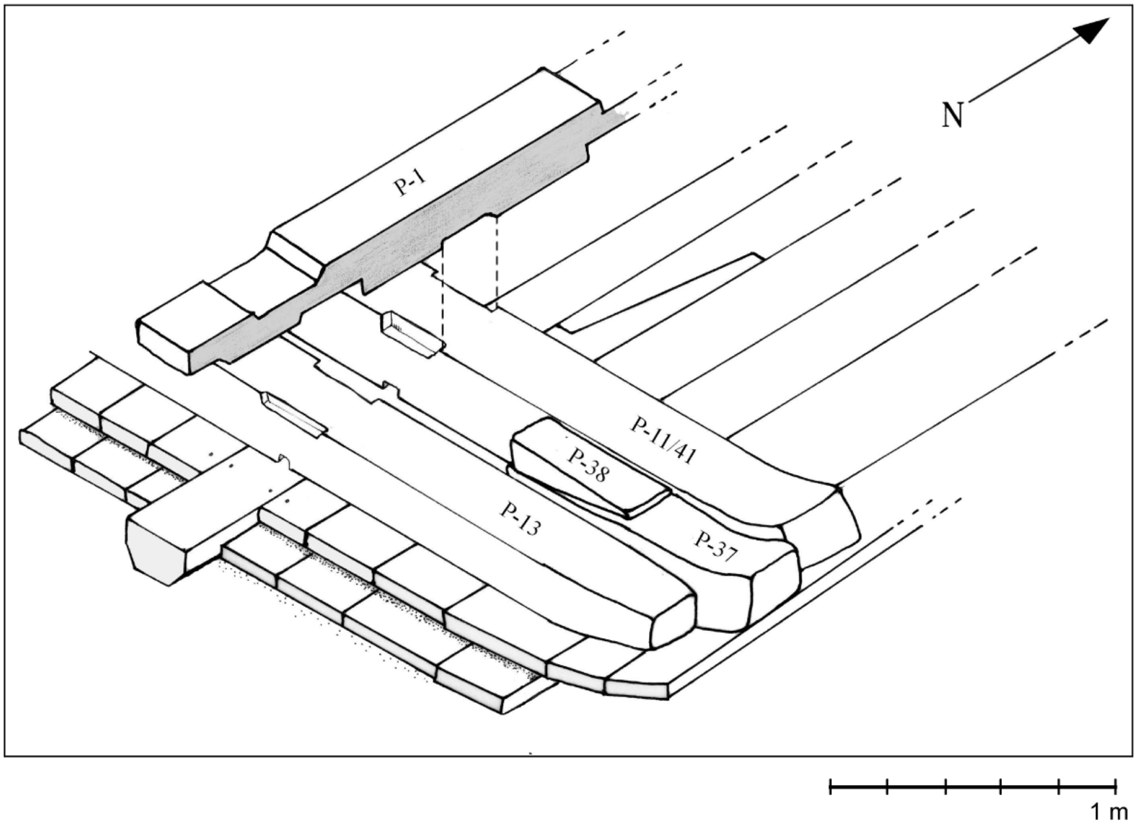


Fig. V.15 Reconstruction of keel–floor–keelson assembly, Angra C shipwreck. Illustration: Erik Phaneuf.

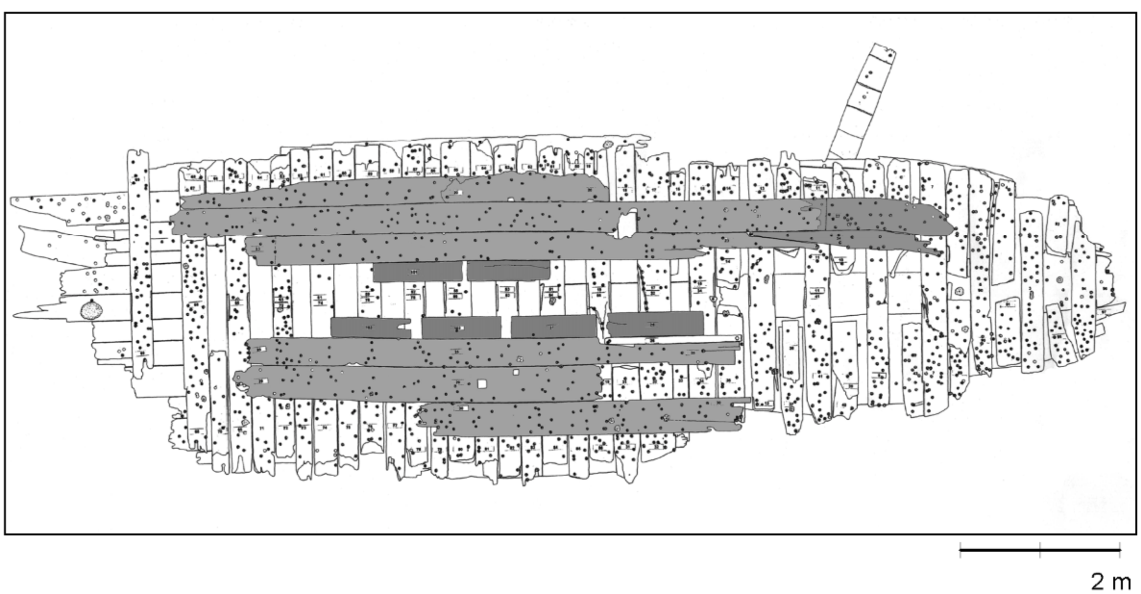


Fig. V.16 Ceiling planking and bilge stringers, Angra C shipwreck. Illustration: Erik Phaneuf.

varies from 0.32 m to 0.45 m in width. The starboard stringer has a maximum preserved length of 4.4 m, is 0.45 m in width, and 0.12 m in thickness.[79] The port stringer and the first fixed ceiling strake indicate that the extremities of the ceiling planking were joined together with diagonal scarves, whereas the planking of the second permanent ceiling strakes shows the use of a butt–joint.[80]

The absence of pine sheathing on the Angra C ship's exterior indicates that it was not destined to sail in tropical waters, but, like the Scheurrak SOI ship, was more likely a large oceangoing merchantman used for the intra–European trade.

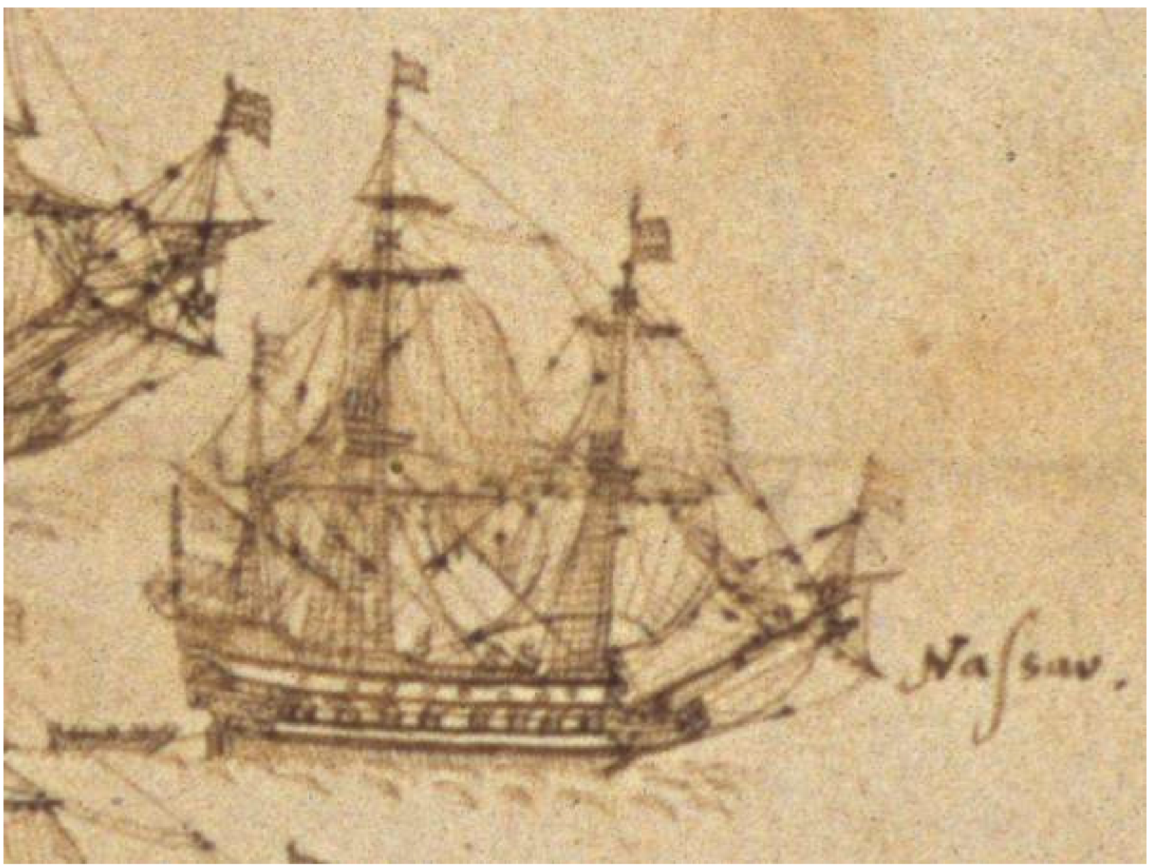


Fig. V.17 VOC ship *Nassau* as part of the so–called Malacca fleet under command of Admiral Cornelis Matelief de Jonge. Battle of Rachado, Straits of Malacca, 1606. Detail of manuscript drawing, Museum Meermanno–Westreenianum, The Hague (MMW 74 A 6).

**Dutch East Indiaman *Nassau* (1606)**

VOC–ship *Nassau* was one of the eleven ships of a navy, renowned nowadays as the so–called "Malacca Fleet" (Fig. V.17). On 12 May 1605, seven ships of this navy, all equipped by the VOC Chamber of Amsterdam, set sail from Texel; *Oranje* (700 tons), *Middelburg* (600 tons), *Mauritius* (700 tons), *Zwarte Leeuw* (600 tons), *Witte Leeuw* (540 tons), *Grote Zon* (540 tons), and *Nassau* (320 tons). Twelve days later two ships equipped by the Chamber of Zeeland, *Amsterdam* (700 tons) and *Kleine Zon* (220 tons), followed suit from the Dutch port of Wielingen.[81] These ships sailed to the Indies under command of Admiral Cornelis Matelief de Jonge, who had secret instructions to besiege the Portuguese stronghold of Malacca.[82] Two stragglers, *Erasmus* (540 tons) from the Chamber of Rotterdam, and the *Geünieerde Provinciën* (400 tons) from the Chamber of Delft, left much later on 30 May, and finally reinforced the fleet at Malacca over a year later, on 14 July 1606.[83] The Dutch offensive was declared when the Dutch burned four Portuguese ships on 30 April 1606. The subsequent period was characterized by a series of bloody events, in which the Dutch were supported by hundreds of galleys and *fustas* of their ally, the Sultan of Johore, who also provided the Dutch with a safe haven in the Johore River to which they could retire in their ships from the battle. The Portuguese were assisted by an armada under command of the Viceroy of Goa.[84] The Dutch did manage to enfeeble the Portuguese by burning three large galleons, *San Salvador* (900 tons), *San Nicolas* (800 tons), *Don Henrique de Norinha* (900 tons), and the ship *Santa Cruz* (600 tons), and left hundreds of Portuguese men slain or wounded.[85] According to the daily register kept by Matelief's fleet eighteen Portuguese ships were lost to Dutch fire or destroyed by the Portuguese crew to keep their ships out of Dutch hands.[86] Nevertheless, Admiral Matelief and his men gave up on 13 December 1606, without having achieved their aim.[87] It took the VOC until 1641 to finally take Malacca.[88]

During the attempted siege of Malacca, two ships of the Dutch fleet were lost in the Straits of Malacca, *Middelburg* and *Nassau*; both on 18 August, during a naval battle.[89] The latter was one of two ships destined to stay in Asia to be depleted; the other was *Kleine Zon*. When the two ships were prepared two years earlier for their last long journey to the Indies, the VOC instructions specifically emphasized that nails and sheathing boards would be sent from Holland to the Indies for their maintenance.[90] The ship *Kleine Zon* was indeed re–sheathed in Bantam, a port city near the western end of Java in Indonesia, after it had started leaking in the fall of 1608.[91] Its pine sheathing was worn out after three years, but its oak planking was still in good condition and worm–free.[92] *Kleine Zon* was eventually decommissioned and broken up in the Banda Islands in 1611.[93]

*Nassau* and *Kleine Zon* probably had an extensive working life before they joined Matelief's navy as they were both to retire in Asia. *Nassau*'s history can, however, only be traced back to one, possibly two, previous journeys. It sailed to the Indies with the large fleet under command of Wybrand van Warwijck from 1602 to 1604.[94] It might also have sailed to the Indies for the Nieuwe Brabantse Company with Pieter Both and Paulus van Caerden in 1599.[95] This journey was undertaken with four ships, *Nederland*, *Verenigde Landen*, *Nassau*, and *Hof van Holland* (360 tons), was organized by the states of Zeeland and sailed simultaneously with the fourth Dutch journey to the Indies.[96] This fleet was intended to trade in China, but never did. Instead, the four ships showed up in Bantam in 1600.[97] It is uncertain whether the ship that sailed on this voyage is the same *Nassau*; it may have been another ship with the same name. No indication of the ship's tonnage is given for this particular journey. The *Nassau* that went down in the Strait of Malacca in 1606 is likely to have been an older ship as it was to retire in the Indies. Matelief mentions in his account how the ship's stern and gallery caught fire after a fierce naval encounter with two enemy ships, *Conceicao* and *Santa Cruz*, on 18 August 1606.[98]

In 1607, Jacques L'Hermite de Jonge aboard *Erasmus* wrote a lengthy letter to his father in which he shared his thoughts about the modifications made by the Chamber of Amsterdam to its ships, including *Nassau*, *Mauritius*, *Middelburg,* and *Witte Leeuw*. All were purposely fitted for this journey *without* a forecastle and quarterdeck aft of their mainmast.[99] According to L'Hermite, the large ship *Middelburg* may not have been burned if it would have had both forecastle and quarterdeck, providing the crew with options for fighting the fire and saving the ship from Portuguese hands. It would have given shelter and protection from the armament on a level higher than the gundeck. Instead, the men had no other choice than to stay below decks to protect themselves.[100] This was essentially the same complaint Richard Hawkins had with the low–built English galleons in fighting high Spanish ships around 1600.[101] L'Hermite elaborates on how the late Adriaen Fransz had purposely removed the forecastle and quarterdeck from *Erasmus* on the ship's previous journey, which cost several lives when putting out a fire at its beakhead and bowsprit during a conflict with a Portuguese carrack.[102] For this particular journey, the ship was purposely fitted with a new forecastle and quarterdeck to prevent a repeat of the incident.

The shipwrecks of *Middelburg* and *Nassau* were found in 1993 by a local marine salvage and engineering company, Transea Sdn Bhd. They are the oldest VOC shipwrecks discovered on the seabed. While *Middelburg* remains untouched, *Nassau* was salvaged two years after its discovery with permission of the Malaysian Government under the direction of Mensun Bound. The ship's hull lies with a list to port and is well preserved to above the turn of the bilge (Fig. V.18). Unfortunately "no attempt was made to reveal and study the lower timberwork [of the ship's hull]."[103] This was due to lack of time, poor visibility, and reluctance to expose any more of the hull than necessary to biological attack.[104] More detrimental, the exposed hull structure has not been recorded or studied in detail. It is known that the ship's hull had a double layer of hull planking equal in thickness (roughly 0.06 to 0.08 m per strake).[105] The same thickness is given for its ceiling planking. Bound elaborates that "[m]ost if not all, of the exterior hull below waterline was lead sheathed and at the stern, around the post and below the tuck, it had been partially coppered."[106] The lead sheathing observed on the outside of the outer layer of hull planking is likely a layer of lead in between the hull planking and pine sheathing.[107]

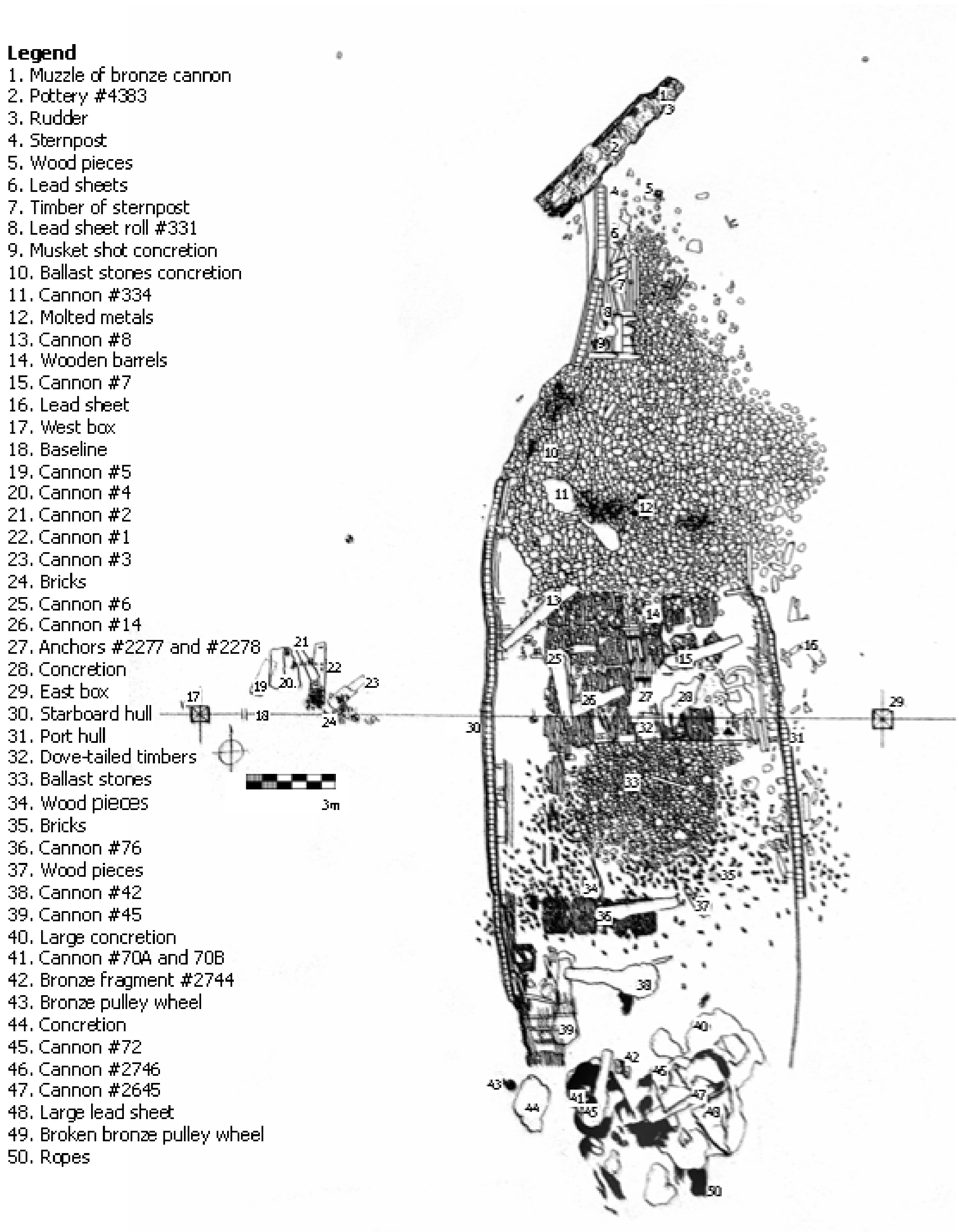


Fig. V.18 Site plan *Nassau* shipwreck. Department of Museums Malaysia.

*Nassau*'s well–preserved rudder was raised during the ship's salvage in 1995 (Fig. V.19). It is unknown what has happened to this timber since its removal from the seabed. No archaeological research has yet been conducted or published on both *Nassau* and *Middelburg*, which is unfortunate since their hulls can provide much detailed information on early seventeenth–century shipbuilding.

NEW SUNDAY TIMES, DECEMBER 3, 1995

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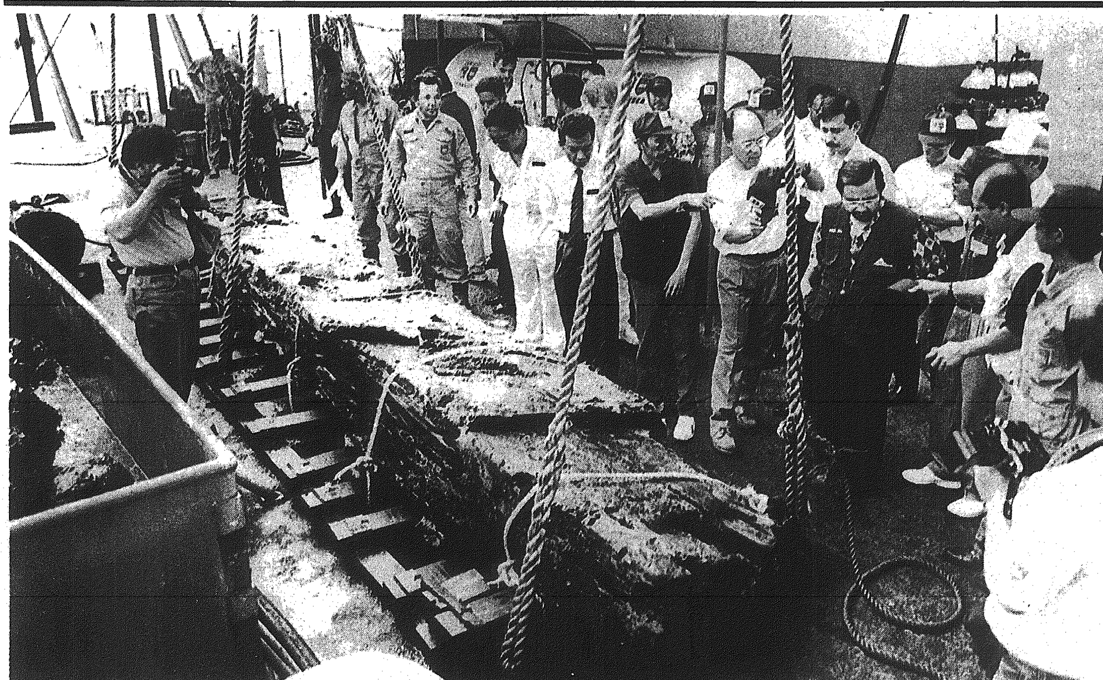

**FOUR-CENTURY-OLD FIND ... Mohamed Isa being briefed by Ong (on Mohamed Isa's right) on the progress of excavation work yesterday. — NST picture by Leong Weng Onn.**

# No decision on salvaging Dutch galleon

PORT DICKSON, Sat. — The decision to bring up the wreckage of the *Nassau*, a 400-year-old Dutch galleon which sank nearly four centures ago at Bambek Shoel, eight nautical miles off Port Dickson, will only be made after the final report on the matter has been studied.

Muzium Negara Antiquity Department acting director Paiman Keromo said the decision would only be made next April once the final report on the archaelogical excavation work was completed.

The vessel which sank in August 1604 is being explored by Transea (M) Sdn Bhd, a local salvage company, in collaboration with Britain's Oxford University and Universiti Kebangsaan Malaysia.

They are being assisted by the national museum's Antiquity Department.

Paiman said this after Menteri Besar Tan Sri Mohamad Isa Abdul Samad's visit to the excavation site today.

Mohamad Isa was briefed on the progress of work by Transea director Ong Soo Hin and Oxford University director of marine archaeology Mensun Bound, who is leading the excavation.

"We have not decided whether to bring up the wreckage. A decision will only be made next April.

"We must make a proper assessment whether it is all right to bring up the wreckage as it may not be practical. The wreckage is now four centuries old. We must be really sure that we can retain its originality.

"As for now, we will collect all data on the artifacts to complete our reports," he said at the excavation site.

Over 3,000 items have been brought up since excavation work started in mid-August.

They include 16 ancient cannons, porcelain ware, coins, musket shots and other items used in a sea battle with the Portuguese.

The excavation work which cost RM3.33 million is being funded by the Government.

Historical records show that the *Nassau*, together with another vessel *Middleburg*, sank there when a Dutch fleet of 11 ships went into battle with a Portuguese armada of 70 vessels.

Two Portuguese galleons were lost in the battle along with about 600 men.

Fig. V.19 *Nassau*'s rudder raised from the seabed. *New Strait Times*. 3 December 1995.

**Dutch East Indiaman *Mauritius* (1609)**

The Dutch East Indiaman *Mauritius* first sailed to the Indies for the Amsterdam Chamber of the VOC in June 1602 as one of the fourteen ships of Wybrand van Warwyck's fleet.[108] It was an East Indiaman with a length between 140 and 160 Amsterdam feet (40–45 m) and a capacity of about 700 tons.[109] The ship was subsequently purchased upon return from the Indies by the VOC for 23,500 guilders in the autumn of 1604.[110] At the same time, the smaller yacht *Witte Leeuw* was purchased for 55,000 guilders. This difference is surprising, since *Witte Leeuw* is a smaller vessel, at only 540 tons. Moreover, it is specifically mentioned that *Witte Leeuw* "had only been to the Indies once before."[111] The low price for *Mauritius* suggests that the vessel was already quite old at this time.[112] If this is true, the ship cannot have been built in 1601 or 1602 on an Amsterdam shipyard as published by L'Hour, Long, and Rieth.[113] It is likely to have sailed to the Indies before it was accessioned into VOC–service in 1602, and *Mauritius* may even have been the same ship that had sailed to the Indies three times

Fig. V.20 VOC ship *Mauritius* as part of the so–called Malacca fleet under command of Admiral Cornelis Matelief de Jonge. Battle of Rachado, Straits of Malacca, 1606. Detail of manuscript drawing, Museum Meermanno–Westreenianum, The Hague (MMW 74 A 6).

before since 1595 (Fig. IV.4). The early *Mauritius* was listed as a 460–ton ship built in 1594, but it may have been rebuilt and enlarged by the VOC in 1602 as was done more often with newly–acquired ships (Chapter VI).[114]

A contemporary manuscript drawing of *Mauritius* details the ship with other VOC ships of the so–called Malacca fleet. This fleet, under the command of Cornelis Matelief de Jonge, encountered the Portuguese in the Battle of Cape Rachado in 1606 (Fig. V.20, see paragraph *Nassau*). On 27 December 1607, *Mauritius* set sail from Bantam to Patani to take over the cargo of a Portuguese prize–ship.[115] For its homebound voyage, it was loaded with 120 tons of pepper, sugar, and gum–benzoin. It was, however, not until 8 September 1609 when news reached Amsterdam that some survivors of *Mauritius* had just arrived in Texel. A clerk who sailed with *Mauritius* recorded its last voyage and from his account we know that it ran aground and broke to pieces near Cape Lopez on the West African coast on 19 March 1609. The wreck of

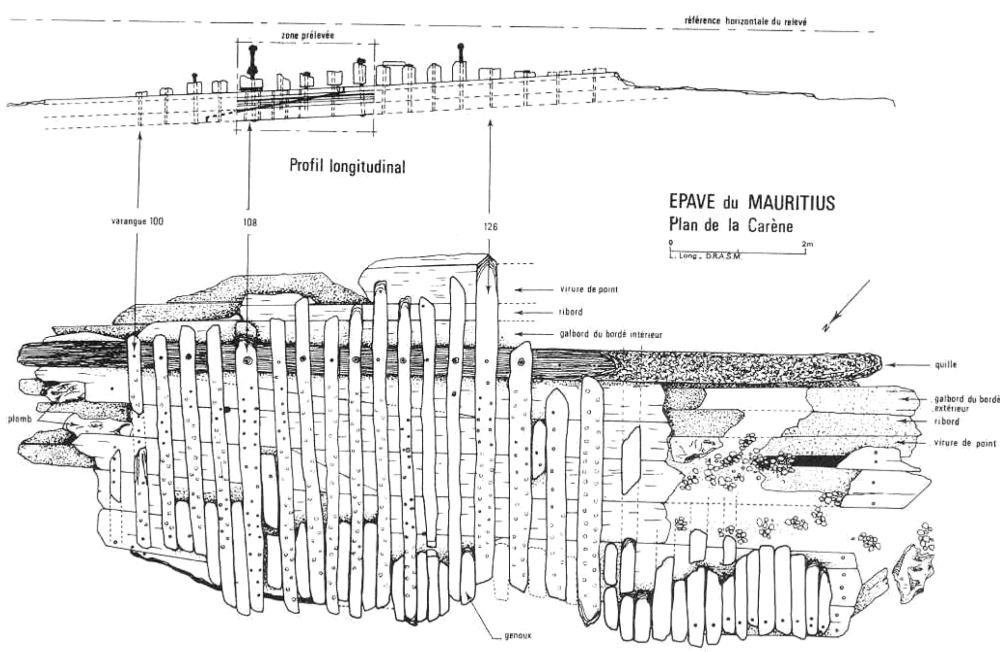


Fig. V.21 Site plan of Dutch East Indiaman *Mauritius*' shipwreck. Illustration: Luc Long and Michel Rival (Michel l'Hour, Luc Long, and Eric Rieth, *Le Mauritius: la mèmoire engloutie*, 198–99). © CASTERMAN S.A.

*Mauritius* was discovered in 1985 by the French oil company Elf–Gabon during bathymetric prospecting. Elf–Gabon subsequently sponsored two excavation campaigns in 1986, which were directed by the Département des recherches archéologiques subaquatiques et sous–marines (DRASSM).[116]

Of *Mauritius*' hull structure only a small section, including 24 floors and 22 futtocks, is preserved, which measures 13 m to 15 m in length and 4 m to 6 m in width (Fig. V.21).[117] The floors are consistently 0.3 m molded at the keel. The molded dimension tapers to 0.25 m about three meters away from the keel. Their average sided dimension varies from 0.18 m to 0.34 m. The futtocks are 0.25 m molded and 0.15 m to 0.2 m sided.[118] The oak floors and futtocks, like those of *Batavia* and Scheurrak SOI

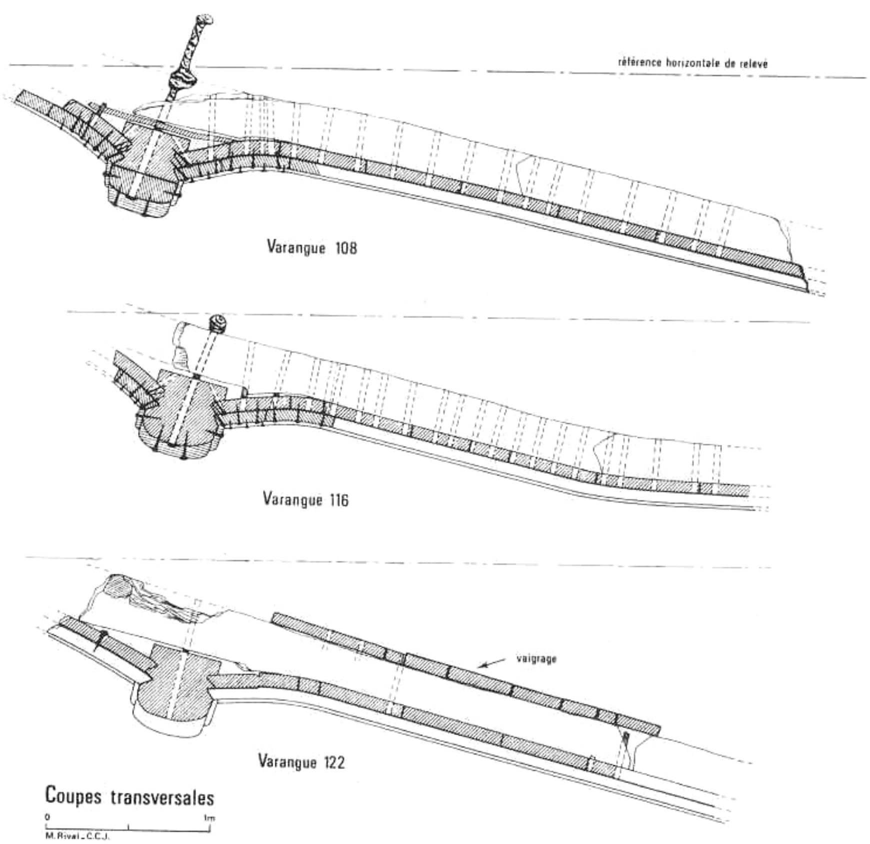


Fig. V.22 Cross–sections of the *Mauritius* ship's hull at frame 108, 116, and 122. Illustration: Michel Rival (Michel l'Hour, Luc Long, and Eric Rieth, *Le Mauritius: la mèmoire engloutie*, 200). © CASTERMAN S.A.

ships, are not fastened to each other but treenailed to the hull planking. The hull planking consists of two layers of oak planks that average 0.14 m in total thickness (0.07 m per strake). The two layers comprising the garboard strake are each 0.09 m thick, and those of the second strake 0.08 m. Like *Batavia* and Barents' ship, the outer layer of planking is fastened to the inner layer with iron spikes.

In addition to the double layer of hull planking, a thin layer of pine sheathing (*Pinus sylvestris*, 0.03 m in thickness) was fastened to the hull with iron nails. Furthermore, a thin layer of lead sheathing was placed between the two layers of hull planking, and between the outer hull planking and pine covering.[119]

The oak keel, consisting of three pieces of timber scarfed together, has a molded dimension of 0.42 m to 0.43 m and a sided dimension from 0.39 m to 0.42 m. It has a double rabbet, like the Scheurrak SOI and Christianshavn B&W 2 ships, to accommodate the two layers of hull oak planking. The ship's planking is sheathed with a layer of pine below its waterline.[120] The angle of the upper rabbet is about 60 degrees, and the lower one 75 degrees (Fig. V.22). The garboard strakes of Dutch ships are usually angled, as illustrated by the Scheurrak SOI (1590s) and Scheurrak T24 (post–1655) ships.[121] According to Witsen, this is important, as water can be pumped out easier when the garboard strakes have some angle (Fig. II.13).[122]

**Yacht *Vergulde Draak* (1656)**

The shipwreck of *Vergulde Draak* was the first Dutch East Indiaman to be discovered in Australian waters, and was the first major shipwreck selected for archaeological excavation by the Western Australian Museum. Excavations were begun in 1972 under the direction of Jeremy Green. The wreck site was revisited and the excavation resumed in 1981 and 1983.[123]

*Vergulde Draak* sank on its second voyage to the Indies when it ran onto an off–shore reef, 120 km north of Perth, along the Western Australian coast.[124] The 260–ton ship was bought by the VOC Chamber of Amsterdam in 1653.[125] The acquisition of the ship was approved on 24 January 1653, after it was inspected by two representatives of the Chamber, Mr. Roch and Mr. Haes. It was probably not new, as it is specifically mentioned that the *newly–bought* ship was at anchor in Zaandam, whereas the VOC archives generally refer to a *newly–built* ship if it was indeed only just constructed.[126] Moreover, the low price, 28,250 guilders, suggests that the ship had been extensively used.[127] The ship, named *Vergulde Draak* on 10 March 1653, was 137 Amsterdam feet (38.78 m) in length, 32 Amsterdam feet (9.05 m) in beam, and 13.5 Amsterdam feet (3.82 m) in height (plus 7 Amsterdam feet —1.98 m— above the upper deck).[128]

Unfortunately, no intact structure of *Vergulde Draak*'s hull was found during any of the three excavation seasons.[129] Fragmentary pieces of the ship's timbers were recovered from the site, and were listed in the 1977 publication as wooden objects recovered from the shipwreck site.[130] After the 1972 excavation, only a frame, some

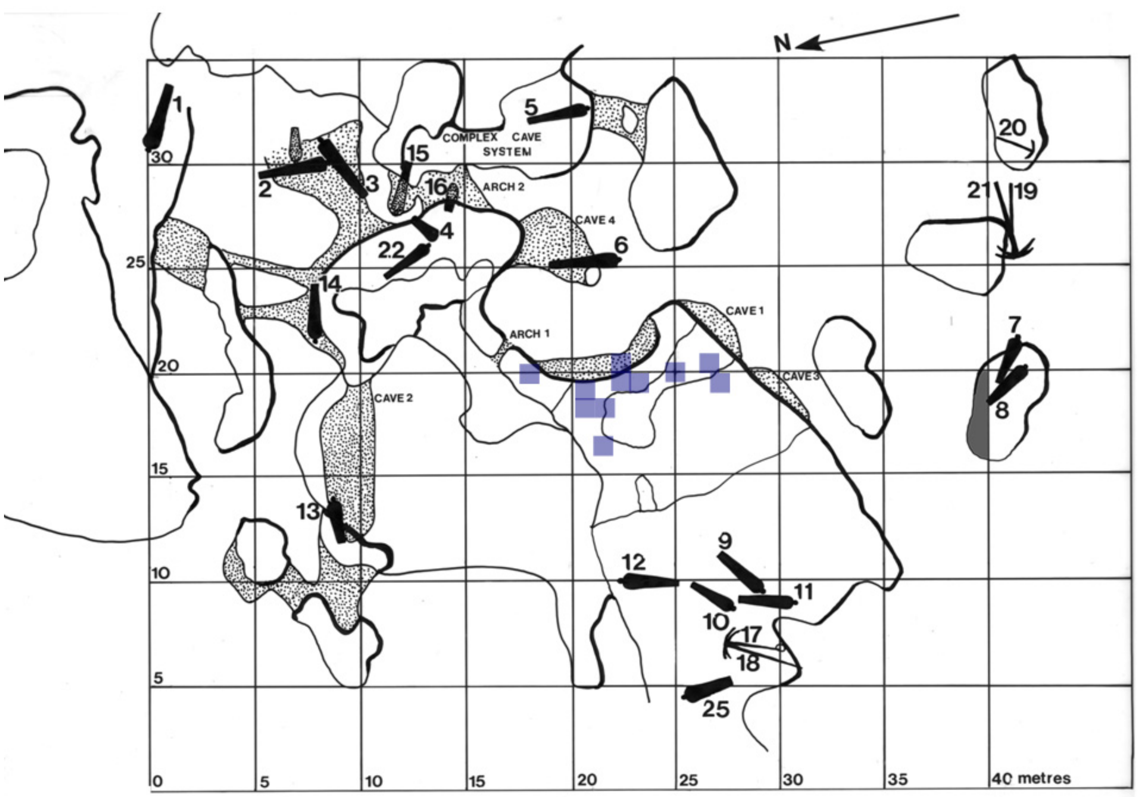


Fig. V.23 *Vergulde Draak* shipwreck site, showing location of the ship's fragmentary timbers. Plan: After J. Cowen, G. Brenzi, R. Sonnerman, and W. Anderson, 1966.

hull planking, and a knee could be identified among the excavated hull remains.[131] Additional fragments of ship timber were raised during the later excavation seasons. Most of these timbers were raised in the areas of the overhanging rocks near Cave 1 and Cave 3 on the site (Fig. V.23).[132] *Vergulde Draak*'s hull remains were so sparsely preserved and disarticulated that they were not recorded *in situ* and initially no attempts were made to study and reconstruct them. Nonetheless, the numerous fragments raised during all three excavation seasons have been conserved (Fig. V.24).

Fig. V.24 *Vergulde Draak* ship's timbers in conservation desalination tank after shipwreck's first excavation, May 1972. Photograph: Patrick Baker, Western Australian Museum.

In June 2007, an intensive study of *Vergulde Draak*'s hull remains was commenced under the direction of the author.[133] To date, 141 diagnostic registered lots of *Vergulde Draak* hull timber have been cleaned, catalogued, and, if representative, photographed and drawn (Fig. V.25).[134] These lots include 482 fragments of the ship's hull timbers, mainly comprising hull planking, frames, sacrificial planking or sheathing, and treenails (Figs. V.26–V.29). The *Vergulde Draak* timbers are, however, poorly preserved and its wood more worm–riddled, degraded, warped, and longitudinally cracked than *Batavia*'s timbers.

Eleven timbers and wooden fasteners have been sampled and analyzed for wood identification. The results have shown that at least two different genii of wood were used in the construction of the *Vergulde Draak*; all structural timbers sampled were made of oak, *Quercus* sp. (Table V.2). The sacrificial planking or sheathing of *Vergulde Draak*'s hull was made of pine, most likely *Pinus sylvestris* (Table V.2).[135]

Table V.2 Wood identification of *Vergulde Draak*'s hull timbers.

| **Catalog No.** | **Sample Taken From** | **Wood Species** |
|---|---|---|
| GT 61 | Sheathing (sacrificial planking) | *Pinus* sp. |
| GT 98 | Sheathing (sacrificial planking) | *Pinus* sp. |
| GT 1386 D | Treenail from frame | *Quercus* sp. |
| GT 1386 L | Sheathing (sacrificial planking) | *Pinus* sp. |
| GT 1386 M | Hull planking | *Quercus* sp. |
| GT 1386 N | Hull planking | *Quercus* sp. |
| GT 1386 P | Treenail from frame | *Quercus* sp. |
| GT 1386 P | Frame | *Quercus* sp. |
| GT 6020 | Sheathing (sacrificial planking) | *Pinus* sp. |
| GT 6095 | Treenail from hull or ceiling planking | *Quercus* sp. |
| GT 6166 | Hull planking | *Quercus* sp. |
| GT 6167 | Nail plug from hull planking | *Quercus* sp. |

None of the fragments of hull planking are preserved over their entire length or width, and the maximum preserved length is 0.91 m and width 0.45 m. The average thickness of the hull planking is 0.09 m and one fragment of a wale is 0.148 m in

Fig. V.25 The author (left) and conservator Maggie Myers (right) cataloging and cleaning the *Vergulde Draak* ship's timbers in the conservation wet laboratory, Shipwreck Galleries, Western Australian Museum, Fremantle, August 2007. Photograph: Patrick Baker, Western Australian Museum.


Fig. V.26 Fragment of hull planking of VOC ship *Vergulde Draak*, GT 6166. Photograph: Patrick Baker, Western Australian Museum.


Fig. V.27 Fragment of frame wood from VOC ship *Vergulde Draak*, GT 1386 P. Photograph: Patrick Baker, Western Australian Museum.


Fig. V.28 Fragment of pine sheathing from VOC ship *Vergulde Draak*, GT 1386 L. Photograph: Patrick Baker, Western Australian Museum.


Fig. V.29 Frame timber from VOC ship *Vergulde Draak*, GT 6164. Photograph: Patrick Baker, Western Australian Museum.

thickness (GT 6012).[136] This planking thickness is consistent with the shipbuilding charter for merchant yachts dating to 24 May 1653. In this charter, the prescribed thickness for the ship's hull planking is the 3.5 Amsterdam thumbs (0.09 m) up to the lowest wale (Appendix A: Charter of a merchant yacht also to be used in war).

Four fragments of hull planking show that they were joined to other planks with flat scarfs.[137] The ends of these flat scarfs were nailed down with iron fasteners, square in section, to strengthen the joint between scarf ends.[138] These nail holes have an average cross–section of 0.008 m, and the diameter of one preserved rounded nail head impression is 0.026 m.

The better–preserved fragments of *Vergulde Draak*'s hull planking all have closely–spaced nail holes on their exterior surfaces, 0.04–0.07 m apart, in a quincunx pattern. The nail holes were left behind by iron sheathing nails that would have fastened the ship's pine sheathing to the hull planking; the nails had square shanks with an average cross–section of 0.004–0.005 m (Fig. V.30, GT 6166).

Interestingly, the hull planking shows no sign of iron nails being used to fasten the outer layer to the inner layer of planking (as seen on Barents', *Batavia, Mauritius*, and Christianshavn B&W 2 ships). Instead, treenails were the primary fasteners of the hull planking as seen on the inner layers of hull planking of all ships listed (and the outer layer of hull planking of the Scheurrak SOI and Angra C ships).

The average diameter of the treenails found in the *Vergulde Draak*'s hull planking, frame fragments, and individual treenails raised from the shipwreck site is 0.032 m. These treenails are not perfectly circular as a result of their manufacture; they were fashioned from oak and not turned on a lathe. Archaeological evidence has demonstrated that treenails split out of oak were used in the construction of many northwestern European ships dating to the post–medieval period. They include seventeenth– and eighteenth–century ships such as *Mauritius*, *Batavia*, Christianshavn B&W 2, Angra C, *Nieuw Rhoon*, but also of later ships such as the nineteenth–century English–built merchantman found in the Netherlands (SL4) that was used in coal trade with Rotterdam.[139]

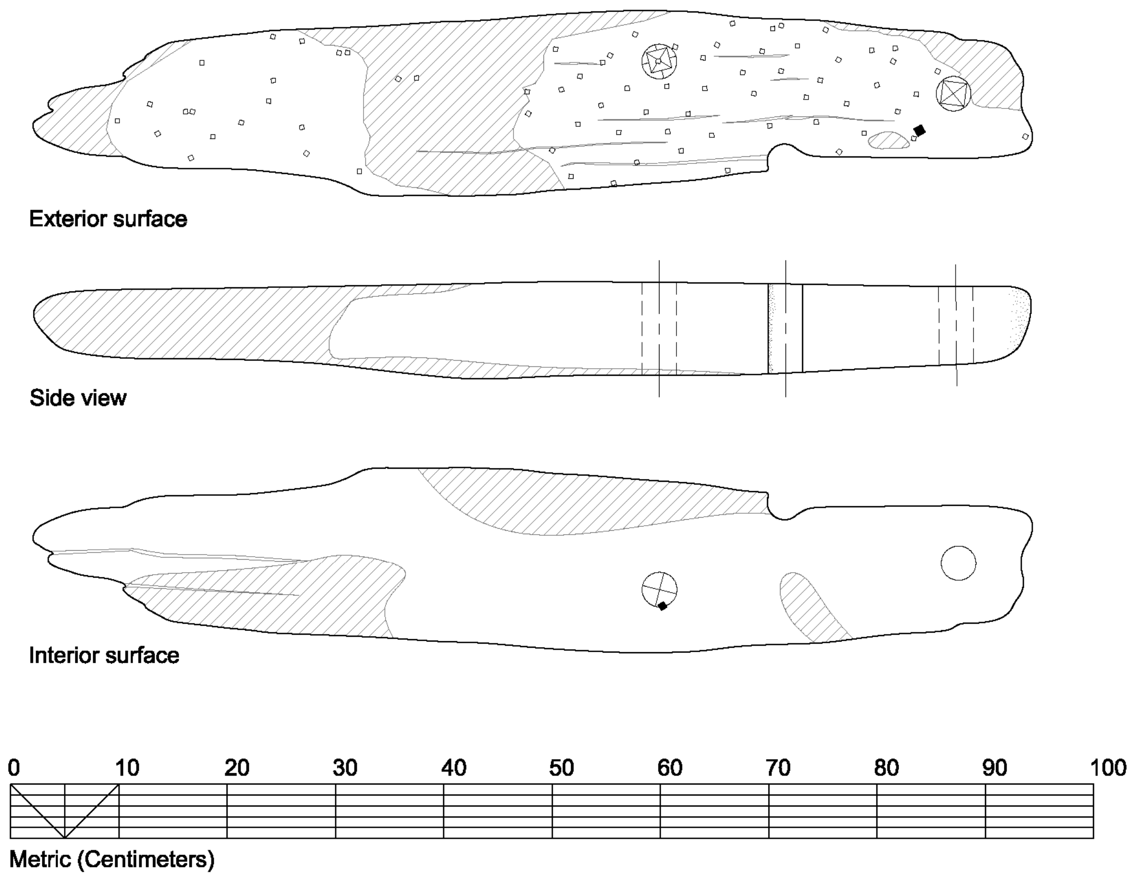


Fig. V.30 Fragment of hull plank from VOC ship *Vergulde Draak*, GT 6166. Illustration: Jessica Berry/Wendy van Duivenvoorde.

No examples of complete treenails from *Vergulde Draak* have been found that are preserved over their entire length. The longest preserved treenail, not seated in a timber, is 0.205 m in length and is pegged with a square peg on its intact end (Fig. V.31, GT 6030 B). To date, twenty–two pegged treenails and three treenail pegs have been identified and, if still seated in hull planking or have sheathing nail holes preserved, they indicate that their pegs were driven into the treenails on the planking's exterior surface (Figs. V.30–32). The pegs have an average width of 0.02 m at their top surface; they taper to a point over an average length of 0.046 m (max. l. 0.05 m).

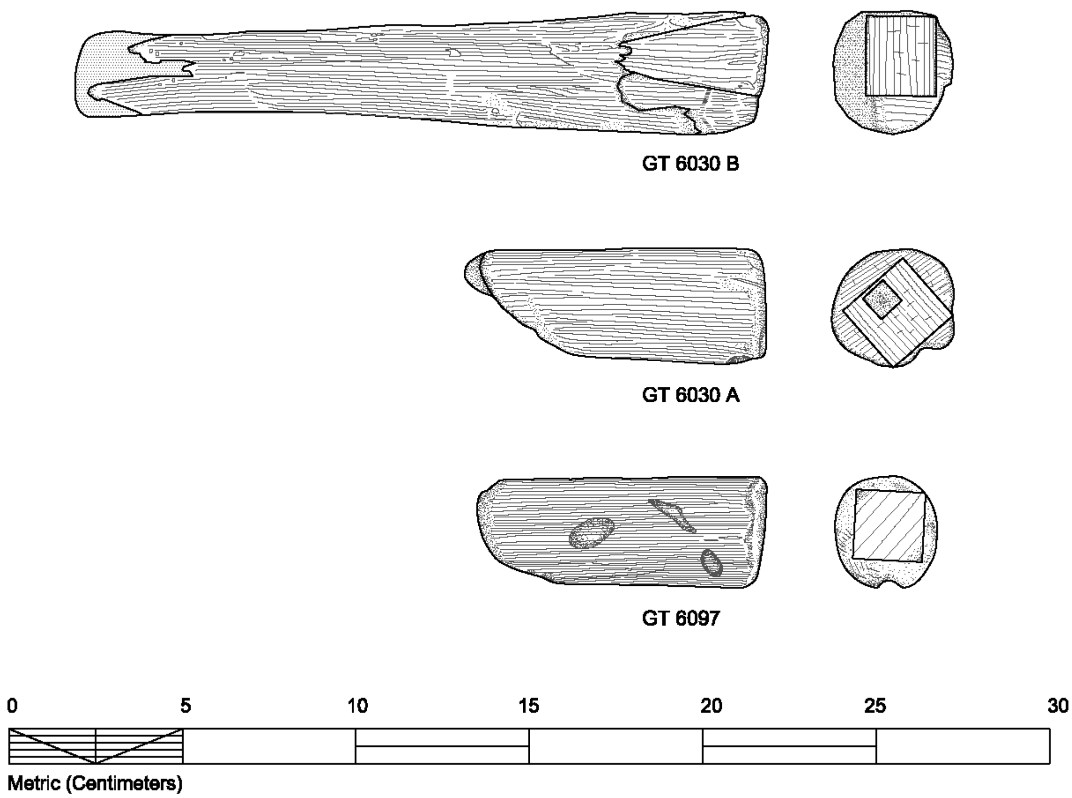


Fig. V.31 Pegged treenails from VOC ship *Vergulde Draak*, GT 6030 B, GT 6030 A, GT 6097. Illustration: Wendy van Duivenvoorde.

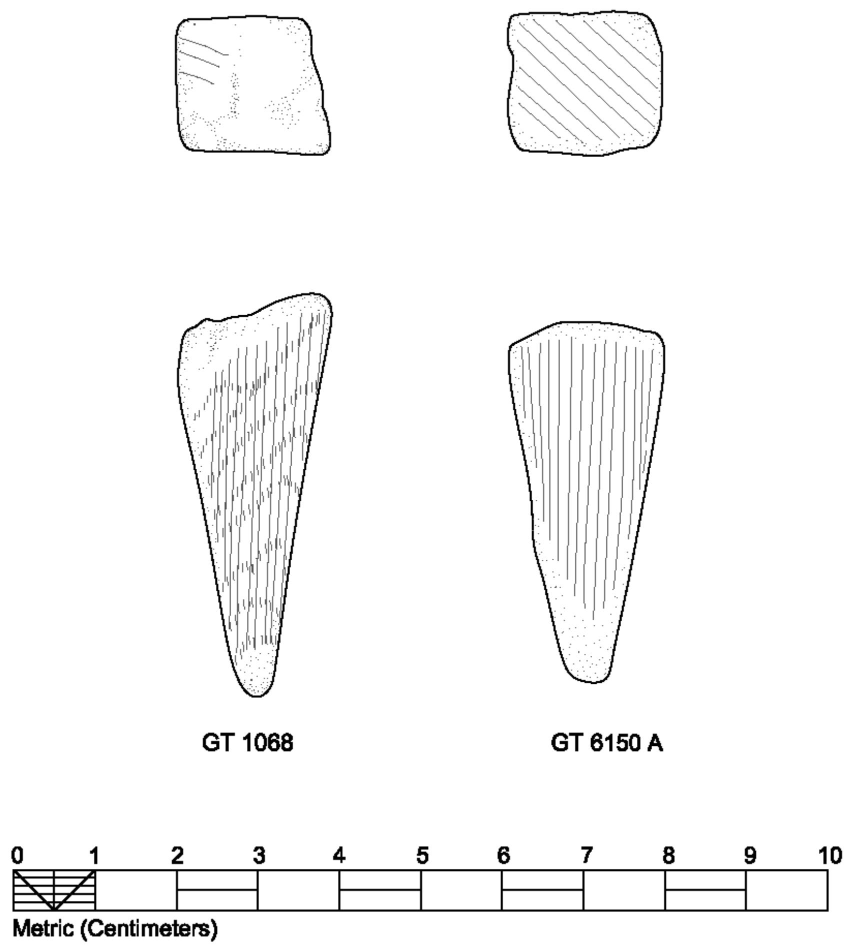


Fig. V.32 Treenail pegs from VOC ship *Vergulde Draak*, GT 1068, GT 6150 A. Illustration: Wendy van Duivenvoorde.

Several wooden nail plugs were found on the interior and exterior faces of poorly–preserved fragments of oak hull planking that all show clear sheathing nail holes on their exterior faces (Fig. V.33, GT 6142 P). One nail plug was removed from hull plank GT 6167; it is preserved over a length of 0.02 m and has a maximum cross–section of 0.006 m (Fig. V.34, Table V.2). Generally, *Vergulde Draak*'s nail plugs vary in length between 0.02 m and 0.03 m, and have an average width of 0.008 m at their top surface.


Fig. V.33 Fragment of hull planking of VOC ship *Vergulde Draak*, GT 6142 P, location of nail plugs indicated by arrows. Photograph: Wendy van Duivenvoorde.

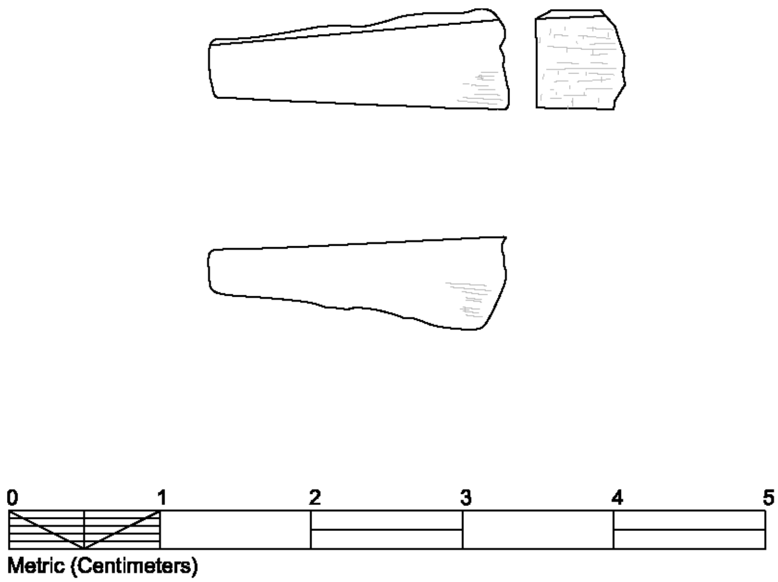


Fig. V.34 Nail plug from VOC ship *Vergulde Draak*, GT 6167. Illustration: Wendy van Duivenvoorde.

In addition, not a single fragment of hull planking from the ship's bottom has been observed *with* nail plugs but *without* sheathing nail holes on its exterior face. In fact, all fragments of hull planking studied have holes from sheathing nails on their exterior surface. This is important as it indicates that *Vergulde Draak* had no inner layer of hull planking, and, thus, was not assembled with two layers of oak hull planking. The absence of fragments from an inner layer of hull planking and the presence of nail plugs on the interior and exterior face of hull planking sheathed with pine (as indicated by the sheathing nails on its exterior), suggests that the ship was constructed in a bottom–based construction method with one single layer of oak hull planking. Furthermore, the nails used to fasten the ends of the flat scarves from the ship's hull planking together, transversally, also support a bottom–based construction method, as the scarf ends would have been nailed to the nearest frame timber if frames had been standing and not to a corresponding scarf end of the hull planking.

Treenails were used below the waterline for VOC ships throughout the seventeenth and eighteenth centuries regardless of whether they were built according to a bottom–based or a frame–based construction method, as all ships discussed in this chapter exemplify for the seventeenth century. The hull remains of, for example, the late eighteenth–century VOC ship *Buitenzorg* (1760) also have provided evidence for the use of pegged treenails below its waterline, even though this ship was built according to a frame–based construction method.[140] Even the meagre hull remains of VOC ship *Zuiddorp* (1712), which sank at the base of steep cliffs situated roughly halfway between Kalbarri and Shark Bay in Western Australia, include one pegged treenail and two fragments of pine sheathing (Fig. V.35). This pegged treenail still retains the nail hole of a sheathing nail indicating that it was used to fasten the frames to the hull planking (or vice versa) and was pegged at the exterior surface of the hull planking. It also suggests that the ship was built with one layer of oak hull planking. Certainly, the presence or lack of treenails is not sufficient evidence for a specific construction method, whether bottom–based or frame–based.

Fragments of the *Vergulde Draak* framing also confirm the use of treenails as the main fasteners to join the frames to the planking. To date, none of the frame remnants have provided evidence for lateral fastening or assembly, which suggests that the *Vergulde Draak* ship's floors and futtocks were not connected. Though evidence from the frames is sparse, their remnants do support a bottom–based method for *Vergulde Draak*'s construction.

Like *Vergulde Draak*'s planking, none of its frame timbers are preserved over their entire length or width, and the largest preserved fragment has a maximum preserved length of 1.44 m, a maximum preserved sided dimension of 0.205 m and a molded dimension of 0.165 m (Fig. V.30, GT 6164). Two treenails have been observed that are wedged with a small wedge (both 0.007 m in thickness) on the interior surfaces of two frame timbers (GT 6171 and GT 6185).

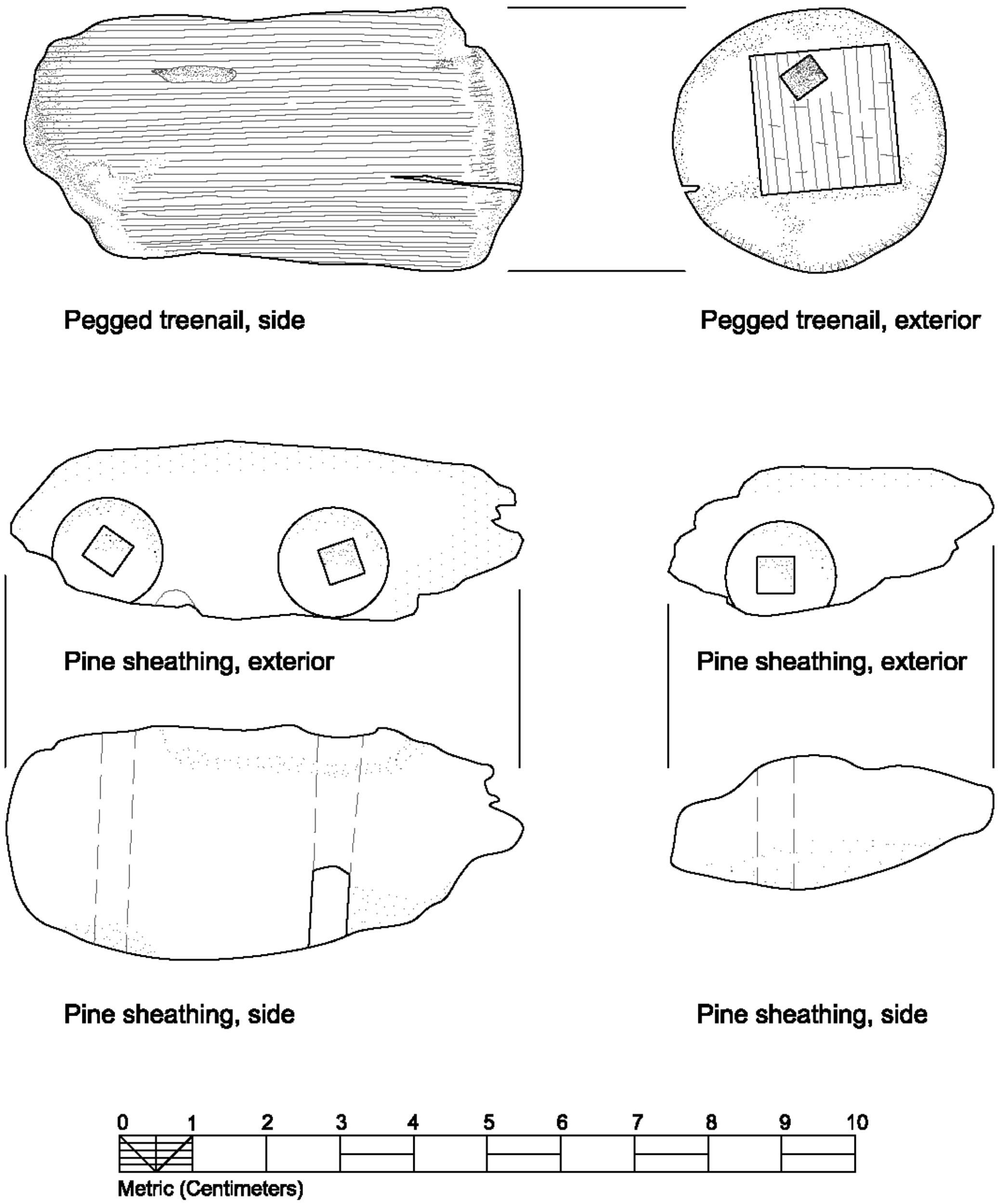


Fig. V.35 Pegged treenail and two fragments of pine sheathing from VOC ship *Zuiddorp*, ZT 4022. Illustration: Wendy van Duivenvoorde.

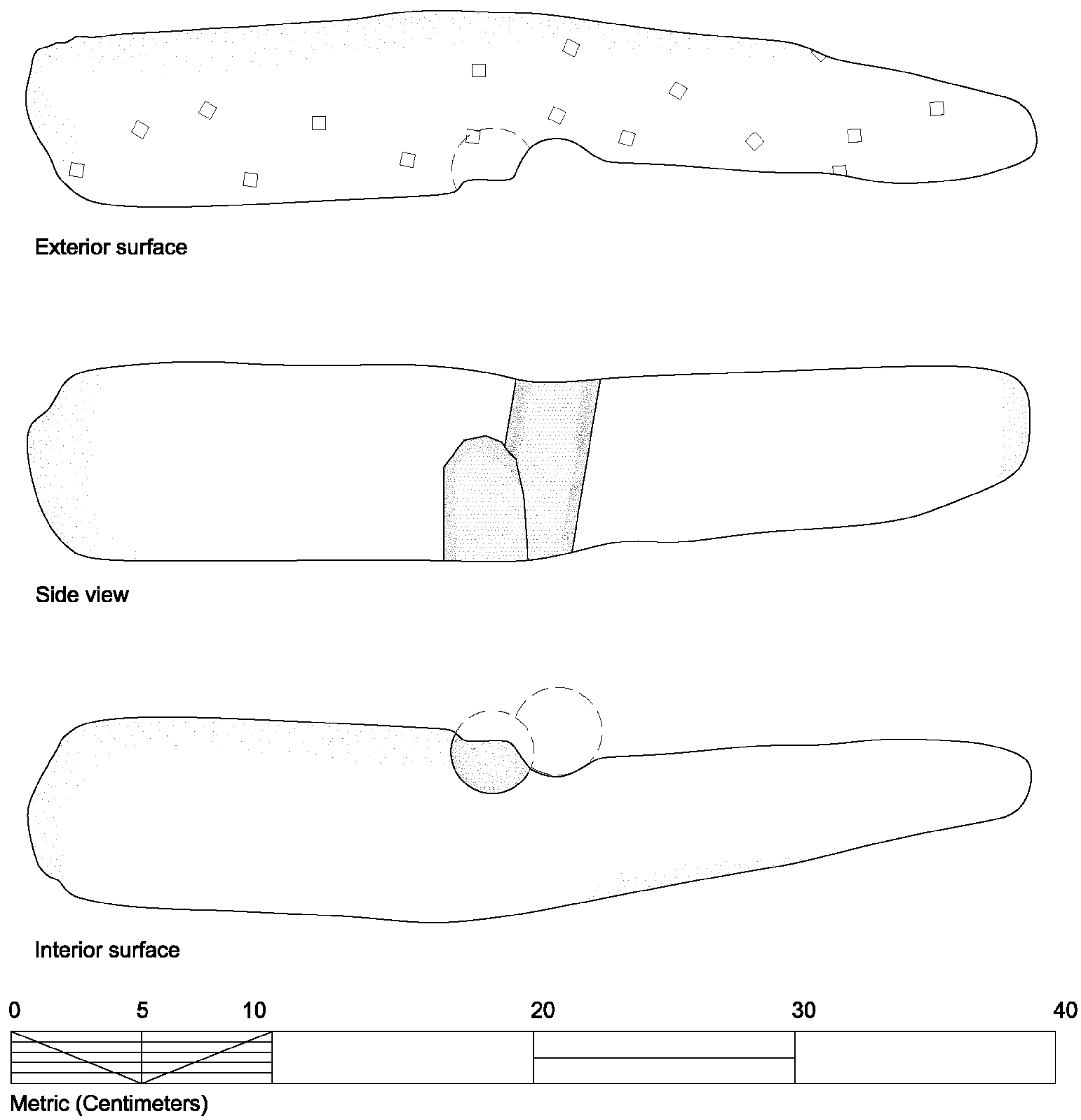


Fig. V.36 Fragment of hull plank from VOC ship *Vergulde Draak*, GT 1386 C. Illustration: Wendy van Duivenvoorde.

Several blind treenails found on the interior surface of the hull planking and frames indicate that the ceiling planking was also fastened to the frames and hull planking by treenails (Fig. V.36).[141] Generally, these blind treenails seem to be slightly smaller in diameter than the ones that were used to fasten the frames to the hull planking, as they vary in diameter between 0.027 m and 0.031 m, average 0.03 m.

Five bolts or bolt holes have been preserved in *Vergulde Draak*'s hull planking and frames that probably fastened the ship's riders to the ceiling planking, frames and hull planking. These bolts have round shanks with an average diameter of 0.022 m. Two bolt head impressions are preserved on the exterior surface of the ship's hull planking (diam. 0.036 m).

As mentioned before, *Vergulde Draak*'s pine sheathing was fastened to the ship's hull planking with iron sheathing nails. These nails had square shanks (average cross–section 0.005 m) and circular nail heads (their diameters vary between 0.013 m and 0.018 m, average 0.015 m). The average thickness of *Vergulde Draak's* pine sheathing is 0.027 m (max. pres. th. 0.038 m). Like the ship's hull planking and frames, none of the pine sheathing planks were preserved over their full length or width. The maximum preserved length of the pine sheathing fragments is 1.120 m and maximum preserved width 0.287 m (GT 6026 and GT 98 A, respectively).

Eight fragments of pine sheathing clearly show mechanical saw marks, which were mainly preserved near knots where the wood is harder (Figs. V.37–38).[142] The saw cuts of all these planks are 1.5 mm apart, which is the distance to be expected for seventeenth–century wind–driven sawing when sawing was performed by setting the mill's scroll wheel to two teeth per stroke (Figs. V.39–40).[143] Simon Jellema, the current miller of a still–operational wind–driven sawmill, *De Rat*, in IJlst in the Netherlands, that dates back to the seventeenth century, explains that the timber is placed on a sled that is pulled through the mill's sawing frame. The mechanism that pulls the sled can be set to a specific speed which influences the distance between the saw marks. With every wind–driven stroke of the mill, a *haler* draws this pre–set number of teeth through the mill's scroll wheel which then pulls the sled through the saw–frame. The number of teeth per stroke can thus be regulated. On average the movement of the sled is 0.6 to 0.7 mm per stroke (by one tooth), which, incidentally, is relatively slow. Jellema prefers to saw slightly faster, two teeth per stroke, as was done in the past. He states that this tuning should provide a distance between the saw marks of 1.5 mm. The *Vergulde Draak* timbers support his theory.


Fig. V.37 Fragment of pine sheathing, showing mechanical saw marks on lower right corner of interior surface (top) from VOC ship *Vergulde Draak*, GT 6020. Photograph: Patrick Baker, Western Australian Museum.


Fig. V.38 Detail of pine sheathing from VOC ship *Vergulde Draak*, showing mechanical saw marks, GT 1389 C. Photograph: Wendy van Duivenvoorde.


Fig. V.39 Sawing blades of a still operational wind–driven sawing mill (originally built prior to 1683), *De Rat*, in IJlst, Netherlands. Photograph: Simon Jellema, miller of *De Rat*.

Fig. V.40 Saw marks on pine joist used in the construction of sawmill, *De Rat*, in IJlst, Netherlands, sawn mechanically by wind–driven sawing mill (17 saw marks per 0.010 m), dating to 1683 or earlier. Photograph: Simon Jellema, miller of *De Rat*.

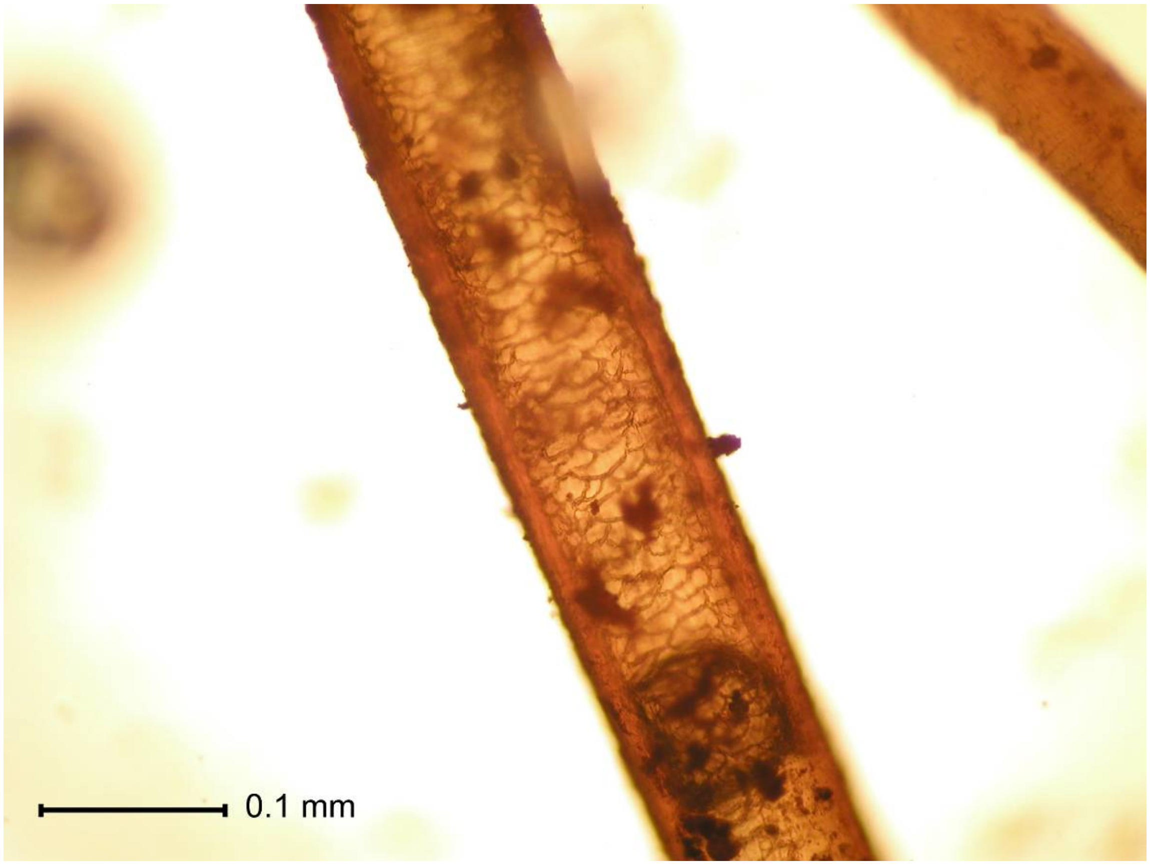


Fig. V.41 Honeycomb lattice' or 'scalloped type' of medulla of hair sample. Goat hair, *Vergulde Draak* shipwreck, GT 98B. Dissecting microscope, magnification x200. Micrograph: Mark van Waijjen, BIAX Consult.

Like the *Batavia* ship, a thin layer of animal hair (approximately 0.005 m thick) was applied between *Vergulde Draak*'s hull and sacrificial planking (Figs. V.41–43). Five samples from the hair found on *Vergulde Draak*'s pine sheathing have recently been identified as goat and one as cattle hair by Dr. Henk van Haaster, BIAX Consult, Netherlands (Table V.3).[144] In addition to the seventeenth–century hair samples of *Batavia* and *Vergulde Draak*, a sample of animal hair, removed from the pine sheathing of the eighteenth–century *Zeewijk* ship (ZW 5602), was also identified as goat hair (Fig. V.44). The *Vergulde Draak* hair identified as being from cattle are comprised

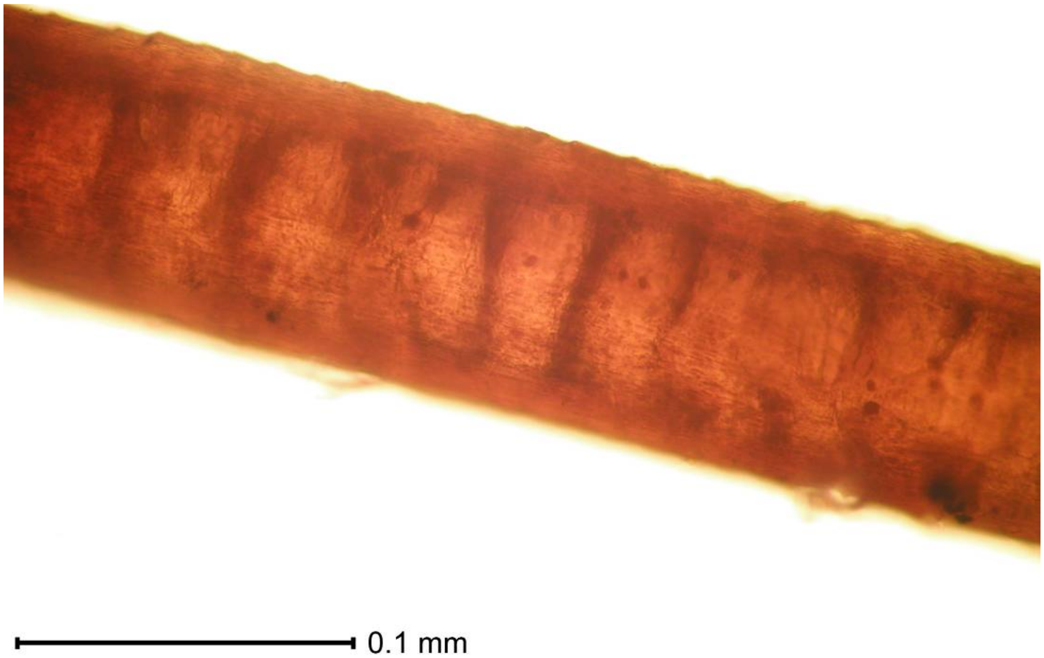


Fig. V.42 Cattle hair, *Vergulde Draak* shipwreck, GT 61. Dissecting microscope, magnification x400. Micrograph: Mark van Waijjen, BIAX Consult.

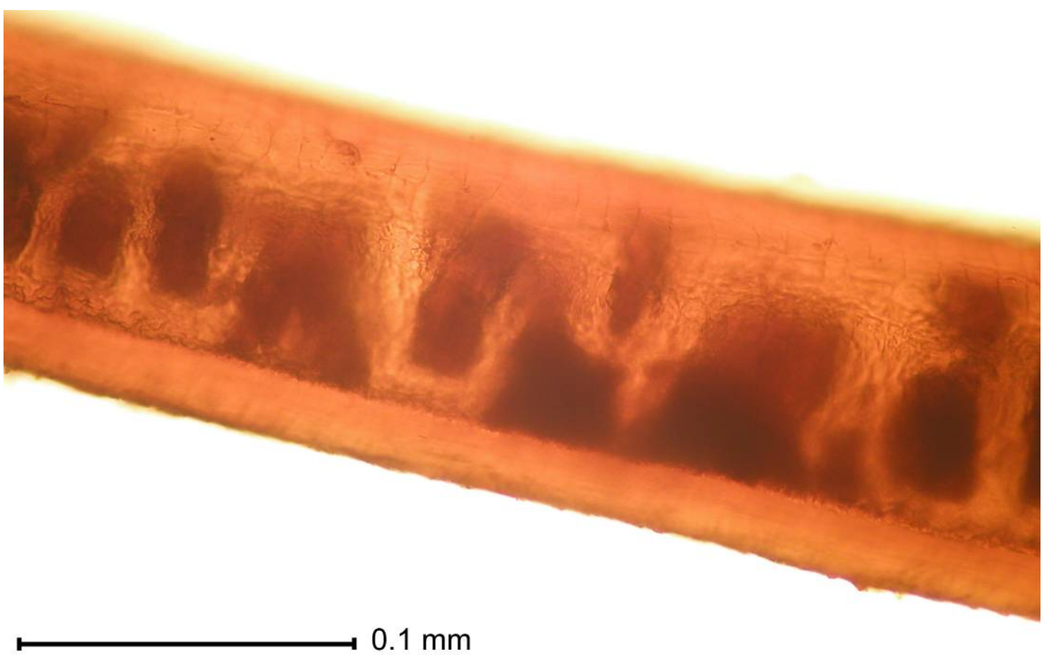


Fig. V.43 Another strand of cattle hair, *Vergulde Draak* shipwreck, GT 61. Dissecting microscope, magnification x400. Micrograph: Mark van Waijjen, BIAX Consult.

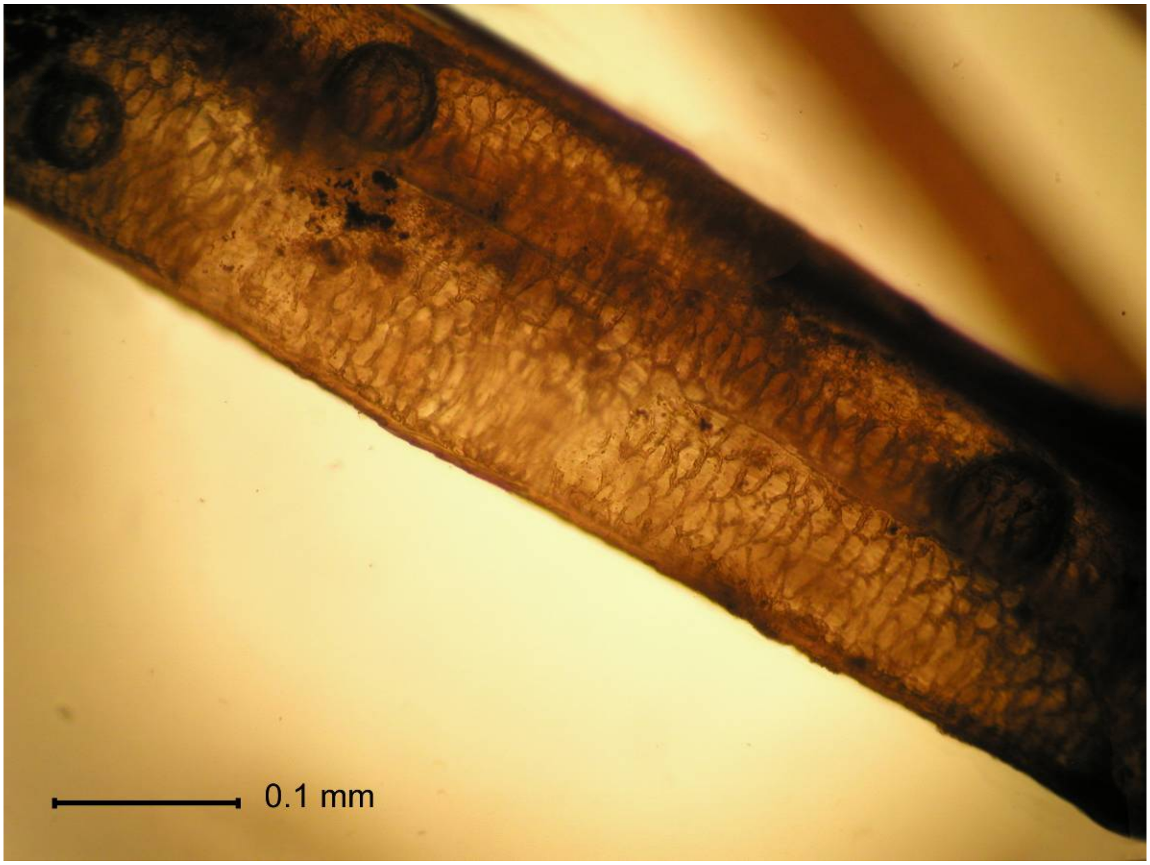


Fig. V.44 Honeycomb lattice' or 'scalloped type' of medulla of hair sample. Goat hair, *Zeewijk* shipwreck, ZW 5602. Dissecting microscope, magnification x200. Micrograph: Mark van Waijjen, BIAX Consult.

Table V.3 Results of hair identification from *Vergulde Draak*'s sheathing.

| **Catalog No.** | **Hair Sample Taken From** | **Species** |
|---|---|---|
| GT 55 | Pine sheathing (sacrificial planking) | *Capra hircus* |
| GT 61 | Pine sheathing (sacrificial planking) | *Bos taurus* |
| GT 98 A | Pine sheathing (sacrificial planking) | *Capra hircus* |
| GT 98 B | Pine sheathing (sacrificial planking) | *Capra hircus* |
| GT 98 C | Pine sheathing (sacrificial planking) | *Capra hircus* |
| GT 6020 | Pine sheathing (sacrificial planking) | *Capra hircus* |

of primary guard hairs, which clearly show the diagnostic marker for cattle hair, the so–called globular vacuoles (Fig. V.43, see 'Layers of goat hair' in Chapter IV).[145]

Additionally, it appears that *Vergulde Draak*'s sternpost was covered with copper sheathing similar to that of the eighteenth–century ship *Buitenzorg* (the ship could simply have carried old copper sheathing from another ship's sternpost as scrap). Unfortunately, all copper sheathing of *Vergulde Draak* was raised before archaeological intervention of 1972 and, hence, the exact location of the sheathing on the site is unknown. Its precise location could have helped to determine the ship's stern area, and consequently have provided a better understanding of how the ship's hull timbers relate to it.

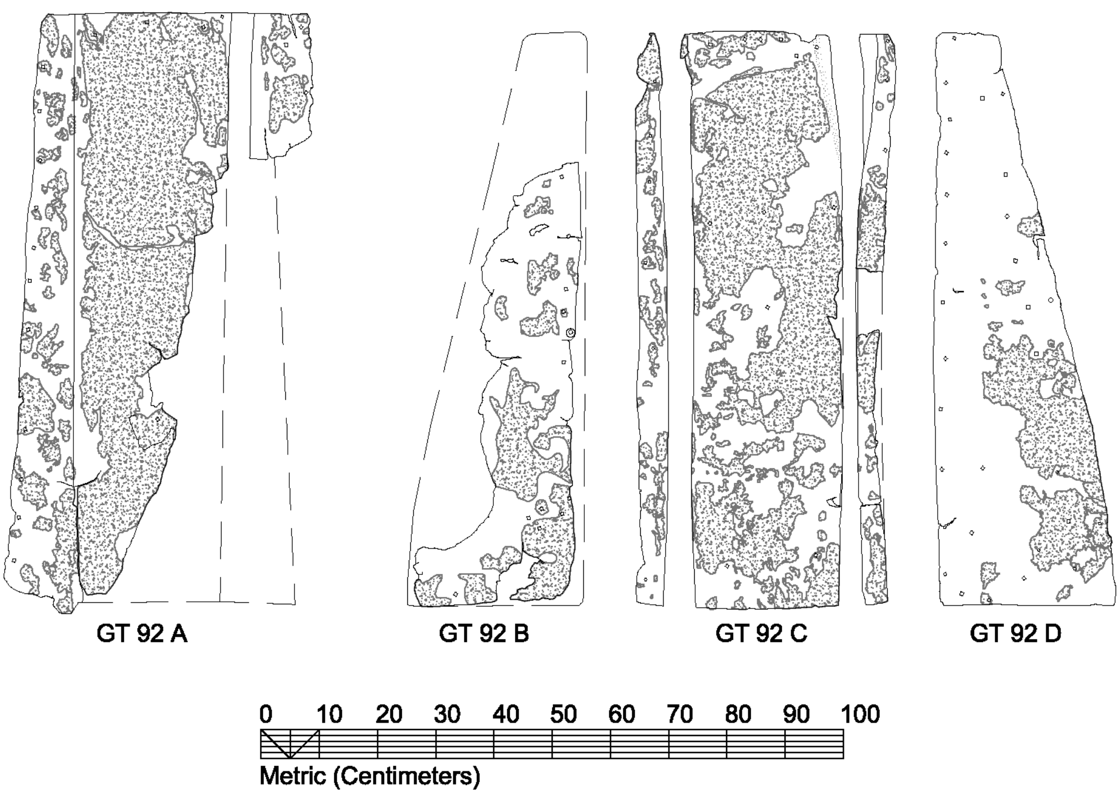


Fig. V.45 Exterior surfaces of copper sheets, possibly from *Vergulde Draak*'s sternpost sheathing, GT 92 A–D. Illustration: Wendy van Duivenvoorde.

A total of eighteen sheets of copper have been identified as sternpost sheathing from *Vergulde Draak* (GT 91, GT 92, GT 1442, and GT 3169). An isometric reconstruction drawing of the sternpost copper sheets has been previously published.[146] Two sets of these copper sheets (one with a lead lining) comprising eight of the eighteen sheets will be discussed below. Recent study of a set of four copper sheets have demonstrated that two sheets nailed on the sternpost's aft face covered one copper sheet on each side of the sternpost (Fig. V.45, GT 92 A–D).


Fig. V.46 Exterior of outer layer of copper sheathing from the *Vergulde Draak* ship's sternpost, GT 3169 A. Photograph: Patrick Baker, Western Australian Museum.

The outer layer of copper sheathing (GT 92 A) measures 1.033 m in length, 0.294 m in width at aft face (one side has a width of 0.065–0.135 m, and the other 0.09 m). The inner layer of copper sheathing (GT 92 C) measures 0.985 m in length and 0.251 m in width (plus 0.04–0.045 m for each side). One of the side sheets is preserved well (GT 92 D); it is 0.982 m in length and tapers from 0.115 to 0.31 m in width. The other side is preserved over a length of 0.758 m and has a maximum width of 0.272 m. All sheets have a maximum thickness of 0.003 m, and the cross–sections of the square shanks of the sheathing tacks vary from 0.004 to 0.006 m. No sheathing tacks have been preserved in association with these sheets.

In addition to this set of copper sheets, another set of multiple layers of copper sheathing with a lead lining of *Vergulde Draak*'s sternpost have been recovered from the shipwreck site (Figs. V.46–51, GT 1442, GT 3169 A–C). This sheathing consists of two copper sheets that fit together, and collectively form an outer layer of sheathing (Figs. V.46–47, 51, GT 3169 A–B) that is nailed over a layer of lead sheathing (Fig. V.48, GT 1442).[147] The outermost layer of copper sheathing (GT 3169 A) measures 0.780 m in length (of which the lowest 0.050 m is bent), 0.230 m in width and has a maximum thickness of 0.003 m. The layer of copper sheathing in between the outermost layer of copper and innermost layer of lead (GT 3169 B) measures 0.625 m in length, is 0.225 m in width (plus few cm for each side) and has a maximum thickness of 0.003 m. The lead sheet measures 0.705 m in length, 0.22 m in width at its aft face (plus 0.06 m in width for each side strip), and 0.005 m in thickness.

The number and arrangement of the nail holes indicate that the lead sheathing was nailed onto the sternpost or rudder first and then one layer of copper sheathing was fastened on top, followed by a second layer of copper sheathing. The nail holes on all sheets clearly indicate the interior and exterior sides of all pieces as the metal curls inwards in the direction the nails were hammered (Fig. V.49, GT 3169 A). Furthermore, a few nail head impressions are preserved on their exterior surfaces. The impressions indicate that the nail heads vary from 0.014 m to 0.016 m in diameter,


Fig. V.47 Exterior of inner layer of copper sheathing presumably from the *Vergulde Draak* ship's sternpost, GT 3169 B. Photograph: Patrick Baker, Western Australian Museum.


Fig. V.48 Interior of inner most layer of sheet lead presumably from the *Vergulde Draak* ship's sternpost, GT 1442. Photograph: Patrick Baker, Western Australian Museum.


Fig. V.49 Detail showing sheathing nail holes along edge of exterior of outer layer of copper sheet, *Vergulde Draak* ship's sternpost, GT 3169 A. Photograph: Patrick Baker, Western Australian Museum.


Fig. V.50 Adjustment patch placed in between the side of the inner and outer layers of copper sheathing of *Vergulde Draak*, GT 3169 C. Photograph: Patrick Baker, Western Australian Museum.

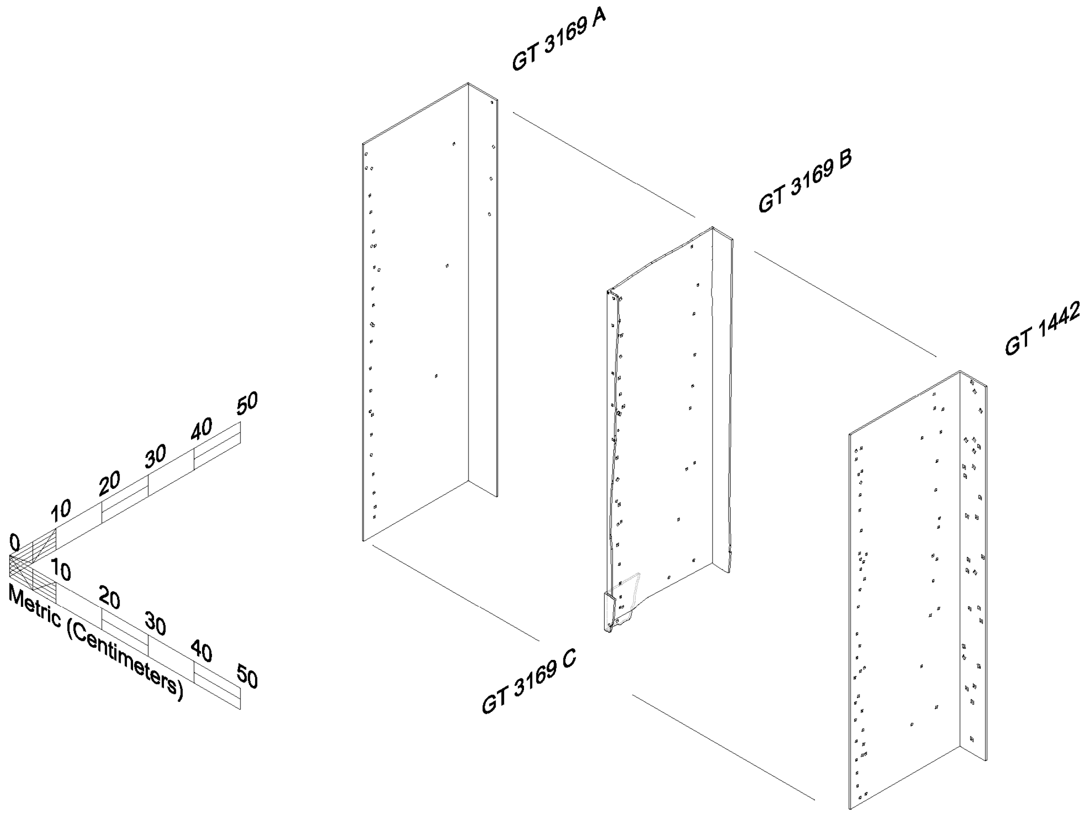


Fig. V.51 Reconstruction of multiple layers of *Vergulde Draak* sternpost sheathing, GT 3169 A–C, GT 1442. Illustration: Wendy van Duivenvoorde.

whereas the nail holes show that the cross–sectional dimension of the nail shafts vary between 0.004 and 0.006 m in width.

The copper and lead sheets cover the entire aftermost face of the post and curl around to the sides of the timber for few centimeters (the sides of the lead sheathing have a max. width of 0.06 m). The lead sheathing was fitted better around the post than the copper sheets, which were cut too short in width to provide enough coverage. In order to compensate for the lack of copper sheet on the sides, a small fragment of copper sheet (Figs. V.50–V.51, GT 3169 C) was placed at the bottom port side of the sternpost in between both the two copper layers. This small fragment of copper sheathing measures 0.078 m in length, 0.070 m in width, and 0.003 m in thickness.

A semi–quantitative chemical analysis of three samples from *Vergulde Draak*'s copper sheathing was conducted in order to approximately determine their composition (Table V.4).[148] The purity of copper varies between 91.81% and 96.60%. The high concentrations of lead are a result of cross–contamination with lead sheet, GT 1442. The copper sheathing from *Vergulde Draak*'s sternpost is, therefore, made of pure copper and not a copper alloy.

Table V.4 Results EDAX analysis of *Vergulde Draak* sternpost sheathing.

| | Wt % | | | | | At % | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Sample** | **AsL** | **FeK** | **CuK** | **PbL** | **Total** | **AsL** | **FeK** | **CuK** | **PbL** | **Total** |
| GT 3169 A | 1.15 | 0.36 | 91.81 | 6.67 | 100 | 1.02 | 0.44 | 96.39 | 2.15 | 100 |
| GT 3169 A | 0.89 | 0.12 | 93.95 | 5.04 | 100 | 0.78 | 0.14 | 97.48 | 1.60 | 100 |
| GT 3169 B | 0.67 | 0.15 | 95.93 | 3.26 | 100 | 0.58 | 0.17 | 98.22 | 1.03 | 100 |
| GT 3169 B | 0.58 | 0.12 | 95.91 | 3.39 | 100 | 0.50 | 0.13 | 98.29 | 1.07 | 100 |
| GT 3169 C | 0.30 | 1.29 | 96.15 | 2.26 | 100 | 0.25 | 1.49 | 97.55 | 0.70 | 100 |
| GT 3169 C | 0.42 | 0.20 | 96.60 | 2.77 | 100 | 0.37 | 0.23 | 98.53 | 0.87 | 100 |

Even though *Vergulde Draak*'s hull remains are scanty and not well preserved, their study has provided clues to the ship's design and assembly. It was built in a bottom–based construction method in which the ship's bottom hull planking was assembled before the frames were installed. The frames were fastened to the hull planking with wooden treenails that were pegged on their exterior end and probably wedged on their interior end. The ship's ceiling planking was fastened to the frames and hull planking with treenails, and the ship's riders were fastened to the ceiling, frames, and hull planking with large iron bolts. *Vergulde Draak*'s lower hull was sheathed with a layer of pine planking that was nailed onto the ship's planking with closely–spaced iron nails to create a teredo–worm repellent iron oxide layer. This sheathing was placed over a thin layer of goat hair mixed with a resinous substance, probably tar. In addition, *Vergulde Draak*'s sternpost was sheathed with multiple layers of copper sheet (with a lead lining). As the discussion above has shown, *Vergulde Draak*'s fragmentary hull timbers have provided significant contributory information on Dutch shipbuilding, specifically of large oceangoing ships for long–distance trade.

**Yacht *Avondster* (1659)**

*Avondster* (360 tons) sank on 2 July 1659, while at anchor at the Black Fort in the harbour of Galle, the most important harbour in Sri Lanka until the nineteenth century.[149] This old yacht was in the service of the VOC at the time of its sinking, but had previously belonged to the English East India Company.[150] Formerly known as *Blessing,* the ship was captured in Persian waters during the first Anglo–Dutch War in 1653 and re–named *Avondster*.[151] It is not known exactly when the ship was built, but in *A Calender of the Court Minutes of the East India Company, 1640–1643,* it is noted that the English East India Company bought the ship *John and Thomas* on 6 November 1641 and re–named it *Blessing*.[152]

On 25 March 1653, *Blessing* was attacked by three Dutch ships and was taken as a prize.[153] The ship was dispatched to Batavia carrying the flag of the VOC and a new name, *Avondster*. According to Robert Parthesius, the VOC's decision to call the ship *Avondster* ('Evening Star' in English) suggests that the ship was seen as an aged vessel at the end of its working life. In the Dutch archives, newly–acquired *Avondster* is often referred to as leaky and un–seaworthy. *Avondster* set sail once to the Netherlands in 1654 where it may have been extensively refitted.[154] It left the Netherlands on 13 March 1655, and after its arrival in Batavia on 8 December 1655, it primarily sailed in Asian waters in service of the VOC until it wrecked in June 1659 while at anchor near the Black Fort in Galle, Sri Lanka.

The tonnage of *Blessing* was approximately 260 tons when in service of the English East India Company. It is mentioned twice in *The English Factories in India, 1642–1645*: first, on 14 and 19 February 1642: "To Bantam they have sent a ship of 250 tons, called the *Blessing*," and then, on 30 October 1643: "the *Blessing* (260 tons)."[155]

The Dutch, however, referred to *Avondster* as a 360–ton yacht, which may indicate that they refitted the ship.[156]

Since 2000, the shipwreck has been excavated by the Sri Lankan Maritime Archaeology Unit under the direction of Robert Parthesius.[157] Research on the artifacts and hull remains is ongoing, and a preliminary study of the ship's exposed *in situ* hull structure was recently published by Christian Murray in the final excavation report.[158]

The hull structure is preserved exceptionally well considering the wrecks' shallow depth and position in the surf zone close to shore.[159] *Avondster*'s hull settled on the seabed with a 34–degree list to starboard and is preserved up to the upper deck on the starboard side, whereas the port side has only been preserved up to 2.5 m beyond the centerline.[160] Its main hull structure covers an area about 30 m in length and 8.6 m in width.[161] Generally, sections of the ship's hull planking and the ends of its futtocks and floors are protruding from the sandy seabed. The after section of the hull is almost entirely covered with sand, except for two large deck beams on the ship's port side. The stern section of the hull was found separately, about 12 m away from the main hull, which corresponds to contemporary accounts of the ship breaking in two at the stern. This section consists of a part of the ship's sternpost, keel, and associated planking, and it measures 7.5 m in length.[162]

Recent study of *Avondster*'s timbers, mainly directly aft of amidships near the galley, has shown that the ship's outer hull consists of three layers of planking, two of elm planking (each about 0.08 m in thickness) and an additional layer of pine sheathing, varying between 0.05 m and 0.08 m.[163] It is likely that *Avondster* was doubled with an extra layer of hull planking and an additional layer of pine sheathing in 1654 when it was refitted according to VOC standards in Holland to make it fit for tropical waters.[164]

The thickness of *Avondster*'s planking diminishes by one quarter in the ship's stern in comparison with the thickness amidships.[165] Murray explains that *Avondster*'s hull planking may have been thinner aft to facilitate the more pronounced curvature and bending of the planks in the ship's stern (and run into the sternpost).[166] Although Murray seems to refer to the ship's hull planking at the stern (no exact location is provided), it is known that transom planking could be one–third thinner than the hull planking.[167]

Preliminary observations from *Avondster*'s bow area suggest that two layers of pine sheathing were used here. Additionally, the ship's stem seems to have been sheathed or encased with a layer of pine sheathing (see Chapter VI, section 'Pine or fir sheathing').[168]

*Avondster*'s pine sheathing was attached to the hull with iron sheathing nails in a quincunx pattern. The sheathing nails have a square cross–sectional dimension varying from 0.005 m to 0.006 m.[169] This cross–sectional dimension is similar to that of *Batavia*'s sheathing nails and all ships discussed above.

Fifteen frame ends on the port side, most likely comprising floors and first futtocks based on their proximity to the centerline, and eleven on the starboard side, possibly second and third futtocks, were studied *in situ*.[170] The sided dimension of the frames near centerline varies from 0.10 m to 0.33 m. No molded dimensions were taken but Murray does mention that the layers of hull planking and sheathing were thicker than the frames.[171] A few wood samples from the frames have been identified as oak.[172] A positive identification of the individual frame timbers and their assembly, however, cannot be made as they are covered by ceiling planking and, on the ship's port side, the keelson. Murray suggests that the ship was constructed with double frames, a practice that came into use much later, some time in the third quarter of the seventeenth century, for the construction of English men–of–war (*Avondster* was a merchant vessel built half a century earlier).[173] Murray exemplifies his hypothesis with a drawing of the port side frames timbers, which he earlier suggested possibly comprise paired floors and futtocks (Fig. V.52). His drawing may however simply show standard frame timbers with floor timber heads and futtock heels exposed under water.

In addition, the remains of a rider were observed on the ship's starboard side, which was bolted to the hull. Oddly, Murray states that "it is commonly asserted that merchant ships had no riders since they reduced capacity."[174] Ships carrying heavy guns, however, such as the yachts and Indiamen in service of the VOC, would certainly have had riders, as supported by the archaeological examples of *Batavia*, Christianshavn B&W 2, *Mauritius*, and Scheurrak SOI the ships (Fig. V.4).[175] In addition, the VOC construction charters dating to the early seventeenth century specifically refer to application of riders (Appendix A).

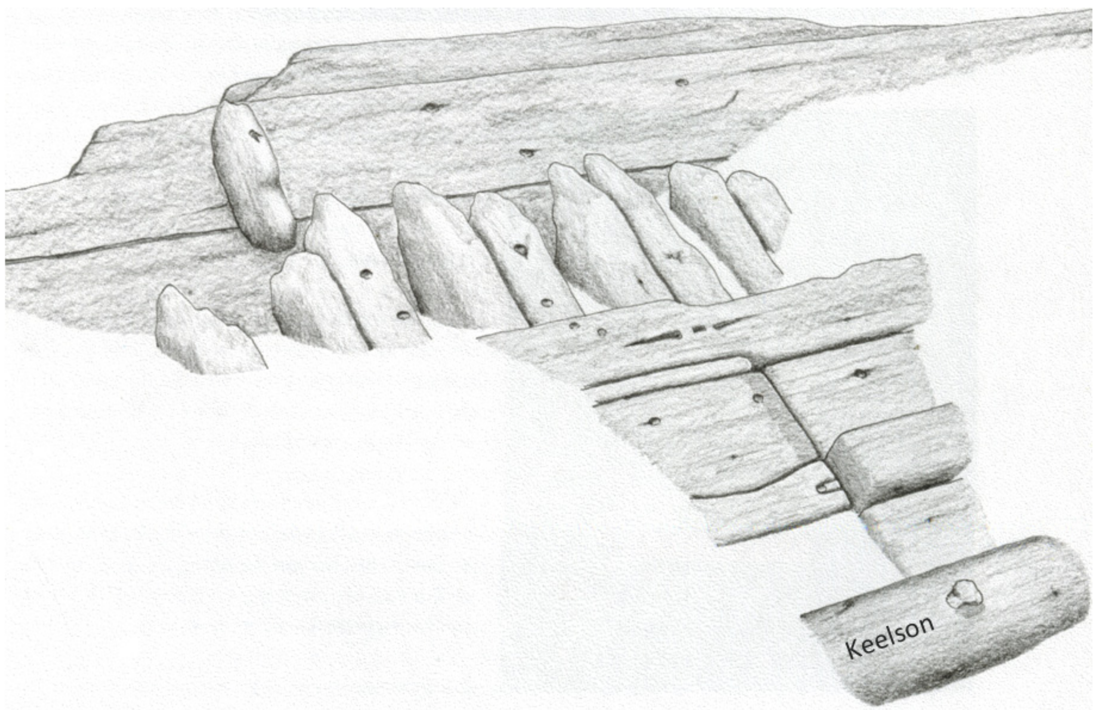


Fig. V.52 Port side bottom of *Avondster*'s amidships. Illustration: Christian Murray, "The Interpretation of the Anglo–Dutch East–Indiaman *Avondster* Ship's Construction," in Avondster *Project: Excavation Report of the VOC Ship* Avondster*,* ed. Robert Parthesius (Amsterdam: Centre for International Heritage Activities, 2007), Fig. 9.6.

The stem, sternpost (with lead and copper sheathing), two concretions of its gudgeons, deck beams, deck planking, spirketting, knees, and a deck clamp have been observed underwater. Rough dimensions are provided in Murray's report, and the identification of wood samples from the sternpost, deck planking, and beams has indicated that they were made of oak.[176] Generally, our present knowledge of

*Avondster*'s hull remains is too incomplete to make broad generalizations about the ship's construction (specifically on what is typically English or Dutch).[177] National characteristics have not yet been defined for Indiamen and ships used in long–distance trade. More in–depth research would have to confirm or refute conclusions drawn upon these preliminary observations and provide more conclusive information about the ship's construction, repairs, and refitting.

**Archaeological evidence from the late seventeenth century**

The mid–seventeenth century marks the time in which the first signs of an important conceptual change in shipbuilding appear in Dutch shipyards: the transformation from a bottom–based to a frame–based construction method for large merchantmen and ships of war. As discussed in Chapter II, Dutch shipbuilders did not construct their ships according to lines and construction drawings until the early eighteenth century. Even though they may have built ships in Rotterdam and the southern part of the Netherlands according to a frame–based construction method in the late seventeenth century, as suggested by Van IJk's manuscript, it was likely still done by eye and experience.

All VOC shipwrecks examined in this chapter, with the exception of *Avondster*, sailed for the Amsterdam Chamber of the VOC. *Nassau* and *Mauritius* were likely built and outfitted in the VOC shipyard of Amsterdam, and *Vergulde Draak* and the Danish East Indiaman Christianshavn B&W 2 were both possibly built in Zaandam which was situated in the *Noorderkwartier* of the Netherlands. None of the ships discussed in this chapter were built in a shipyard in Rotterdam or the southern regions of the Netherlands.

Comparison of the late sixteenth– and early seventeenth–century ships of long–distance trade to those built in the late seventeenth century is currently problematic. Compared to the early seventeenth century, even less archaeological data is available for the study of ship construction from Dutch East Indiamen and large oceangoing ships dating to the second half of the seventeenth century. Shipwrecks from this period include the following VOC ships: *Dolfijn* (1663), *Hercules* (1661), *Kennermerland* (1664), *Lelie*

(1653), *Lastdrager* (1653), *Oosterland* (1697), *Prinses Maria* (1686), and *Waddinxveen* (1697).

Many publications of shipwreck data from the 1970s state that no hull remains were found, regardless of the excavations' intent, archaeological or commercial. At this time, the realms of scholarly research and methodical excavation were still being refined, and it is not always clear whether archaeologists were specifically referring to an assembled part of the hull or simply did not know what to do with small fragments of hull timber, if they said that no hull remains were preserved. According to Sténuit, for example, no hull remains were found on the wreck of VOC yacht *Lastdrager*, and similarly there is no discussion of hull timbers in Richard and Bridget Larn's publications on the Dutch Indiaman *Prinses Maria* (1686).[178] They, however, do mention "revealed ship remains" and "huge sections of the vessel's deck timbers are still intact beneath the sand" indicating that hull remains of *Prinses Maria* have been preserved.[179]

It may simply have been a reflection of the development of nautical archaeology from its somewhat light–hearted beginnings to a serious discipline supported by the latest scientific aids. What may have been acceptable thirty years ago should no longer be a legitimate excuse today.

The two large Indiamen, *Oosterland* (1123 tons) and *Waddinxveen* (751 tons), for example, that sank at Cape Town in South Africa in 1697, have been excavated and studied under the direction of Bruno Werz of the Southern African Institute of Maritime Archaeology.[180] According to Werz, no hull remains of *Oosterland* and *Waddinxveen* were found due to the violent wrecking of both ships in 1697. During the excavation of both ships, very little wood remains were found. Presumably, the timber had washed ashore from both ships and would have been used as construction materials or firewood. The few wooden fragments of the ships' hulls that were found were not diagnostic in most cases. Werz elaborates that any fragments of extant hull wood were left on the seabed as no conservation facilities to preserve the hull wood were available in South Africa. He adds that "no part of the ships' hull has been found, not even a trace of the ship's keel."[181] This statement seems to indicate that Werz' focus has mainly been on large fragments of hull wood.

As the study of the fragmentary remains of *Vergulde Draak* has shown, even the smallest fragments in poor condition are diagnostic for the trained eye and would undoubtedly have provided some essential information on the ships' construction. Interestingly, in Werz' recently published book on *Oosterland* and *Waddinxveen* a full–page photograph is seen with a diver recording large hull timber in perfect condition.[182]

Fragmentary hull remains were found of *Kennermerland* (1664), an Indiaman that sank in the Shetland Islands, U.K. These fragments indicated that the ship had oak hull planking fastened with treenails and pine sheathing.[183] Although all wooden fragments have been accessioned into the collection of the county museum in Lerwick, their final study has not been published to date.[184] Only twenty fragmentary pegged treenails of *Kennermerland* have been published.[185] Like *Vergulde Draak*'s treenails, none of them are preserved over their entire length and their square pegs are relatively large in cross–section.

Unfortunately, archaeological data pertaining to ship construction and hull remains from late seventeenth–century shipwrecks are poorly published. In addition, some shipwrecks have yet to be studied. The archaeological remains of *Dolfijn* and *Hercules* in the harbor of Galle, Sri Lanka, and *Lelie* that sank near Texel in the Netherlands, have been relatively untouched and lie well–protected on the seabed. Their hull remains, even if fragmentary, can provide important information on the development of VOC shipbuilding in the late seventeenth century.

Study of late seventeenth–century VOC ships would provide conclusive evidence on whether the use of double hull planking had a direct relationship to a bottom–based construction method or not.

**Conclusions**

Archaeological data from late seventeenth–century Dutch ships is virtually non–existent in comparison to material dating to the late sixteenth and early seventeenth centuries. Even data from earlier wrecks is scarce when it comes to a comprehensive study of Dutch shipbuilding focused on large oceangoing ships built to sail long distances over the world's oceans.

The hull remains of all late sixteenth– and early seventeenth–century ships discussed above, with the exception of *Vergulde Draak*, indicate that they were constructed with two layers of hull planking, each roughly of the same thickness. The *Vergulde Draak* seems to be the first example of a Dutch Indiaman from the seventeenth century with a single layer of oak hull planking. The archaeological remains of all VOC ships, *Nassau*, *Mauritius*, *Batavia*, *Vergulde Draak*, and *Avondster*, and the Dutch–built Danish East Indiaman Christianshavn B&W 2 have also shown that they were fitted with an additional thinner layer of sacrificial planking or pine sheathing.

Furthermore, the archaeological evidence from the hull remains of almost all shipwrecks discussed in this chapter has shown that they are built in a bottom–based construction method, typical for northwestern Europe. This type of construction method entails the assembly of the keel, garboard strakes and bottom planking, which are temporarily fastened with cleats before the framework of the hull is erected. Not much information on *Nassau* is available, and *Avondster* was a re–fitted English ship, probably constructed in a frame–based construction method. The bottom–based construction method and the use of double hull planking by the Dutch may be better understood if complemented by and compared to historic documentation as the next chapter will demonstrate.

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1 George F. Bass et al., *Serçe Limanı: An Eleventh–Century Shipwreck: The Ship and Its Anchorage, Crew, and Passengers* (College Station: Texas A&M University Press, 2004), 73–240; Steffy, *Wooden Shipbuilding and the Interpretation of Shipwrecks*, 42–59, 79–91.

2 American Numismatic Rarities, LLC, *The Classics Sale: The Thomas H. Sebring Collection* (Orlando: Auction held on 5–6 January 2004), 281; Sotheby & Co., *Catalogue of Treasure Recovered off the Shetland Isles Comprising Gold and Silver Coins and Important Artifacts from the Wrecks of the* Wendela*, Danish Asiatic Company* (*Lost 1737)*, *the* Lastdrager, *Dutch East India Company* (*Lost 1653)*, *the* Curaçao, *Admiralty of Amsterdam (Lost 1727),* The EvstafII, *Imperial Russian Navy* (*Lost 1780)* (London: Auction held on 8 November 1973); and Christie's Amsterdam B.V. *Important Gold, Silver, Jewelry and Artifacts Recovered from the Wrecks of Dutch, Spanish and English 17th, 18th and 19th*

*Century Ships:* Hollandia*,* Utrecht*,* Slot ter Hooge*,* Nuestra Senora de Esperanza*, Standing Cannon Wreck,* H.M.S. Athenienne*: Dutch and Foreign Coins* (Amsterdam: Auction held on 16 March 1983).

3 Theo Toebosch, "'*T Vliegend Hert*: Brieven aan Rex Cowan," in *Grondwerk: 200 Jaar archeologie in Nederland* (Amsterdam: Uitgeverij SUN, 2003), 146.

4 Toebosch, "'*T Vliegend Hert*," 130.

5 Toebosch, "'*T Vliegend Hert*," 130.

6 Toebosch, "'*T Vliegend Hert*," 146.

7 Toebosch, "'*T Vliegend Hert*," 138.

8 Toebosch, "'*T Vliegend Hert*," 145.

9 Wendy van Duivenvoorde, "Dutch Ministry of Finance Violates Agreement on Submerged Cultural Heritage," *INA Quarterly* 33:1 (2006): 15–16.

10 Robert Sténuit, "De *Witte Leeuw*: De schipbreuk van een schip van de V.O.C. in 1613 en het onderwateronderzoek naar het wrak in 1976," *Bulletin van het Rijksmuseum* 25.4 (1977): 165–69.

11 Christine L. van der Pijl–Ketel, ed., *The Ceramic Load of the* Witte Leeuw *(1613)* (Amsterdam: Rijksmuseum, 1982), 23; Sténuit, "De *Witte Leeuw*," 173–74.

12 Sténuit, "De *Witte Leeuw*," 173–74.

13 Van der Pijl–Ketel, ed., *The Ceramic Load of the* Witte Leeuw *(1613)*, 23.

14 Van der Pijl–Ketel, ed., *The Ceramic Load of the* Witte Leeuw *(1613)*, 23–26; Sténuit, "De *Witte Leeuw*," 170–77.

15 Robert Sténuit, "The Sunken Treasure of St. Helena," *National Geographic* 154.4 (October 1978): 568–69.

16 Hoving and Emke, *Het schip van Willem Barents*, 33–34, 52–53.

17 Hoving and Emke, *Het schip van Willem Barents*, 16.

18 Baker and Green, "Recording Techniques Used during the Excavation of the *Batavia*," 143–58; Green, "The VOC Ship *Batavia* Wrecked in 1629 on the Houtman Abrolhos, Western Australia," 43–63; Green, "The Planking–first Construction of the VOC Ship *Batavia*," 70–71; L'Hour, Long, and Rieth, *Le Mauritius*; Michel l'Hour, Luc Long, and Eric Rieth, "The Wreck of an 'Experimental' Ship of the 'Oost Indische Companie': The *Mauritius* (1609)," *IJNA* 19:1 (1990): 63–73; Maarleveld, *Archaeological Heritage Management in Dutch Waters*, 95–96, 125–26; and Arent D. Vos, "De replica van een VOC–retourschip te Lelystad: de *Batavia*?," in *Bouwtraditie en scheepstype: inleidingen gehouden tijdens het vierde Glavimans symposion*, ed. H. Reinder Reinders (Groningen: Universiteitsdrukkerij, 1991), 48–55.

19 Lemée, *The Renaissance Shipwrecks from Christianshavn,* 23, 29–31.

20 VOC ship *Kampen* that sank in 1627 on the Needles rocks (Isle of Wight U.K.) is, for example, not included as its poorly preserved hull remains have not been subject to scholarly scrutiny. It has been published that no significant hull remains were found, and only include a few fragments and some pine sheathing. Larn, ed., "The Wreck of the Dutch East Indiaman *Campen* on the Needles Rocks, Isle of Wight, 1627—Part 1," 15.

21 Hoving and Emke, *Het schip van Willem Barents*, 33.

22 Hoving and Emke, *Het schip van Willem Barents*, 33.

23 Hoving and Emke, *Het schip van Willem Barents*, 15.

24 Hoving and Emke, *Het schip van Willem Barents*, 52.

25 Hoving and Emke, *Het schip van Willem Barents*, 52.

26 Hoving and Emke, *Het schip van Willem Barents*, 34.

27 Thijs J. Maarleveld, "Schiffsarchäologie im Wattenmeer," *Das Logbuch* 26 (1990): 103–7; Thijs J. Maarleveld, "Het schip Scheurrak SO1: Een scheepsopgraving in de Waddenzee," *Spiegel Historiael* 25.12 (1990): 573–77; and Martijn R. Manders, "The Mysteries of a Baltic Trader," in *Boat, Ships, and Shipyards: Proceedings of the Ninth International Symposium on Boat and Ship Archaeology, Venice* 2000, ed. Carlo Beltrame (Oxford: Oxbow Books, 2003), 321.

28 Thijs J. Maarleveld, "Archaeology and Early Modern Merchant Ships: Building Sequences and Consequences: An Introductory Review," in *Rotterdam Papers VII: A Contribution to Medieval Archaeology*, ed. Arnold Carmiggelt (Rotterdam: Bureau Oudheidkundig Onderzoek van

Gemeentewerken, 1992), 164; Manders, “The Mysteries of a Baltic Trader,” 321; and Manders, “The BZN 10–Wreck, Threatened by Nature?” 99–100.

29 Manders, “The Mysteries of a Baltic Trader,” 321.

30 Thijs J. van Maarleveld, letter to author, 14 May 2003.

31 Geert J. van der Heide, “Reconstructie van een bijzondere Italiaanse trompet van de vindplaats Scheurrak SO1,” in *Vis en visvangst: inleidingen gehouden tijdens het zevende Glavimans symposion, Vlaardingen, 23 april 1993*, eds. H. Reinder Reinders and Mette Bierma (Groningen: Glavimans Stichting, 1994), 107; Manders, “The Mysteries of a Baltic Trader,” 323–324; and Martijn R. Manders, “Raadsels rond een gezonken oostzeevaarder,” in *Goud uit graan: Nederland en het Oostzeegebied 1600–1850*, ed. Remmelt Daalder et al, (Zwolle: Waanders Uitgevers, 1998), 75–77.

32 Maarleveld, “Het schip Scheurrak SO1,” 574; and Vos, “De replica van een VOC–retourschip te Lelystad: de *Batavia*?” 51.

33 Maarleveld, “Het schip Scheurrak SO1,” 574; Maarleveld, “Archaeology and Early Modern Merchant Ships,” 156; and Vos, “De replica van een VOC–retourschip te Lelystad: de *Batavia*?” 51.

34 Maarleveld, “Het schip Scheurrak SO1,” 573.

35 Thijs J. Maarleveld, “Archaeology and Early Modern Merchant Ships: Building Sequences and Consequences: An Introductory Review,” in *Rotterdam Papers VII: A Contribution to Medieval Archaeology*, ed. Arnold Carmiggelt (Rotterdam: Bureau Oudheidkundig Onderzoek van Gemeentewerken, 1992), 164–65.

36 Maarleveld, “Archaeology and Early Modern Merchant Ships,” 164.

37 Thijs J. Maarleveld, “Double Dutch Solutions in Flush–Planked Shipbuilding: Continuity and Adaptations at the Start of Modern History,” in *Crossroads in Ancient Shipbuilding, Proceedings of the Sixth International Symposium on Boat and Ship Archaeology*, *Roskilde 1991,* ed. Christer Westerdahl (Oxford: Oxbow Books, 1994), 159.

38 Maarleveld, “Double Dutch Solutions in Flush–Planked Shipbuilding,” 159.

39 Maarleveld, “Archaeology and Early Modern Merchant Ships,” 164; Van IJk, *De Nederlandsche scheeps–bouw–konst open gestelt*, 81; and Thijs J. van Maarleveld, letter to author, 3 December 2007.

40 During the ship’s excavation, only the fore– and aftermost parts of the keel were raised, and the keel timber in between was left *in situ* on the seabed. It is not known of how many pieces the keel timber comprises in total. Maarleveld, “Archaeology and Early Modern Merchant Ships,” 164; and Vos, “De replica van een VOC–retourschip te Lelystad: de *Batavia*?” 50; and Thijs J. van Maarleveld, letter to author, 14 May 2003.

41 Lemée, *The Renaissance Shipwrecks from Christianshavn*, 15–16.

42 Lemée, *The Renaissance Shipwrecks from Christianshavn*, 23–24, 196.

43 Lemée, *The Renaissance Shipwrecks from Christianshavn*, 23 and 196.

44 Lemée, *The Renaissance Shipwrecks from Christianshavn*, 23, 217–18.

45 Lemée, *The Renaissance Shipwrecks from Christianshavn*, 23 and 298.

46 Lemée, *The Renaissance Shipwrecks from Christianshavn*, 210–12.

47 Lemée, *The Renaissance Shipwrecks from Christianshavn*, 204–10.

48 Lemée, *The Renaissance Shipwrecks from Christianshavn*, 203; and Clements R. Markham, *The Hawkins’ Voyages during the Reigns of Henry VIII*, *Queen Elizabeth, and James I* (London: Hakluyt Society, 1878), 203.

49 Lemée, *The Renaissance Shipwrecks from Christianshavn*, 205–6.

50 Lemée, *The Renaissance Shipwrecks from Christianshavn*, 208.

51 Lemée, *The Renaissance Shipwrecks from Christianshavn*, 217–18, 227–28.

52 Lemée, *The Renaissance Shipwrecks from Christianshavn*, 217–18.

53 Lemée, *The Renaissance Shipwrecks from Christianshavn*, 307–8.

54 See Chapter II, section ‘The invention of the sawmill.’

55 Lemée, *The Renaissance Shipwrecks from Christianshavn*, 206.

56 Lemée, *The Renaissance Shipwrecks from Christianshavn*, 213.

57 Lemée, *The Renaissance Shipwrecks from Christianshavn*, 23, 202.

[58] Phaneuf, "Angra C, une épave hollandaise en contexte Açoréen du XVIIe siècle," II, 2–3, 120–23; and Catarina Garcia and Paulo Monteiro, "The Excavation and Dismantling of Angra D, a Probable Iberian Seagoing Ship, Angra Bay, Terceira Island, Azores, Portugal: Preliminary Assessment," in *Proceedings: International Symposium on Archaeology of Medieval and Modern Ships of Iberian–Atlantic Tradition: Hull Remains, Manuscripts and Ethnographic Sources: a Comparative Approach,* ed. Francisco Alves (Lisbon: Centro Nacional de Arqueologia Náutica e Subaquática, 1998), 431–47.

A preliminary study of Angra C was published in the last reference. Data of the Angra C shipwreck from this particular article have, however, been omitted in this study as they are from the 1998 field campaign. They predate the more–scholarly study made in 2000 that Erik Phaneuf used for his thesis project.

[59] Phaneuf, "Angra C, une épave hollandaise en contexte Açoréen du XVIIe siècle," 54–55.

[60] Phaneuf, "Angra C, une épave hollandaise en contexte Açoréen du XVIIe siècle," 7.

[61] Phaneuf, "Angra C, une épave hollandaise en contexte Açoréen du XVIIe siècle," 54–88.

[62] Erik Phaneuf, letter to author, 18 August 2007.

[63] Phaneuf, "Angra C, une épave hollandaise en contexte Açoréen du XVIIe siècle," 57 and 139 (fig. 15).

[64] Phaneuf, "Angra C, une épave hollandaise en contexte Açoréen du XVIIe siècle," 56–57, and 148 (fig. 37).

[65] Phaneuf, "Angra C, une épave hollandaise en contexte Açoréen du XVIIe siècle," 56–57, and 148 (fig. 37).

[66] Phaneuf, "Angra C, une épave hollandaise en contexte Açoréen du XVIIe siècle," 59–62.

[67] Phaneuf, "Angra C, une épave hollandaise en contexte Açoréen du XVIIe siècle," 85–86.

[68] Phaneuf, "Angra C, une épave hollandaise en contexte Açoréen du XVIIe siècle," 63, 85–86.

[69] Phaneuf, "Angra C, une épave hollandaise en contexte Açoréen du XVIIe siècle," 68.

[70] Phaneuf, "Angra C, une épave hollandaise en contexte Açoréen du XVIIe siècle," 67–69.

[71] Phaneuf, "Angra C, une épave hollandaise en contexte Açoréen du XVIIe siècle," 68.

[72] Phaneuf, "Angra C, une épave hollandaise en contexte Açoréen du XVIIe siècle," 57–59.

[73] Phaneuf, "Angra C, une épave hollandaise en contexte Açoréen du XVIIe siècle," 73–74.

[74] Phaneuf, "Angra C, une épave hollandaise en contexte Açoréen du XVIIe siècle," 70–71.

[75] Phaneuf, "Angra C, une épave hollandaise en contexte Açoréen du XVIIe siècle," 71–72.

[76] Phaneuf, "Angra C, une épave hollandaise en contexte Açoréen du XVIIe siècle," 69.

[77] Phaneuf, "Angra C, une épave hollandaise en contexte Açoréen du XVIIe siècle," 69.

[78] Phaneuf, "Angra C, une épave hollandaise en contexte Açoréen du XVIIe siècle," 83–85.

[79] Phaneuf, "Angra C, une épave hollandaise en contexte Açoréen du XVIIe siècle," 84–85.

[80] Phaneuf, "Angra C, une épave hollandaise en contexte Açoréen du XVIIe siècle," 83.

[81] National Archives (NA) of the Netherlands, The Hague*, Archieven van de Verenigde Oostindische Compagnie, 1602–1795*, reference code 1.04.02, item number 99 (Kopie–resoluties van de Heren XVII, 1602–1607), folio 161; Bruijn, Gaastra, and Schöffer, *Dutch–Asiatic Shipping in the 17th and 18th Centuries: Outward–bound Voyages from the Netherlands to Asia and the Cape (1595–1794)*, nos. 0100.2, 0096.2, 00.97.1, 0098.2, 0099.1, 0100.2, 0102.1, 0103.1, 0104.1, 0.105.2, and 0106.1; Commelin, ed., and Matelief de Jonge, "Historische verhael vande treffelijcke reyse, gedaen naer de Oost–Indien ende China met elf Schepen, door den manhaften Admirael Cornelis Matelief de Jonge, inden jaren 1605, 1606, 1607, ende 1608," 1.

[82] On 3 April 1606, Matelief informs his men of the undisclosed VOC instructions to siege Malacca. Initially, this causes serious tension with the crew as they had enlisted in VOC service as sailors, not soldiers. Commelin, ed., and Matelief de Jonge, "Historische verhael vande treffelijcke reyse, gedaen naer de Oost–Indien ende China met elf Schepen, door den manhaften Admirael Cornelis Matelief de Jonge, inden jaren 1605, 1606, 1607, ende 1608," 6.

[83] Commelin, ed., and Matelief de Jonge, "Historische verhael vande treffelijcke reyse, gedaen naer de Oost–Indien ende China met elf Schepen, door den manhaften Admirael Cornelis Matelief de Jonge, inden jaren 1605, 1606, 1607, ende 1608," 22.

In a preliminary publication on the *Nassau* shipwreck, this event is dated erroneously to June 14, 1606. See, Mensun Bound, Ong Soo Hin, and Nigel Pickford, "The Dutch East Indiaman *Nassau*, Lost at the Battle of Cape Rachado, Straits of Malacca, 1606," in *Excavating Ships of War*, ed. Mensun Bound (Oxford: University of Oxford, 1998), 86.

[84] Charles R. Boxer, *The Affair of the "Madre de Deus": A Chapter in the History of the Portuguese in Japan* (London: Kegan Paul, Trench, Trubner and Co., Ltd., 1929), 23; and L'Hermite de Jonge, *Breeder verhael ende klare beschrijvinge van tghene den admirael Cornelis Matelief de Jonge inde Oost–Indien voor de stadt Malacca, ende int belegh der zelver wedervaren is*, 339.

[85] Cornelis Matelief de Jonge, *An Historicall and True Discourse, of a Voyage Made by the Admirall Cornelis Matelife the Yonger into the East Indies, who Departed out of Holland, in May 1605: with the Besieging of Malacca and the Battaile by Him Fought at Sea Against the Portugales in the Indies, With other Discourses* (London: William Barret, 1608), 14; Commelin, ed., and Matelief de Jonge, "Historische verhael vande treffelijcke reyse, gedaen naer de Oost–Indien ende China met elf Schepen, door den manhaften Admirael Cornelis Matelief de Jonge, inden jaren 1605, 1606, 1607, ende 1608," 39–40.

[86] Commelin, ed., and Matelief de Jonge, "Historische verhael vande treffelijcke reyse, gedaen naer de Oost–Indien ende China met elf Schepen, door den manhaften Admirael Cornelis Matelief de Jonge, inden jaren 1605, 1606, 1607, ende 1608," 39–40.

[87] Boxer, *The Affair of the "Madre de Deus"*, 28–29; Commelin, ed., and Matelief de Jonge, "Historische verhael vande treffelijcke reyse, gedaen naer de Oost–Indien ende China met elf Schepen, door den manhaften Admirael Cornelis Matelief de Jonge, inden jaren 1605, 1606, 1607, ende 1608," 6–51; and Matelief de Jonge, *An Historicall and True Discourse, of a Voyage Made by the Admirall Cornelis Matelife the Yonger into the East Indies, who Departed out of Holland, in May 1605*, 14.

[88] Charles R. Boxer, *The Portuguese Seaborne Empire 1415–1825* (New York: A.A. Knopf, 1969), 110.

[89] Commelin, ed., and Matelief de Jonge, "Historische verhael vande treffelijcke reyse, gedaen naer de Oost–Indien ende China met elf Schepen, door den manhaften Admirael Cornelis Matelief de Jonge, inden jaren 1605, 1606, 1607, ende 1608," 27–28, 167–70; L'Hermite de Jonge, *Breeder verhael ende klare beschrijvinge van tghene den admirael Cornelis Matelief de Jonge inde Oost–Indien voor de stadt Malacca, ende int belegh der zelver wedervaren is*, 5–8.

Matelief mentions the burning of three Dutch ships (page 14) but, apart from *Kleine Zon* and *Grote Zon*, all other ships from his fleet returned to the Netherlands, so it is not certain what the third ship would have been. *Grote Zon* is left behind in 1610 in Banda, incapable for sailing. See, De Booy, *De derde reis van de V.O.C. naar Oost–Indië onder het beleid van admiraal Paulus van Caerden uitgezeild in* 1606 (1970), 233 (Letter from Hendrik Jansz. Craen to the Gentlemen XVII, May 20, 1610, from Dartmouth); Bruijn, Gaastra, and Schöffer, *Dutch–Asiatic Shipping in the 17th and 18th Centuries: Outward–bound Voyages from the Netherlands to Asia and the Cape (1595–1794)*, 21; Bruijn, Gaastra, and Schöffer, *Dutch–Asiatic Shipping in the 17th and 18th Centuries: Homeward–bound Voyages from Asia and the Cape to the Netherlands (1597–1795)*, no. 5083.1; and Parthesius, "Dutch Ships in Tropical Waters," 175.

[90] National Archives (NA) of the Netherlands, The Hague*, Archieven van de Verenigde Oostindische Compagnie, 1602–1795*, reference code 1.04.02, item number 99 (Kopie–resoluties van de Heren XVII, 1602–1607), folio 170 (1604).

[91] De Booy, *De derde reis van de V.O.C. naar Oost–Indië onder het beleid van admiraal Paulus van Caerden uitgezeild in 1606* (1970), 191, 204, 216, and 220.

[92] De Booy, *De derde reis van de V.O.C. naar Oost–Indië onder het beleid van admiraal Paulus van Caerden uitgezeild in 1606* (1970), 216 and 220.

[93] De Booy, *De derde reis van de V.O.C. naar Oost–Indië onder het beleid van admiraal Paulus van Caerden uitgezeild in 1606* (1970), 220; and Parthesius, "Dutch Ships in Tropical Waters," 175. According to Parthesius, the ship went out of service in 1611.

[94] Bruijn, Gaastra, and Schöffer, *Dutch–Asiatic Shipping in the 17th and 18th Centuries: Outward–bound Voyages from the Netherlands to Asia and the Cape (1595–1794)*, no. 0074.1; Bruijn, Gaastra, and

Schöffer, *Dutch–Asiatic Shipping in the 17th and 18th Centuries: Homeward–bound Voyages from Asia and the Cape to the Netherlands (1597–1795)*, no. 5057; and Van Dam, *Beschrijvinge van de Oostindische Compagnie*, 15.

95 Bruijn, Gaastra, and Schöffer, *Dutch–Asiatic Shipping in the 17th and 18th Centuries: Outward–bound Voyages from the Netherlands to Asia and the Cape (1595–1794)*, no. 0037.1; Bruijn, Gaastra, and Schöffer, *Dutch–Asiatic Shipping in the 17th and 18th Centuries: Homeward–bound Voyages from Asia and the Cape to the Netherlands (1597–1795)*, no. 5020; and Isaac Commelin, ed., and Paulus van Caerden, "Kort verhael/ofte Journael/Van de Reyse gedaen naer de Oost Indien met 4. schepen, *Nederlandt*, *Vereenigde Landen*, *Nassou*, ende *Hoff van Hollandt*, onder den Admirael Pieter Both van Amesfort, voor Reeckeninge van de Nieuwe Brabantsche Compagnie tot Amsterdam; in den jaren 1599. 1600. ende 1601," in *Begin ende Voortgangh der Vereenigde Nederlantsche Geoctroyeerde Oost–Indische Compagnie. Begrypende de volgende twaelf voyagien door de inwoonderen der selviger provintien derwaerts gedaen* (Amsterdam: Facsimile Uitgaven Nederland, 1969), 1.

96 Bruijn, Gaastra, and Schöffer, *Dutch–Asiatic Shipping in the 17th and 18th Centuries: Outward–bound Voyages from the Netherlands to Asia and the Cape (1595–1794)*, 8, nos. 0035.1, 0036.1, 0037.1, and 0038.1.

97 Rietbergen, *De eerste landvoogd Pieter Both (1568–1615)*, 60; Hendrik A. van Foreest and A. de Booy, *De vierde schipvaart der Nederlanders naar Oost–Indië onder Jakob Wilkens and Jacob van Neck (1599–1604)* ('s–Gravenhage: Martinus Nijhoff, 1980), 127; and Hendrik A. van Foreest and A. de Booy, *De vierde schipvaart der Nederlanders naar Oost–Indië onder Jakob Wilkens and Jacob van Neck (1599–1604)* ('s–Gravenhage: Martinus Nijhoff, 1981), 216.

98 Boxer, *The Affair of the "Madre de Deus,"* 24; and Matelief de Jonge, *An Historicall and True Discourse, of a Voyage Made by the Admirall Cornelis Matelife the Yonger into the East Indies, who Departed out of Holland, in May 1605*, 8.

According to Mensun Bound, Commelin mentions specifically that *Nassau* exploding at the stern. To date, I have not been able to find this reference in the journals kept by Matelief's fleet in Commelin's publication. Bound, Soo Hin, and Pickford, "The Dutch East Indiaman *Nassau*, Lost at the Battle of Cape Rachado, Straits of Malacca, 1606," 87.

99 For information on *boevenet* see Appendix A, note 5.

100 L'Hermite de Jonge, *Breeder verhael ende klare beschrijvinge van tghene den admirael Cornelis Matelief de Jonge inde Oost–Indien voor de stadt Malacca, ende int belegh der zelver wedervaren is*, 339.

101 Markham, *The Hawkins' Voyages during the Reigns of Henry VIII*, *Queen Elizabeth, and James I*, 287–88.

102 Commelin, ed., and Van Caerden, "Kort verhael/ofte Journael/Van de Reyse gedaen naer de Oost Indien met 4. schepen, *Nederlandt*, *Vereenigde Landen*, *Nassou*, ende *Hoff van Hollandt*, onder den Admirael Pieter Both van Amesfort, voor Reeckeninge van de Nieuwe Brabantsche Compagnie tot Amsterdam; in den jaren 1599. 1600. ende 1601," 186. The letters of L'Hermite de Jonge to his father can be found on pages 140–87.

103 Bound, Soo Hin, and Pickford, "The Dutch East Indiaman *Nassau*, Lost at the Battle of Cape Rachado, Straits of Malacca, 1606," 97.

104 Bound, Soo Hin, and Pickford, "The Dutch East Indiaman *Nassau*, Lost at the Battle of Cape Rachado, Straits of Malacca, 1606," 97.

105 Bound, Soo Hin, and Pickford, "The Dutch East Indiaman *Nassau*, Lost at the Battle of Cape Rachado, Straits of Malacca, 1606," 97.

106 Bound, Soo Hin, and Pickford, "The Dutch East Indiaman *Nassau*, Lost at the Battle of Cape Rachado, Straits of Malacca, 1606," 97.

107 Bound, Soo Hin, and Pickford, "The Dutch East Indiaman *Nassau*, Lost at the Battle of Cape Rachado, Straits of Malacca, 1606," 97.

108 National Archives (NA) of the Netherlands, The Hague, *Archieven van de Verenigde Oostindische Compagnie, 1602–1795*, reference code 1.04.02, item number 99 (Kopie–resoluties van de Heren XVII, 1602–1607), folio 6 (14 April 1602); Bruijn, Gaastra, and Schöffer, *Dutch–Asiatic Shipping in the 17th and 18th Centuries: Outward–bound Voyages from the Netherlands to Asia and the Cape*

*(1595–1794)*, no. 0073.1; and Bruijn, Gaastra, and Schöffer, *Dutch–Asiatic Shipping in the 17th and 18th Centuries: Homeward–bound Voyages from Asia and the Cape to the Netherlands (1597–1795)*, no. 5052.1.

109 National Archives (NA) of the Netherlands, The Hague*, Archieven van de Verenigde Oostindische Compagnie, 1602–1795*, reference code 1.04.02, item number 99 (Kopie–resoluties van de Heren XVII, 1602–1607), folio 145 (September–December 1604); National Archives (NA) of the Netherlands, The Hague*, Archieven van de Verenigde Oostindische Compagnie, 1602–1795*, reference code 1.04.02, item number 99 (Kopie–resoluties van de Heren XVII, 1602–1607), folio 161; Commelin, ed., and Matelief de Jonge, "Historische verhael vande treffelijcke reyse, gedaen naer de Oost–Indien ende China met elf Schepen, door den manhaften Admirael Cornelis Matelief de Jonge, inden jaren 1605, 1606, 1607, ende 1608," 1; and L'Hour, Long, and Rieth, "The Wreck of an 'Experimental' Ship of the 'Oost Indische Companie'," 64.

110 National Archives (NA) of the Netherlands, The Hague*, Archieven van de Verenigde Oostindische Compagnie, 1602–1795*, reference code 1.04.02, item number 99 (Kopie–resoluties van de Heren XVII, 1602–1607), folio 146 (September–December 1604); L'Hour, Long, and Rieth, "The Wreck of an 'Experimental' Ship of the 'Oost Indische Companie'," 64; and L'Hour, Long, and Rieth, *Le Mauritius*, 228.

111 National Archives (NA) of the Netherlands, The Hague*, Archieven van de Verenigde Oostindische Compagnie, 1602–1795*, reference code 1.04.02, item number 99 (Kopie–resoluties van de Heren XVII, 1602–1607), folio 146 (September–December 1604).

112 The VOC would not have bought a ship partly–built and/or assembled from inferior materials as the risk of losing valuable cargo would have been too high.

113 L'Hour, Long, and Rieth, *Le Mauritius*, 228; and L'Hour, Long, and Rieth, "The Wreck of an 'Experimental' Ship of the 'Oost Indische Companie'," 64.

114 Bruijn, Gaastra, and Schöffer, *Dutch–Asiatic Shipping in the 17th and 18th Centuries: Outward–bound Voyages from the Netherlands to Asia and the Cape (1595–1794)*, nos. 0004.1, 0014.2, and 0034.3; and Bruijn, Gaastra, and Schöffer, *Dutch–Asiatic Shipping in the 17th and 18th Centuries: Homeward–bound Voyages from Asia and the Cape to the Netherlands (1597–1795)*, nos. 5003.1, 5006.2, and 5018.3.

115 Bruijn, Gaastra, and Schöffer, *Dutch–Asiatic Shipping in the 17th and 18th Centuries: Homeward–bound Voyages from Asia and the Cape to the Netherlands (1597–1795)*, no. 5077.2.

116 L'Hour, Long, and Rieth, *Le Mauritius*, 228; and L'Hour, Long, and Rieth, "The Wreck of an 'Experimental' Ship of the 'Oost Indische Companie'," 63.

117 L'Hour, Long, and Rieth, *Le Mauritius*, 207–9; and L'Hour, Long, and Rieth, *Le Mauritius*, 228; and L'Hour, Long, and Rieth, "The Wreck of an 'Experimental' Ship of the 'Oost Indische Companie'," 65.

118 L'Hour, Long, and Rieth, *Le Mauritius*, 228; and L'Hour, Long, and Rieth, "The Wreck of an 'Experimental' Ship of the 'Oost Indische Companie'," 65.

119 L'Hour, Long, and Rieth, *Le Mauritius*, 215–16; and L'Hour, Long, and Rieth, *Le Mauritius*, 228; and L'Hour, Long, and Rieth, "The Wreck of an 'Experimental' Ship of the 'Oost Indische Companie'," 65.

120 L'Hour, Long, and Rieth, *Le Mauritius*, 206; and L'Hour, Long, and Rieth, *Le Mauritius*, 228; and L'Hour, Long, and Rieth, "The Wreck of an 'Experimental' Ship of the 'Oost Indische Companie'," 64.

121 Maarleveld, *Archaeological Heritage Management in Dutch Waters*, 94 (fig. 29), 119, 130–31; Thijs J. Maarleveld, "Double Dutch Solutions in Flush–Planked Shipbuilding: Continuity and Adaptations at the Start of Modern History," in *Crossroads in Ancient Shipbuilding, Proceedings of the Sixth International Symposium on Boat and Ship Archaeology*, *Roskilde 1991,* ed. Christer Westerdahl (Oxford: Oxbow Books, 1994), 154; Maarleveld, "Archaeology and Early Modern Merchant Ships," 157 and 165; and Maarleveld, Goudswaard, and Oosting, "New Data on Early Modern Dutch–flush Shipbuilding" fig. 4.

122 Witsen, *Architectura navalis et reginem nauticum*, 169.

[123] Jeremy N. Green, "The *Vergulde Draak* Excavation 1981 and 1983," *Bulletin of the Australasian Institute for Maritime Archaeology* 7:2 (1983): 1–8; Jeremy N. Green "*Vergulde Draak* Excavation 1981," *Bulletin of the Australasian Institute for Maritime Archaeology* 5 (1981): 46–47.

[124] Jeremy N. Green, *The Loss of the Verenigde Oostindische Compagnie Jacht* Vergulde Draak*, Western Australia 1656: A Historical Background and Excavation Report with an Appendix on Similar Loss of the Fluit* Lastdrager, vol. 1 (Oxford: British Archaeological Reports, 1976), 71.

[125] Green, *The Loss of the Verenigde Oostindische Compagnie Jacht* Vergulde Draak*, Western Australia 1656* (Vol. 1), 23.

[126] National Archives (NA) of the Netherlands, The Hague*, Archieven van de Verenigde Oostindische Compagnie, 1602–1795*, reference code 1.04.02, item number 363 (Adviezen van rechtsgeleerden uitgebracht aan de bewindhebbers van de VOC 1622–1723, 21 January 1653).

[127] Green, *The Loss of the Verenigde Oostindische Compagnie Jacht* Vergulde Draak*, Western Australia 1656* (Vol. 1), 23.

[128] National Archives (NA) of the Netherlands, The Hague*, Archieven van de Verenigde Oostindische Compagnie, 1602–1795*, reference code 1.04.02, item number 363 (Adviezen van rechtsgeleerden uitgebracht aan de bewindhebbers van de VOC 1622–1723, 10 March 1653); and Green, *The Loss of the Verenigde Oostindische Compagnie Jacht* Vergulde Draak*, Western Australia 1656* (Vol. 1), 23.

[129] Green, *The Loss of the Verenigde Oostindische Compagnie Jacht* Vergulde Draak*, Western Australia 1656* (Vol. 1), 81 and 90.

[130] Green, *The Loss of the Verenigde Oostindische Compagnie Jacht* Vergulde Draak*, Western Australia 1656* (Vol. 1), 249–50; and Jeremy N. Green, *Treasures from the* Vergulde Draak (Perth: Western Australian Museum, 1985), 27.

[131] Jeremy N. Green, "The Wreck of the Dutch East Indiaman the *Vergulde Draak*, 1656," *IJNA* 2:2 (1973): 287; and Green, *Treasures from the* Vergulde Draak, 27.

[132] More specifically in grid squares 17.5 S/20 E, 21 S/18 E, 21 S/19 E, 22 S/16 E, 22 S/18 E, 22.5 S/210 E, 23 S/19 E, 24 S/19 E, 27 S/20 E, 25 S/20 E, and 27.5 S/18.5 E.

[133] The *Vergulde Draak* Timber Project was conducted with the help of Western Australian Museum staff Tracey Miller, Maggie Myers, and Richenda Prall, whose dedication was beyond expectations. Also, many thanks to those who were so kind to volunteer to sort and record the *Vergulde Draak* timbers: Jessica Berry (Flinders University, Australia) and Genevieve Brown (Esperance High School, Australia).

[134] One lot of timbers accessioned into the Western Australian Museum's collection can contain more than one timber of the same descriptor, and so some lots represent several timbers.

[135] Identification made by Caroline Vermeeren and Pauline van Rijn, BIAX Consult, the Netherlands.

[136] Hull fragments specifically described and discussed will have their museum registration number listed which begins with the shipwreck's designation, GT, and a four–digit catalog number.

[137] GT 6123 B, GT 6135, GT 6172 E, and GT 6173.

[138] Hull planking numbers GT 6172 E and GT 6173.

[139] Jonathan Adams, André F.L. van Holk, and Thijs J. Maarleveld, *Dredgers and Archaeology: Shipfinds from the Slufter* (Alphen aan den Rijn: Afdeling Archeologie Onder water, Ministerie van Welzijn, Volksgezondheid en Cultuur, 1990), 114; and Lightley, "An 18th Century Dutch East Indiaman Found at Cape Town, 1971," 310–11.

[140] Arjan den Braven et al., *De* Buytensorgh, 27, 48, and 62.

[141] GT 1386 C, GT 1386 P, GT 6008, GT 6129, GT 6168, and GT 6178.

[142] GT 98 A, GT 1387 C, GT 1404 A, GT 1405 B, GT 6020, GT 6123 D, GT 6142 B, and GT 6174.

[143] Simon Jellema, letter to author, 22 May 2007.

[144] Identification made by Henk van Haaster, BIAX Consult, the Netherlands.

[145] Henk van Haaster, letter to author, 21 November 2007.

[146] Green, *The Loss of the Verenigde Oostindische Compagnie Jacht* Vergulde Draak*, Western Australia 1656* (Vol. 1), 206–7. At the bottom of page 207 is referred to "(GT 92 and GT921)", which should have been "GT 91 and GT 92."

147 These sheets have previously been published as one layer of copper sheathing with two layers of lead lining (under registration number GT 1442, which is now GT 1442 and GT 3169), but during its conservation this turned out to be incorrect. See, Green, *The Loss of the Verenigde Oostindische Compagnie Jacht* Vergulde Draak*, Western Australia 1656* (Vol. 1), 207.

148 The samples from *Vergulde Draak* sternpost sheathing have been analyzed at the CSIRO laboratories, Perth, Western Australia, using a SEM with a SUTW–Sapphire detector. This is a semi–quantitative method of conducting chemical analysis by spot testing. The areas analysed on each sample vary in size between 250 and 300 µm. As this method of analysis is a localized testing method, it is not necessarily representative for the composition of the entire sample. Therefore, preferably two or more small areas per sample were tested.

The following SEM settings were used during data acquisition: Kilovoltage: kV 30, EDAX ZAF Quantification, Element Normalized, SEC table: default, standardless, resolution: 160.70, tilt: 0.00, tc: 2.5. The time per sample analysis was set to about 60 seconds for each test.

149 Robert Parthesius, "Het wrak van VOC–schip *Avondster* in de haven van Galle (Sri Lanka): Een potentiële bron van kennis over de Europese expansie in Azië," in *Hollanders uit en thuis: archeologie, geschiedenis en bouwhistorie gedurende de VOC–tijd in de Oost, de West en thuis: Cultuurhistorie van de Nederlandse expansie*, ed. Michiel H. Bartels, Erich H.P. Cordfunke, and Herbert Sarfatij (Hilversum: Verloren, 2002), 64–65.

150 Robert Parthesius, "Het wrak van VOC–schip *Avondster* in de haven van Galle (Sri Lanka): Een potentiële bron van kennis over de Europese expansie in Azië," in *Hollanders uit en thuis: archeologie, geschiedenis en bouwhistorie gedurende de VOC–tijd in de Oost, de West en thuis: Cultuurhistorie van de Nederlandse expansie*, ed. Michiel H. Bartels, Erich H.P. Cordfunke, and Herbert Sarfatij (Hilversum: Verloren, 2002), 64–65; Bruijn, Gaastra, and Schöffer, *Dutch–Asiatic Shipping in the 17th and 18th Centuries: Outward–bound Voyages from the Netherlands to Asia and the Cape (1595–1794)*, no. 0823.1; Bruijn, Gaastra, and Schöffer, *Dutch–Asiatic Shipping in the 17th and 18th Centuries: Homeward–bound Voyages from Asia and the Cape to the Netherlands (1597–1795)*, nos. 5409.1, and 5448.2.

151 Parthesius, "Het wrak van VOC–schip *Avondster* in de haven van Galle (Sri Lanka)," 64–65.

152 Ethel B. Sainsbury, *A Calendar of the Court Minutes, Etc. of the East India Company 1640–1643* (Oxford: The Clarendon Press, 1909), xxi, 205, 207, 209, and 217.

153 John Bruce, *Annals of the Honorable East–India Company, from Their Establishment by the Charter of Queen Elizabeth, 1600, to the Union of the London and English East–India Companies, 1707–8* (Farnborough Hants, England: Gregg Press, 1968), 482; William Foster, *The English Factories in India, 1651–1654: A Calendar of Documents in the India Office, Westminister* (Oxford: The Clarendon Press, 1915), 145.

154 Bruijn, Gaastra, and Schöffer, *Dutch–Asiatic Shipping in the 17th and 18th Centuries: Homeward–bound Voyages from Asia and the Cape to the Netherlands (1597–1795)*, no. 5409.1; Parthesius, "Het wrak van VOC–schip *Avondster* in de haven van Galle (Sri Lanka)," 64; National Archives (NA) of the Netherlands, The Hague, *Archieven van de Verenigde Oostindische Compagnie, 1602–1795*, reference code 1.04.02, item number 1196 (Overgekomen Brieven en Papieren, 1654), folio 313; and National Archives (NA) of the Netherlands, The Hague, *Archieven van de Verenigde Oostindische Compagnie, 1602–1795*, reference code 1.04.02, item number 1202 (Overgekomen Brieven en Papieren, 1655), folio 241.

155 William Foster, *The English Factories in India, 1642–1645: A Calendar of Documents in the India Office, Westminister* (Oxford: The Clarendon Press, 1913), 26–27, 121–22.

156 Bruijn, Gaastra, and Schöffer, *Dutch–Asiatic Shipping in the 17th and 18th Centuries: Outward–bound Voyages from the Netherlands to Asia and the Cape (1595–1794)*, no. 0823.1; Bruijn, Gaastra, and Schöffer, *Dutch–Asiatic Shipping in the 17th and 18th Centuries: Homeward–bound Voyages from Asia and the Cape to the Netherlands (1597–1795)*, nos. 5409.1 and 5448.2.

157 The Sri Lankan Mutual Heritage Centre, Central Cultural Fund, Department of Archaeology, Department of National Museums, Post–Graduate Institute of Archaeology, and the University of Kelaniya with the Amsterdam Historical Museum, University of Amsterdam, and the Western Australian Museum.

[158] Christian Murray, "The Interpretation of the Anglo–Dutch East–Indiaman *Avondster* Ship's Construction," in Avondster *Project: Excavation Report of the VOC Ship* Avondster*,* ed. Robert Parthesius (Amsterdam: Centre for International Heritage Activities, 2007), 131–53; Robert Parthesius et al., *Sri Lanka Maritime Archaeological Unit Report on the* Avondster *Project 2001–2002* (Amsterdam: Amsterdams Historisch Museum, 2003), 8.

[159] *Avondster*'s hull is well preserved, but it is by no means "better preserved [hull remains] than other VOC shipwrecks" as stated in Murray's chapter in the shipwreck's final publication. First, the precise extent of the hull will remain unknown until further and more–intensive investigation. Moreover, as explained previously in this chapter, the archaeological hull remains of other known VOC shipwrecks, such as *Middelburg, Nassau*, and *Witte Leeuw*, are also well–preserved. It may, therefore, be premature to make comparisons on which hull is better preserved. See, Murray, "The Interpretation of the Anglo–Dutch East–Indiaman *Avondster* Ship's Construction," 153; and Parthesius et al., *Sri Lanka Maritime Archaeological Unit Report on the* Avondster *Project 2001–2002*, 4.

[160] Murray, "The Interpretation of the Anglo–Dutch East–Indiaman *Avondster* Ship's Construction," 138; and Parthesius et al., *Sri Lanka Maritime Archaeological Unit Report on the* Avondster *Project 2001–2002*, 4, 18, and 39.

[161] Murray, "The Interpretation of the Anglo–Dutch East–Indiaman *Avondster* Ship's Construction," 138.

[162] Murray, "The Interpretation of the Anglo–Dutch East–Indiaman *Avondster* Ship's Construction," 139.

[163] This identification may not be representative for the ship's hull planking in general, especially regarding the ship's old age at the time of sinking and evidence for repairs and maintenance work throughout its life. Murray, "The Interpretation of the Anglo–Dutch East–Indiaman *Avondster* Ship's Construction," 136 and 144; and Parthesius et al., *Sri Lanka Maritime Archaeological Unit Report on the* Avondster *Project 2001–2002*, 39.

[164] Parthesius et al., *Sri Lanka Maritime Archaeological Unit Report on the* Avondster *Project 2001–2002*, 39.

[165] Murray, "The Interpretation of the Anglo–Dutch East–Indiaman *Avondster* Ship's Construction," 144.

[166] Murray, "The Interpretation of the Anglo–Dutch East–Indiaman *Avondster* Ship's Construction," 144.

[167] Van IJk, *De Nederlandsche scheeps–bouw–konst open gestelt*, 90.

[168] Murray, "The Interpretation of the Anglo–Dutch East–Indiaman *Avondster* Ship's Construction," 144.

[169] Murray, "The Interpretation of the Anglo–Dutch East–Indiaman *Avondster* Ship's Construction," 145.

[170] Murray, "The Interpretation of the Anglo–Dutch East–Indiaman *Avondster* Ship's Construction," 140–42.

[171] Murray, "The Interpretation of the Anglo–Dutch East–Indiaman *Avondster* Ship's Construction," 143–44.

[172] Murray, "The Interpretation of the Anglo–Dutch East–Indiaman *Avondster* Ship's Construction," 140–41.

[173] Murray, "The Interpretation of the Anglo–Dutch East–Indiaman *Avondster* Ship's Construction," 140–42; and Kroum N. Batchvarov, "The Framing of Seventeenth–Century Men–Of–War in England and other Northen European Countries," (M.A. thesis, Texas A&M University, 2002), 46, 154, 158–59.

[174] Murray, "The Interpretation of the Anglo–Dutch East–Indiaman *Avondster* Ship's Construction," 146.

[175] Maarleveld, *Archaeological Heritage Management in Dutch Waters*, 126.

[176] Murray, "The Interpretation of the Anglo–Dutch East–Indiaman *Avondster* Ship's Construction," 147–49.

[177] Murray states, for example, that hanging knees were used in English and Dutch shipbuilding, whereas lodging knees were characteristic of English shipbuilding. This is incorrect as demonstrated by

the lodging deck knee preserved on the *Batavia* ship (Chapter IV). Murray, "The Interpretation of the Anglo–Dutch East–Indiaman *Avondster* Ship's Construction," 148.

178 Richard Larn, "Wrecks Round the Scillies," in *Buried and Sunken Treasure: Amazing Discoveries of Modern Times*, ed. Windsor Chorlton (London: Marshall Cavendish, 1974), 31; Richard Larn and Bridget Larn, *Shipwreck Index of the British Isles,* vol. 1, section 3, Isles of Scilly; and Robert Sténuit, "Early Relics of the VOC Trade From Shetland: The Wreck of the Flute *Lastdrager* Lost off Yell, 1653," *IJNA* 3:2 (1974): 220.

179 Richard Larn, "Wrecks Round the Scillies," in *Buried and Sunken Treasure: Amazing Discoveries of Modern Times*, ed. Windsor Chorlton (London: Marshall Cavendish, 1974), 31; and Larn and Larn, *Shipwreck Index of the British Isles* (Vol. 1.3), Isles of Scilly.

180 Bruno E.J.S. Werz, '*Een bedroefd, en beclaaglijck ongeval:' De wrakken van de VOC–schepen* Oosterland *en* Waddinxveen *(1697) in de Tafelbaai* (Zutphen: Walburg Press, 2004).

181 Bruno E.J.S. Werz, letter to author, 2 August 2005). Original message: "Kan je niet verder helpen met scheepshout. Zowel de *Oosterland* als de *Waddinxveen* zijn bij de ondergang in stukken geslagen en archiefstukken benadrukken dit. Wat er aanspoelde is weggevoerd om te dienen als bouwmateriaal of brandhout. Tijdens de opgraving hebben we bijzonder weinig hout gevonden en dat was sterk gefragmenteerd en in de meeste gevallen niet te identificeren. We hebben dit onderwater laten liggen omdat er hier geen faciliteiten zijn om hout te conserveren. Er is niets gevonden dat duidelijk deel uitmaakt van de romp; zelfs geen spoor van de kiel."

182 Werz, '*Een bedroefd, en beclaaglijck ongeval,'* 70.

183 William A. Forster and Kenneth B. Higgs, "The *Kennemerland*, 1971: An Interim Report," *IJNA* 2:2 (1973): 298; and Keith Muckelroy, ed., *Archeology Under Water: An Atlas of the World's Submerged Sites* (New York: McGraw–Hill Book Company, 1980), 125.

184 Muckelroy, ed., *Archeology Under Water*, 125.

185 Richard Price and Keith Muckelroy, "The *Kennemerland* Site: The Third and Fourth Seasons 1974 and 1976: An Interim Report," *IJNA* 6:3 (1977): 214.

# CHAPTER VI
# DOUBLE HULL PLANKING AND SHEATHING

## *Dubbeling* or *verdubbeling*

The practice of building ships with a double–planked hull seems to have been typical for Dutch East Indiamen, as illustrated by the archaeological remains discussed in the previous chapter and also according to archival documents dating to the late sixteenth and early seventeenth centuries. The earliest references to double layers of hull planking can be found in the manuscripts and journals of the United East India Company and the earlier long–distance private trading companies, *voorcompagnieën*.[1]

The denotation of the Dutch terms *dubbeling* or *verdubbeling* (English translation: doubling) are thought to refer to pine sheathing added to ship's hull below the waterline to protect the hull from marine organisms, specifically teredo worms.[2] According to historical sources, practically all ships in the service of the VOC had a layer of pine planking or sheathing, called *dubbeling* or *verdubbeling*, which was fastened to the outer layer of hull planking with iron nails.[3] In 1697, Van IJk, for example, states that ships destined to sail around the Cape of Good Hope or to the West Indies should be coated with a resinous substance (*harpuis*) from their bottom up to the sides, or above the waterline, and covered with a layer of sheathing, which he refers to as "dubbeling".[4]

The terms *dubbeling* or *verdubbeling,* however, were also used to refer to a second layer of oak hull planking as shown in documents of the *voorcompagnieën* and VOC dating to the late sixteenth and early seventeenth centuries.[5] A resolution dating to 6 January 1606, for example, states that a VOC ship was doubled with an extra oak skin on top of which a layer of pine was added.[6] Subsequently, the terms *dubbeling* and *verdubbeling* were exclusively used to refer to pine sheathing from the late seventeenth century onwards when double hull planking was no longer employed in the construction of Dutch Indiamen.[7]

**Double hull planking**

One of the earliest textual references to double planking is found in a journal of the first two Dutch attempts to sail to China through the northern route in 1594 and 1595. This account includes an inventory of two newly–bought Dutch ships *Griffioen* (172 tons) and *Zwaan* (80 tons), which mentions the purchase of 550 pounds (approximately 272 kg) of *harpuis* and 300 pounds (approximately 148 kg) of enriched sulfur to be placed between the old planking and the double planking.[8]

In the first decades after its establishment in 1602, the VOC bought existing vessels and refitted them to build up its fleet. In the earliest VOC shipbuilding charter, dating to 1603, the word "covering" is used for the addition of a second layer of oak hull planking.[9] In this manuscript, the inner layer of hull planking is sheathed with lead and hair after which it is covered with oak planks and doubled up to the quarterdeck wales (see Appendix A).[10] Ships that were bought had to be modified and outfitted for the long journeys to Southeast Asia.[11] A decree of the Amsterdam Chamber dating to January 1606 mentions an order to double plank the hull of a large, newly–bought ship, *Hercules,* by adding an extra layer of oak hull planking, and then sheath it with pine.[12] A few years earlier in 1603, for example, when the Amsterdam Admiralty offered their war vessel *Hollandse Tuin* (1000 tons) for service in the Company's East India trade, the VOC had to double the ship's hull planking at great expense (Fig. II.3).[13]

During the circumnavigation of Jacob Le Maire and Willem Corneliszoon Schouten between 1615 and 1617, the flagship *Eendracht* (360 tons) collided with a large horned fish in the Atlantic Ocean, a few days south of Sierra Leone.[14] This large horned fish was probably a narwhal.[15] When the damage to the ship was investigated, the broken–off horn of the animal was found stuck in the ship's hull, seven feet (approximately 2 m) below the waterline. The horn, equivalent in thickness to an elephant's tusk, had penetrated about half a foot (0.14 m) into the hull wood and was protruding almost a foot from the outside of the hull.[16] The captain, Willem Schout, who was in the gallery at the after end of the ship at the time of the incident, noticed a great turmoil at the bow and thought a man had fallen off the bowsprit. The horn of the fish must have been broken off with great force, causing the animal to bleed so badly that the water at the bow turned red. Upon removal of the horn, it became evident that the horn had pierced through all three layers of the ship's hull, consisting of a thick layer of oak and two thick layers of pine.[17] This may be similar to *Batavia*'s hull, which has one layer of oak hull planking sheathed with two layers of pine between the two lower wales directly above the termination of the double–planked bottom (Fig. IV.24).

The main problem for the VOC, especially in the early years of its existence, was the wear and tear on ships engaged in the long journeys to the Indies. Letters and other VOC documents from the early seventeenth century often refer to problems with vessels due to their lengthy time at sea and the activity of marine organisms in tropical waters.[18] In a letter from Holland about the preservation of ships from worms, the following is stated:

> Although you have visited our Port (*Amsterdam*) I know not whether you have noticed the ill condition, our ships are in that return from the *Indies*. There is on those seas a kind of small worms, that fasten themselves to the timber of the ships, and pierce them, that they make water everywhere; or if they do not altogether pierce them thorow, they do weaken them the wood so it is impossible to repair them.[19]

Most of the vessels in VOC service arrived in the Indies with significant worm damage. In 1620, the Dutch East Indiaman *Morgenster* sailed into the harbor of Sangora (in modern–day Malaysia), and was, in some places, riddled with worms through all its layers of planking up to its knees or frames.[20] Ships were sometimes re–planked or re–sheathed in Asia from the "keel up" or as much as was necessary.[21]

The 1608 journal of Paulus van Caerden, which describes the third journey of the VOC to the Indies, mentions that the large Dutch East Indiaman, *Bantam* (700 tons), was not allowed to stay long in tropical waters since the vessel's hull was "undoubled".[22] In spite of this warning, the vessel did not return to Amsterdam for over three years after leaving in April 1606.[23]

In his observations during his voyage into the South Sea in 1593, Sir Richard Hawkins discusses various practices to protect ships against teredo worms. He mentions the use of double planking as one means: "Another manner is used with double plankes, as thicke without as within, after the manner of furring: which is little better then that with lead; for, besides his waight."[24] The Dutch, however, did not use double hull planking to prevent worms from devouring their ships. The outer layer of pine sheathing and the iron nails used to attach it served this purpose. The iron corroded rapidly and the iron oxide spread readily through the layer of pine, creating a toxic, protective layer of worm guard.[25]

According to Arent Vos, double planking is a result of the transition from lapstrake to carvel–planked vessels. He argues that Dutch shipbuilders could not immediately distance themselves from the concept of a self–supporting skin with overlapping planks, and compensated for the lack of overlapping planking with a double layer of planking.[26] This may have been true if Dutch ships were constructed entirely in a shell–first construction method with lapstrake planking. Dutch ships, however, did not have a completely self–supporting skin as they were built in a bottom–based construction method; they only had a self–supporting bottom assembled without the support of frames. Furthermore, these bottoms, which dictated the initial shape of the vessels, had been built in a carvel–planked manner for many centuries.

Hocker suggested that planking a hull with two layers may be a solution to one of the problems related to the assembly of free–standing planks during the ship's construction, namely the stabilization of the planks before the frames are inserted.[27] The second layer, however, was added to the first layer of hull planking *after* the frame work was installed as shown in the previous chapter. Therefore, stabilizing the planks during construction does not appear to have been the reason for the doubling.

The lower part of the ships' hulls may have been double–planked to ensure water tightness for valuable freight and to protect the hull from damage during the long voyage. According to Witsen and Van IJk, ships with an overall length (from stem to stern) from 120 to 140 Amsterdam feet (34 to 40 m), should have hull planking with a thickness of approximately four thumbs, which corresponds to 0.103 m.[28] Van IJk also lists a planking thickness of four thumbs (0.103 m) for a 154–foot long vessel (43.6 m in length).[29] A shipbuilding charter endorsed by the VOC on 24 May 1653, also lists a planking thickness of four thumbs up to the first wale (Appendix A: Charter of an Indiaman and a yacht–of–war). In addition, Witsen mentions that the garboard strake of a 130–foot–long (36.8 m) vessel would be 22 to 24 thumbs in width (0.56–0.61 m).[30] A plank of 10 m in length, 0.56 m in width, and 0.1 m in thickness would then weigh approximately 347 kg, depending on the species of oak.[31] The heavy weight of the planks that made up the strakes likely caused problems when bent in the proper shape without the support of frames.[32] It is more difficult to bend one thick plank into shape and keep it in place than it would be to do the same thing with two thinner planks. It is simply easier to bend a thinner plank if there is no framing to bend against.

While textual evidence shows strict standards for planking thickness, the archaeological evidence does not always correspond to the prescribed measurements. An average planking thickness of four thumbs (0.103 m), for ships ranging between 120 and 140 feet (34–40 m) in length, as given by Witsen and Van IJk, does not correspond with the 0.14 m (five Amsterdam thumbs) thickness of the double layer of planking of the Scheurrak SOI ship, which belonged to that class.[33] The total thickness of the layer of double planking of *Mauritius* also exceeds the average thickness listed by Witsen and Van IJk. The common planking thickness of a vessel between 150 and 170 feet (42.5–48 m) in length should be 4.5 thumbs (0.116 m).[34] The hull planking of the early seventeenth century ships such as *Mauritius, Batavia*, and *Nassau* are much thicker than expected. *Mauritius*' garboard strake has a total thickness of 0.18 m, the second strake 0.16 m, and the remainder of its hull planking 0.14 m. The average planking thickness of *Batavia* is 0.16 m for both layers of oak planking strakes. Moreover, *Nassau,* a much smaller ship than *Batavia* and *Mauritius*, has a maximum planking thickness of 0.16 m as well.[35] It must also be noted that the planking thickness (3.5 thumbs or 0.09 m) of the mid–seventeenth–century *Vergulde Draak* perfectly conforms to the VOC shipbuilding charter of 24 May 1653 (Appendix A: Charter of a merchant yacht also to be used in war). Furthermore, the planking thicknesses of *Buitenzorg* (0.105 m), a 880–ton ship built in 1753, and *Nieuw Rhoon*, an 1150–ton ship built in 1764 (0.102 m) does correspond to the average planking thickness for ships ranging between 120 and 140 feet in length, as given by Witsen and Van IJk in the late seventeenth century.[36]

It may be that the VOC enlarged the thickness of the hull planking in the early seventeenth century in order to increase the strength of its Indiamen, so their vessels would endure the rough journeys to the Indies better, and perhaps stay in the Company's service a bit longer. Witsen does mention that flutes sailing to the Indies are built much stronger than flutes sailing in European waters. He does not, however, refer to double hull planking or thicker hull planking, but describes the usage of stronger frames and large lodging in the bow and stern.[37] Van IJk observed the construction of a vessel (155 feet or 44 m in length) that was going to sail around the Cape of Good Hope, and recorded a planking thickness of 6 thumbs (0.15 m), which was in his opinion excellent craftsmanship in order to get a strong ship.[38] The planking thickness of this ship is 1.5 thumbs thicker than the average thickness of 4.5 thumbs listed for a ship this size, and corresponds with the planking thickness of the *Mauritius*. In a report dating to 1615, written by a Frenchman who had been imprisoned by the Dutch expedition circumnavigating the world between 1614 and 1617 under the command of Joris van Spilbergen, it is stated that the Admiral's ship of the Dutch fleet (600 tons), named *Grote Zon*, and the vice–Admiral's ship (600 tons), named *Grote Maan,* were very strong ships with double layers of hull planking.[39] He elaborates that regardless of their thick hulls, the Spanish cannon balls did manage to penetrate them.[40] Both *Grote Zon* and *Grote Maan* were warships from the Amsterdam Admiralty that were doubled and equipped by the Admiralty for their planned circumnavigation in the service of the VOC.[41]

The VOC's solution to the additional strength requirements of large hulls was, thus, focussed primarily in the laminated outer shell of planking. It is the most obvious answer for the construction of large ships in a bottom-based or shell-based method. A similar solution was used for the construction of large ships in the ancient Mediterranean, as evidenced by the Madrague de Giens ship. This large Roman merchant ship, dating to the first or second century B.C., was constructed in a shell-based method with two layers of hull planking.[42] The ship measured about 40 m in length and 9 m in beam.[43] The first evidence for the use of multiple layers of hull planking in northern Europe comes from the large medieval naval ships built for the English crown. These large warships were constructed in a shell–based construction method with lapstrake planking.

The archaeological remains of *Grace Dieu*, also known as the Burlesdon ship, indicate that each strake of the ship's hull planking consisted of three layers of planking.[44] The 1400–ton *Grace Dieu,* launched in 1418 by Henry V to serve in the

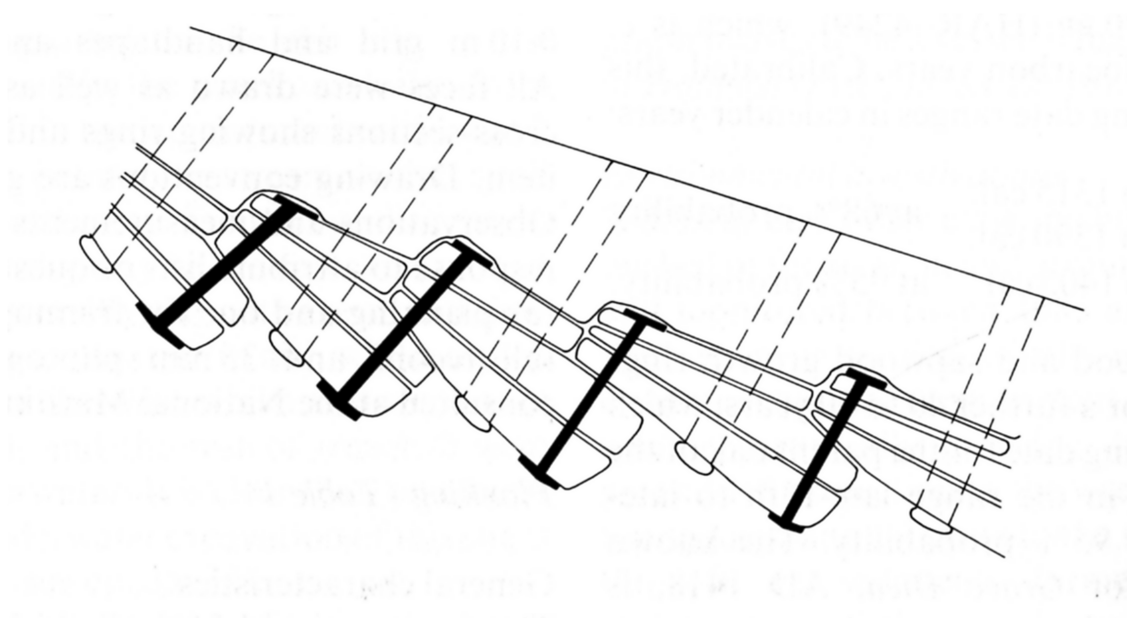

Fig. VI.1 Reconstruction drawing of the triple–layer of hull planking of the R. Hamble wreck at Burlesdon or Henry V's *Grace Dieu* of 1418. Illustration: Richard Clarke et al., "Recent Work on the R. Hamble Wreck near Burlesdon, Hampshire," *IJNA* 22:1 (1993): fig. 5.

Hundred Years War, was the largest ship constructed in Europe at its time. This two–masted carrack had an overall length of 180 feet (54.86 m) and a beam of 50 feet (15.24 m). The ship's keel was 125 feet (38.1 m) in length. *Grace Dieu* was struck by lightning and partially destroyed 21 years after its construction.[45] The archaeological remains of the Burlesdon ship have provided important evidence that large and heavy ships could be build in a shell–first construction method with lapstrake planking.

Three layers of planking that make up each of *Grace Dieu*'s planking strakes are fastened together with small nails to form a thick composite plank.[46] This, however, conceptually differs from the Dutch–built ships, as in the construction of the latter the second layer of hull planking was not added to the first layer before they were erected but much later in the construction process (after the frames were installed). The inner layer of the Burlesdon ship's composite planking was about 4 inches (0.102 m) less wide at its bottom than two outer ones. The two wider layers of this strake overlapped the three planks of the strake below and were fastened to it with iron nails riveted over roves (Fig. VI.1).[47] Thus, the overlap of the planking strakes consisted of five layers of planking. After the planking was assembled, the ship's joggled frames were installed and fastened to the thick triple planking strakes with wooden treenails.[48] For the construction of *Grace Dieu* and its attending vessels 3,906 trees were felled, including 2,735 oaks and 1,171 pine, ash, and elm trees.[49]

Ian Friel's study in *The Good Ship* has shown convincingly that the enormous total length of planking needed for the construction of each individual English warship, as listed in the royal navy records, is so long that they must have been double or triple planked like *Grace Dieu*. He explains that for the construction of the Graveney boat 830 ft (253 m) of planking was used. This local watercraft has an estimated length of 13.75 meter and was built with eleven strakes of planking on each side of its keel. Friel provides lengths of planking used for three of the royal galleys built in 1295: "[one] built in Southampton (60 oars; 12,444+ ft/3794+ m), Ipswich (100 oars; 7600+ ft/2317+ m) and Lyme (54 oars; 6200+ ft/1890+ m). The smallest of the 1295 galleys used at least seven times as much planking as the Graveney boat. Even allowing for extra decking, and the probability that the galleys were at least twice the size of the earlier vessel, the difference is considerable."[50]

The Dutch may have known about medieval English shipbuilding practices but the application of double hull planking was more likely a direct result of the lengthening of existing ships, which had started to occur more frequently in the late sixteenth century as discussed in Chapter II. An archaeological example of a lengthened vessel or *verlanger* is the Christianshavn B&W 1 ship, built shortly after 1584 and lengthened sometime after 1608.[51] The Christianshavn B&W 1 ship was double planked only in the forward and aft section of its hull, whereas the newly added mid section of 7.7 m in length was single–planked.[52] The second layer of hull planking in the fore and aft hull (9.6 m and 9.1 m in length, respectively) was added when the ship was lengthened and ran over the entire length of the ship (hence, this is the single layer of its mid section).[53] It was fastened to the inner layer of planking with wooden treenails (diam. 0.03 m).[54] The thickness of the original inner layer and the new outer layer of hull planking in the bow and stern was 0.045 m (in total 0.09 m at the extremities). Directly forward of the inserted section on the port side, three pine boards were inserted between the inner layer and new outer layer of hull planking. These boards were 1 m in length and taper from 0.035 m fore to 0.02 m in thickness aft (where they stop at the first nearby frame of the new central section of the hull). Lemée suggests that the addition of these boards would have provided a better curvature of the ship's hull as they widened the hull and therefore created a rounder hull shape in the ships center.[55] When the ship was lengthened three additional bilge stringers were inserted for additional longitudinal reinforcement (varying in thickness from 0.1 m to 0.15 m).[56]

According to Wegener Sleeswyk there must have been two basic methods of strengthening a ship's hull when lengthening it; one is by adding more planking to the ship's exterior and the other by adding thicker ceiling planking in the interior.[57] Both these methods have been applied in the rebuilding or lengthening of the Christianshavn B&W 1 ship.

The use of two layers of hull planking as seen in Dutch–built large merchantmen, East Indiamen, and yachts was, therefore, likely to have been directly influenced by the practice of lengthening ships in the same period. All the more since Pieter Jansz Liorne, who must have been intimately familiar with this practice, would provide technical advice to the VOC as discussed in Chapter II.

Double planking seems to have been abandoned around the middle of the seventeenth century; at the same time frame–based construction became the main method of building large merchantmen and warships in the Netherlands.[58] The bottom–based construction method continued, however, for inland craft until the disappearance of the wooden hull.[59]

While the bottom–based construction method continued to be used on inland craft until the disappearance of the wooden hull, frame–based construction became more prevalent. As frame–based construction became popular, the practice of double–planking hulls was abandoned. The last–known archaeological example of a Dutch ship in service with the VOC built with two layers of hull planking and a layer of sheathing is *Avondster*. If the yacht was indeed doubled with an extra layer of hull planking and an additional layer of pine sheathing in 1654, when it was possibly refitted in Holland, then the VOC still outfitted its ships with a double layer of hull planking in the 1650s.[60] By the same token, *Vergulde Draak*, bought in 1653, was built in a bottom–based construction method albeit with one layer of oak hull planking (plus a layer of pine sheathing). It is unknown precisely when *Vergulde Draak* was built. Although Van IJk writes that a frame–based construction method was used in the southern parts of the Netherlands, archaeological evidence for VOC ships or large oceangoing merchantmen built in a frame–based construction method dating to late seventeenth century is not yet available.

According to Hocker, neither Witsen nor Van IJk mention double–hull planking.[61] Witsen indeed does not, but Van IJk does mention it in his manuscript on shipbuilding, published in 1697. He even suggests the construction of double hull planking as the solution to a problem with the ceiling planks and bilge stringers in the hold (between the upper deck and bilges). The water running down from the sides into the hold settles on the ceiling and stringers, and causes significant rot.[62] This affects the strength of the ship in both longitudinal and transverse directions. Van IJk recommends all master builders to consider reinforcing hull strength of new large ships with a double layer of hull planking from the turn of the bilge to the first wale, and omitting the rot–prone ceiling planks between the upper deck and the turn of the bilge.[63] It is interesting that Van IJk makes this suggestion in period when double planking was probably no longer employed for large merchantmen.

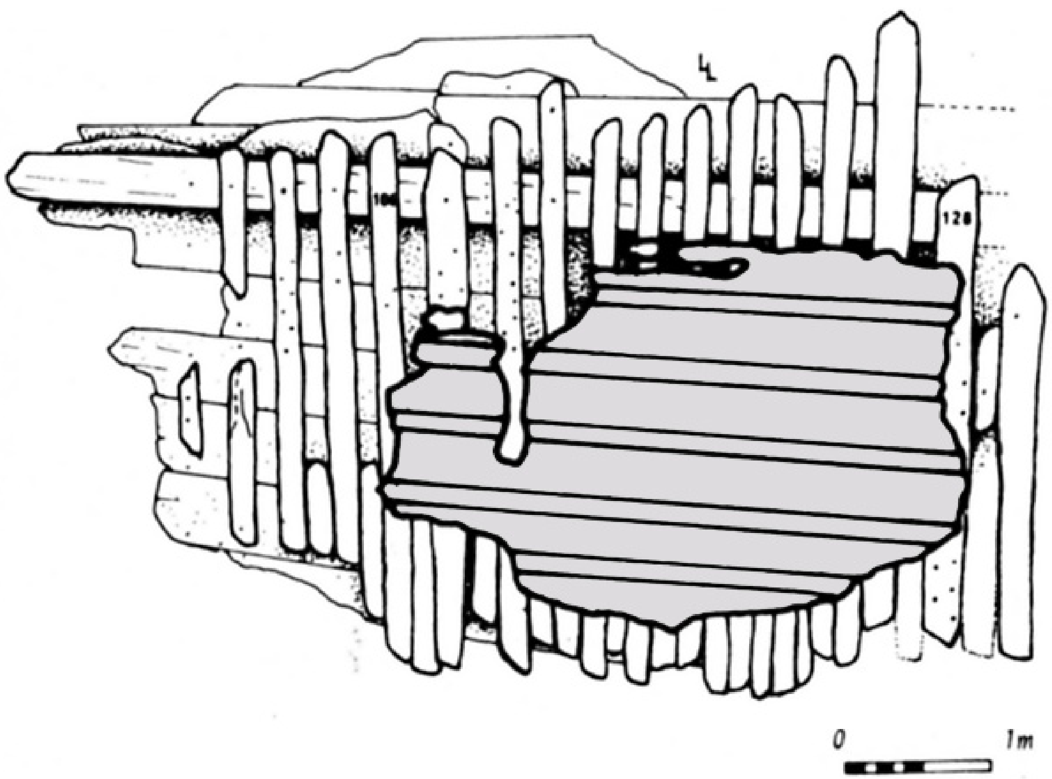


Fig. VI.2 The ceiling planking between frames 106 and 128, VOC ship *Mauritius*. Illustration: Michel Rival, from L'Hour, Long, and Rieth, *Le Mauritius*, 214. © CASTERMAN S.A.

Van IJk's proposition is the same as Ab Hoving's suggested possibility for the construction of ships with two layers of hull planking. The addition of a second layer of hull planking, about a meter in width around the ship's waterline, can increase the stability of a ship. It makes a ship slightly broader around the waterline, and, thus, provides a girdle which stabilizes a ship better.[64] The use of double–planking around the waterline may indeed have stabilized or girdled a ship better, but then the Dutch–built VOC ships were double–planked from their keel up.

Furthermore, the twelve strakes of ceiling planking of *Batavia* cover the entire preserved stern side of the ship (above the bilges). The ceiling planking varies from 0.06 m to 0.07 m in thickness at the ship's bottom and from 0.08 to 0.09 m at the sides.[65] The ceiling planking found on *Mauritius* is located at the bottom of the ship's hold next to the keel between frames 106 and 128, and is treenailed to the frames, presumably the floors (Fig. VI.2).[66] It has an average thickness of 0.08 m, and the width of the ceiling planks varies from 0.3 m to 0.55 m.[67] Its thickness is equal to that of one layer of hull planking and must have added significant strength to the ship's hull. The hull remains of *Mauritius* are, however, insufficient to conclude whether or not the ceiling planking extended beyond the bilges.

After the VOC no longer employed a double layer of hull planking in the late seventeenth century, ships used for whaling or navigating in polar waters continued to be planked with a layer of double hull planking in order to protect the hull from the impact of collisions or crushing if they became icebound.[68] Vos argues that these whaling ships had to be reinforced to withstand the rough conditions in cold polar waters, but that the double planking of large seagoing ships is unnecessary.[69] However, the tropical waters and the long voyages to the Indies took a heavy toll on the hulls of the ships sailing in the service of the VOC as illustrated above, and therefore a thicker hull may have been considered essential. Reinforcing a hull, when building in a bottom–based construction method, was made easier by the assembly of two layers of oak planking instead of one. This eliminates the need for excessively thick planking strakes. In addition, two thinner layers of hull planking are easier to repair *en route* should the need arise. Regardless of its division in multiple layers, this type of construction requires large quantities of good quality, straight trees to facilitate the thick planking strakes. Double–planked hulls are presumably much less prone to leakage due to filling of space between the planks with fiber and tar or resin, and then staggering the seams so that the seams on the inner/outer layers do not align. It makes for much tighter hulls with fewer leaks.

Ships in service of the VOC in the early seventeenth century, such as Indiamen, flutes, and yachts were subject to similar instructions regarding their outfitting, as all of these ship types were only considered capable to sail to the Indies if they had two layers of hull planking and a layer of pine sheathing.

Dutch ships of exploration in service of the *voorcompagnieën*, and later the VOC were obviously outfitted differently than, for example, the warships of the Amsterdam Admiralty. It is interesting to note that the VOC added double planking to, for example, the warships *Grote Zon*, *Grote Maan*, and the four–masted *Hollandse Tuin* (all discussed previously). This makes the ships of the *voorcompagnieën* and VOC planked more heavily than the warships of the Admiralty as the VOC went through the effort to rebuild Admiralty ships offered to its service in order to make them more adequate for tropical waters, storms, and enemy attack.

**Lead and copper sheathing**

Lead sheathing, like that used between the hull planking layers, and planking and sheathing, of *Mauritius* and *Nassau,* seems to have been common practice in the earliest years of the VOC's establishment. In May 1603, a ship of 360 tons was purchased by the VOC Chamber of Amsterdam from Brother Sijmons van Hinlopen. On 19 August 1603, the VOC's "Gentlemen XVII" decided to make the ship ready for a voyage to the Indies, and, therefore, the hull of the vessel needed to be refitted with lead and pine sheathing.[70] According to shipbuilding decrees of the VOC dating to the early seventeenth century, new ships built in Amsterdam had a layer of pine and lead sheathing up to the first wale of the quarterdeck.[71] An account of the VOC lists several materials used for the doubling of the Dutch East Indiamen *Amsterdam* and *Zon*, which includes 207 rolls of thin lead sheathing weighing 14,859 pounds (approximately 7,207 kg), bought for 167 guilders, three nickels, and four pennies.[72]

Sheathing with lead appears to have been a short–lived practice of the VOC. In 1606, it is specifically mentioned to apply pine sheathing without a layer of lead to the hull of *Hercules*.[73] "Without lead sheathing" seems to be purposely mentioned for a short period of time around 1606, after which the VOC generally no longer added layers of lead sheathing between the planking of its Indiamen.

Lead sheathing was considered costly, heavy, and not durable. Richard Hawkins noted: "In Spaine and Portingall, some sheate their shippes with lead; which, besides the cost and waight, although they use the thinnest sheet–lead that I have seene in any place, yet it is nothing durable, but subject to many casualties."[74] However, it can be said with certainty that the material costs of lead could not have influenced its abandonment. *Amsterdam* and *Zon* were sheathed for about 167 guilders in 1604, which is a negligible amount in comparison with the overall expenditure of building a large Indiaman (estimated to have cost roughly 100,000 guilders, see Chapter II, section 'Construction costs of Indiamen').[75]

It is not known whether the use of lead sheathing by the Dutch was discontinued because of the high maintenance, its weight, or its electrolytic reduction in the vicinity of iron fasteners.[76] Lead sheathing did add several thousand kilograms to a ship's hull.

From the journal of *Mauritius* (250 tons), a ship that circumnavigated the world with Olivier van Noort between 1598 and 1601, it is known that the ship's stern rudder was sheathed with lead. On 25 October 1600, the ship's rudder was re–sheathed at the island of Capul in the Philippines as its lead sheathing had fallen off.[77] So, in addition to the ships' hulls and sternposts, their rudders may have been sheathed in lead as well.

Witsen states in his manuscript, published in 1671, that copper or lead sheathing for Indiamen was optional, which indicates that it was not standard practice in the late seventeenth century.[78] In the early years of its existence, the VOC was obviously experimenting with different methods of sheathing in order to find the most ideal combination for its East Indiamen.[79]

The Dutch West India Company supposedly experimented with the copper sheathing of its ships in the early seventeenth century. According to a late eighteenth–century Danish publication, Dutch Admiral Piet Hein put copper sheathing to use first but then it was abandoned until reintroduced by the English in the eighteenth century.[80] Furthermore, English shipwright William May, who worked for the Amsterdam Admiralty in the late eighteenth century, mentioned that he "recollects to have read somewhere that the ship with which Admiral Piet Hein had sailed to Brazil was coppered."[81]

One of Piet Hein's ships, *Hollandia*, sank off the coast of Brazil in 1627. Its wreck site was found a few decades ago and, unfortunately, salvaged. All artifacts were sold off at Christie's in the 1980s and some coinage was reoffered for sale more recently by American Numismatic Rarities.[82] This shipwreck could have provided key evidence for the use of copper sheathing much earlier than the eighteenth century if it had been subject to proper archaeological research.

In 1777, the Dutch admiralties carried out their first experiments with copper sheathing.[83] The archaeological remains of the Dutch frigate *Alfen* (1778), a warship that sank in St. Anna Bay in Curaçao after an explosion, suggest it was sheathed with copper. Numerous pieces of copper sheets and sheathing tacks were found at the shipwreck site that also contained several fragmentary hull timbers. Although no extensive site report has been published to date, it is known that the copper sheets are 1.20 m by 0.35 m in size.[84]

According to VOC archives, the company followed in the footsteps of the Dutch Admiralties in 1791, fourteen years later, when the Hoorn Chamber may have been the first to copper sheath its Indiaman *Oosthuizen*.[85] As the VOC was declared bankrupt in 1795, it did not sheath its Indiamen with copper for a long period of time, and due to the high costs the practice was never made compulsory.[86] These high costs were the Gentlemen XVII's main concern in the discussion of the 1790s on whether to copper sheath all VOC ships. The admiralties also had not yet decided by 1794 whether to copper all the ships of their fleets.[87]

Jerzy Gawronski, who studied the use of copper sheathing in VOC ship construction, found that in the 1740s an average of 1,500 kg of copper sheets was used by the Amsterdam Chamber for the construction of its large Indiamen. He adds that this amount of copper sheets is too much for application to a ship's inner works alone (such as the galley and the interior of the bow). Gawronski, therefore, suspects that the VOC had already started to experiment with copper sheathing its ships' hulls in the 1740s. The costs for the copper sheets, sheathing tacks, and associated labor for the construction of the ships *Amstelveen* (1150 tons), *Overnes* (1150 tons), and *Sloten* (1150 tons) in the 1740s was respectively 2,250, 2,450, and 2,650 guilders.[88]

Gawronski also elaborates that VOC archives show that large amounts of copper sheets were already employed in the 1720s. Furthermore, in 1744, the Gentlemen XVII discuss a proposal to sheath the top of the stern castle's topside planking or taffrail and the gallery, preferably with thin copper sheets instead of lead to increase its durability. This advice was given by several officers in Asia to improve upon the construction of the VOC's ships and the Gentlemen XVII were willing to follow upon it.[89]

Van IJk mentions that in the late seventeenth century the stem and sternposts of ships destined to sail around the Cape of Good Hope or to the West Indies are sheathed with copper in order to keep the wood–eating worm away.[90] Archaeological evidence has shown that it was standard practice of the VOC to sheath the sternposts of its ships with copper sheets (fastened by copper sheathing tacks) throughout its entire existence. The archaeological remains of *Nassau* (1606), *Batavia* (1629), *Vergulde Draak* (1656), and *Buitenzorg* (1760) have all shown that their sternposts were sheathed with copper. In case of *Batavia*, the preserved sheathing on the sternpost consisted of a single layer of copper sheets, whereas *Vergulde Draak*'s sternpost was covered with multiple layers of copper with a lead lining, as discussed in Chapter V. No archaeological evidence has been found to date that demonstrates copper sheathing of the ships' stem for any seventeenth–and eighteenth–century Dutch oceangoing ships.

The sternpost of the VOC ship *Buitenzorg* (880 tons), built at the Amsterdam shipyard in 1753, demonstrates that it was coppered with sheets that covered the post's after face and about 0.1 m on each side.[91] The sides of the sternpost were sheathed with pine sheathing. No copper sheathing was found on the lower hull planks that ran into the ship's sternpost and that were raised with the sternpost assembly. Although the after face of the sternpost was mainly sheathed with copper, it was sheathed with lead directly underneath its iron gudgeons.[92]

The surviving sternpost of *Buitenzorg* is preserved over a length of 5.87 m and is 0.33 m sided on its after face. Based on copper sheets from *Batavia* and *Vergulde Draak*, the copper sheathing would have had a maximum thickness of about 0.003 m. This provides a volume of 0.0093 $m^3$ (if 0.1 m of copper sheet is added to each side of the sternpost's thickness). As the density of copper is 8920 $kg/m^3$ (Rho for copper), the copper sheathing of *Buitenzorg*'s preserved sternpost would then weigh 83.23 kg, not taking into account the overlap between the sheets.[93] Therefore, the sternpost of a large Indiaman would have approximately required 100 kg of copper, based on the method of sheathing seen on the *Buitenzorg*. Furthermore, it is known from the 1616 bookkeeping records pertaining to VOC ship *Enkhuizen* (500 tons) that 494 pounds (approximately 239 kg) of copper was employed for the ship's galley, rudder, and endposts.[94] In addition to the galley, rudder, and endposts, the bread and cheese chamber, manger, seams of the gallery, the corners of the cabin, sail and rigging locker, the mast hoops, mastheads, and bowsprit, were frequently sheathed or lined with copper.[95] From the archives of Admiralty of Zeeland, dating to the mid–seventeenth century, is, for example, known that the total amount of copper sheathing used for all these parts and compartments of warships varied roughly from 555 pounds (273 kg) to 875 pounds (432.25 kg).[96] This is indeed a fraction of the 1,500 kg of copper sheets used for some Dutch Indiamen in the early eighteenth century.[97]

Interestingly, the VOC did not sheath the sternposts, stems, inner works, and possibly hulls in–house but contracted the work out to external specialists.[98] Four Dutch coppersmiths were usually contracted for all work related to copper sheathing in the early eighteenth century. They include Van Hasselt, Mauris van Lijn, Abraham Deutgen, and Pieter Vermaten (in order of most amount of work contracted for).[99]

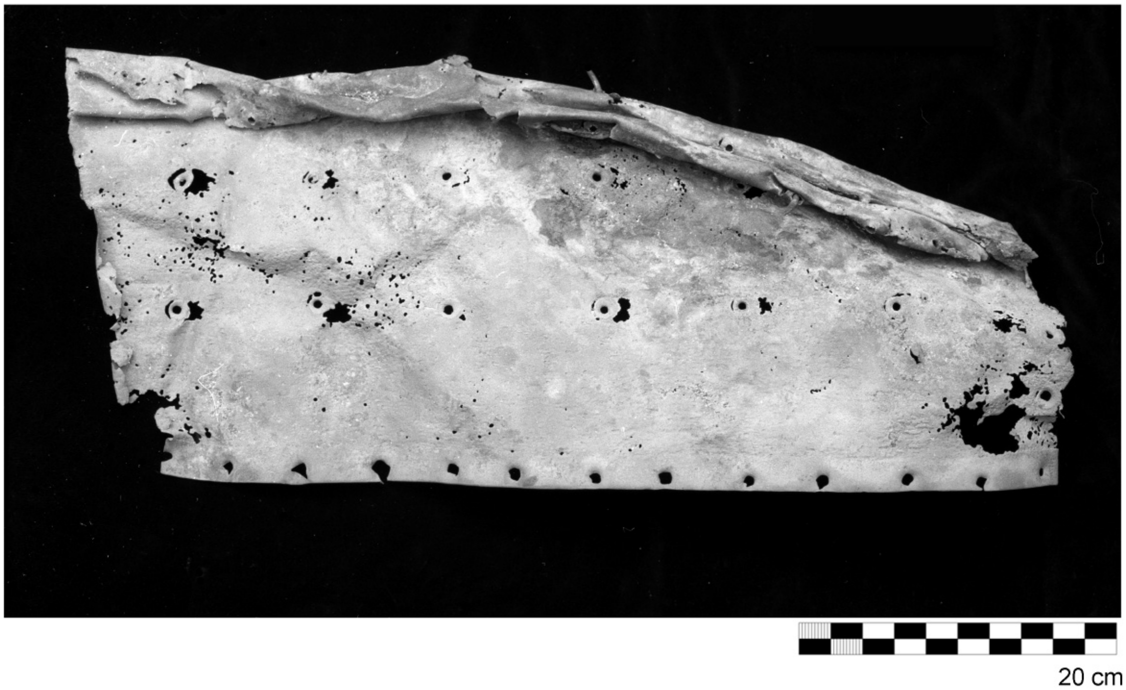


Fig. VI.3 Fragment of copper sheathing, 92/GH/102, Site G, Galle, Sri Lanka. Photograph: Patrick Baker, Western Australian Museum.


Fig. VI.4 Detail of copper sheathing fragment stamped "Nantes," 92/GH/102, Site G, Galle, Sri Lanka. Photograph: Patrick Baker, Western Australian Museum.

When the Dutch Admiralty began copper sheathing the bottoms of their ships in the late–eighteenth century (around 1780), they initially adopted the French way of coppering ships' bottoms.[100] The French separated the layer of copper sheathing from the hull planking by adding a buffer layer consisting of tarred paper. This method was not considered satisfactory by the Dutch shipyards. The Dutch soon followed English example and tried to reduce the effects of electrolytic reduction between the copper sheathing and iron fastenings of their ships by replacing iron with copper fasteners. In order to compensate for the weakening in the ship's hull caused by the use of copper fasteners diagonal braces were applied in the hold. One specific example of this construction method was the 68–gun warship *Leiden* in 1785.[101]

During a survey and test excavation of shipwreck Site G, in Galle harbor in Sri Lanka in 1992 and 1993, fragments of copper sheathing were found (Fig. VI.3). It was thought that the shipwreck most likely had a French origin as one copper sheet was raised from the seabed with the city name Nantes stamped on it, as well as a pair of calipers with the name Limoges (Fig. VI.4). Recent archival study, however, may indicate that this shipwreck represents the remains of the Dutch VOC ship *Geinwens* that sank at the Punto Gale in 1776.[102] *Geinwens* was an 1100–ton Indiaman built for the Amsterdam Chamber in 1765. As the Dutch initially adopted the French way of coppering ships' bottoms, the copper sheets from Site G do not necessarily prove the ship to be of French origin.[103] Although the copper sheets were associated with hull timbers, their original location on the ship has never been fully investigated (Fig. VI.5).

Therefore, a semi–quantitative chemical analysis of a sheathing sample from the so–called *Geinwens* shipwreck was conducted in order to approximately determine its composition.[104] The analysis indicates that the sheathing sample consists of 65% copper and 35% tin. The sheathing from this ship is made of a copper alloy and not, like that of *Batavia* or *Vergulde Draak* sternposts, of pure copper. The alloying of copper sheets is a much later phenomena introduced in the 1820s to 1830s.[105] Therefore, this particular shipwreck is unlikely to be that of *Geinwens*. Regardless, Dutch East Indiamen dating to the early– or mid–eighteenth century, such as *Buitenzorg,* that have been positively identified, have yet to provide evidence for the practice of copper sheathing the ships of the Amsterdam Chamber.

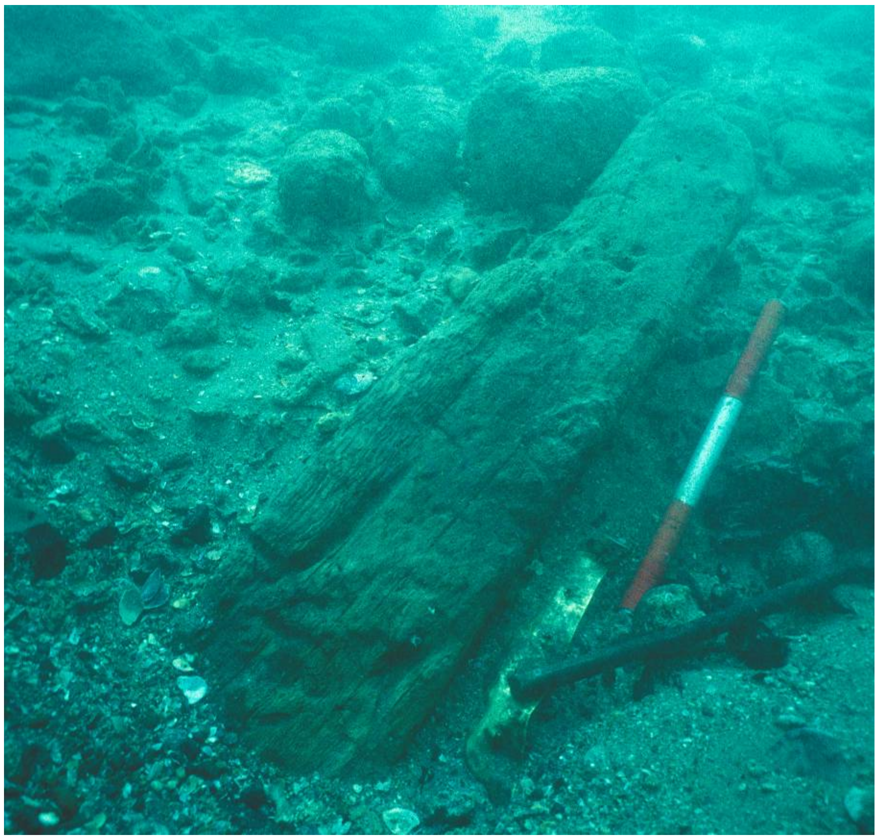

Fig. VI.5 Copper sheathing *in situ* next to the hull timber to which it was originally attached, Site G, Galle, Sri Lanka. Photograph: Patrick Baker, Western Australian Museum.

## Tar and hair

In his manuscript on shipbuilding, Witsen lists the ingredients of a "porridge" with which ships were coated from the bottom to above the waterline. It consisted of *harpuis*, low–grade resin, whale oil, and sulfur.[106] In Van Dam's glossary *harpuis* is described as a mixture of resin, whale oil, fat, and sometimes also sulphur. It was not only used to protect the ship's hull against worms and weathering, but also to prevent rot of mast and spars.[107] The word derives from the French *poix* (Old–French: *harpois*) which means resin or tar.[108] Van IJk, however, explicitly writes that *harpuis* is a juice or gum which flows from French pine trees and is burnt.

This resinous substance was imported into the Netherlands in disks, each weighing between 120 and 180 pounds (approximately 59.28–88.92 kg) at a cost of four to five guilders per 100 pounds (49.4 kg). Van IJk adds that it was much more expensive in time of war.[109] This resinous substance or *harpuis* was mixed with sulphur, which created a white substance, and applied to the ship's hull on the inside, outside and above the waterline.[110] According to Van IJk, sulphur was mainly imported from the Aeolian Islands near Sicily, although the best quality came from a small island or promontory, named Molo, along the Italian coast.[111] It was also found in the Italian Apennine mountain range.[112] It used to cost 5 guilders per 100 pounds, but apparently had become more expensive in Van IJk's time as he mentions a price of 10 guilders per 100 pounds. The most expensive sulphur had the deepest yellow color.[113]

A layer of tar and wax was applied first in between the layers of planking after which a thick coating of animal hair, mainly goat and cattle hair as discussed in the previous chapters was applied as a waterproofing with an anti–teredo repellent.[114]

**Pine or fir sheathing**

From a letter written by Jan Pieterszoon Coen on 10 November 1614, it is known that all Dutch ships in service of the VOC in Jakarta were sheathed with a layer of pine planking to protect the ships from *teredo* infestation.[115] In this letter, he refers to the re–sheathing of ships on a regular basis and, if needed, before they set sail to the Netherlands. With the exception of foreign prizes, all ships built in the Lowlands were double–planked and sheathed as a matter of maintenance. Captured ships were also doubled and refitted at shipyards in the Indies to meet VOC requirements.[116] The re–sheathing or re–planking of VOC ships was generally done every two to four years, depending on the condition of a vessel.[117] A letter written in 1634 from Batavia states that ships purchased by the VOC require more maintenance than those built in–house.[118]

The archaeological remains of all VOC ships, such as *Mauritius* (1613), *Batavia* (1629), *Vergulde Draak* (1656), *Avondster* (1659), *Kennermerland* (1664), *Risdam* (1727), *Zuiddorp* (1712), *Zeewijk* (1727), *Buitenzorg* (1760), and *Nieuwe Rhoon* (1776), have provided evidence for such protection.[119] Pine sheathing, animal hair, tar, and sulphur were used as a protective layer on ships' hulls throughout the seventeenth and eighteenth centuries.[120] The hull remains of *Buitenzorg* have indicated that the quincunx pattern of the sheathing nails was laid out carefully by an incised pattern of diagonal lines scratched into the exterior surface of the ship's pine sheathing. Where two incised lines cross or intersect a sheathing nail is hammered in.[121] The incised pattern certainly facilitated in spacing the nails out evenly and, hence, ensured a more even build–up of the corrosion products that inhibited the invasion of teredoes.

The archaeological remains of *Batavia* have demonstrated that the sternpost of the ship was encased by a layer of oak planking and an additional layer of pine sheathing. Furthermore, the keels of the Christianshavn B&W 2, *Mauritius* and *Buitenzorg* ships were protected by pine sheathing. The Christianshavn B&W 2 ship shows two layers of cover planking on each side of its keel and false keel, but it is not clear whether both are pine or if the inner is oak and the outer layer is pine.[122]

The VOC ship *Buitenzorg* (880 tons) was built at the Amsterdam shipyard in 1753.[123] The ship sank upon return from its second voyage to the Indies after it had become icebound between Texel and Den Helder in January 1760.[124] In 1958, part of the ship's keel, sternpost and stem were raised.[125] Even though the fragmentary bow assembly, including part of the stem and its deadwood, has not been subject to scholarly study and publication, the many closely–set nail holes on either side of the stem and keel indicate that they were sheathed.[126] Preliminary observations of *Avondster*'s hull remains also suggest the use of pine sheathing to protect the ship's stem.[127] Reference to such application is already made much earlier in the journal of Jan Huygen van Linschoten's second attempt to sail to Indies through the northern route in 1595. The wooden sheathing of a ship's stem, probably that of the *Griffioen*, was torn off when the ship ran into a submerged rock during a storm near Norway's North Cape.[128] It is, therefore, likely that the stems of Dutch ships of exploration and VOC ships were protected with a layer of pine sheathing from the late sixteenth century onwards.

The shipyards of the VOC chambers had to follow the company's regulations as prescribed in its shipbuilding charters but they did not operate according to a specific norm when it came to the details of the construction and outfitting of their ships. There were certainly regional differences.

In a letter from Batavia dated to 27 December 1634, suggestions are written down for the VOC in the Netherlands regarding the sheathing of ships in the Dutch shipyard with the intention of saving work for the ship carpenters in the Indies.[129] It is also recommended that the nails fastening the pine sheathing should be set as closely as it is done by the Amsterdam Chamber, because the dense layer of rust on the bottoms of the Amsterdam ships repel worm miraculously.

At the shipyards of the VOC Chamber of Hoorn nails are supposedly set even closer than in Amsterdam, which is considered more preferable, as the skin becomes almost indestructible through the rust layer. The nails should be short and have heads larger and thicker than usual. As shown in the previous chapters, the heads of the sheathing nails of the Amsterdam Chamber ships generally had a diameter of 0.015 m (*Mauritius*, *Batavia*, and *Vergulde Draak*), slightly smaller as the heads of the large spikes used in *Batavia*'s construction. The 12 December 1634 letter also states that the "boat oak" used by the VOC Chamber of Enkhuizen to sheath the bows of its ships is willing to bend and stay in place beautifully, but is also very "sweet" to worms which results in continuous work for the carpenters in the Indies. It is, therefore, recommended to sheath with pine only, "as iron corrosion does not spread well through oak [because of its higher density] and pine is much cheaper."[130]

The time required to add extra layers of planking varied from a few weeks to several months depending on the size of the ship, the amount of work that needed to be done, availability of resources and craftsmanship, physical circumstances, and the weather.[131] An account from Zeeland, dating to 1595, tells us that the newly–bought Dutch ship *Griffioen* (172 tons) was outfitted for its journey to the Indies via the hypothesized Open Polar Sea, by fifteen carpenters in sixteen days. This outfitting included stripping the ship's planking down from the channels (imbedded in the upper part of the wales), renewal of the vertical support timbers on the after side of the hull overlaying the wales, taking apart and rebuilding the stern, renewal of the lower deck over the entire length of the ship, the addition of a second layer of hull planking, and a new permanent *boevenet* aft of the mast (probably a quarterdeck).[132]

**Double–planking or sheathing ships abroad**

Between the first Dutch journey to the Indies in 1595 and the founding of the VOC in 1602, fifteen fleets traveled to Asia.[133] In this period, there were no permanent stations in the Indies for ships to be repaired. If severe leaks or damage occurred to the ships' hull, ships were anchored in the nearest safe bay for repair.[134] These temporary stations had no readily accessible facilities and ship's crew had to work with limited available resources. They had to set up a shipyard and camp, unload the ship, heel it over to expose the bottom of the hull, and obtain materials such as planks.[135] This alone could take several months. In addition, a chronic shortage of carpenters—this was self–evident throughout the entire seventeenth century—, sick crews, and bad weather could delay repairs further.

In December 1603, the fleet of Joris van Spilbergen, sailing for the Company de Moucheron, had an encounter with the yacht *Jager* in the waters off St. Helena. Here, they learned that *Jager*'s chief merchant, Willem van Haghen, had anchored in Mauritius and wintered on the island for four months to repair his ship. He had set sail from Bantam in March, 1602, but did not dare to pass the Cape because the ship was severely leaking. In Mauritius, *Jager* was unloaded, heeled over, and repaired.[136]

Re–planking or sheathing in foreign waters could take much longer. In 1603, for example, the ship *Leiden* was heeled over near Patani (modern–day Thailand) where one side of the hull was made "double." It took the crew seven months to do so. Skipper

Hendrik Jansz had set sail with *Leiden* from Texel in 1600 as part of the fourth Dutch fleet, commissioned by the Old Company, to reach Southeast Asia. After three years in tropical waters, one side of the ship's hull had started leaking.[137]

Unfortunately, most of these references are entries from ship or travel journals which are not very descriptive. Information on how long repairs took, why they took a certain time, how many men worked on it, and how much was re–planked or sheathed is only provided on rare occasions. It is clear, however, that major ship repairs were all subject to the variables of circumstances, as well as available resources and manpower.

One of the most detailed descriptions derives from a ship's journal written on the Indiaman *Zwarte Leeuw*, which sailed to Atjeh and Bantam in 1601. The ship was part of the fifth Dutch expedition to the Indies under the command of Jacob van Heemskerck.[138]

On 8 September 1601, the ship *Zwarte Leeuw* sailed from the Bay of Antongil, Madagascar, where it had anchored for eleven days so its sick crew had a chance to recover. Their condition, however, hardly improved due to a lack of fresh food.[139] After the ship had set sail again, it shaved against a cliff near the island of Sainte Marie and lost two or three of its pine sheathing boards. These boards were about a fathom (1.698 m) in length and a palm wide. The crew expected the ship would not start taking on more water than it already had because the damage only included some sheathing boards. Nevertheless, they anchored south of the island in an anchorage 12 fathoms deep (20.38 m). The morning after, it turned out the ship was taking on more and more water; therefore, the crew began unloading it. On 12 September, two cables were run from the ship to shore and four tide anchors were placed on the ship's weatherboard. After six days, on 18 September, they started heaving stones in order to heel the ship over.[140] Heavy materials, such as stone, were stashed against one side of the ship on its deck to tilt the ship. Once heeled over, the ship's hull could be inspected and repaired. It took the crew three days before they finally managed to get the ship's keel out of the water.[141] The damage turned out to be located at the forward end of the keel; the ship was repaired and righted on the same day. This leak was repaired, but the ship was still taking on water.

On 22 September, it was determined to heel the ship over on its port side and, to avoid taking any risks, they used the large ship's boat or sloop to hold the bowsprit and the small boat to support the sloop's mast. The latter was also used earlier when heeling the starboard side.[142]

On the 23rd, the crew began to pull the ship over to port by ballasting the sloop and small boat. Around the sloop eight empty water barrels were tightly fastened, while on the weatherboard, or windward side, of the ship herself seventeen barrels, filled with water, were hung in tackles to better balance the ship. The tackles allowed the crew to better control of the positioning of the ship. To leeward, they fastened a raft made from the yards and topmasts of the ship, to which another thirteen empty water barrels were fastened. This was all done to properly secure the ship.[143]

By 27 September, the damaged area was located at turn of the bilge forward of the mainmast; two pine boards about eight feet long, and planks of the first layer of oak planking were in some places worn through, which the crew, by their own accounts, "stuffed and repaired industriously."

Three days later, the crew managed "by God's grace" to straighten the ship and immediately started loading it. On 8 October, the spars and topmasts were set in place, and a day later the sails were hoisted. Finally, the night of 11 October, the ship set sail again.[144] The actual repair was performed relatively quickly, but it took a month to unload, heel *Zwarte Leeuw* over, and repair the ship. Most of the time was spent unloading and heeling the ship over to its side.

**VOC shipyards in Asia**

After the establishment of the VOC and, consequently, the foundation of permanent bases in Asia to better organize and control the local Dutch trade, facilities were created for the maintenance and repair of its ships.[145] Ships were repaired, sheathed, and/or re–planked in Dutch settlements at Firando (Hirado, Japan), Masulipatnam (Coromandel, India), Johore (Malaysia), Sangora and Patani (Siam), and in various places in the Moluccas (Indonesia), such as Ambon, Banda, Batjan, Ternate, and Japara on the northeast coast of Java, Bantam in the northwest, and the islands north of Batavia.[146]

Having permanently well–equipped shipyards in the Indies certainly facilitated and sped–up the maintenance and repair of Dutch ships. A letter of the English, written after having observed and tried to predict Dutch activities in the Straits of Malacca, provides some information on the little time needed by the VOC shipyards to sheath their ships.[147] In February 1615, Lucas Autheunis wrote to Sir Thomas Roe in Masulipatnam, India, that "The Dutch in Jaccatra [Jakarta] sheathed three ships in 35 days, which are in the fleet off Mallacca, being at least 800 tons each. It toucheth our reputation too near that we should not be able to do it there as well as they; for although they have continued here this twelve year they never sheathed ship, to take away all occasion whereby they might eat upon them."[148] The three ships being doubled at this time were *Rotterdam*, *Zon*, and *Maan*.[149] The first, *Rotterdam,* was indeed a large ship of about 800 tons, but *Zon* and *Maan* were only 400 tons each.[150] These three ships were part of a fleet of twelve ships and a yacht that had sailed to the Indies in 1612 under the command of Adriaen Block Martenszoon.[151] The ships *Zon* and *Maan* were brand–new ships and *Rotterdam* had been extensively renovated before it left Dutch waters.[152] The three ships had been under way for three and a half years when they were brought into the Batavia shipyard to be doubled and probably were in desperate need of maintenance. Although it took 35 days to entirely sheath the three ships, it is not known how many workmen and how much material were needed or used to do so. The previous discussion has, however, demonstrated that Mr. Autheunis slightly exaggerated the size of the three ships and was obviously not fully aware of Dutch activities as they *had* sheathed and re–planked ships in Asia prior to 1615.

From 1614 onwards, after Jan Pieterszoon Coen's proclamation to sheath all VOC ships in Batavia, the islands nearby were used as shipyard and repair stations. The sheltered anchorage of Batavia was probably the safest and most tranquil bay of

Southeast Asia. A great advantage of the bay was that it was accessible to ships during both monsoon seasons. The shallow waters of the harbor were not suitable to heel ships over, however.[153]

Batavia's insurmountable drawback was its location near the mouth of Ciliwung River as the water of the bay was too shallow due to alluvial deposits and did not allow ships to get close to shore to be heeled over to be careened, caulked, or doubled.[154] In order to heel over ships, a location sheltered from wind and strong currents is needed, and where water is deep enough to bring ships close to shore.[155] Repairs on ships that did not involve heeling over were usually performed in the Batavia anchorage. For all other repairs, ships were often sent to the Dutch shipyards at the coral islands situated about 14 km north of Batavia. The most important and largest of these islands was Onrust (Engl. Unrest), which quickly became and remained an important shipyard in the Indies between 1614 and 1795.[156] Today the name of the island still refers to its days as a shipyard: Pulau Kapal means Ship Island in English. In the seventeenth century, however, it was called Onrust due to working conditions on the island. Since the repair and maintenance of ships provided an overload of work, which kept carpenters working around the clock, allowing them no rest, the island was named Onrust.[157] Ships were often sent to Onrust to be doubled.[158] In 1625, for example, Witte Corneliszoon de With mentions in his journal that the ships *Delft* and *Amsterdam* of the Nassau Fleet were sent to Onrust to be doubled in order to prepare both ships for their homeward voyage to Holland a few months later.[159] In another source, Onrust is referred to specifically as "our doubling place."[160] The shipyard of Onrust only had enough space for three ships to be worked on at one time.[161] The shipyard and settlement of Onrust were not fortified and had to be evacuated in time of war. In 1618, for example, the English used such an opportunity to ransack the evacuated island for its shipbuilding supplies. Their booty included eight cannon (that were lying in the water), 120 small and large anchors, 200 hewn oak beams (*swalpen*), a consignment of tropical wood, two hawsers, a twenty–oar galley, the yacht *Halve Maan*, and a Javanese junk.[162]

**Anchorages**

Even though permanent shipyards were established in the Indies after 1602, in case of emergency, ships were still repaired or doubled at nearby and accessible anchorages. Near Sierra Leone, for example, a Spanish sugar–prince, captured and re–named *Windhond,* is set ashore to be doubled on 12 August 1623.[163] This small Spanish ship was taken together with three barques on 4 June 1623, by a Dutch fleet of eleven vessels under command of Admiral Jacques L'Heremite and Vice–Admiral Huygen Schapendam.[164] Three and a half months earlier, these Dutch ships, better known as the Nassau Fleet, had set sail from Holland with 1637 men aboard to circumnavigate the world and were instructed to attack the Spanish strongholds on the western coast of South America.[165] The Dutch ships of this fleet were *Amsterdam* (800 tons), *Delft* (800 tons), *Oranje* (700 tons), *Hollandia* (600 tons), *Eendracht* (600 tons), *Mauritius* (560 tons), and the yachts *Arend* (400 tons), *Koning David* (360 tons), *Hoop* (260 tons), *Griffioen* (320 tons), and *Windhond* (60 tons).[166] The last turned out to be an albatross around the fleet's neck and even needed to be towed for several days in order not to lose sight of it.[167] In June 1623, the slow sailing *Windhond* was sent back to Holland with two of the Spanish barques, all loaded with sugar.[168] They were escorted by a Dutch warship from the Amsterdam Admiralty, *Overijssel*, which had met the fleet on 12 June in Safia (modern–day Morocco, south of Cape Cantin).[169] The remaining Spanish barque was named *Pinksterbloem* and the small Spanish ship took *Windhond*'s place and name.[170] The Nassau Fleet was now twelve ships strong.[171]

The new *Windhond*, still referred to as a yacht, was also causing problems, as its worm–riddled hull was making so much water that its crew could hardly keep it afloat. It was anchored at the Sierra Leone River to be repaired.[172] Crews from all ships of the fleet participated; from each ship two carpenters were sent to help, and their crews chopped down trees in the forest and sawed the planks for the *doubling*.[173] The larger ships were instructed to provide thirty sheathing boards and the smaller ships provided supplies in proportion.[174]

The carpenters could not reach the keel due to a high water level that did not drop as anticipated at the last quarter of the moon. At the same time, they could not get the yacht afloat again as the water level was too low to do so.[175] It took five days before *Windhond* was heeled over along side the ship *Griffioen*, which was used as its tow ship. The heavy tackles used to heel *Windhond* over consisted of pulley blocks fastened to the top of its mast whereas lower blocks of these tackles were fastened to *Griffioen*.[176] Generally, if other ships were present when a ship needed to be sheathed or re–planked, they assisted in heeling the ship over to make the work easier.

The sea remained too rough to repair the severely leaking ship, and it eventually was sailed into another bay where the entire procedure had to be started again. There, the carpenters were finally able to reach the ship's keel. On August 26, with more or less twenty–four carpenters at work, *Windhond* was finally sheathed.[177] Consequently, a series of uncorrelated events complicated matters even further. One day after the ship was sheathed, its mast cracked as a result of too much pressure from the tackles.[178] Another ship in the fleet, *Mauritius*, nearly sank because the crew had heeled it over but had forgotten to seal the ship's scupper holes. By the time they discovered the omission, *Mauritius* had already taken on seven to eight feet (1.98 m to 2.27 m) of water.[179]

While *Windhond* was being doubled, the other ships were careened and cleaned. A number of deaths, bad weather, and heavy rainfall prevented the fleet from continuing its journey. Finally, after three weeks, on 4 September 1623, the fleet once again set sail.[180]

As far as time required for the actual repair work, the fleet's journal states that *Windhond*'s carpenters managed to double its hull in one day. However, this probably refers to re–sheathing the ship only and not to replacing its hull planking. Elsewhere, the journal specifically mentions that the larger ships in the fleet had to donate collectively 30 *delen*—pine sheathing boards and *not* hull planks— to accomplish this.[181]

In this particular case, there was enough assistance and supplies to repair *Windhond* but not every ship was in such an advantageous position. The crew of *Hollandia*, for example, refused to unload its cargo and double its hull planking at

Mauritius in 1611, despite specific instructions to do so at their port of departure (Batavia) and to have their companion ship *Middelburg* assist. Evidently *Hollandia* was not watertight when it set sail from Batavia and its clove cargo was heated to begin with. The cargo continued to gain temperature until the ship caught fire near the Azores.[182] In order to save the ship, the cargo was thrown overboard and the financial loss of the ship's cargo was later tallied to be 70,000 thalers (140,000 guilders –roughly 2 guilders per thaler).[183]

Fig. VI.6 The Dutch discovery of the island Mauritius by Warwijck and his men in September 1598. Illustration: Isaac Commelin, ed., "Waerachtigh verhael van de Schipvaerd op Oost–Indien gedaen by de acht Schepen in den jare 1598. Van Amstedam uyt–ghezeylt, onder 't beleyd van den Admirael Jacob Cornelissooon van Neck, ende Vice–Admirael Wybrand van Warwijck," in *Begin ende Voortgangh der Vereenigde Nederlantsche Geoctroyeerde Oost–Indische Compagnie. Begrypende de volgende twaelf voyagien door de inwoonderen der selviger provintien derwaerts gedaen* (Amsterdam: Facsimile Uitgaven Nederland, 1969), plate no. 2 (between pages 3–4).

*Hollandia*'s skipper, Piet Heyn, who later became famous for capturing the Spanish treasure fleet at Cuba, did manage to sail the ship safely back to the Netherlands, even though they had an acute shortage of provisions and water, in addition to a high mortality rate and an enfeebled crew.[184] There were probably too many sick and too few healthy men to carry out the doubling of *Hollandia* in Mauritius.

The island of Mauritius was a location that quickly became well known as a good refuge *en route* for repairs and a post for activities in the southern hemisphere. It was uninhabited and had good resources such as wood for shipbuilding and provisions for the crew. The first Dutch to set foot on the island were Wybrant Warwijck and his men. Warwijck named the island after Dutch viceroy and Prince of Orange, Maurice van Nassau.[185] Mauritius was a fertile haven with an abundance of fruits (mainly coconut), turtles, fish and birds, such as pigeons and dodos.[186] Warwijck and his men discovered the island on 17 September 1598, and anchored their five ships, *Amsterdam*, *Zeeland*, *Gelderland*, *Utrecht*, and *Friesland* in its waters for weeks. Ashore, they foraged for anything edible, the sick were given a chance to recover, and some huts were constructed. Interestingly, the carpenters even built a sloop on the island (Fig. VI.6). The island was used mainly as an occasional staging post or shipyard in the years there after.

On 31 March 1606, for example, the ship *Dordrecht* started leaking on its homebound voyage as some oak planks of its outer layer of hull planking had washed away. The crew had no other option than to anchor in Mauritius for repairs along with the other ships in its fleet.[187] While *Dordrecht* was partially re–planked in Mauritius, the ship *Hollandia* was given a new transom. The resources of wood in Mauritius are stressed in the fleet's journal and, while both ships were being repaired, the crews of the other ships kept busy chopping trees and forging iron. Apparently, tens of thousands of trees of all kinds were cut down for the maintenance of the ships, construction warehouses, used as firewood to make charcoal, and for the furnaces of two smithies that were set up to forge all sorts of iron work, large numbers of iron bolts, and twenty thousand nails.[188]

In the years after the Dutch discovery of Mauritius, they planted fruit trees and left animals, such as pigs, deer, and goats, on the island to ensure future provisions.[189] These trees and animals were brought by ship from Madagascar and Bantam.[190] In the 1630s, the VOC finally founded a permanent post on the island to prevent the French or English from settling it.

**Wood resources and costs of re–planking/sheathing in Asia**

It was expensive to add extra layers of planking to a ship's hull. The cost depended mainly on the location of the shipyard, the local price of resources, and availability of craftsmen. According to Coen, the VOC shipyard in Japan charged high prices for re–doubling a ship's hull. In a 1627 letter he complains about the significant outlay of 30,000 guilders for the doubling and repairs of two ships in Japan. It is not known whether he was referring to pine sheathing or the re–planking of the outer layer of the hull planking.[191] Coen may have expressed discontent to protect his centralized power and control over the company's financial assets. It is clear he did not have his way, as too many ships needed maintaining and the chronic shortage of wood, carpenters, and sawyers left him no other choice but to send ships elsewhere, including Japan, to be sheathed and/or re–planked.[192]

It is known from extracts of the daily journal kept in Batavia Castle, which holds information on incoming and outgoing ships and on events occurring in the Dutch–Indies, that large quantities of wood were needed to construct buildings and to refit ships.[193] The VOC in the Indies, however, had to contend with a continuous lack of wood. Although Southeast Asia had plenty of forested areas, they were not always easily accessible to the VOC due to hostilities between the VOC and local rulers. Java, for example, had plenty of timber, but cutting trees there and on nearby islands was a dangerous matter for the Dutch, and only possible under protection by armed escorts.[194] The initially congenial relationship between the Dutch and local rulers became strained when the former began establishing a permanent presence on the island. Thereafter, the relationship was characterized by intermittent armed conflicts and lingering wars.

Wood was occasionally imported from Mataram (southern Java, the area around modern–day Yogyakarta) but at great expense, and was not a very dependable source for supply due to tensions between the VOC and the Mataram sultanate. In 1622, the sultanate closed it harbors for the VOC and timber from Mataram became off–limits for the Dutch. In the same period, similar circumstances cut off the timber supply from Japara in the northeastern Java. A document from 1622 describes how the Dutch previously procured large amounts of planks, deck beams, gun carriages, beams, wheels and spokes, futtocks, and all sorts of timber from Japara to construct ships, but by then the place had become inaccessible due to hostilities. They were forced to get their timber elsewhere.[195]

A letter from Batavia dating to 27 December 1634, written by four men, Brouwer, Van Diemen, Van der Burch, and Van Broeckum, reports the necessity of timber for the ships and boats, such as masts/spars, hewn oak beams, and in particular good pine planking for sheathing as no quality wood for shipbuilding is found in the Indies, except for teak, which costs ten times as much as pine from Holland.[196] They also report that Dutch shipyards near Batavia consume large quantities of *baye* wood, which is not very rot–resistant and only comes in small lengths of about 14 feet long (4.27 m) and 9 thumbs (0.229 m) wide.[197] Hundred planks cost between 33 and 36 *eight reals* (66 and 72 guilders —approximately 2 guilders per *eight reals*) and did not last for longer than six months, which resulted in a loss of nails and labor.[198] Nineteen years earlier, in 1615, Jan Pieterszoon Coen had already suggested that it would be better to use complete planks (as the VOC shipyards in Holland did) and not to use planks sawn in smaller lengths.[199]

When wood was available, its price could be insanely high, particularly in times of war, which more often than not was the case. A complaint from the Dutch in Ambon in the early 1620s relates how 300 *reals* (approximately 75 guilders) had to be paid to sheath one strake of a *corracorra*, a local rowing vessel, and elaborates how, with such prices, it may be better to have ships sheathed in the Kingdom of Spain.[200]

A potential timber supply was situated on the islands of Bessy and Sebessy, located west of Java. Being uninhabited, the Company took possession of them in 1624 to prevent other nations from requisitioning and exploiting their resources.[201]

Nevertheless, the VOC shipyards of Onrust and the other nearby islands remained dependent upon major supplies such as masts and spars, ropes, nails, tar, resin, lead, and carpentry tools, from the Netherlands until the bankruptcy of the VOC in 1795.[202] Ships arriving at Batavia from the Netherlands were instructed to put their surplus at the shipyards' disposal.[203]

**Conclusion**

In the late sixteenth and early seventeenth centuries, Dutch shipwrights built many large merchantmen with a double layer of thick oak hull planking. The VOC especially preferred to build its large East Indiamen with two or more layers of planking. Hull planking was made thicker than called for in the late–seventeenth–century Dutch shipbuilding manuscripts of Witsen and Van IJk, as demonstrated by archaeological remains and VOC shipbuilding charters dating to the late sixteenth and early seventeenth centuries. The VOC most likely aimed to construct stronger and heavier ships to better protect the ships' hulls from the damage of heavy seas and from the results of spending many months at sea and away from repair facilities. As Dutch ships were still being built according to a bottom–based tradition in this period, dividing a thicker hull skin into two layers facilitated the bending of heavy oak planks and keeping them in place. Double–hull planking is mentioned often in archival documents from the formative years of the VOC, 1602–22. Ships were often purchased and put into service, particularly during the first years after the establishment of the VOC. If such ships were not originally provided with double planking, they had to be fitted with an extra layer of oak planking for the voyage to the Indies. Sometime after the 1650s, however, double planking was no longer employed in the construction of large merchantmen and warships, with the exception of whaling vessels. This corresponds to the time when the bottom–based tradition is replaced with the frame–based construction method in most Dutch shipyards in building large merchantmen and ships of war.

In addition to double planking the hulls, the VOC often outfitted its ships with an additional layer of pine sheathing to protect the hull from the ravages of *teredo* worms and other marine borers. This pine sheathing was fastened with iron nails to the outer layer of hull planking, and the nails were closely spaced in order to create an iron rust layer to provide additional protection for the hull against marine organisms. This method became a standard worm–protection measure throughout the seventeenth and eighteenth centuries.

Placed between the double planking and also between the hull sheathing was a coating consisting of animal hair, tar, and sulphur. Sometimes lead sheathing was also added between the hull planking and sheathing, as in the hull of *Nassau* and *Mauritius*. Lead was often used during the first few years of the VOC, as revealed by several decrees dating between 1602 and 1606. After 1606, however, its use became less and less common. Apparently, lead sheathing failed to provide the desired protection when the VOC was experimenting with multiple layers of hull planking and sheathing in order to determine the most efficient hull protection for its East Indiamen.

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[1] National Archives (NA) of the Netherlands, The Hague*, Archieven van de Verenigde Oostindische Compagnie, 1602–1795*, reference code 1.04.02, item number 307 (Zakenindex op de resoluties van de kamer Amsterdam, 1602–1743), 441; Isaac Commelin, ed., "Historisch verhael vande reyse gedaen inde Oost–Indien, met 15 schepen voor de reeckeninghe van de vereenichde gheoctroyeerde Oost–Indische Compagnie," in *Begin ende Voortgangh der Vereenigde Nederlantsche Geoctroyeerde Oost–Indische Compagnie. Begrypende de volgende twaelf voyagien door de inwoonderen der selviger provintien derwaerts gedaen* (Amsterdam: Facsimile Uitgaven Nederland, 1969), 85; Willem A. Engelbrecht and Pieter J. van Herwerden, *De ontdekkingsreis van Jacob Le Maire en Willem Cornelisz. Schouten in de jaren 1615–1617: Journalen, documenten en andere bescheiden* ('s–Gravenhage: Martinus Nijhoff, 1945), 157; Parthesius, "De dubbele huid van Oostindïevaarders aan het begin van de 17de eeuw," 26; Jan K. Parmentier, Karel Davids, and John Everaert, *Peper, plancius, en porselein: De reis van het schip* Swarte Leeuw *naar Atjeh en Bantam, 1601–1603* (Zutphen: Walburg Pers, 2003), 120; Van Dam, *Beschrijvinge van de Oostindische Compagnie*, 458–59; Van Linschoten, *Reizen van Jan Huyghen van Linschoten naar het Noorden (1594–1595)*, 264; Joris van Spilbergen, *De reis om de wereld van Joris van Spilbergen 1614–1617* ('s–Gravenhage: Martinus Nijhoff, 1933), 129, 161; and De Booy, *De derde reis van de V.O.C. naar Oost–Indië onder het beleid van admiraal Paulus van Caerden uitgezeild in 1606* (1968), 14.

[2] Van Beylen, *Schepen van de Nederlanden, van de late middeleeuwen tot het einde van de 17e eeuw*, 42–43; Van Dam, *Beschrijvinge van de Oostindische Compagnie*, 454; Diekerhof, *De oorlogsvloot in de zeventiende eeuw*, 33–34; Elias, *De vlootbouw in Nederland in de eerste helft der 17e eeuw, 1596–1655*, 11; and Vos, "De replica van een VOC–retourschip te Lelystad: de *Batavia*?" 50.

[3] For *verdubbeling* or *dubbeling* see, Witsen, *Architectura navalis et reginem nauticum,* 334; and Van IJk, *De Nederlandsche scheeps–bouw–konst open gestelt*, 87, 91–92, 289, 292.

[4] Van IJk, *De Nederlandsche scheeps–bouw–konst open gestelt*, 91.

[5] According to Vos, only historical documents of the middle to late seventeenth century are available for the study of the construction of ships with double hull planking, but in the archives of the VOC and travel journals of the early seventeenth century numerous references are made to the construction of double–planked ships. Vos, "De replica van een VOC–retourschip te Lelystad: de *Batavia*?" 52.

[6] National Archives (NA) of the Netherlands, The Hague*, Archieven van de Verenigde Oostindische Compagnie, 1602–1795*, reference code 1.04.02, item number 307 (Zakenindex op de resoluties van de kamer Amsterdam, 1602–1743), 441; and National Archives (NA) of the Netherlands, The Hague*, Archieven van de Verenigde Oostindische Compagnie, 1602–1795*, reference code 1.04.02, item number 226 (Resoluties kamer Amsterdam, 14 November 1606, 2 January 1606, 6 January 1606).

[7] Witsen, *Architectura navalis et reginem nauticum*, 334; and Van IJk, *De Nederlandsche scheeps–bouw–konst open gestelt*, 87, 289, and 292.

[8] Van Linschoten, *Reizen van Jan Huyghen van Linschoten naar het Noorden (1594–1595)*, 263 (Heren staten van Zeelandt).

[9] Van Dam, *Beschrijvinge van de Oostindische Compagnie*, 458–59; and Hoving and Emke, *Het schip van Willem Barents*, 111.

[10] In the charter is written that the hull planking is doubled from the bottom up to the quarterdeck wale with "Oostersche plancken" (Engl. Eastern planks), which are oak planks that were imported from the countries on the *Oostzee* or Baltic Sea, see: National Archives (NA) of the Netherlands, The Hague, *Archieven van de Verenigde Oostindische Compagnie, 1602–1795*, reference code 1.04.02, item number 99 RJ (Kopie–resoluties van de Heren XVII, 1602–1607), folio 67; and Van Dam, *Beschrijvinge van de Oostindische Compagnie*, 457.

Dutch historic research has demonstrated a clear distinction in Old Dutch between use of plural noun "planken" (planks) and "delen" (boards). The first refers to oak planks, whereas the latter refers to pine planks. Van IJk, for example, does not use the word *delen* to refer to planking while discussing the use of oak planks, and by the same token he does not mention to word *planken* while discussing pine sheathing. Schillemans mentions in his dissertation that the word *delen,* in all catalogs of the Zaandam timber auctions dating from 1655 to 1811, exclusively refers to pine or fir planks, see: Van Beylen, *Schepen van de Nederlanden, van de late middeleeuwen tot het einde van de 17e eeuw*, 39; Nanning Porsius,"Eiken en grenen," in *Herbouw van een Oostindïevaarder: Batavia Cahier 5*, ed. Robert Parthesius (Lelystad: Stichting Nederland bouwt een VOC–retourschip, 1994), 59; Porsius and De Munck, "Over hout, de herkomst, de kwaliteitseisen en de bewerking daarvan," 143, note 11; Van IJk, *De Nederlandsche scheeps–bouw–konst open gestelt*, 35–46; Janse, "Bouwbedrijf en houtgebruik in het verleden: eikehout en naaldhout als bouwmateriaal," 19; and Schillemans, "De houtveilingen van Zaandam in de jaren 1655–1811," 62.

[11] National Archives (NA) of the Netherlands, The Hague*, Admiraliteitscolleges*, reference code 1.01.46, item number 1360; Van Dam, *Beschrijvinge van de Oostindische Compagnie*, 450; and Parthesius, "De dubbele huid van Oostindïevaarders aan het begin van de 17de eeuw," 26.

[12] National Archives (NA) of the Netherlands, The Hague*, Archieven van de Verenigde Oostindische Compagnie, 1602–1795*, reference code 1.04.02, item number 307 (Zakenindex op de resoluties van de kamer Amsterdam, 1602–1743), 441; National Archives (NA) of the Netherlands, The Hague*, Archieven van de Verenigde Oostindische Compagnie, 1602–1795*, reference code 1.04.02, item number 226 (Resoluties kamer Amsterdam, 14 November 1606, 2 January 1606, 6 January 1606); and De Booy, *De derde reis van de V.O.C. naar Oost–Indië onder het beleid van admiraal Paulus van Caerden uitgezeild in 1606* (1968), 37.

[13] Elias, *De vlootbouw in Nederland in de eerste helft der 17e eeuw, 1596–1655*, 11. This particular vessel sailed to Brazil in a fleet of five ships under command of Paulus van Caerden in 1603, and returned in 1604–1605 (p. 12). It is, therefore, not its namesake *Hollandse Tuin* (360/440 ton) that sailed to Atjeh and Bantam for VOC chamber Enkhuizen on June 17, 1602, and returned in Holland April 8, 1605. See, Bruijn, Gaastra, and Schöffer, *Dutch–Asiatic Shipping in the 17th and 18th Centuries: Outward–bound Voyages from the Netherlands to Asia and the Cape (1595–1794)*, no. 0077.1; Bruijn, Gaastra, and Schöffer, *Dutch–Asiatic Shipping in the 17th and 18th Centuries: Homeward–bound Voyages from Asia and the Cape to the Netherlands (1597–1795)*, no. 5060.1.

[14] Engelbrecht and Van Herwerden, *De ontdekkingsreis van Jacob Le Maire en Willem Cornelisz. Schouten in de jaren 1615–1617*, 16, 157; Isaac Commelin, ed., "Historische ende Journaelsche aenteyckeningh: Van 't gene Pieter van den Broecke op sijne Reysen, soo van Cabo Verde, Angola, Gunea, en Oost–Indien (aenmerckens waerdigh) voorghevallen is, &c," in *Begin ende Voortgangh der Vereenigde Nederlantsche Geoctroyeerde Oost–Indische Compagnie. Begrypende de volgende twaelf voyagien door de inwoonderen der selviger provintien derwaerts gedaen* (Amsterdam: Facsimile Uitgaven Nederland, 1969), 13; and James D. La Fleur, *Pieter van den Broecke's Journal of Voyages to Cape Verde, Guinea and Angola (1605–1612)* (London: Hakluyt Society, 2000), 65.

[15] Parthesius, "De dubbele huid van Oostindïevaarders aan het begin van de 17de eeuw," 26–27.

[16] Engelbrecht and Van Herwerden, *De ontdekkingsreis van Jacob Le Maire en Willem Cornelisz. Schouten in de jaren 1615–1617*, 16, 157.

[17] Engelbrecht and Van Herwerden, *De ontdekkingsreis van Jacob Le Maire en Willem Cornelisz. Schouten in de jaren 1615–1617*, 157.

[18] National Archives (NA) of the Netherlands, The Hague, *Archieven van de Verenigde Oostindische Compagnie, 1602–1795*, reference code 1.04.02; Coen, *Bescheiden omtrent zijn bedrijf in Indië* (1919), 73 and 130; Jan P. Coen, *Bescheiden omtrent zijn bedrijf in Indië*, ed. Herman T. Colenbrander ('s–Gravenhage: Martinus Nijhoff, 1921), 352, 664–67; Coen, *Bescheiden omtrent zijn bedrijf in Indië* (1952), 15–16, 628–29, and 649; Jan P. Coen, *Bescheiden omtrent zijn bedrijf in Indië*, ed. Herman T. Colenbrander ('s–Gravenhage: Martinus Nijhoff, 1953), 985, 1507, and 1579; Coolhaas, *Generale missiven van gouverneurs–generaal en raden aan Heren XVII der Verenigde Oostindische Compagnie* (1960), 478–79; De Booy, *De derde reis van de V.O.C. naar Oost–Indië onder het beleid van admiraal Paulus van Caerden uitgezeild in 1606* (1968), 51, 67, and 90; De Booy, *De derde reis van de V.O.C. naar Oost–Indië onder het beleid van admiraal Paulus van Caerden uitgezeild in 1606* (1970), 62, 150–52, 162, 216; Van Spilbergen, *De reis om de wereld van Joris van Spilbergen 1614–1617*, 75, 88.

[19] Royal Society of London, "An Extract of a Letter, Written from Holland, about Preserving of Ships Being Worm–Eaten,"190–91.

[20] Coen, *Bescheiden omtrent zijn bedrijf in Indië*, ed. Herman T. Colenbrander (1952), 649; Coen, *Bescheiden omtrent zijn bedrijf in Indië*, ed. Herman T. Colenbrander (1919), 581; Coen, *Bescheiden omtrent zijn bedrijf in Indië*, ed. Herman T. Colenbrander (1921), 625.

The Dutch East Indiaman *Morgenster* was last doubled in 1618 in Bantam or the islands near Jakarta. Coen, *Bescheiden omtrent zijn bedrijf in Indië*, ed. Herman T. Colenbrander (1919), 388.

[21] The following references date, or refer to documents dating, between 1599 and 1634, and are listed as examples only, as there are undoubtedly more references to re–planking or re–sheathing of Dutch East Indiamen in Asia. Specifically regarding re–planking from "the keel up", Petrus J.A.N. Rietbergen, *De eerste landvoogd Pieter Both (1568–1615): Gouverneur–generaal van Nederlands–Indië (1609–1614)* (Zutphen: De Walburg Pers, 1987), 317–19; Jan P. Coen, *Bescheiden omtrent zijn bedrijf in Indië*, ed. Herman T. Colenbrander ('s–Gravenhage: Martinus Nijhoff, 1919), 143; Jan P. Coen, *Bescheiden omtrent zijn bedrijf in Indië*, ed. Herman T. Colenbrander ('s–Gravenhage: Martinus Nijhoff, 1920), 109; Jan P. Coen, *Bescheiden omtrent zijn bedrijf in Indië*, ed. Herman T. Colenbrander ('s–Gravenhage: Martinus Nijhoff, 1922), 52, 55, 58; and Jan P. Coen, *Bescheiden omtrent zijn bedrijf in Indië*, ed. Herman T. Colenbrander ('s–Gravenhage: Martinus Nijhoff, 1952), 786

For general references to re–planking, Rietbergen, *De eerste landvoogd Pieter Both (1568–1615)*, 241, and 317–19; Coen, *Bescheiden omtrent zijn bedrijf in Indië* (1919), 73, 130, 143, 153, 388, 516, 581, 673; Coen, *Bescheiden omtrent zijn bedrijf in Indië* (1920), 2, 29, 106, 109, 138; Coen, *Bescheiden* *omtrent zijn bedrijf in Indië*, (1921), 10, 351–52, 479, 625, 665–67, 702, 707; Coen, *Bescheiden omtrent zijn bedrijf in Indië* (1922), 52, 55, 58, 60, 66; Jan P. Coen, *Bescheiden omtrent zijn bedrijf in Indië*, ed. Herman T. Colenbrander ('s–Gravenhage: Martinus Nijhoff, 1923), 38; Coen, *Bescheiden omtrent zijn bedrijf in Indië* (1952), 15–16, 26, 29, 93, 102, 191–92, 196, 310–11, 368, 447, 530, 552, 562, 621, 628–29 , 639, 786, 804; Coen, *Bescheiden omtrent zijn bedrijf in Indië* (1953), 985, 1507, 1579, 1660–61; Isaac Commelin, ed., "Historisch verhael vande voyagie der Hollanderen met dry schepen gedaen naer de Oost–Indien, onder het beleydt van den Admirael Steven vander Hagen, in den jaren 1599 ende volghende," in *Begin ende Voortgangh der Vereenigde Nederlantsche Geoctroyeerde Oost–Indische Compagnie. Begrypende de volgende twaelf voyagien door de inwoonderen der selviger provintien derwaerts gedaen* (Amsterdam: Facsimile Uitgaven Nederland, 1969), 3–4; Isaac Commelin, ed., "'t Historiael journael / van voyagie ghedaen met drie Schepen / ghenaemt den *Ram*, *Schaep*, ende het *Lam*, ghevaren uyt Zeelandt, van der stadt Camp–Vere, naer d'Oost–Indien, onder 't beleyt van den heer Admirael Joris van Spilbergen, gedaen in de jaren 1601.1602.1603. ende 1604," in *Begin ende Voortgangh der Vereenigde Nederlantsche Geoctroyeerde Oost–Indische Compagnie. Begrypende de volgende twaelf voyagien door de inwoonderen der selviger provintien derwaerts gedaen* (Amsterdam: Facsimile Uitgaven Nederland, 1969), 50 and 57; Commelin, ed., "Historisch verhael vande reyse gedaen inde Oost–Indien, met 15 schepen voor de reeckeninghe van de vereenichde gheoctroyeerde Oost–Indische Compagnie," 85–86; Isaac Commelin, ed., and Jacques L'Heremite, "Iournael van de Nassausche Vloot ofte beschrijvingh van de voyagie om den gantschen aerd–kloot, gedaen met elf schepen: onder 't beleydt van den Admirael Iaques L'Heremite, ende Vice–Admirael Gheen Huygen Schapendam, in den jaren 1623.1624.1625. en 1626," in *Begin ende Voortgangh der Vereenigde Nederlantsche Geoctroyeerde Oost–Indische Compagnie. Begrypende de volgende twaelf voyagien door de inwoonderen der selviger provintien derwaerts gedaen* (Amsterdam: Facsimile Uitgaven Nederland, 1969), 11–12; Commelin, ed., and Matelief de Jonge, "Historische verhael vande treffelijcke reyse, gedaen naer de Oost–Indien ende China met elf Schepen, door den manhaften Admirael Cornelis Matelief de Jonge, inden jaren 1605, 1606, 1607, ende 1608," 174; Commelin, ed., and Van Caerden, "Kort verhael/ofte Journael/Van de Reyse gedaen naer de Oost Indien met 4. schepen, *Nederlandt*, *Vereenigde Landen*, *Nassou*, ende *Hoff van Hollandt*, onder den Admirael Pieter Both van Amesfort, voor Reeckeninge van de Nieuwe Brabantsche Compagnie tot Amsterdam; in den jaren 1599. 1600. ende 1601," 17; Isaac Commelin, ed., and Joris van Spilbergen, "Historisch journael vande voyagie ghedaen met ses schepen, uytghereed zijnde door de vermaarde heeren bewint hebberen van de Oost–Indische Compaignie uyt de Vereenighde Nederlanden te weten de *groote Sonne*, de *groote Mane*, den *Jager*, de *Jacht*, de *Meeuwe* van Amsterdam, den *Aelos*, van Zeelandt, de *Morgenster* van Rotterdam omme te varen door de strate Magallanes naer de Molucques, met commssie der Hoogh Mogende Heeren Staten Generael, ende sijne princelijcke excellentie," in *Begin ende Voortgangh der Vereenigde Nederlantsche Geoctroyeerde Oost–Indische Compagnie. Begrypende de volgende twaelf voyagien door de inwoonderen der selviger provintien derwaerts gedaen* (Amsterdam: Facsimile Uitgaven Nederland, 1969), 67; Coolhaas, *Generale missiven van gouverneurs–generaal en raden aan Heren XVII der Verenigde Oostindische Compagnie* (1960), 197–98, 241–42, 458, and 478–79; De Booy, *De derde reis van de V.O.C. naar Oost–Indië onder het beleid van admiraal Paulus van Caerden uitgezeild in 1606* (1968), 51, 67, 90; De Booy, *De derde reis van de V.O.C. naar Oost–Indië onder het beleid van admiraal Paulus van Caerden uitgezeild in 1606* (1970), 143–44, 150–52, 191, 204, 216, 220; Samuel P. L'Honoré Naber, "'t Leven en bedrijff van vice–admirael de With, zaliger," in *Bijdragen en mededeelingen van het Historisch Genootschap (gevestigt te Utrecht)* (Utrecht: Kemink, 1926), 83, 93; Van den Broecke, *Pieter van den Broecke in Azië*, 62; Van Foreest and De Booy, *De vierde schipvaart der Nederlanders naar Oost–Indië onder Jakob Wilkens and Jacob van Neck (1599–1604)* (1980), 275; Van Foreest and De Booy, *De vierde schipvaart der Nederlanders naar Oost–Indië onder Jakob Wilkens and Jacob van Neck (1599–1604)* (1981), 324; Heeres, ed., *Dagh–register gehouden int Casteel Batavia vant passerende daer ter plaetse als over geheel Nederlandts–India, anno 1624–1629*, 5, 16, 48, 69, 164, 216, 279, 304, 325; Historisch genootschap, "Twaalfde vergadering: 26 November 1871: Verhaal van eenige oorlogen in Indië, 1622: Uit het archief van Hilten," in *Kroniek van het historisch genootschap, gevestigd te Utrecht* (Utrecht: Kemink en zoon, 1872), 538 547; May, *De reis van Jan Cornelisz. May naar de IJszee en de Amerikaanse kust,* *1611–1612*, 145; Van Opstall, ed., *De reis van de vloot van Pieter Willemsz Verhoeff naar Azië, 1607–1612*, 117, 124–25, 155, 285; Van Spilbergen, *De reis om de wereld van Joris van Spilbergen 1614–1617*, 129, 161; Voorbeijtel Cannenburg, ed., *De reis om de wereld van de Nassausche vloot, 1623–1626*, 20–22; and Willem S. Unger, ed., *De Oudste Reizen van de Zeeuwen naar Oost–Indië*, *1598–1604* ('s–Gravenhage: Martinus Nijhoff, 1948), 208–9.

22 De Booy, *De derde reis van de V.O.C. naar Oost–Indië onder het beleid van admiraal Paulus van Caerden uitgezeild in 1606* (1968), 14, 67, 90. A similar situation is known from June 1599, when the crew of three ships from the fleet under Commander Steven van de Hagen ran into a severely leaking and worm–riddled yacht along the coast of Ethiopia. This yacht coming from Amsterdam and destined to Benin, was "un–doubled" without pine sheathing. See, Commelin, ed., "Historisch verhael vande voyagie der Hollanderen met dry schepen gedaen naer de Oost–Indien, onder het beleydt van den Admirael Steven vander Hagen, in den jaren 1599 ende volghende," 3–4.

23 De Booy, *De derde reis van de V.O.C. naar Oost–Indië onder het beleid van admiraal Paulus van Caerden uitgezeild in 1606* (1968), 81.

24 Markham, *The Hawkins' Voyages during the Reigns of Henry VIII, Queen Elizabeth, and James I*, 202.

25 Coolhaas, *Generale missiven van gouverneurs–generaal en raden aan Heren XVII der Verenigde Oostindische Compagnie* (1960), 478–79.

26 Vos, "De replica van een VOC–retourschip te Lelystad: de *Batavia*?" 52.

27 Hocker, "Bottom–Based Shipbuilding in Northwestern Europe," 83; Hocker, "The Development of the Bottom–Based Shipbuilding Tradition in Northwestern Europe and the New World," 177; and Parthesius, "De dubbele huid van Oostindïevaarders aan het begin van de 17de eeuw," 29.

28 National Archives (NA) of the Netherlands, The Hague, *Archieven van de Verenigde Oostindische Compagnie*, 1602–1795, reference code 1.04.02, item number 147 (Resoluties van de ordinaris en extraordinaris vergaderingen van de Heren XVII, 29 March 1626); Porsius and De Munck, "Over hout, de herkomst, de kwaliteitseisen en de bewerking daarvan," 146; Witsen, *Architectura navalis et reginem nauticum,* 112, 133; and Van IJk, *De Nederlandsche scheeps–bouw–konst open gestelt*, 68, 128, 147, 152, 168.

29 Van IJk, *De Nederlandsche scheeps–bouw–konst open gestelt*, 147.

30 Witsen, *Architectura navalis et reginem nauticum*, 133.

31 For this calculation a wood density of 0.62 tons/$m^3$ is used, which corresponds to the density of both *Quercus petraea* and *Quercus robur,* which, according to Porsius, are the two wood types used in Dutch shipbuilding because of their strength and durability. See, Porsius,"Eiken en grenen," 57–64; and R. Bruce Hoadley, *Identifying Wood: Accurate Results with Simple Tools* (Newton, CT: Taunton Press, 1990), 151.

32 Parthesius, "De dubbele huid van Oostindïevaarders aan het begin van de 17de eeuw," 29.

33 Witsen, *Architectura navalis et reginem nauticum*, 112, and 133; and Van IJk, *De Nederlandsche scheeps–bouw–konst open gestelt*, 68, 128, 147, 152.

34 Van IJk, *De Nederlandsche scheeps–bouw–konst open gestelt*, 68, 154, 159.

35 Bound, Soo Hin, and Pickford, "The Dutch East Indiaman *Nassau*, Lost at the Battle of Cape Rachado, Straits of Malacca, 1606," 97.

36 Den Braven et al., *De* Buytensorgh, 48; and Lightley, "An 18th Century Dutch East Indiaman Found at Cape Town, 1971," 309.

37 Witsen, *Architectura navalis et reginem nauticum*, 178.

38 Van IJk, *De Nederlandsche scheeps–bouw–konst open gestelt*, 87.

39 Van Spilbergen, *De reis om de wereld van Joris van Spilbergen 1614–1617*, 160–61; and National Archives (NA) of the Netherlands, The Hague*, Admiraliteitscolleges*, reference code 1.01.46, item number 1360 (Resoluties, 16 February 1614, 26 February 1614, 2–3 April 1614, 15 April 1614, 1 July 1614, and 4 July 1614).

40 Van Spilbergen, *De reis om de wereld van Joris van Spilbergen 1614–1617*, 160–61.

41 The cost for the doubling and outfitting both ships was 48,000 guilders, which includes the use of oak planks from Hamburg. Van Spilbergen, *De reis om de wereld van Joris van Spilbergen 1614–1617*,

160–61; and National Archives (NA) of the Netherlands, The Hague*, Admiraliteitscolleges*, reference code 1.01.46, item number 1360 (Resoluties, 16 February 1614, 26 February 1614, 2–3 April 1614, 15 April 1614, 1 July 1614, and 4 July 1614).

42 Steffy, *Wooden Shipbuilding and the Interpretation of Shipwrecks*, 62–65.

43 Steffy, *Wooden Shipbuilding and the Interpretation of Shipwrecks*, 62.

44 Roger C. Anderson, "The Burlesdon Ship," *Mariner's Mirror* 20:2 (1934): 159–60; and Richard Clarke et al., "Recent Work on the R. Hamble Wreck near Burlesdon, Hampshire," *IJNA* 22:1 (1993): 26.

45 Ian Friel, *The Good Ship: Ships, Shipbuilding and Technology in England 1200–1520* (London: British Museum Press, 1995), 34–35, 67; and Ian Friel, "Henry V's *Grace Dieu*," *IJNA* 22:1 (1993): 3–19.

46 Anderson, "The Burlesdon Ship," 159–60; and Clarke et al., "Recent Work on the R. Hamble Wreck near Burlesdon, Hampshire," 26.

47 Anderson, "The Burlesdon Ship," 159–60; and Clarke et al., "Recent Work on the R. Hamble Wreck near Burlesdon, Hampshire," 26.

48 Anderson, "The Burlesdon Ship," 160; and Clarke et al., "Recent Work on the R. Hamble Wreck near Burlesdon, Hampshire," 31.

49 Friel, "Henry V's *Grace Dieu*," 4–5.

50 Friel, *The Good Ship*, 71.

51 Lemée, *The Renaissance Shipwrecks from Christianshavn*, 255–56.

52 Lemée, *The Renaissance Shipwrecks from Christianshavn*, 234.

53 Lemée, *The Renaissance Shipwrecks from Christianshavn*, 241.

54 Lemée, *The Renaissance Shipwrecks from Christianshavn*, 242–43.

55 Lemée, *The Renaissance Shipwrecks from Christianshavn*, 253–54.

56 Lemée, *The Renaissance Shipwrecks from Christianshavn*, 253–54.

57 Wegener Sleeswyk, *De Gouden Eeuw van het fluitschip*, 43.

58 Hocker, "The Development of the Bottom–Based Shipbuilding Tradition in Northwestern Europe and the New World," 177; and Vos, "De replica van een VOC–retourschip te Lelystad: de *Batavia*?" 52.

59 Hocker, "The Development of the Bottom–Based Shipbuilding Tradition in Northwestern Europe and the New World," 178.

60 Parthesius et al., *Sri Lanka Maritime Archaeological Unit Report on the Avondster Project 2001–2002*, 39.

61 Hocker, "Bottom–Based Shipbuilding in Northwestern Europe," 84; Hocker, "The Development of the Bottom–Based Shipbuilding Tradition in Northwestern Europe and the New World," 178.

62 Van IJk, *De Nederlandsche scheeps–bouw–konst open gestelt*, 363.

63 Van IJk, *De Nederlandsche scheeps–bouw–konst open gestelt*, 363.

64 Hoving and Emke, *Het schip van Willem Barents*, 52.

65 Baker and Green, "Recording Techniques Used during the Excavation of the *Batavia*," 148, 156.

66 L'Hour, Long, and Rieth, *Le Mauritius*, 214; L'Hour, Long, and Rieth, "The Wreck of an 'Experimental' Ship of the 'Oost Indische Companie'," 65.

67 L'Hour, Long, and Rieth, *Le Mauritius*, 214; L'Hour, Long, and Rieth, "The Wreck of an 'Experimental' Ship of the 'Oost Indische Companie'," 65.

68 Witsen only mentions that the bow of whaling ships was double planked. Witsen, *Architectura navalis et reginem nauticum*, 78; and Vos, "De replica van een VOC–retourschip te Lelystad: de *Batavia*?" 54.

69 Vos, "De replica van een VOC–retourschip te Lelystad: de *Batavia*?" 54.

70 National Archives (NA) of the Netherlands, The Hague*, Archieven van de Verenigde Oostindische Compagnie, 1602–1795*, reference code 1.04.02, item number 307 (Zakenindex op de resoluties van de kamer Amsterdam, 1602–1743), 441; see also National Archives (NA) of the Netherlands, The Hague*, Archieven van de Verenigde Oostindische Compagnie, 1602–1795*, reference code 1.04.02, item number 225 (Resoluties Kamer Amsterdam, 19 August 1603).

71 Van Dam, *Beschrijvinge van de Oostindische Compagnie*, 458–59; Hoving and Cor Emke, *Het schip van Willem Barents*, 111; and Parthesius, "De dubbele huid van Oostindïevaarders aan het begin van de 17de eeuw," 26.

[72] National Archives (NA) of the Netherlands, The Hague, *Archieven van de Verenigde Oostindische Compagnie, 1602–1795*, reference code 1.04.02, item number 14336 (Rekening van de equipage der schepen de *Amsterdam* —groot 350 lasten— en de *Zon* 1604 —groot 120 lasten—), folio 4 (Verscheiden materialen tot timmeren ende verdubbelen vande schepen *Amsterdam* ende de *Sonne*") [two pages with a list of materials and equipment], line 3.

[73] National Archives (NA) of the Netherlands, The Hague, *Archieven van de Verenigde Oostindische Compagnie, 1602–1795*, reference code 1.04.02, item number 307 (Zakenindex op de resoluties van de kamer Amsterdam, 1602–1743), 441; see also National Archives (NA) of the Netherlands, The Hague, *Archieven van de Verenigde Oostindische Compagnie, 1602–1795*, reference code 1.04.02, item number 226 (Resoluties kamer Amsterdam, 14 November 1606, 2 January 1606, 6 January 1606).

[74] Markham, *The Hawkins' Voyages during the Reigns of Henry VIII, Queen Elizabeth, and James I*, 202.

[75] Witsen provides a cost of 93,685 guilders for a ship of 165 feet long. The size of this ship compares roughly to the size of the ship *Amsterdam*. Witsen, *Architectura navalis et reginem nauticum*, 176–77; and Van IJk, *De Nederlandsche scheeps–bouw–konst open gestelt*, 287–99.

[76] Markham, *The Hawkins' Voyages during the Reigns of Henry VIII, Queen Elizabeth, and James I*, 202–4, and 210; François Pyrard, *The Voyage of François Pyrard of Laval to the East Indies, the Maldives, the Moluccas and Brasil*, (London: Hakluyt Society, 1887), 66; François Pyrard, *The Voyage of François Pyrard of Laval to the East Indies, the Maldives, the Moluccas and Brasil* (London: Hakluyt Society, 1888), 183 and 388; R.V. Salville, "3. The Management of the Royal Dockyards, 1672–1678," in *The Naval Miscellany (Publications of the Navy Records Society, Vol. 125)*, ed. N.A.M. Rodger (London: Navy Records Society, 1984), 125, 129–30; and Richard C. Temple and Lavinia M. Anstey, *The Life of the Icelander, Jón Ólafsson* (London: Hakluyt Society, 1931), 66.

[77] IJzerman, *De reis om de wereld door Olivier van Noort, 1598–1601*, 99.

[78] Witsen, *Architectura navalis et reginem nauticum*, 334.

[79] Parthesius, "De dubbele huid van Oostindïevaarders aan het begin van de 17de eeuw," 27.

[80] John H. Harland, "Note: Piet Heyn and the Early Use of Copper Sheathing," *Mariner's Mirror* 62:1 (1976): 1–2.

[81] Alan Lemmers, *Techniek op schaal: Modellen en het technologiebeleid van de Marine 1725–1885* (Amsterdam: De Bataafse Leeuw, 1996), 65.

[82] American Numismatic Rarities, LLC, *The Classics Sale: The Thomas H. Sebring Collection*, 281–82; and Christie's Amsterdam B.V. *Important Gold, Silver, Jewelry and Artifacts Recovered from the Wrecks of Dutch, Spanish and English 17th, 18th and 19th Century Ships:* Hollandia*,* Utrecht*,* Slot ter Hooge*,* Nuestra Senora de Esperanza*, Standing Cannon Wreck,* H.M.S. Athenienne.

[83] Bruijn, Gaastra, and Schöffer, *Dutch Asiatic Shipping in the 17th and 18th Centuries: Introductory Volume*, 52.

[84] Wil Nagelkerken, "1989 Survey of the Dutch Frigate *Alphen* which Exploded and Sank in 1778 in the Harbour of Curacao," in *Proceedings of the Thirteenth International Congress for Caribbean Archaeology, Curaçao, Netherlands Antilles, 1991*, ed. Edwin N. Ayubi and Jay B. Haviser (Curaçao, Netherlands Antilles: AAINA, 1991), 774; and Wil Nagelkerken, "1996 Excavation of the Dutch Frigate *Alphen,* Which Exploded and Sank in 1778 in the Harbor of Curaçao," *Abstracts Society for Historical Archaeology, 30th Conference on Historical and Underwater Archaeology (8–12 January 1997)*, ed. Shawn B. Carlson and Denise Lakey (Corpus Christi: Society for Historical Archaeology, 1997), 117–18.

The brigantine *Sirene* from the Dutch Royal Navy that sank in Bonaire in 1831 has also provided archaeological evidence for the use of copper sheathing (of the same dimensions as the sheets found at *Alfen*'s site). See, Wil Nagelkerken, and Raymond Hayes, *The Historical Anhorage of Kralendijk, Bonaire, Netherlands Antilles, including the Wreckage of the Dutch Brigantine* Sirene *(1831)* (Curaçao, Netherlands Antilles: STIMANA, 2002), 94–97.

[85] Bruijn, Gaastra, and Schöffer, *Dutch Asiatic Shipping in the 17th and 18th Centuries: Introductory Volume*, 51.

[86] Jacobus R. Bruijn, Femme S. Gaastra, and Ivo Schöffer, *Dutch Asiatic Shipping in the 17th and 18th Centuries: Introductory Volume* (The Hague: Martinus Nijhoff, 1987), 52, 106.

[87] Jacobus R. Bruijn, Femme S. Gaastra, and Ivo Schöffer, *Dutch Asiatic Shipping in the 17th and 18th Centuries: Introductory Volume* (The Hague: Martinus Nijhoff, 1987), 52, 106.

[88] Gawronski, *De equipage van de* Hollandia *en de* Amsterdam, 290.

[89] Gawronski, *De equipage van de* Hollandia *en de* Amsterdam, 290.

[90] Van IJk, *De Nederlandsche scheeps–bouw–konst open gestelt*, 121.

[91] Den Braven et al., *De* Buytensorgh, 3D–model (photomodeler).

[92] Den Braven et al., *De* Buytensorgh, 112–15.

[93] Formulae, Tables, converters specific to Materials, (www.allmeasures.com/Formulae/static/materials/12/density.htm): copper (Cu).

[94] National Archives (NA) of the Netherlands, The Hague, Archieven van de Verenigde Oostindische Compagnie, 1602–1795, reference code 1.04.02, item number 14854 (Journaal van inkomsten en uitgaven van de kamer Enkhuizen, van een gedeelte van de periode van de eerste en tweede tienjarige rekening, 1616).

[95] Zeeuws Archief: Archief Rekenkamer van Zeeland. Rekeningen Equipagemeesters te Vlissingen, Veere, Zierikzee en Middelburg, 1587–1794, reference code 508, item numbers 7019.1 a–c (1665), 7007 (1667).

[96] Zeeuws Archief: Archief Rekenkamer van Zeeland. Rekeningen Equipagemeesters te Vlissingen, Veere, Zierikzee en Middelburg, 1587–1794, reference code 508, item numbers 7019.1 a–c (1665), 7007 (1667).

[97] Gawronski, *De equipage van de* Hollandia *en de* Amsterdam, 290.

[98] Gawronski, *De equipage van de* Hollandia *en de* Amsterdam, 290.

[99] Gawronski, *De equipage van de* Hollandia *en de* Amsterdam, 290.

[100] Jeremy N. Green, Somasiri Devendra, and Robert Parthesius, ed., *Sri Lanka Department of Archaeology Report on the Joint Sri Lanka–Australian–Netherlands Galle Harbour Project: Archaeology, History, Conservation and Training* (Fremantle: Western Australian Museum, 1998), 16.

[101] Lemmers, *Techniek op schaal*, 65–66; Alan Lemmers, “Kruisverbanden en Kippekonten,” in *Techniek in schoonheid: De Marinemodellenkamer van het Rijksmuseum te Amsterdam*, ed. Harm Stevens (Amsterdam: Rijksmusem Stichting, 1995), 27–28.

[102] Bruijn, Gaastra, and Schöffer, *Dutch–Asiatic Shipping in the 17th and 18th Centuries: Outward–bound Voyages from the Netherlands to Asia and the Cape (1595–1794)*, no. 4118.3; and Green, Devendra, and Parthesius, ed., *Sri Lanka Department of Archaeology Report on the Joint Sri Lanka–Australian–Netherlands Galle Harbour Project*, 14–16.

[103] Bruijn, Gaastra, and Schöffer, *Dutch–Asiatic Shipping in the 17th and 18th Centuries: Outward–bound Voyages from the Netherlands to Asia and the Cape (1595–1794)*, no. 4118.3; and Green, Devendra, and Parthesius, ed., *Sri Lanka Department of Archaeology Report on the Joint Sri Lanka–Australian–Netherlands Galle Harbour Project*, 14–16.

[104] Special thanks to Rasika Muthucumarana, Archaeologist/Research officer Maritime Archaeology Unit in Galle, Sri Lanka for sending small samples of copper–alloy sheet, 92/GH/102. These samples from *Geinwens* sheathing were analyzed at the CSIRO laboratories, Perth, Western Australia, using a SEM with a SUTW–Sapphire detector. This is a semi–quantitative method of conducting chemical analysis by spot testing. The areas analysed on each sample vary in size between 250 μm and 300 μm. As this method of analysis is a localized testing method, it is not necessarily representative for the composition of the entire sample. Therefore, preferably two or more small areas per sample were tested.

The following SEM settings were used during data acquisition: Kilovoltage: kV 30, EDAX ZAF Quantification, Element Normalized, SEC table: default, standardless, resolution: 160.70, tilt: 0.00, tc: 2.5. The time per sample analysis was set to about 60 seconds for each test.

[105] McCarthy, *Ships' Fastenings*, 115–18.

[106] Witsen, *Architectura navalis et reginem nauticum*, 42.

[107] Van Dam, *Beschrijvinge van de Oostindische Compagnie*, 733.

[108] Van Dam, *Beschrijvinge van de Oostindische Compagnie*, 733.
[109] Van IJk, *De Nederlandsche scheeps–bouw–konst open gestelt*, 51.
[110] Van IJk, *De Nederlandsche scheeps–bouw–konst open gestelt*, 51.
[111] Van IJk, *De Nederlandsche scheeps–bouw–konst open gestelt*, 51.
[112] Van IJk, *De Nederlandsche scheeps–bouw–konst open gestelt*, 51.
[113] Van IJk, *De Nederlandsche scheeps–bouw–konst open gestelt*, 51.
[114] Van IJk, *De Nederlandsche scheeps–bouw–konst open gestelt*, 91.
[115] Coen, *Bescheiden omtrent zijn bedrijf in Indië* (1919), 73.
[116] Coen, *Bescheiden omtrent zijn bedrijf in Indië* (1952), 552, 562, 621.
[117] Coen, *Bescheiden omtrent zijn bedrijf in Indië* (1952), 649; Coen, *Bescheiden omtrent zijn bedrijf in Indië* (1919), 388, 581; Coen, *Bescheiden omtrent zijn bedrijf in Indië* (1921), 625.

The Dutch East Indiaman *Morgenster* was doubled in 1618, and again in 1620. The ships *Leiden* and *Haarlem* were sheathed almost four years after they had sail from Holland, see Van Foreest and De Booy, *De vierde schipvaart der Nederlanders naar Oost–Indië onder Jakob Wilkens and Jacob van Neck (1599–1604)* (1981), 324–26. The entire fleet of Joris van Spilbergen, that circumnavigated the world from 1614 to 1617, was doubled in Jakarta in 1616, two years after its ships had set sail in the fall of 1614. See, Van Spilbergen, *De reis om de wereld van Joris van Spilbergen 1614–1617*, 129.

[118] Coolhaas, *Generale missiven van gouverneurs–generaal en raden aan Heren XVII der Verenigde Oostindische Compagnie* (1960), 479 (Henrick Brouwer, Antonio van Diemen, Jan van der Burch en Jan van Broeckum, Batavia, 27–December–1634).

[119] Den Braven et al., *De* Buytensorgh, 26–27; Forster and Higgs, "The *Kennemerland*, 1971," 295; Green, "The Survey of the VOC Fluit *Risdam* (1727), Malaysia," 95–97; Nico Habermehl, *Scheepswrakken in de Waddenzee (1500–1900)* ( Lelystad: Nederlands Instituut voor Scheeps– en onderwaterArcheologie, Rijksdienst Oudheidkundig Bodemonderzoek (NISA/ROB), 2000), 39; Lightley, "An 18th Century Dutch East Indiaman Found at Cape Town, 1971," 308–310; Michael McCarthy, "Ship Fastenings (A Preliminary Study)," *Bulletin Australian Institute for Maritime Archaeology* 7:1 (1983): 9; Muckelroy, ed., *Archeology Under Water*, 122–27; and Parthesius, "Het wrak van VOC–schip *Avondster* in de haven van Galle (Sri Lanka), 67.

[120] Den Braven et al., *De* Buytensorgh, 26; Forster and Higgs, "The *Kennemerland*, 1971," 295; Jerzy H.G. Gawronski, ed., Amsterdam *Project: Jaarrapport van de Stichting VOC–Schip 'Amsterdam'/Annual Report of the VOC–Ship 'Amsterdam' Foundatio*n 1986 (Amsterdam: Stichting VOC–ship "Amsterdam", 1986), 14; Green, "The Survey of the VOC Fluit *Risdam* (1727), Malaysia," 95–97; Habermehl, *Scheepswrakken in de Waddenzee (1500–1900)*, 39; Richard Larn, ed., "The Wreck of the Dutch East Indiaman *Campen* on the Needles Rocks, Isle of Wight, 1627—Part 1," 15; Lightley, "An 18th Century Dutch East Indiaman Found at Cape Town, 1971," 308–10; Muckelroy, ed., *Archeology Under Water*, 122–27; Parthesius, "Het wrak van VOC–schip *Avondster* in de haven van Galle (Sri Lanka)," 67; Britt–Marie Petersen, "The Dutch Fluitship *Anna Maria*, Foundered in Dalarö Harbour in 1709," *IJNA* 16:4 (1987): 295; and Hans H. van Rooij, and Jerzy H.G Gawronski, *East Indiaman* Amsterdam*: Long 150 Feet, Not Returned—Beached on the Coast of Essex between Hastings and Beachyhead* (Haarlem: Becht, 1989), 42.

[121] Den Braven et al., *De* Buytensorgh, 57.
[122] Lemée, *The Renaissance Shipwrecks from Christianshavn*, 210, fig. 4.3.13.
[123] Bruijn, Gaastra, and Schöffer, *Dutch–Asiatic Shipping in the 17th and 18th Centuries: Outward–bound Voyages from the Netherlands to Asia and the Cape (1595–1794)*, no. 3600.1.
[124] Bruijn, Gaastra, and Schöffer, *Dutch–Asiatic Shipping in the 17th and 18th Centuries: Homeward–bound Voyages from Asia and the Cape to the Netherlands (1597–1795)*, no. 7553.2; and Den Braven et al., *De* Buytensorgh, 45.
[125] Den Braven et al., *De* Buytensorgh, 48.
[126] Den Braven et al., *De* Buytensorgh, 147–48.
[127] Murray, "The Interpretation of the Anglo–Dutch East–Indiaman *Avondster* Ship's Construction," 144.
[128] Van Linschoten, *Reizen van Jan Huyghen van Linschoten naar het Noorden (1594–1595)*, 147.

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[129] Coolhaas, *Generale missiven van gouverneurs–generaal en raden aan Heren XVII der Verenigde Oostindische Compagnie*, 478–79 (Henrick Brouwer, Antonio van Diemen, Jan van der Burch en Jan van Broeckum, Batavia, 27–December–1634).

[130] "... door 't eeckenhout can oock de roest sich niet soo verspreyen ende alsoo 't costelijcker valt als met greene deelen." See, Coolhaas, *Generale missiven van gouverneurs–generaal en raden aan Heren XVII der Verenigde Oostindische Compagnie*, 478–79 (Henrick Brouwer, Antonio van Diemen, Jan van der Burch en Jan van Broeckum, Batavia, 27–December–1634).

[131] Van Foreest and De Booy, *De vierde schipvaart der Nederlanders naar Oost–Indië onder Jakob Wilkens and Jacob van Neck (1599–1604)* (1980), 275; Van Spilbergen, *De reis om de wereld van Joris van Spilbergen 1614–1617*, 129; and Coen, *Bescheiden omtrent zijn bedrijf in Indië* (1919), 143.

[132] Hoving and Emke, *Het schip van Willem Barents*, 36; and Van Linschoten, *Reizen van Jan Huyghen van Linschoten naar het Noorden (1594–1595)*, 263 (Heren staten van Zeelandt).

[133] Gaastra, *The Dutch East India Company*, 19.

[134] Commelin, ed., and Van Caerden, "Kort verhael/ofte Journael/Van de Reyse gedaen naer de Oost Indien met 4. schepen, *Nederlandt*, *Vereenigde Landen*, *Nassou*, ende *Hoff van Hollandt*, onder den Admirael Pieter Both van Amesfort, voor Reeckeninge van de Nieuwe Brabantsche Compagnie tot Amsterdam; in den jaren 1599. 1600. ende 1601," 7.

[135] Commelin, ed., "Historisch verhael vande voyagie der Hollanderen met dry schepen gedaen naer de Oost–Indien, onder het beleydt van den Admirael Steven vander Hagen, in den jaren 1599 ende volghende," 3–4.

[136] Joris van Spilbergen, *De reis van Joris van Spilbergen naar Ceylon, Atjeh, en Bantam 1601–1604,* ed. Johan C.M. Warnsinck ('s–Gravenhage: Martinus Nijhoff, 1943), 88; and Commelin, ed., and Van Caerden, "Kort verhael/ofte Journael/Van de Reyse gedaen naer de Oost Indien met 4. schepen, *Nederlandt*, *Vereenigde Landen*, *Nassou*, ende *Hoff van Hollandt*, onder den Admirael Pieter Both van Amesfort, voor Reeckeninge van de Nieuwe Brabantsche Compagnie tot Amsterdam; in den jaren 1599. 1600. ende 1601," 17.

[137] Van Foreest and De Booy, *De vierde schipvaart der Nederlanders naar Oost–Indië onder Jakob Wilkens and Jacob van Neck (1599–1604)* (1980), 275.

According to other documents from this fleet, the ships *Leiden* and *Haarlem* were doubled in November, 1602, near Cochin in China. See, Van Foreest and De Booy, *De vierde schipvaart der Nederlanders naar Oost–Indië onder Jakob Wilkens and Jacob van Neck (1599–1604)* (1981), 324.

[138] Parmentier, Davids, and Everaert, *Peper, plancius, en porselein*, 11–15.

[139] Parmentier, Davids, and Everaert, *Peper, plancius, en porselein*, 25, 118.

[140] Parmentier, Davids, and Everaert, *Peper, plancius, en porselein*, 119.

[141] Parmentier, Davids, and Everaert, *Peper, plancius, en porselein*, 119.

[142] Parmentier, Davids, and Everaert, *Peper, plancius, en porselein*, 119.

[143] Parmentier, Davids, and Everaert, *Peper, plancius, en porselein*, 120.

[144] Parmentier, Davids, and Everaert, *Peper, plancius, en porselein*, 121.

[145] Jan K.J. de Jonge, *De opkomst van het Nederlandsch gezag in Oost–Indië (1595–1610): Verzameling van onuitgegeven stukken uit het oud–koloniaal archief* ('s–Gravenhage: Martinus Nijhoff, 1862), 258.

[146] Rietbergen, *De eerste landvoogd Pieter Both (1568–1615)*, 241, 317; Coen, *Bescheiden omtrent zijn bedrijf in Indië*, (1919), 73, 388, 581, 673; Coen, *Bescheiden omtrent zijn bedrijf in Indië* (1921), 625, 702; Coen, *Bescheiden omtrent zijn bedrijf in Indië*, (1952), 15, 93, 102, 368, 530, 621, 639, 649; Coen, *Bescheiden omtrent zijn bedrijf in Indië* (1953), 985; De Booy, *De derde reis van de V.O.C. naar Oost–Indië onder het beleid van admiraal Paulus van Caerden uitgezeild in 1606*, 90, 150–52, 191, 204; Heeres, ed., *Dagh–register gehouden int Casteel Batavia vant passerende daer ter plaetse als over geheel Nederlandts–India, anno 1624–1629*, 69, 84, 260, 325; Historisch genootschap, "Twaalfde vergadering," 547; L'Honoré Naber, "'t Leven en bedrijff van vice–admirael de With, zaliger," 93; Van Opstall, ed., *De reis van de vloot van Pieter Willemsz Verhoeff naar Azië, 1607–1612*, 285.

[147] William Foster, *Letters Received by the East India Company from its Servants in the East, transcribed from the 'Original Correspondence' Series of the India Office Records*, (Amsterdam: Israel, 1968), 31–34.

[148] William Foster, *Letters Received by the East India Company from its Servants in the East, Transcribed from the 'Original Correspondence' Series of the India Office Records*, (Amsterdam: Israel, 1968), 34.

[149] Coen, *Bescheiden omtrent zijn bedrijf in Indië* (1919), 143, 153; Coen, *Bescheiden omtrent zijn bedrijf in Indië* (1920), 29; and Coen, *Bescheiden omtrent zijn bedrijf in Indië* (1921), 351–52.

[150] National Archives (NA) of the Netherlands, The Hague*, Archieven van de Verenigde Oostindische Compagnie, 1602–1795*, reference code 1.04.02, item number 100 (Kopie–resoluties van de Heren XVII, 1608–1623), folio 161.

The *Zon* and *Maan* should not be confused with the (*Grote*) *Zon* and (*Grote*) *Maan* (600 tons each) that set sail on August 8, 1614, with Commander Joris van Spilbergen to sail around the world. These two ships arrive in Jakarta on September 15, 1616. See, Van Spilbergen, *De reis om de wereld van Joris van Spilbergen 1614–1617* (1933), xlv, 1, 129.

[151] National Archives (NA) of the Netherlands, The Hague, *Archieven van de Verenigde Oostindische Compagnie, 1602–1795*, reference code 1.04.02, item number 100 (Kopie–resoluties van de Heren XVII, 1608–1623), folio 169, point 13 (14 November 1611).

Ships of this fleet are *Eolus* (320 tons), *Gelderland* (600 tons), *Groene Leeuw* (180 tons), *Maan* (400 tons), *Oranje* (600 tons), *Patana* (340 tons), *Rode Leeuw* (340 tons), *Rotterdam* (800 tons), *Ceylon* (340 tons), *Zon* (400 tons), *Ster* (180 tons), *Zeelandia* (500 tons), and the yacht *Duifje* (50 tons).

In his travel journal Pieter van den Broecke confirms the presence of *Rotterdam* and *Zon* in Asian waters in 1615. *Rotterdam* is part of a fleet of nine ships under command of General Rijnst that anchored in Banda in April 1615. Two others ships, that sailed from Holland in Block's fleet, *Ster* and *Zeelandia,* are also part of this fleet in Banda. See, Van den Broecke, *Pieter van den Broecke in Azië*, 63.

*Zon* is also seen by Van den Broecke on 1 June 1615; close to Ternate, in company of six other VOC ships. Two others ships, that set sail from Holland in Block's fleet, *Rode Leeuw* and *Patana,* are also part of this fleet in Ternate. See, Van den Broecke, *Pieter van den Broecke in Azië*, 67.

[152] National Archives (NA) of the Netherlands, The Hague*, Archieven van de Verenigde Oostindische Compagnie, 1602–1795*, reference code 1.04.02, item number 100 (Kopie–resoluties van de Heren XVII, 1608–1623), folio 153, point 30.

[153] Bonke, "Het eiland Onrust," 47.

[154] Bonke, "Het eiland Onrust," 47.

[155] Coen, *Bescheiden omtrent zijn bedrijf in Indië* (1952), 530; Parmentier, Davids, and Everaert, *Peper, plancius, en porselein*, 119.

[156] Bonke, "Het eiland Onrust," 43.

[157] Coen, *Bescheiden omtrent zijn bedrijf in Indië* (1920), 456 (October 4, 1618).

[158] Heeres, ed., *Dagh–register gehouden int Casteel Batavia vant passerende daer ter plaetse als over geheel Nederlandts–India, anno 1624–1629*, 69; Historisch genootschap, "Twaalfde vergadering," 547; L'Honoré Naber, "'t Leven en bedrijff van vice–admirael de With, zaliger," 93; and Wagenaar, "Het eiland Onrust bij Batavia als onderdeel van het VOC–scheepsbedrijf in de 17de en 18de eeuw," 67–68.

[159] L'Honoré Naber, "'t Leven en bedrijff van vice–admirael de With, zaliger," 93.

[160] Historisch genootschap, "Twaalfde vergadering" 547.

[161] Wagenaar, "Het eiland Onrust bij Batavia als onderdeel van het VOC–scheepsbedrijf in de 17de en 18de eeuw," 67–68.

[162] Historisch genootschap, "Twaalfde vergadering," 547.

[163] Voorbeijtel Cannenburg, ed., *De reis om de wereld van de Nassausche vloot, 1623–1626*, lxvi–lxvii, 4, 20–23; and Commelin, ed., and L'Heremite, "Iournael van de Nassausche Vloot ofte beschrijvingh van de voyagie om den gantschen aerd–kloot, gedaen met elf schepen: onder 't beleydt van den Admirael Iaques L'Heremite, ende Vice–Admirael Gheen Huygen Schapendam, in den jaren 1623.1624.1625. en 1626," 11–12.

[164] Voorbeijtel Cannenburg, ed., *De reis om de wereld van de Nassausche vloot, 1623–1626*, lxi, 11; and L'Honoré Naber, "'t Leven en bedrijff van vice–admirael de With, zaliger," 82.

[165] Bruijn, Gaastra, and Schöffer, *Dutch–Asiatic Shipping in the 17th and 18th Centuries: Outward–bound Voyages from the Netherlands to Asia and the Cape (1595–1794)*, 50–52; L'Honoré Naber, "'t Leven en bedrijff van vice–admirael de With, zaliger," 80–81; and Voorbeijtel Cannenburg, ed., *De reis om de wereld van de Nassausche vloot, 1623–1626*, cxxii, 4–6.

[166] In the journal kept by Witte Corneliszoon de With, the Admiral ship of the fleet, *Amsterdam*, and vice–Admiral, *Delft,* are listed as 166 feet long [Amsterdam feet; so 47 m long]. Bruijn, Gaastra, and Schöffer, *Dutch–Asiatic Shipping in the 17th and 18th Centuries: Outward–bound Voyages from the Netherlands to Asia and the Cape (1595–1794)*, 50–53; L'Honoré Naber, "'t Leven en bedrijff van vice–admirael de With, zaliger," 80–81; and Voorbeijtel Cannenburg, ed., *De reis om de wereld van de Nassausche vloot, 1623–1626*, 4–6.

[167] Voorbeijtel Cannenburg, ed., *De reis om de wereld van de Nassausche vloot, 1623–1626*, lx, 9.

[168] Voorbeijtel Cannenburg, ed., *De reis om de wereld van de Nassausche vloot, 1623–1626*, lxiv, 14.

[169] Voorbeijtel Cannenburg, ed., *De reis om de wereld van de Nassausche vloot, 1623–1626*, lxiii, 13.

[170] Voorbeijtel Cannenburg, ed., *De reis om de wereld van de Nassausche vloot, 1623–1626*, lxiv, 14.

[171] Voorbeijtel Cannenburg, ed., *De reis om de wereld van de Nassausche vloot, 1623–1626*, lxiv.

[172] Voorbeijtel Cannenburg, ed., *De reis om de wereld van de Nassausche vloot, 1623–1626*, lxvii, 20; and L'Honoré Naber, "'t Leven en bedrijff van vice–admirael de With, zaliger," 83 (11 August 1623).

[173] Voorbeijtel Cannenburg, ed., *De reis om de wereld van de Nassausche vloot, 1623–1626*, lxvii and 20–21.

[174] Voorbeijtel Cannenburg, ed., *De reis om de wereld van de Nassausche vloot, 1623–1626*, lxvii.

[175] Voorbeijtel Cannenburg, ed., *De reis om de wereld van de Nassausche vloot, 1623–1626*, lxvii, 21–23 (12 August to 3 September 1623).

[176] Voorbeijtel Cannenburg, ed., *De reis om de wereld van de Nassausche vloot, 1623–1626*, lxvii, 22.

[177] Voorbeijtel Cannenburg, ed., *De reis om de wereld van de Nassausche vloot, 1623–1626*, lxvii and 22 (26 August 1623).

[178] Voorbeijtel Cannenburg, ed., *De reis om de wereld van de Nassausche vloot, 1623–1626*, 22 (27 August 1623).

[179] Voorbeijtel Cannenburg, ed., *De reis om de wereld van de Nassausche vloot, 1623–1626*, 22 (25 August 1623).

[180] L'Honoré Naber, "'t Leven en bedrijff van vice–admirael de With, zaliger," 83 (4 September 1623); and Voorbeijtel Cannenburg, ed., *De reis om de wereld van de Nassausche vloot, 1623–1626*, 23 (4 September 1623).

[181] Voorbeijtel Cannenburg, ed., *De reis om de wereld van de Nassausche vloot, 1623–1626*, lxvii; and Schillemans, "De houtveilingen van Zaandam in de jaren 1655–1811," 62. See also note 10.

[182] Van Opstall, ed., *De reis van de vloot van Pieter Willemsz Verhoeff naar Azië, 1607–1612*, 124–25.

[183] Johann Verken, *Molukken–Reise 1607–1612* ('s–Gravenhage: Martinus Nijhoff, 1930), 132–33 (29 May 1612). For currency conversion rates, see Francis Turner, "Money and Exchange Rates in 1632," on *http://1632.org/1632Slush/1632money.rtf*; and B.E. Supple, "Currency and Exchange in the Early Seventeenth Century," *The Economic History Review*, New Series, 10.2 (1957): 239-55.

[184] Van Opstall, ed., *De reis van de vloot van Pieter Willemsz Verhoeff naar Azië, 1607–1612*, 127–43.

[185] Keuning, ed., *De tweede schipvaart der Nederlanders naar Oost–Indië onder Jacob Cornelisz. van Neck en Wybrant Warwijck*, *1598–1600* (1938), 30–31; Keuning, ed., *De tweede schipvaart der Nederlanders naar Oost–Indië onder Jacob Cornelisz. van Neck en Wybrant Warwijck*, *1598–1600*

(1940), liii–lxxviii; and Keuning, ed., *De tweede schipvaart der Nederlanders naar Oost–Indië onder Jacob Cornelisz. van Neck en Wybrant Warwijck*, *1598–1600* (1947), 60.

186 Keuning, ed., *De tweede schipvaart der Nederlanders naar Oost–Indië onder Jacob Cornelisz. van Neck en Wybrant Warwijck*, *1598–1600* (1940), lxxvi–lxxviii.

187 Commelin, ed., "Historisch verhael vande reyse gedaen inde Oost–Indien, met 15 schepen voor de reeckeninghe van de vereenichde gheoctroyeerde Oost–Indische Compagnie," 85.

188 Commelin, ed., "Historisch verhael vande reyse gedaen inde Oost–Indien, met 15 schepen voor de reeckeninghe van de vereenichde gheoctroyeerde Oost–Indische Compagnie," 86.

189 National Archives (NA) of the Netherlands, The Hague, *Archieven van de Verenigde Oostindische Compagnie, 1602–1795*, reference code 1.04.02, item number 99 (Kopie–resoluties van de Heren XVII, 1602–1607), folio 145 (September 1604); National Archives (NA) of the Netherlands, The Hague, *Archieven van de Verenigde Oostindische Compagnie, 1602–1795*, reference code 1.04.02, item number 100 (Kopie–resoluties van de Heren XVII, 1608–1623), folio 191, point 32 (1612).

190 National Archives (NA) of the Netherlands, The Hague, *Archieven van de Verenigde Oostindische Compagnie, 1602–1795*, reference code 1.04.02, item number 100 (Kopie–resoluties van de Heren XVII, 1608–1623), folio 191, point 32 (1612).

191 Coen, *Bescheiden omtrent zijn bedrijf in Indië* (1923), 38.

192 Numerous references to the repair and maintenance of ships in Asia can be found in: Coen, *Bescheiden omtrent zijn bedrijf in Indië* (1919–1953), 7 vols.

193 Heeres, ed., *Dagh–register gehouden int Casteel Batavia vant passerende daer ter plaetse als over geheel Nederlandts–India, anno 1624–1629*, 16, 84.

194 Bonke, "Het eiland Onrust: Van scheepswerf van de VOC tot bedreigd historisch archeologisch monument," 48.

195 Historisch genootschap, "Twaalfde vergadering," 537.

196 Coolhaas, *Generale missiven van gouverneurs–generaal en raden aan Heren XVII der Verenigde Oostindische Compagnie* (1960), 458 (Henrick Brouwer, Antonio van Diemen, Jan van der Burch en Jan van Broeckum, Batavia, December 27, 1634).

197 This wood species remains unidentified today. Coolhaas, *Generale missiven van gouverneurs–generaal en raden aan Heren XVII der Verenigde Oostindische Compagnie* (1960), 458 (Henrick Brouwer, Antonio van Diemen, Jan van der Burch en Jan van Broeckum, Batavia, December 27, 1634).

198 Coolhaas, *Generale missiven van gouverneurs–generaal en raden aan Heren XVII der Verenigde Oostindische Compagnie* (1960), 458 (Henrick Brouwer, Antonio van Diemen, Jan van der Burch en Jan van Broeckum, Batavia, December 27, 1634). For information on currency conversion rates, see note 183.

199 Coen, *Bescheiden omtrent zijn bedrijf in Indië* (1919), 143.

200 Historisch genootschap, "Twaalfde vergadering," 537. For information on currency conversion rates, see note 183.

201 Heeres, ed., *Dagh–register gehouden int Casteel Batavia vant passerende daer ter plaetse als over geheel Nederlandts–India, anno 1624–1629*, 84 (19 September 1624).

202 Bonke, "Het eiland Onrust," 48–49; and Wagenaar, "Het eiland Onrust bij Batavia als onderdeel van het VOC–scheepsbedrijf in de 17de en 18de eeuw," 69, 78–80.

203 Bonke, "Het eiland Onrust," 48–49.

# CHAPTER VII

# TIMBER USED IN THE CONSTRUCTION OF *BATAVIA*

## Historic documentation and timber trade

When the reconstruction of *Batavia* was built in the Netherlands in the 1980s, Nanning Porsius conducted research into the provenance and nature of timber used by the VOC in the early seventeenth century.[1] He wanted to determine what criteria the VOC used to buy such essential resources and what differences in quality were encountered between the contemporaneous timber trading areas.[2]

Porsius promptly realized that the scarcity or outright lack of historic sources on the Dutch timber trade immensely complicated his research. Limited VOC archival resources are available for the early seventeenth century. Unfortunately, what VOC archives are preserved do not provide detailed information on where the Chamber of Amsterdam bought its timber when *Batavia* was constructed, what types of timber were used at its shipyards, nor how the timber was processed. All six VOC Chambers are likely to have kept detailed bookkeeping records, which could have contained useful information on these matters. Unfortunately, hardly any of these records dating to the seventeenth century survive today. The only such accounts in existence are the earliest journals of the Chamber of Amsterdam and Chamber of Zeeland up to 1608, the Chamber of Zeeland from 1614 to 1628, and the Chamber of Enkhuizen from 1608 to 1619.[3] The records of the Chamber of Amsterdam, for example, demonstrate that, in the earliest years of the VOC's existence, the purchase of wood was not restricted to any particular supplier.[4] A variety of merchants and shipmasters sold timber for shipbuilding in various quantities, ranging from one to 400 beams, and at prices from, for example, forty guilders per hundred pine–sheathing planks to one guilder for a single plank.[5] This variation in price probably depended upon a range of conditions such as quality, size, availability, and bargaining power of the seller.

To help fill the gaps of an otherwise scarce record, Porsius has published his research on the bookkeeping of the Chamber of Amsterdam between February 1603 and

January 1604.[6] These bookkeeping records show that most imported wood came from the Baltic and Scandinavia. Sweden, Denmark, Prussia, and Hamburg were the primary suppliers of pine timber and sheathing, while oak lumber came from Danzig (Gdansk) and Königsberg (Kaliningrad) in Poland, Courland (Lithuania), the Memel Territory (Klaipėda Region) in East Prussia, Denmark, and Hamburg.[7] Straight timber for use as planks, sheathing, and beams came from the Baltic, whereas compass timber was transported from the Wesel region in Germany (North Rhine, Westphalia), close to the Dutch border.[8]

The earliest VOC shipbuilding charter, dating to 1603, complies with the preserved bookkeeping records. In this charter, for example, Baltic oak is explicitly listed for the double layer of hull planking, ceiling planking, and for all deck planking (Appendix A).[9]

Furthermore, the minutes from the Gentlemen XVII's meetings indicate that the Chamber of Amsterdam decided to bypass the intermediary trade in 1611, and a year later, the VOC outfitted a ship destined to sail to Danzig and Königsberg to acquire timber for shipbuilding, including masts, spars, Königsberg planks, hewn oak, and wainscot.[10] In 1616, they sent another ship to buy mast timber in Danzig.[11] By this time, the Chamber of Amsterdam had a contact in Danzig with the name Albert van Elburg. The Chamber of Zeeland seems to have followed the same procedure when they ordered two hundred of the best Königsberg planks and fifteen Prussian masts through their contact in Danzig or Königsberg, Sir Tobias Evertssen.[12] The VOC, however, did not continue to bypass the intermediate trade; by 1620, they no longer went out to buy timber themselves and acquired it from the Dutch timber traders.[13]

In addition to material in VOC archives, the first extensive documentation on the wood trade and nature of the timber itself appears in the late seventeenth century. There are many more sources on the wood trade and the nature of the wood itself dating from the late seventeenth century onwards.

The auction books of the Zaandam timber market have been preserved from 1655 to 1811 and an in–depth study of the books has been published by Cornelis Schilleman.[14]

The auction books inform us that oak timber in this period came primarily from the forests of the Rhine Valley and its tributaries. It dominated the trade volume of the Zaandam timber market by 60%, whereas oak from Baltic region, mainly Hamburg, consisted of only 13.4%.[15]

Other contemporaneous sources, such as the manuscripts of Nicolaes Witsen and Cornelis Van IJk, discuss timber for shipbuilding.[16] In addition, Pieter van Dam's work details VOC policy and provides insights on what timber and shipbuilding material the VOC preferred for the construction of its ships.[17] As the Company's counsel from 1652 to 1706, he was commissioned by its directors in 1693 to write a description of the United East India Company. He completed his work in 1701.[18] From Witsen, Van IJk, and Van Dam, we also learn that oak timber was transported down the Rhine River to Westphalia in Germany.

According to Witsen, the fine quality of Rhine oak makes it water–resistant and, therefore, suitable for shipbuilding.[19] Compass timber from the Rhine region and straight timbers from Westphalia was highly praised by Witsen's contemporaries.[20] Witsen, however, does not elaborate on timber from the Baltic, with the exception of one remark in which he mentions that the best quality timbers are oak and pine from Königsberg, as well as pine from Norway.[21]

Van IJk, twenty–six years later than Witsen, also lists Westphalia as a source for oak ship timber in his manuscript, but includes Brandenburg, Poland and other regions of Germany as well. Heavy planks and compass timbers from these areas were utilized in the North Holland shipyards of Amsterdam, Zaandam, Edam, Hoorn, and Enkhuizen.[22]

Van Dam had access to the VOC archives for more than half a century, but he does not seem to have used bookkeeping and outfitting documents of the early seventeenth century. His manuscript is actually more in accordance with Van IJk's late seventeenth century discussion of shipbuilding timber. Van Dam explains that the Company built three to four new ships annually, which he records should be made of good and durable timber, preferably *not* from the Rhine region, or directly north of the

Rhine. He believed oak from this region to be of poor quality and unsuitable for shipbuilding.[23] Here, Van Dam adds that wood from Munster, purchased on the timber market of Deventer, is much more preferable as it lasts longer, even though it is less flexible than Rhine wood. Furthermore, the Chamber of Amsterdam made it a practice to acquire Munster wood from the Deventer market.[24] In addition, the shipyard of the Chamber of Amsterdam used timber from Berlin or Silesia in eastern Germany and Poland for the assembly of ships' keels.[25] Compass timber was mainly imported from the Weser region and surroundings.[26]

Van Dam continues that timber from the Rhine region was suitable to use for shipbuilding if not in contact with seawater, as, for example, heavy deck beams, deck planking and other timbers related to the decks, but only if no other wood was available.[27] He also adds that wood from the Rhine region was very flexible, a feature that allows it to be bent easily and were therefore be used for strongly curved timber, such as wales in the bow area.[28] He explains that the poor quality of Rhine timber is a direct result of the trees generally being felled here in summer.[29] Furthermore, planking from Hamburg was the preferred timber shipped to the Company's shipyards in the Indies, such as Onrust, probably for maintenance and repairs.[30] Van Dam probably provides the characteristics from the late–seventeenth/early–eighteenth century era in which he compiled his manuscript, which may not necessarily reflect the Company's preferences for timber over its entire 193–year existence. At the time of his writing, for example, the shipyard of the Amsterdam Chamber had problems with oak timber from Rhine forests, which did *not* provide satisfactory results in ship construction.

Despite their limitations, the manuscripts of Witsen, Van IJk, and Van Dam provide a general overview of shipbuilding timbers and their provenance, mainly Germany (Rhine, Elbe, and Weser areas), Scandinavia, Silesia, and the Baltic Sea region in the late seventeenth century. As noted above, this overview may not be representative for the entire seventeenth century due to the absence of detailed sources from the early seventeenth century. Furthermore, the few bookkeeping records and shipbuilding charters of the VOC in the early seventeenth century indicate that most oak shipbuilding timber came from the Baltic Sea, and pine mainly from Scandinavia. There appears to have been a change towards the mid seventeenth century, in which the main source for oak timber shifts from the Baltic to Germany.

The study of historic sources is, however, not likely to provide a clear insight into this change, neither will it provide answers to the basic questions asked by Porsius a few decades ago. The archaeological record and examination of ship's timbers, on the other hand, may provide complementary data to better understand the timber trade and the use of timber in VOC's shipyards in the early seventeenth century.

**Wood identification**

Twenty *Batavia* timbers have been sampled and analyzed for wood species identification.[31] The results have shown that at least two different genii of wood were used in the construction of the ship; all structural timbers, such as the planking, frames, ceiling planking, treenails, and beams, were made of oak, *Quercus* sp. (Figs. VII.1–VII.3, Tables VII.1–VII.2). This oak can be either *Quercus robur* (Pedunculate oak) or *Quercus petraea* (Sessil oak); the wood of these two species can currently not be distinguished based on their anatomical characteristics.[32] The sacrificial planking or sheathing of *Batavia*'s hull and the floor on top of its ceiling planking were made of pine, most likely *Pinus sylvestris* (Figs. VII.4–VII.6, Tables VII.1–VII.2). Anatomically, no differentiation can be made between *Pinus sylvestris* (Scots pine) and *Pinus mugo* (Mountain pine), but the latter is a dwarf shrub variety which is not suitable for shipbuilding and therefore unlikely.[33]

The wood used for the construction of *Batavia* is consistent with historical records and archaeological evidence from other shipwrecks of Dutch merchantmen, such as Scheurrak SOI, *Mauritius,* B&W 2 Christianshavn, *Zeewijk*, and *Amsterdam*.[34] In general, shipbuilders preferred oak for the construction of large merchantmen and warships. Oak is stronger, more durable, and more resistant to rot than other timbers, especially pine. The pine on these Dutch ships was mainly used as sacrificial planking. Large ocean–going ships destined to sail long distances to tropical regions were not built

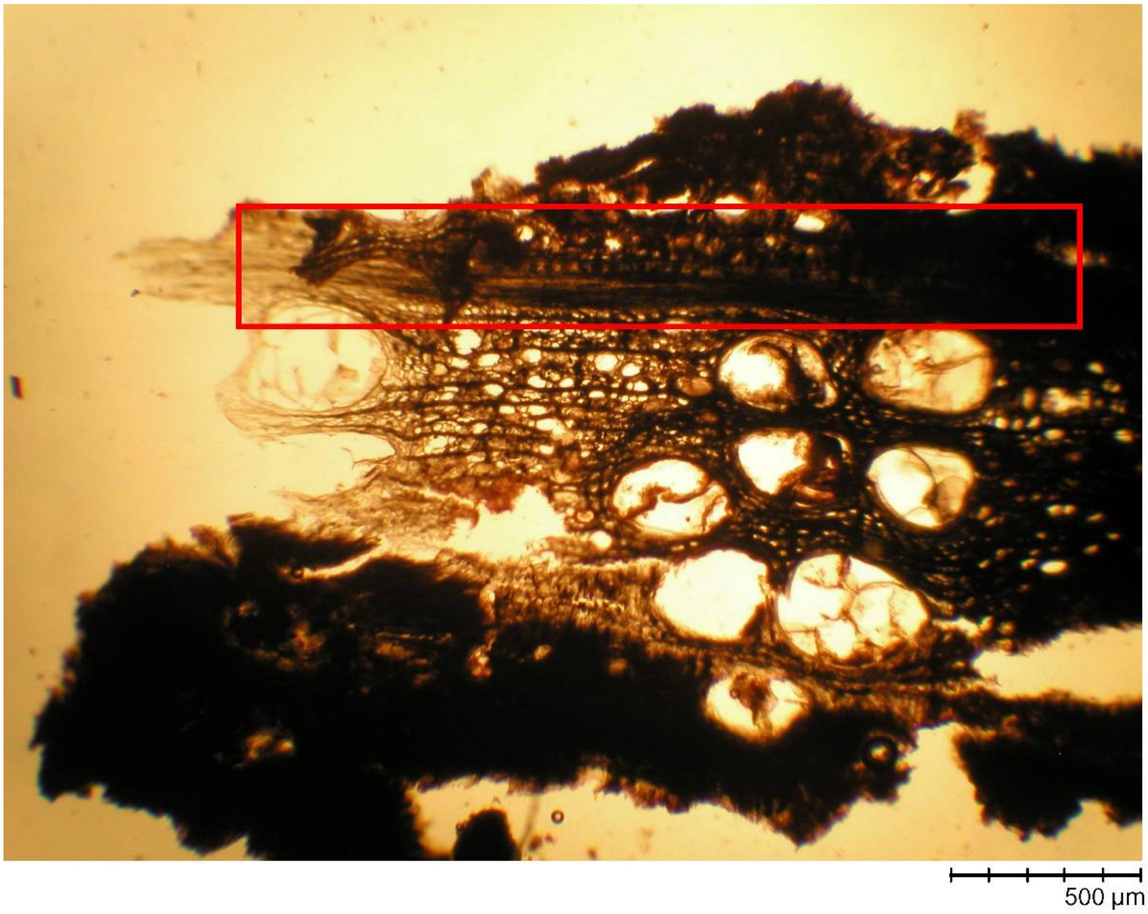


Fig. VII.1 Transverse section showing ring–porous wood with flame–like distribution of pores in late–wood, thin walled tyloses in the vessels of the earlywood, and a wide multiseriate ray. *Quercus* sp. *Batavia* shipwreck, BAT 6180. Dissecting microscope, magnification x40. Micrograph: Mark van Waijjen, BIAX Consult.

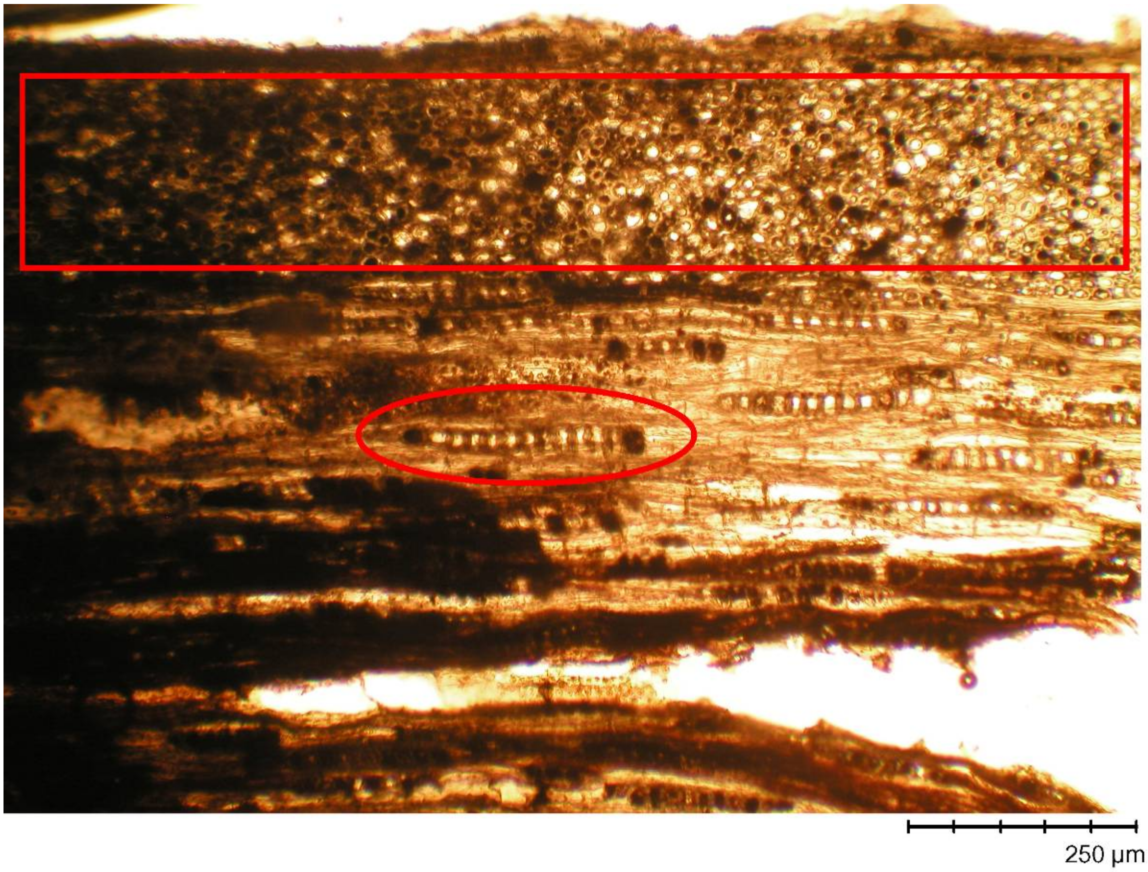


Fig. VII.2 Tangential section, with multiseriate ray (top, rectangle) and several one–cell wide rays (bottom, ellipse). *Quercus* sp. *Batavia* shipwreck, BAT 6180. Dissecting microscope, magnification x100. Micrograph: Mark van Waijjen, BIAX Consult.


Fig. VII.3 Radial section. *Quercus* sp. *Batavia* shipwreck, BAT 6180. Dissecting microscope, magnification x100. Micrograph: Mark van Waijjen, BIAX Consult.

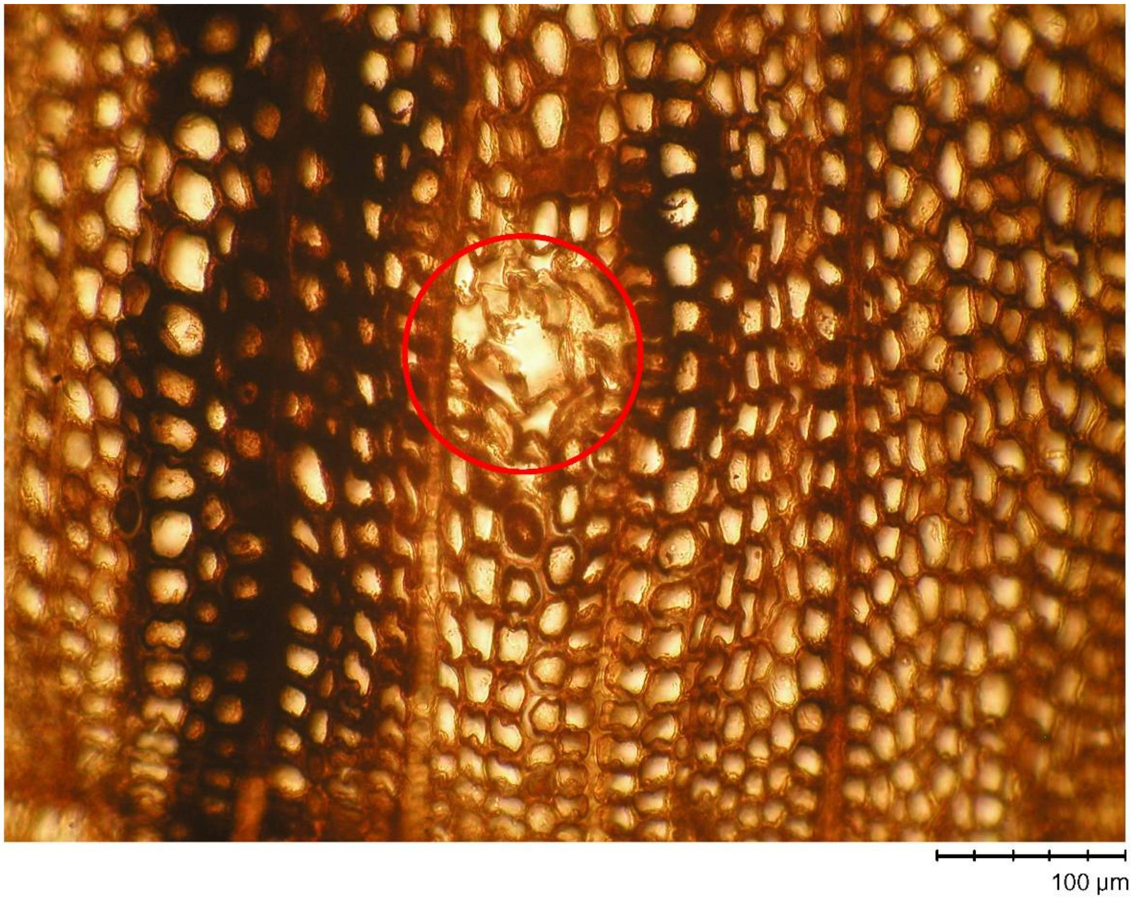


Fig. VII.4 Transverse section with resin canal (encircled). *Pinus* sp. *Batavia* shipwreck, BAT 6150. Dissecting microscope, magnification x200. Micrograph: Mark van Waijjen, BIAX Consult.

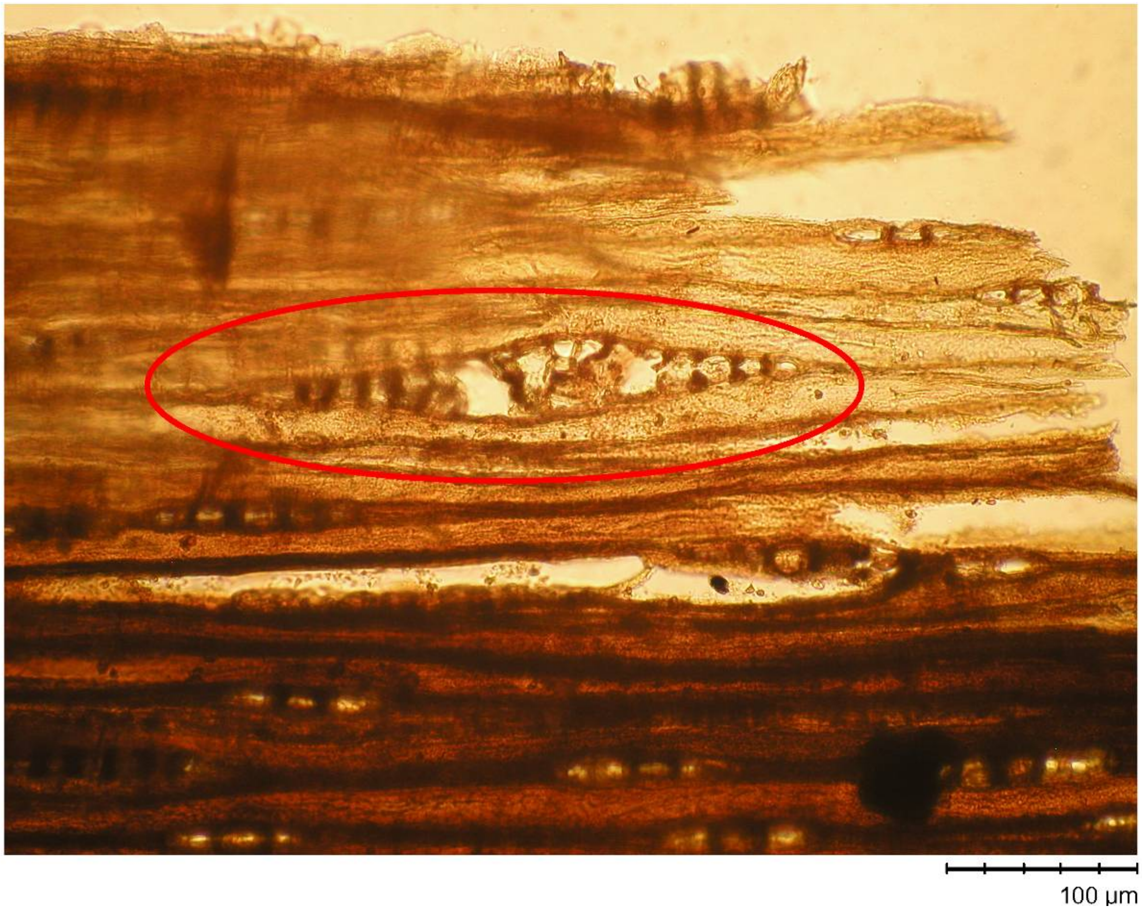


Fig. VII.5 Tangential section with resin canal (encircled). *Pinus* sp. *Batavia* shipwreck, BAT 6150. Dissecting microscope, magnification x200. Micrograph: Mark van Waijjen, BIAX Consult.


Fig. VII.6 Radial section with parenchyma cells with large open pits, mostly one per cross field. *Pinus* sp. *Batavia* shipwreck, BAT 6150. Dissecting microscope, magnification x400. Micrograph: Mark van Waijjen, BIAX Consult.

Table VII.1 Wood identification of *Batavia* timbers by Nancy Mills Reid.

| Catalog Nr. | Sample Taken From | Wood Species |
|---|---|---|
| BAT 6063 | Ceiling planking, strake 7 | *Quercus* sp. |
| BAT 6084 | Outer layer of hull planking, strake 14 | *Quercus* sp. |
| BAT 6296 | Transom knee, A2 | *Quercus* sp. |
| BAT 6306 | Frame, C34 | *Quercus* sp. |
| BAT 6311 | Frame, C42 | *Quercus* sp. |
| BAT 6334 | Treenail from frame, C35 | *Quercus* sp. |
| BAT 6356 | Upper fashion piece | *Quercus* sp. |
| BAT 6358 | Transom beam 7 | *Quercus* sp. |
| BAT 6390 | Inner layer of hull planking, strake 4 | *Quercus* sp. |
| BAT 6422 | Outer layer of transom planking, strake 7 | *Quercus* sp. |
| BAT 6444 | Fashion Piece | *Quercus* sp. |

Table VII.2 Wood identification of *Batavia* timbers by Caroline Vermeeren, BIAX Consult.

| Catalog Nr. | Sample Taken From | Wood Species |
|---|---|---|
| BAT 6022 | Frame, C22 | *Quercus* sp. |
| BAT 6068 | Inner layer of hull planking, loose fragment | *Quercus* sp. |
| BAT 6150 | Sheathing (sacrificial planking) | *Pinus* sp. |
| BAT 6180 | Outer layer of hull planking, strake 2 | *Quercus* sp. |
| BAT 6226 | Plank between transom and side ceiling planking | *Quercus* sp. |
| BAT 6273 | Floor on ceiling planking | *Pinus* sp. |
| BAT 6375 | Inner layer of hull planking, loose fragment | *Quercus* sp. |
| BAT 6404 | Inner layer of hull planking, strake 13 | *Quercus* sp. |
| BAT 6439 | Sternpost cover planking | *Quercus* sp. |
| BAT 6441 | Sheathing (sacrificial planking) | *Pinus* sp. |

lightly and shipwrights would employ oak in their entire construction. Van Dam mentions that ships built of pine, or oak below and pine above [the waterline] are not good in tropical waters.[35]

**Dendrochronological research**

The *Batavia* timbers provide a unique archaeological resource for dendrochronological examination, because exact dates are available for the ship's construction *and* its sinking. It is known, for example, that the construction of the ship began some time after the spring of 1626. The Gentlemen XVII commissioned no new construction of Indiamen at its meeting in the summer of 1627, and did not meet in the spring of 1628. On 25 May 1628, however, *Batavia*'s shipwright, Jan Rijcksen and several administrators were sent to purchase timber for the construction of two new ships, one of which would be named *Batavia* (see Chapter IV).[36] Whether the construction of both ships was already underway by then is not known, however. *Batavia* set sail on 28 October 1628 from Texel, bound for the Indies, and was only eight months old at the time of its sinking on 4 June 1629.[37] It was practically brand–new, and the crew did not stop and refit on its maiden voyage; therefore, all of the timbers of the archaeological remains must be the timbers of the original construction. This is especially important, for no repairs or maintenance work can possibly confuse the outcome of dendrochronological research, as is often the case with other well–used and repaired wooden hulls.

Six samples were taken for dendrochronological purposes from four planks of *Batavia*'s hull and one plank of the pine sheathing in order to determine a felling date and provenance of the timber (Table VII.3).[38] Only a limited number of samples were taken from *Batavia*'s hull due to the destructive nature of the sampling (sawing a 6–centimeter–wide strip out of the planks). When less destructive methods are available in the future, more samples should be studied to provide a better statistical comparison and more representative data for all structural members of *Batavia*'s hull.

Unfortunately, pine sample BAT 6441 and oak sample BAT 6180 were not preserved well enough to be dated, both being riddled with wormholes. The dendrochronological data from the remaining four oak samples demonstrate the use of oak trees more than one hundred years old from the Baltic region for the construction of the ship. More detailed information on the statistical results, reference chronologies, and characteristics of each sample, which includes the number of tree–rings, sapwood, and distance to core, and more can be found in Tables VII.3, VII.4, VII.5, and Appendix D.

None of the planks submitted for sampling contain any remnants of sapwood. Only heartwood is evident, which means the felling dates of the trees are an unknown number of years after the last year or most recent tree–ring examined in the sample, as listed in Appendix D. The samples only provide a *post quem* date.

The dendrochronological investigations of the Renaissance shipwrecks of Christianshavn demonstrate similar results regarding timber use in the ship construction. The absence of sapwood demonstrates that contemporaneous shipbuilders primarily used the heartwood, as it is more resistant to rot than the softer sapwood.[39] Sapwood is softer and contains sugars, which makes it more subject to insect infestation and decay by microorganisms. Van Dam recommends the use of "good and decent" wood, stripped of all its sapwood. Sapwood is "a pest causing rot like a spreading fire when ships sail in those countries" (he refers to the East Indies and its tropical waters). Van Dam adds that being thrifty with wood is an absolute menace.[40]

Table VII.3 Dendrochronological results of *Batavia* wood samples.

| Sample | Felling Date | Probability[41] | Used Reference Chronology |
|---|---|---|---|
| BAT 6068A | After 1616 +9/–6 | 99.50% | NLARTP01 |
| BAT 6068B | After 1612 +9/–6 | 99.00% | NLARTP01 |
| BAT 6180 | Not dated | – | – |
| BAT 6226 | After 1614 +9/–6 | 99.99% | NLARTP01 |
| BAT 6375 | After 1540 +9/–6 | 99.98% | NLARTP01 |
| BAT 6441 | Not dated | – | – |

Table VII.4 Dendrochronological results *Batavia* hull wood, *Quercus* sp. Elsemieke Hanraets, RING Report Numbers 2007002 and 2007014.

| **Sample** | **Pith** | **Sapwood** | **Wood Edge** | **n-Rings** | **First Year** | **Last Year** | **Felling Date** | ***t*** | **%P** | **P** | **Chronology** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| BAT 6068A | - | - | - | 116 | 1484 | 1599 | After 1616 +9/-6 | 5.2 | 64.2 | 0.0050 | NLARTP01 |
| BAT 6068B | 20 | - | - | 95 | 1498 | 1592 | After 1612 +9/-6 | 5.3 | 67.2 | 0.0100 | NLARTP01 |
| BAT 6180 | - | - | - | 87 | - | - | Not dated | - | - | - | - |
| BAT 6226 | - | - | - | 113 | 1485 | 1597 | After 1614 +9/-6 | 4.6 | 70.4 | 0.0001 | NLARTP01 |
| BAT 6375 | 10 | - | - | 182 | 1342 | 1523 | After 1540 +9/-6 | 6.9 | 63.8 | 0.0002 | NLARTP01 |

Table VII.5 Dendrochronological results *Batavia* hull wood, *Pinus* sp. Elsemieke Hanraets, RING Report Number 2007014.

| **Sample** | **Pith** | **Sapwood** | **Wood Edge** | ***n-Rings*** | ***First Year*** | ***Last Year*** | **Felling Date** | **t** | **%P** | **P** | **Chronology** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| BAT 6441 | 20 | - | - | 116 | - | - | Not dated | - | - | - | - |

The manufacturing process itself (sawing planks from the timber) easily removed all sapwood and possibly some heartwood growth rings. Planks and sheathing were sawn from the halves of evenly grown oak logs that were split over their entire length. After the bark and sapwood were removed, the tapering sides were taken off and the timber sawn plain or tangentially into planks (Fig. VII.7). This manner of sawing can easily be recognized by the pattern of semi–circular tree–rings at the end grain visible in the ends of the planks. Plain– or tangential–sawn timber also tends to cup more over time than quartered or radial sawn lumber. All planks of *Batavia* sampled for dendrochronological study, were sawn according to this method (Figs. VII.8–VII.12). Hull plank BAT 6375 could, however, be slightly misleading to the untrained eye as it is broken in two sections over its pith (Figs. VII.7.3 and VII.11).

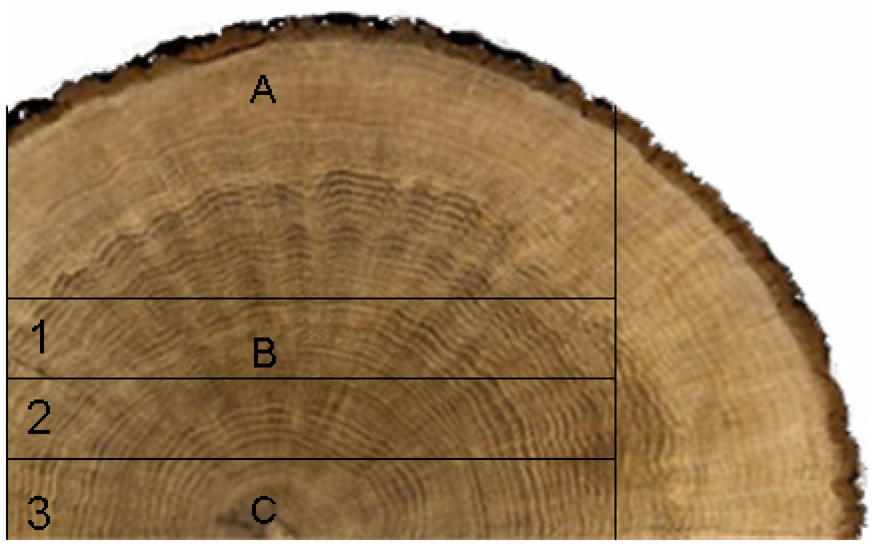


Fig. VII.7 Cross–section of oak tree with sapwood (A), heartwood (B), and pith (C). Photograph: Wendy van Duivenvoorde.

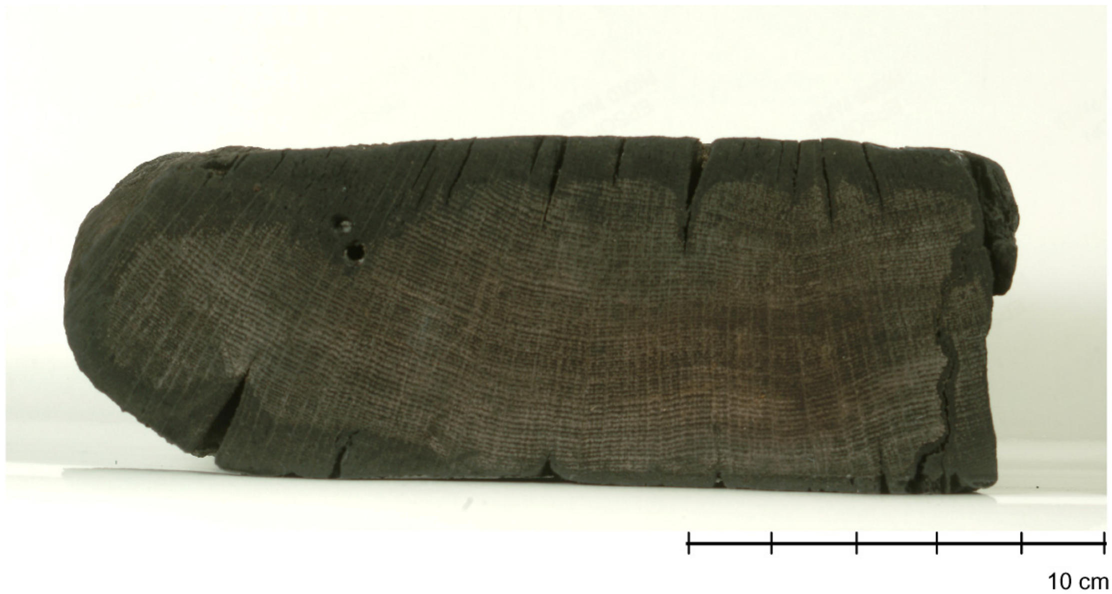


Fig. VII.8 *Batavia* sample for dendrochronological study, BAT 6068A. Cross–section of tangential–sawn oak hull plank. Photograph: Patrick Baker, Western Australian Museum.


Fig. VII.9 *Batavia* sample for dendrochronological study, BAT 6180. Cross–section of tangential–sawn oak hull plank. Photograph: Patrick Baker, Western Australian Museum.

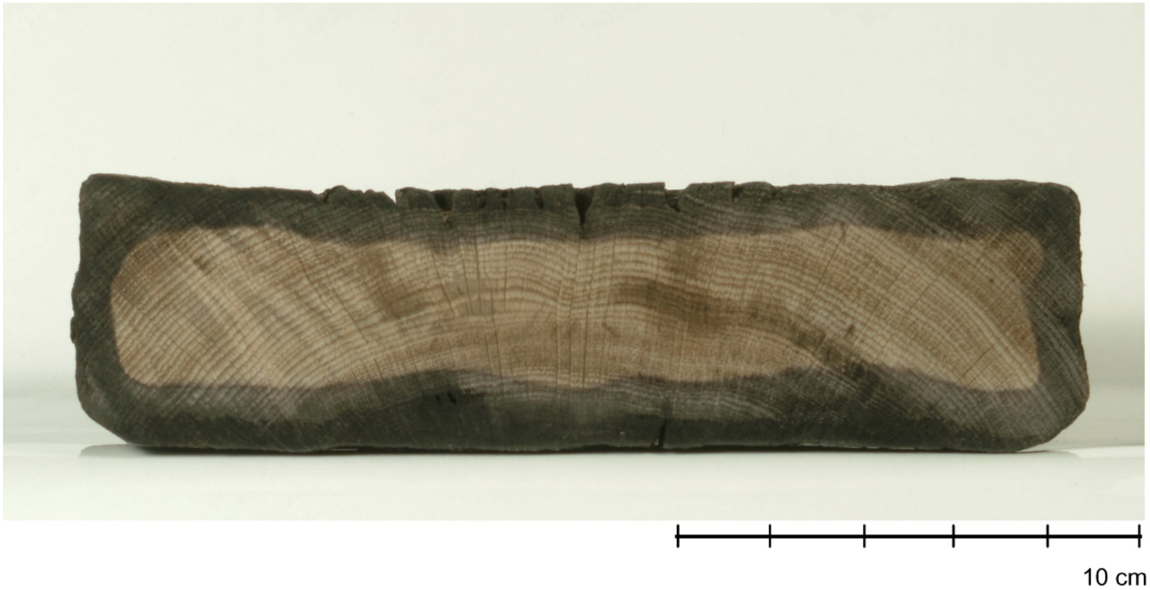


Fig. VII.10 *Batavia* sample for dendrochronological study, BAT 6226. Cross–section of tangential–sawn oak hull plank. Photograph: Patrick Baker, Western Australian Museum.


Fig. VII.11 *Batavia* sample for dendrochronological study, BAT 6375. Cross–section of tangential–sawn oak hull plank over tree's center. Photograph: Patrick Baker, Western Australian Museum.


Fig. VII.12 *Batavia* sample for dendrochronological study, BAT 6441. Cross–section of tangential–sawn pine sheathing with wormholes. Photograph: Patrick Baker, Western Australian Museum.

**Provenance of timber**

The statistical certainty of the analyzed wood samples indicates a near 100% match between the *Batavia* wood and the NLARTP01 chronology, which ranges from 1115 to 1643 and covers the forests along the banks of the Polish Vistula River (Weichsel) (Table VII.3).[42] This calendar, given its present name in 2006, was referred to in prior publications as Chronology II, SCH1115M, or NLPP.[43]

The research to establish this particular chronology finds its origin in the 1960s when Brongers, Bauch, and Eckstein combined their research efforts.[44] Their initial dendrochronological study focused on wood used in works of art. The sample group included 151 panels, which form the base of oil paintings, and two wooden sculptures, all of which were made by Dutch and Flemish masters.[45] These artists include Van Alkmaar, Lambert Doomer, Antoon van Dijk, Engelbrechtsen, Geertgen, Jan van Goyen, Frans Hals, Egbert van Heemskerck, Willem de Heusch, Hans Holbein, Jacob Jordaens, Lucas van Leyden, Hans Memling, Jan Mostaert, Rembrandt van Rijn, Peter Paul Rubens, Tibout Regters, Daniël Seghers, Hercules Pieterszoon Seghers, Jacob Toorenvliet, Adriaen van de Werff, de Wouters, Philips Wouwerman, and several unknowns.[46]

The majority of the wooden panels were made of radial sections cut from oak trees and contained more than 200 tree–rings, in a few cases more than 300.[47] Compiling and matching tree–rings gave a chronology from the twelfth to seventeenth centuries, 1140 to 1623, and included paintings made between the fourteenth and the mid–seventeenth century.[48]

The art–historical dendrochronology of these panels established a new oak chronology that did not match any of the existing ones (Chronology II).[49] Most tree–ring series of the panel paintings matched each other so well that a floating chronology of 530 years was created. Initially, Brongers, Bauch, and Eckstein assumed this chronology was typical for the Netherlands. They also thought it unlikely that the Lowlands would have continually imported timber from one particular source for such an extended period of time.[50]

A similar study established a chronology from English art works. When the Dutch and English chronologies were compared they cross–matched.[51] This led to the assumption that the wood in the two chronologies came from forests on either side of the English Channel. The provenance and exact time span of the Dutch and English floating chronology were eventually determined few decades later through a collaborative research effort between the Dendrochronological Laboratory of the Academy of Fine arts in Warsaw and the Institute for Wood Biology of the University of Hamburg.[52] Researchers from both institutions conducted a dendrochronological study on building timbers from churches, historic buildings, art–historic objects, and archaeological material found around Danzig in northern Poland. They could cross–match this wood with Chronology II (now NLARTP01).[53] Thus, the oak panels of the Dutch painters were not cut from local trees growing on either side of the English Channel, but from trees that grew in the Baltic forests along the Vistula River.[54] The NLARTP01 chronology nowadays ranges from 1115 to 1643.[55]

Historical and dendrochronological research suggests an intense wood trade between the Netherlands and Danzig, with timber from the regions around the Vistula River being shipped to the Netherlands by sea since the fourteenth century.[56] Growth of this Dutch trade with the Baltic resulted in the pre–eminent position of Dutch merchants in the Baltic by 1600.

Dutch vessels arrived in the Baltic with salt from Portugal and France, herring and construction materials such as tiles and bricks from the Netherlands, French and German wine, textiles from England and India, and exotic goods from the East Indies. These good were traded for grain and timber from Poland, hemp and flax from Russia, tar from Finland and copper and iron from Sweden.[57] The Dutch were at the center of a trade system involving nearly all of northern and western Europe. This trade laid the foundations for, and was inextricably bound to, Dutch primacy in world trade in the seventeenth century.[58]

The main commercial center for the import of Baltic timber seems to have shifted over the centuries, first from the harbor town of Bruges to Antwerp and later from Antwerp to Amsterdam.[59] Timber was shipped into Flanders from the early thirteenth century onwards. The earliest archaeological evidence of Baltic oak in this region comes from the fishing village of Raversijde in Flanders where wooden barrels, possibly used for herring, have been excavated. The timber of the barrel staves was felled in the late fourteenth century.[60]

By the early seventeenth century, Amsterdam had become Europe's main staple market for timber and the majority of the wood demanded abroad was supplied by Dutch merchants, half of which were from Amsterdam.[61] Most of the wood imported into Amsterdam came from Norway and the Baltic region; to a lesser degree, timber also came from the Rhine area.[62]

Timber from Scandinavia and the Baltic region was shipped in flute ships that were specifically designed to carry bulk cargoes of this type.[63] These flutes were fitted with cargo ports in their bow to facilitate the loading of logs and timber.[64]

Bonde, Tyers, and Wazny observe that the dendrochronological data of Baltic wood in Western Europe from the fourteenth to the mid–seventeenth century usually comes from finished products, such as moveable objects or planks, and not from logs and large beams.[65] This does not mean that large beams or logs were not transported from the Baltic ports to the Dutch timber markets. To the contrary, wooden logs and lumber were, in general, carried in bulk and processed in the Netherlands into beams or planks manually by sawyers or mechanically by wind–driven sawing mills. Fully processed or sawn planks are only sporadically mentioned in the books of the Zaandam timber auctions and they comprise only 0.65% of timber trade over the entire period between 1655 and 1714.[66] If planks were imported entirely sawn, they always came from the Baltic or Scandinavia, never from the Rhine region. The import of sawn wood into the Netherlands must not have been very profitable due to competition with the Dutch sawing industry.[67] The city of Zaandam, for example, had 600 windmills in its heyday, during the late seventeenth century, of which more than one–third were for sawing timber.[68]

The contribution of Baltic oak to the Dutch timber market in the late sixteenth and early seventeenth centuries has evidently been underrated. Historic sources become more abundant after 1650, when the Baltic timber trade had declined and timber from the Vistula forests was no longer transported to the Netherlands. The dendrochronological examination of *Batavia*, plus the earliest VOC documentation in which timber from the Baltic is specifically listed, demonstrate that oak from the Baltic Sea region played an important role at the VOC shipyards in the early seventeenth century.

**Baltic oaks for shipbuilding**

Baltic oaks, especially those from the Vistula region, have beautifully straight trunks and their wood consists of very fine tree–rings, which makes the wood easy to work. Dutch and Flemish painters highly prized this straight–grained and smooth wood to paint upon.[69] They would have avoided using panels of soft woods or oaks with knots and other growth aberrations, as these would tend to work, warp, and crack more easily. Wealthy patrons were paying them handsomely to produce masterpieces for family heirlooms that would last for generations. The use, therefore, of high–quality and presumably expensive Baltic oak for such luxury items is not surprising and completely justifiable economically.[70]

It is telling that the Dutch, in particular the VOC, used the same high–quality Baltic oak for shipbuilding as the Dutch and Flemish painters did for their artwork. This practice is certainly consistent with the VOC shipbuilding charter of 1603, in which "Eastern planks," which specifically refers to timber from the Baltic (see Appendix A), are listed for the ships' hull planking.[71] It is also consistent with early seventeenth–century bookkeeping records of VOC chambers, as previously discussed. VOC shipwrights were building large ships that needed to be strong enough to last through three or four round–trip voyages to Southeast Asia. Obviously, this required good building materials and a high standard of workmanship. The quality of Baltic oak surpassed that of German oaks, which tended to grow more crooked and develop more knots. Even in the late seventeenth century, when discussing the latter, Witsen makes special mention of the superior quality of Baltic oak.[72]

Regardless of the type of wood, all timber contains some amount of imperfection. Irregularities such as knots or growth aberrations would be problematic in shipbuilding, especially in areas of the hull where shipwrights had to bend heavy planks in complex curves. Dutch shipbuilders, in particular, would remove knots or other imperfections in hull planking and fill in the cavities with graving pieces. Such applications are found in the hull planking of the *Batavia*, Christianshavn B&W 2, and Angra C ships (see Chapters IV and V).[73] The use of high–quality oak and meticulous woodworking techniques in *Batavia*'s hull exemplify a high standard of workmanship.

**The disappearance of Vistula region oaks after 1643**

The import of oak timber from the Vistula forests into northwestern Europe ceased completely after 1643.[74] Attempts to find evidence for the use of this wood in later seventeenth century artwork or buildings have also failed. Oil paintings after 1643 were produced on panels of oak from the Lowlands and Germany, on tropical hardwoods, or were painted on canvas.[75]

Eckstein, Brongers, and Bauch observed in 1975 that the Vistula river habitat was exploited for its lumber to produce artworks. They also suggested that it could have been "denuded completely for the purpose of building ships."[76] The authors offered no evidence or supporting arguments to back up this hypothesis, and their idea was largely disregarded by historical scholars.[77] Such criticism notwithstanding, the possibility they raise deserves serious examination, especially since the VOC sourced oak timber from the Vistula forests for shipbuilding from its earliest years of existence.

Both Zunde and Wazny have attempted to do just this. Each cites Olechnowitz's work on shipbuilding in the late medieval period when stating that some 4,000 well–grown oaks were needed to build a medium–size merchantman or oceangoing vessel in the seventeenth century.[78] This number is, however, too large, especially since Olechnowitz does not refer to merchantmen or oceangoing ship but to warships.[79] Olechnowitz bases his 4,000–oak requirement on an article in *Mariner's Mirror*, which states that "the average 'seventy–four' of the eighteenth century, varying between 1600 and 1900 tons, consumed about 3,000 loads of timber, which was equivalent to stripping sixty acres of oaks a century old."[80] The seventy–four–gun ship, however, was not medium–sized nor a merchantman, but was a large warship. Furthermore, it was built in the eighteenth century.

Henry Adams, shipwright of the 1,370–ton HMS *Agamemnon*, mentions in 1781 that he "needed the felling of 2,000 average oaks to supply 2,000 loads of timber" for the construction of the ship.[81] One "load" of that time equals 50 cubic feet, or 1.42 cubic meters, which means that 2,831 cubic meters of timber went into building the ship's hull. Therefore, approximately 3,000 average oaks would have been required for an eighteenth–century seventy–four gun ship and not 4,000 oaks as suggested by Olechnowitz.[82]

The dimensions and volume of timber used in such large warships exceeds by far that of "medium–sized" oceangoing vessels in the seventeenth century. The reconstruction of the small United India Company yacht *Duifje* in 1998, for example, utilized approximately 95 cubic meters of timber already sawn to its near–finished shape.[83] This 60–ton yacht was 19.6 m (69 Amsterdam feet) in length from stem to sternpost and 5.45 m (19 Amsterdam feet, 2 thumbs) in beam.[84] The actual volume of wood used was slightly less, however, because of the taper and sny of the ship's planking and other workings of its timber.[85] The corresponding volume of flitched logs and sawn planks was approximately 200 tons, which was shipped from Latvia in eleven 40–foot containers.[86] Using the *HMS Agamemnon* timber ratios, this volume of lumber would have required the felling of some 228 trees.[87] It must be noted that the *Duifje* reconstruction was made with a single layer of hull planking. The original ship, like other VOC yachts and Indiamen of the early seventeenth century, must have been double planked and so the volume of wood used in *Duifje*'s reconstruction is significantly less than what the original ship would have required.

*Duifje*'s reconstruction is roughly equivalent in size to a late–Medieval cog, and about one–third the size of an average oceangoing Dutch merchantman from the early seventeenth century. Therefore, depending on the specific size of a ship and the actual size of well–grown trees, the number of trees needed to build a seventeenth–century oceangoing merchantman is many hundreds, perhaps even a thousand, but not nearly four thousand. Nevertheless, this still represents an annual felling of at least 700,000 trees to supply Dutch shipyards; a phenomenal number.[88] It is certainly possible that the Dutch shipbuilding industry played a significant role in the deforestation of the Vistula River area by 1643. A similar situation occurred in the upper reaches of the Daugava River basin in the Gulf of Riga in Latvia, which was exhausted of its timber in the second half of the seventeenth century.[89]

In support of an historical cause for termination of the use of Vistula–region oak, Bauch, Eckstein, Wazny, and Klein point to the Thirty Years War and the subsequent decline in trade between northwestern Europe and the Baltic.[90] They assert that the ensuing Second Swedish–Polish War from 1655 to 1660 caused a total breakdown of the European trade with the Vistula region, including the Danzig timber trade.[91] As a result of this collapse, the Riga region became a more prominent timber market in the Baltic.[92]

While the overall Dutch trade volume with Danzig did, indeed, decline, it certainly did not disappear entirely during the seventeenth to nineteenth centuries.[93] To the contrary, hundreds of Dutch ships continued to transport fabrics, salt, and herring to Danzig in the late seventeenth century. Moreover, grain and timber were shipped from Danzig well into the nineteenth century.[94]

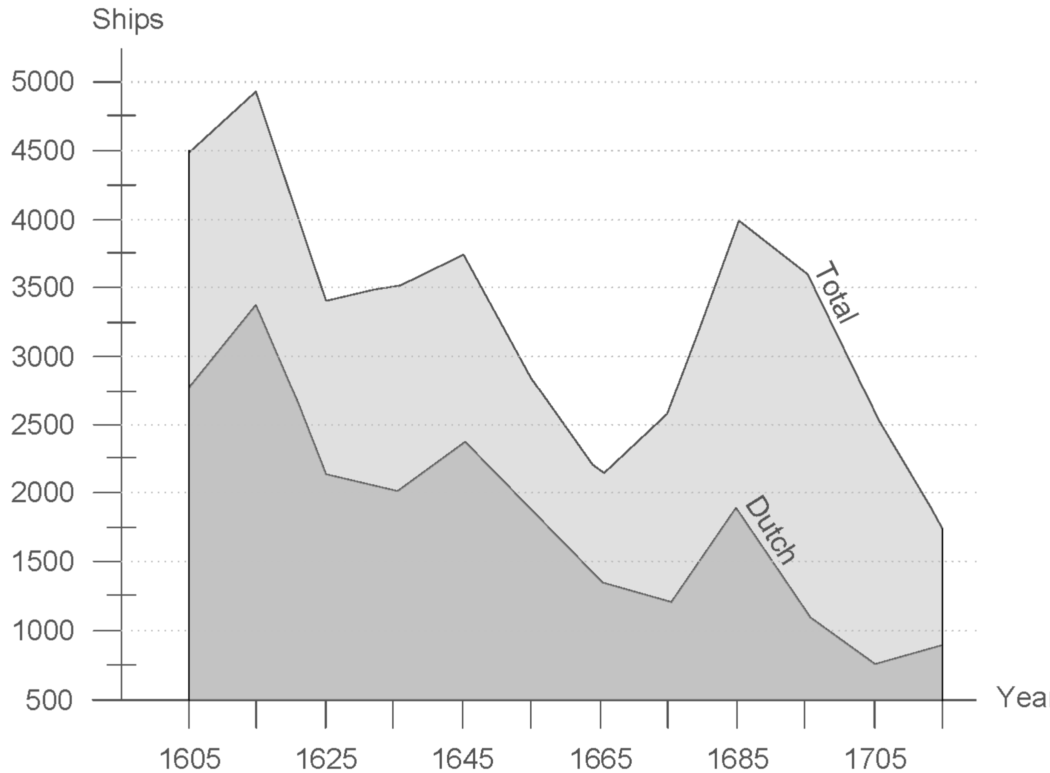


Fig. VII.13 Number of ships sailing through the Danish Sound from 1602 to 1720, average per decennium. After: Lindblad, "Nederland en de Oostzee 1600–1850," 15, graph 1.

Danish taxation registers from the seventeenth century demonstrate that the number of Dutch ships sailing through the Danish Sound decreased from 3,400 ships per annum between 1610 and 1620 to 2,300 between 1640 and 1650, representing a one–third drop in traffic (Fig. VII.13).[95] However, the majority of Dutch merchantmen sailing to Baltic harbors before 1640 were between 60 and 200 tons, whereas after 1640 the average size of the ships increased to 200 tons and over. Thus, the actual volume of trade did not necessarily decrease during this particular period.[96]

Even in 1672, when concurrent political conflicts between the Netherlands, England, France, and some German states temporarily obstructed Baltic trade, some 1,200 Dutch ships still sailed through the Danish Sound. Once hostilities ceased, this trade quickly rebounded. In 1680, 2,000 Dutch ships sailed into the Baltic Sea, a number comparable to the traffic of 1640.[97] Thus, Dutch trade with the Baltic and Danzig did not collapse entirely and the collective impact of the Swedish–Polish War, Anglo–Dutch War, and Thirty Years War did not cause permanent damage to the general Dutch trade with the region. Even though no records are available prior to 1650, the amount of timber that the Dutch imported from the Baltic region as a whole increased from 54,000 tons in 1650 to 160,000 tons in 1750 (see Table II.1). Furthermore, the portion of the overall Dutch timber demand that was supplied by Baltic wood also increased, from 16% to 47%, respectively.[98]

**Dendrochronology of archaeological ship timbers**

The study of the material record of oak use from the Vistula region by the Dutch mainly derives from dendrochronological investigations of hundreds of panel paintings. In fact, large–scale dendrochronological study of archaeological ships' timbers started only recently. The first extensive study on the timber of a Dutch shipwreck is of an early eighteenth–century *ventjager* (a type of fishing vessel) published in 2004. One hundred and three wood samples from this ship were dated, which indicate that it was constructed after 1705 from oak that cross–matched with at least two areas in Germany, one near Hannover, and the other east of Liège in Belgium.[99]

A few modest studies of ship timbers, including *Batavia*'s, demonstrate the potential that a comprehensive examination has to answer questions regarding the Dutch timber trade and shipbuilding industry in the late sixteenth and early seventeenth centuries. *Batavia* is not the only example of a Dutch ship constructed with oak from the Vistula region in Poland dating to the late sixteenth and early seventeenth centuries. Timber from the Scheurrak T24 and Christianhavn B&W 5 shipwrecks cross–matched with the NLARTP01 chronology as well.[100] These two seventeenth–century shipwrecks are not large VOC ships like *Batavia,* destined to haul long–distances for the inter–continental trade, but nonetheless substantial merchantmen, both possibly flutes.

The Scheurrak T24 ship was one of twelve Dutch shipwrecks that André van Holk studied for his M.A. thesis on hull timber in the 1980s.[101] The timbers of only six of these shipwrecks could be dated and provenanced. The Scheurrak T24 wreck, a Dutch merchant ship, had well–preserved hull remains measuring 26.85 m in length and 6.65 m wide on the seabed.[102] From this shipwreck, samples of twelve hull and ceiling planks were dated and five cross–matched to the western Germany, four with the Schleswig–Holstein or Hamburg, and three with the Polish NLARTP01 chronologies.[103] Samples matching the NLARTP01 chronology were taken from one hull plank (M15, fourth strake) and two ceiling planks (M1 and M2); the most recent rings present on the samples date respectively 1536, 1595, and 1537.[104] Like those of *Batavia*, no sapwood was present on these particular samples. The Scheurrak T24 ship was probably constructed in the early seventeenth century, based on the use of the bottom–based construction method and associated archaeological finds.[105] The ship sank in the Waddenzee some time after 1655, however, as dendrochronological study of one hull plank (M13, sixth strake) has clearly demonstrated. This particular sample, originating in western Germany, has sapwood rings preserved; the most recent ring of which dates to 1635, providing a felling date around 1655.[106] It may not necessarily have come from the ship's original construction as old or rotten planks were commonly replaced as part of standard maintenance of a ship's hull.

Polish Vistula–region oak was also used in the construction of the Dutch–built Christianshavn B&W 5 ship, most likely a *pinasse* or flute dating to first half of the seventeenth century. Three of ten datable wood samples taken from this ship's hull planking may match the same Polish oak chronology NLARTP01 as with the *Batavia* and Scheurrak T24 ships.[107] Seven other hull planks from the B&W 5 Christianshavn ship cross–match best with timber from Lower Saxony in Germany.[108]

The two dendrochronological examinations of the Christianshavn B&W5 and Scheurrak T24 ships indicate that the majority of their planking came from Germany, however, not the Vistula region.[109] Moreover, timber of Dutch–built Danish Indiaman Christianshavn B&W 2, *verlanger* Christianshavn B&W 1, and Baltic trader Scheurrak SOI shipwrecks mainly came from modern–day Germany, probably the forested regions around Lüneberger Heide and Westphalia, including Lower Saxony.[110] It should be noted as well that the small number of wood samples studied from *Batavia* may not be representative of all its planking, nor of all its hull members. Nevertheless, the dendrochronological studies of *Batavia,* Christianshavn B&W 5, and Scheurrak T24 shipwrecks now securely confirm the use of timber from the Vistula region in Dutch shipbuilding.[111] Still, more research is needed to provide additional evidence for the use of this oak in Dutch shipbuilding, particularly at VOC shipyards.[112]

**Drying or seasoning of timber**

Ideally, wood has to be seasoned or dried before it is used in order, to extract the tree's natural sap and prevent any deformation or rot. It is unknown whether the VOC required its wood to be dried before use on ships. *Batavia*'s timbers are a unique archaeological record that could provide evidence on such a matter, as it is known exactly when the ship was built. Unfortunately, the dendrochronological research of the *Batavia* timbers did not provide a conclusive felling date of the wood due to the absence of sapwood.

When wood is dried, it not only becomes lighter, but also stiffer and significantly stronger, and shrinks slightly. The bending of hull planking for a ship's bottom, however, is an intense process in which the heat applied over an open fire or steam is used to facilitate the bending and extracts a substantial amount of moisture from the timber's surface. If timbers have been dried properly, the process of bending becomes more difficult and causes the wood to crack. For the construction of the replica of the VOC–yacht *Duifje* in Western Australia, for example, shipwrights purposely used green wood for the ship's bottom. Contrary to the general expectation, this has not caused unusual problems since its construction in 1997.[113] Conversely, the usage of dried timber below the waterline is likely to cause serious problems. When the shipwrights assemble the bottom planking, they close the seams as much as possible, and subsequently caulk them well. After the ship is launched, the planks swell due to immersion in seawater; this causes enormous stress on the fastenings. When dried, the planks in this circumstance have no place to go but to force themselves off the framing, causing the seams to split open, and ultimately resulting in serious leaks.

Bill Leonard, shipwright of the *Duifje*, explains that shipwrights of large wooden vessels differentiated between timber that should be dry and timber that should be damp, with a moisture content in excess of 30%. The availability of resources and other restrictions, however, also influence the construction process and often shipwrights will simply have to work with what their particular circumstances allow. This applied to the shipwrights who constructed the *Duifje* in the late twentieth century as much as it did for those who worked at the VOC shipyards in the sixteenth and seventeenth centuries.[114] Furthermore, the need for dry timber, with less that 12% humidity, in traditional shipbuilding is simply not there, and not practical with large timbers, because of the hydroscopic nature of wood (it adsorbs and exudes moisture). It is, for example, evident that the climate of northern Europe is generally wet and ships spent their working lives in an even wetter environment.

Traditional shipwrights are aware that some timbers need to be dryer than others. Bill Leonard explained that he would prefer to install well–seasoned dry hanging and lodging knees if available. The structural integrity of knees is important, for if they start working, they will twist the ship's hull. Leonard also favors reasonably dry quarter–sawn deck planking as, if kept moist, it will not shrink and hence will keep everything below dry. More importantly, it would enhance the fore and aft integrity of the ship, making the vessel stiffer.

For their part, both Witsen and Van IJk warn against the usage of wood that is too green, and prefer dry wood as it is denser, stronger, and less likely to split.[115] What "dry wood" exactly means, or how long wood needs to be dried, is not clear.

Van IJk explained that wood stored in salt water preserves well for many years, as does wood in an exclusively dry environment, but wood subject to dry and wet conditions disintegrates quickly.[116] He recommends that timber in storage should be sawn into planks before the shipbuilding process begins in order to extract excess sapwood.[117] He does not specify how long before construction "in time" is, but he does not seem to indicate a number of years. Witsen elaborates that oak felled in winter is stronger as it contains less nutrients. He advises to cut crosswise into a tree, about four to five days prior to felling, in order to extract live sap and, hence, dry the wood.[118]

**Timber processing in shipbuilding, construction, and artwork**

The time allotted to process or dry timber for shipbuilding in the early seventeenth century is not known precisely. It may, therefore, be helpful to look at the drying time for wood in regular construction and artwork. Research of contemporaneous structures in Germany has indicated that 67% of the wood was used within a year of its felling date, 29% within two years, and only 4% after more than two years.[119] The Dutch probably used a similar practice as their German neighbors. Many timbers used in Dutch construction works have deformed or cupped cross–sections, confirming this practice.[120]

Similarly, Bauch and Eckstein concluded, after their study of hundreds of oak panel paintings, that the panels were probably only dried after the cutting of the oak trunk, which made it possible to use them rather quickly. Although panel making for oil paintings and ship construction are two very different crafts and do not necessarily have the same quality criteria for wood, some of the practices of the former may shed light on those of the latter. Bauch and Eckstein's research contradicted a widespread, now outdated, opinion that panel wood had to be dried for decades before use, and showed that the time between cutting and painting the wood varied from one to several years.[121] Since oil paints and their primers do not adhere well to damp surfaces, the panels do require a minimum amount of drying time.

The dendrochronological examination of several paintings that are signed and dated has demonstrated an average drying time of 5 ±3 years (between two and eight years), before utilization of the panels by painters of the Dutch and Flemish Schools in the sixteenth and seventeenth centuries.[122] The curing or drying period is not consistent or similar throughout the centuries or between different artists. The painters in the Cologne School in the fourteenth and fifteenth centuries, for example, seem to have preferred to dry their wood for a period of about ten years.[123]

If wood for artwork was not dried for a long period and timber for building construction was used soon after the trees were felled, then it is likely that shipbuilding timber was not dried for years either. Since at least the seventeenth century, many accounts stress that dry–rot is the most prominent enemy of wood. These documents explain that the dry–rot fungus occurs in wood that is not well–seasoned or worked while still damp in a poorly ventilated space.[124] Accoring to Van Beylen, ships built of unsuitable wood completely rotted away within five years, after which time, timber could not be re–used and was generally burned.[125] There are plenty of examples in which ships needed to be pumped out for months during long journeys due to leaks caused by dry–rot.[126]

An old measure taken to prevent dry–rot was the watering of wood, which replaced sap by, preferably, salt or fresh water. Witsen refers to this practice being used in Italy where sap was leached out by keeping shipbuilding timber submerged in water for long periods to make it strong and stiff.[127] In 1657, the VOC bought a large plot of land, the Funen or Keerweer, behind the bastion of Jaap Hannes to build a wind–driven sawmill with a house for the miller and storage sheds. This plot was situated at a floating harbor where timber could be watered for six months before use.[128] Even though it has been published that the VOC watered its wood for six months prior to use, no reference to a specific written document has confirmed such practice for the early seventeenth century.[129] As Bruijn, Gaastra, and Schöffer point out, there was no explicit term for this practice at the time that the Gentlemen XVII made decisions on the construction of new ships. Moreover, Bruijn, Gaastra, and Schöffer demonstrate that the VOC did plan to water its ship timber for about six months from the early eighteenth century onward. Timbers were immersed in water from the time they were acquired in the spring to the laying down of the keels in November or December.[130]

Such a method of seasoning wood was used in the Netherlands well into the twentieth century.[131] Shipwright Bill Leonard remembers such a practice in Great Britain in the 1950s. Timber would be placed in the ocean at so–called silting points to replace fresh water or sap with salt water. Salt water enhances the wood’s quality and additionally reduces the need for large storage facilities. The watering of wood, however, would likely be done for a short period as timber becomes unsuitable for shipbuilding when waterlogged. Timber was also in such high demand that long periods of watering would not have been realistic.[132]

Surface cracking and some repairs, or graving pieces, of *Batavia*'s hull planking suggest the use of green wood as green wood tends to crack easily (Chapter IV). Also, it is unlikely that timber was stored at the shipyard of the Amsterdam Chamber for a long period of time, as Jan Rijcksen was sent to acquire timber for the construction of *Batavia* at the end of May 1628, only five months before it was completed and set sail to the Indies.[133]

**Conclusion**

Durability of ships in service of the long–distance Dutch trading companies, and later the VOC, and their ability to navigate in difficult conditions are likely to have required timber of particularly high quality. Based on dendrochronological and historic research, the import volume of Baltic timber, specifically from the Vistula region, must have played an important role at VOC shipyards and those that were building ships for long–distance trade in the early seventeenth century.

Dutch shipbuilding in general, and the enormous increase in the construction of large oceangoing vessels in the early seventeenth century in particular, likely made a large call on the Baltic oak forests. The Dutch bottom–based construction method for oceangoing ships, such as large Indiamen, was entirely based on the excessively thick hull composed of two layers of oak hull planking (see Chapter VI). The structural integrity of ships built by this construction method was heavily dependent on the ships' hulls, and, therefore, high–quality straight–grained oak with few growth defects and knots was essential. The construction of ships with two layers of oak planking was expensive and perhaps made too much of a call on the Baltic oak forests, particularly, those of the Vistula region, where the best quality oak seems to have come from.

When the frame–based construction method was adopted in the Netherlands in the late–seventeenth century, the planking thickness of the ship's hull decreased significantly, reducing the need for high–quality straight oaks from the Baltic (Chapter VI). The frame–based ship's skeleton became the basic principle of ship construction and, therefore, compass timber began to play a much more important role at the VOC shipyards than straight–grained oak. In the late seventeenth century, large quantities of compass timber were imported into the Netherlands from Germany, in particular the Rhine and Wesel regions, as has been recorded by Witsen, Van IJk, Van Dam, and the account books of the Zaandam timber auctions.[134] This conceptual change in shipbuilding philosophy in Dutch shipyards would also have changed the types of timber needed and caused a shift of Dutch import markets.

Recent dendrochronological study of Dutch and Flemish furniture and sculpture indicates that artists and artisans mainly used oak from the Baltic before 1660, whereas around 1660 a relative change occurred in the trading of oak volume from Baltic region to south and central Germany.[135] This trend most likely was a reflection of timber imports for shipbuilding.

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[1] Porsius,"Eiken en grenen," 57–64.

[2] Porsius,"Eiken en grenen," 57.

[3] National Archives (NA) of the Netherlands, The Hague*, Archieven van de Verenigde Oostindische Compagnie, 1602–1795*, reference code 1.04.02, item number 7142 (Journaal van inkomsten en uitgaven, voornamelijk de equipage, 13 August 1602–9 May 1608); see also National Archives (NA) of the Netherlands, The Hague*, Archieven van de Verenigde Oostindische* Compagnie, 1602–1795, reference code 1.04.02, item number 7169 (Grootboek van inkomsten en uitgaven, voornamelijk de equipage, 13 August 1602–May 1608); National Archives (NA) of the Netherlands, The Hague, *Archieven van de Verenigde Oostindische Compagnie*, 1602–1795, reference code 1.04.02, item number 13782–13785 (Journalen en grootboeken van de kapitaalrekeningen van de eerste tienjarige rekening van de kamer Zeeland, August 3, 1602–October 31, 1607); National Archives (NA) of the Netherlands, The Hague, *Archieven van de Verenigde Oostindische Compagnie,* 1602–1795, reference code 1.04.02, item number 14339 (Rekening van de uitrusting van de schepen Wapen van Hoorn, uitgevaren op 1619 december 27, Medemblik, uitgevaren op 1619 december 26, en Purmerend, uitgevaren op 1620 mei 25); and National Archives (NA) of the Netherlands, The Hague, Archieven van de Verenigde Oostindische Compagnie, 1602–1795, reference code 1.04.02, item number 14854 (Journaal van inkomsten en uitgaven van de kamer Enkhuizen, van een gedeelte van de periode van de eerste en tweede tienjarige rekening, 30 June 1608–29 May 1619).

[4] National Archives (NA) of the Netherlands, The Hague*, Archieven van de Verenigde Oostindische Compagnie, 1602–1795*, reference code 1.04.02, item number 7142 (Journaal van inkomsten en uitgaven, voornamelijk de equipage, 13 August 1602–9 May 1608).
[5] Porsius,"Eiken en grenen," 60.
[6] Porsius,"Eiken en grenen," 60–61.
[7] National Archives (NA) of the Netherlands, The Hague*, Archieven van de Verenigde Oostindische Compagnie, 1602–1795*, reference code 1.04.02, item number 7142 (Journaal van inkomsten en uitgaven, voornamelijk de equipage, February 1603 –January 1604); and Porsius,"Eiken en grenen," 60–61.
[8] National Archives (NA) of the Netherlands, The Hague*, Archieven van de Verenigde Oostindische Compagnie, 1602–1795*, reference code 1.04.02, item number 7142 (Journaal van inkomsten en uitgaven, voornamelijk de equipage, February 1603 –January 1604); and Porsius,"Eiken en grenen," 61.
[9] Van Dam, *Beschrijvinge van de Oostindische Compagnie*, 457.
[10] National Archives (NA) of the Netherlands, The Hague*, Archieven van de Verenigde Oostindische Compagnie, 1602–1795*, reference code 1.04.02, item number 227 (Resoluties van de ordinaris en extraordinaris vergaderingen van de kamer Amsterdam, 19 July 1612).
[11] National Archives (NA) of the Netherlands, The Hague*, Archieven van de Verenigde Oostindische Compagnie, 1602–1795*, reference code 1.04.02, item number 228 (Resoluties van de ordinaris en extraordinaris vergaderingen van de kamer Amsterdam, 26 May and 13 June 1616).
[12] National Archives (NA) of the Netherlands, The Hague*, Archieven van de Verenigde Oostindische Compagnie, 1602–1795*, reference code 1.04.02, item number 7287 (Minuut–uitgaande missiven van de kamer Zeeland aan autoriteiten in de Republiek en Indië, 25 July 1615).
[13] National Archives (NA) of the Netherlands, The Hague*, Archieven van de Verenigde Oostindische Compagnie, 1602–1795*, reference code 1.04.02, item number 4458 (Haags Besogne en andere commissies, 12–17 July 1685).
[14] Schillemans, "De houtveilingen van Zaandam in de jaren 1655–1811."
[15] Schillemans, "De houtveilingen van Zaandam in de jaren 1655–1811," 74.
[16] Witsen, *Architectura navalis et reginem nauticum*, 35–46; and Van IJk, *De Nederlandsche scheeps–bouw–konst open gestelt*, 39–40.
[17] Van Dam, *Beschrijvinge van de Oostindische Compagnie*, 453–54.
[18] Bruijn, Gaastra, and Schöffer, *Dutch Asiatic Shipping in the 17th and 18th Centuries: Introductory Volume*, 15.
[19] Witsen, *Architectura navalis et reginem nauticum*, 199.
[20] Witsen, *Architectura navalis et reginem nauticum*, 199.
[21] Witsen, *Architectura navalis et reginem nauticum*, 199.
[22] Van IJk, *De Nederlandsche scheeps–bouw–konst open gestelt*, 39–40.
[23] Van Dam, *Beschrijvinge van de Oostindische Compagnie*, 453–54.
[24] Van Dam, *Beschrijvinge van de Oostindische Compagnie*, 453.
[25] Van Dam, *Beschrijvinge van de Oostindische Compagnie*, 453.
[26] Van Dam, *Beschrijvinge van de Oostindische Compagnie*, 454.
[27] Van Dam, *Beschrijvinge van de Oostindische Compagnie*, 454.
[28] Van Dam, *Beschrijvinge van de Oostindische Compagnie*, 454.
[29] Van Dam, *Beschrijvinge van de Oostindische Compagnie*, 454.
[30] Van Dam, *Beschrijvinge van de Oostindische Compagnie*, 454–55.
[31] Initially, Nancy Mills Reid and Ian Godfrey, of the Department of Material Conservation and Restoration, Western Australian Museum, examined eleven wood samples in–house (Table VII.1). Reid concluded that she could identify ten samples as oak, presumably European oak (*Quercus robur*). However, it is currently not possible to differentiate Pendunculate oak (*Quercus robur*) from Sessil oak (*Quercus petrea*) as both species are nearly identical anatomically. See, Esther Jansma et al., "Historische dendrochronologie in Nederland: de stand van zaken anno 2001," in *Praktijkboek Instandhouding Monumenten,* ed. Jaap M. van der Veen and Stef Binst (The Hague: SDU Uitgevers, 2002), 6; and Nancy

R. Mills, *Unpublished Report, Department of Material Conservation and Restoration* (Fremantle: Western Australian Museum, 9 October 1985).

An additional seven samples were analyzed recently by Caroline Vermeeren and Pauline van Rijn, BIAX Consult (Research and Consultancy for Biological Archaeology and Landscape Reconstruction). This laboratory is specialized in northwest European wood species (Table VII.2).

32 Pauline van Rijn, *The Analysis of Ten Wood Samples from VOC Shipwrecks* Batavia *and* Zeewijk, unpublished report (Zaandam: BIAX Consult, 2007).

33 Van Rijn, *The Analysis of Ten Wood Samples from VOC Shipwrecks* Batavia *and* Zeewijk.

34 Historic documentation: Witsen, *Architectura navalis et reginem nauticum*, 204; Van IJk, *De Nederlandsche scheeps–bouw–konst open gestelt*, 456.

Archaeological reports: W. Eenkhoorn and A.J.M. Wevers, *Report of an Investigation into Wood and Soil Samples from and in the Area of the East Indiaman* Amsterdam (Lelystad: Rijksdienst voor de IJsselmeerpolders, 1983); Esther Jansma, "Dendrochronologisch onderzoek van het V.O.C.–schip *De Amsterdam*," *Westerheem* 36 (1987): 184–90; Lemée, *The Renaissance Shipwrecks from Christianshavn*, 197–216; L'Hour, Long, and Rieth, "The Wreck of an 'Experimental' Ship of the 'Oost Indische Companie'," 64–65; and Maarleveld, "Archaeology and Early Modern Merchant Ships," 164–66.

35 Van Dam, *Beschrijvinge van de Oostindische Compagnie*, 456.

36 National Archives (NA) of the Netherlands, The Hague*, Archieven van de Verenigde Oostindische Compagnie, 1602–1795*, reference code 1.04.02, item number 229 (Resoluties van de ordinaris en extraordinaris vergaderingen van de kamer Amsterdam, 18 November 1617 and 25 May 1628).

37 Pelsaert, *Ongeluckige voyagie, van* '*t schip* Batavia*, nae de Oost–Indien*, 1–2.

38 The dendrochronological examination was made by Elsemieke Hanraets, RING, Netherlands Center for Dendrochronology, Postbus 510, 8200 AM, Lelystad, Netherlands.

Justification of dating results: RING bases its dendrochronological dating on a combination of observations: (a) comparison and relative dating (in relation to one another) of tree ring patterns within a location or building phase; (b) comparison of these tree ring patterns with more than one absolutely dated reference chronology. These comparisons are both statistically and visually controlled. Observations that both support and confirm each other are considered correct.

39 Lemée, *The Renaissance Shipwrecks from Christianshavn*, 117–20, 164–65, 217–18.

40 Van Dam, *Beschrijvinge van de Oostindische Compagnie*, 456.

41 Probability or statistical certainty of the match refers to the possibility that the similarity between the sample and the reference chronology is *not* a coincidence. The value is based on the 'Gleichlaufigkeit' between the two compared series, also called %PV (percentage of parallel variation). See, Ernst Hollstein, *Mitteleuropäische Eichenchronologie* (Mainz am Rhein: Verlag Philipp von Zabern, 1980), 17–18, 27–33; and Jansma et al., "Historische dendrochronologie in Nederland," 12.

42 Jansma et al., "Historische dendrochronologie in Nederland," 4, table 1 (SCH1115M); and Esther Jansma, *RemembeRINGs: The Development and Application of Local and Regional Tree–Ring Chronologies of Oak for the Purposes of Archaeological and Historical Research in the Netherlands* (Amersfoort: Rijksdienst Oudheidkundig Bodemonderzoek, 1995), 142 (NLPP).

43 Elsemieke Hanraets, letter to author, 7 February 2007; Jansma et al., "Historische dendrochronologie in Nederland," 4, table 1 (SCH1115M); and Jansma, *RemembeRINGs*, 142 (NLPP).

44 Josef Bauch and Dieter Eckstein, "Dendrochronological Dating of Oak Panels of Dutch 17th Century Painting", *Studies in Conservation* 15 (1970): 45–50; Dieter Eckstein, Johannes A. Brongers, and Josef Bauch, "Tree–Ring Research in the Netherlands," *Tree–Ring Bulletin* 35 (1975): 1–13; and Jansma, *RemembeRINGs*, 18–19, 99, 142.

45 Eckstein, Brongers, and Bauch, "Tree–Ring Research in the Netherlands," 2.

46 Eckstein, Brongers, and Bauch, "Tree–Ring Research in the Netherlands," 2.

47 Eckstein, Brongers, and Bauch, "Tree–Ring Research in the Netherlands," 4.

48 Jansma, *RemembeRINGs*, 18–19, 99, 142; and Dieter Eckstein et al., "New Evidence for the Dendrochronological Dating of Netherlandish Paintings," *Nature* 320 (April 3, 1986): 465.

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[49] Eckstein et al., "New Evidence for the Dendrochronological Dating of Netherlandish Paintings," 465.

[50] Eckstein et al., "New Evidence for the Dendrochronological Dating of Netherlandish Paintings," 465.

[51] Eckstein et al., "New Evidence for the Dendrochronological Dating of Netherlandish Paintings," 465.

[52] Eckstein et al., "New Evidence for the Dendrochronological Dating of Netherlandish Paintings," 465; Thomasz Wazny, "Aufbau und Anwendung der Dendrochronologie für Eichenholz in Polen" (Ph.D. diss., Universität Hamburg, 1990); Jansma et al., "Historische dendrochronologie in Nederland," 3–4; and Jansma, *RemembeRINGs*, 18.

[53] Eckstein et al., "New Evidence for the Dendrochronological Dating of Netherlandish Paintings," 465; Wazny, "Aufbau und Anwendung der Dendrochronologie für Eichenholz in Polen;" and Jansma, *RemembeRINGs*, 18.

[54] Elsemieke Hanraets, letter to author, 7 February 2007; Eckstein et al., "New Evidence for the Dendrochronological Dating of Netherlandish Paintings," 465; and Jansma, *RemembeRINGs*, 18.

[55] Eckstein et al., "New Evidence for the Dendrochronological Dating of Netherlandish Paintings," 465.

[56] Eckstein et al., "New Evidence for the Dendrochronological Dating of Netherlandish Paintings," 465–66; Israel, *Dutch Primacy in World Trade 1585–1740*, 18–19; and Schillemans, "De houtveilingen van Zaandam in de jaren 1655–1811," 3.

[57] Daalder et al., ed., *Goud uit graan*, 8, 42–55; and Scammell, *The World Encompassed*, 378.

[58] Daalder et al., ed., *Goud uit graan*, 8, 42–55; and Scammell, *The World Encompassed*, 378.

[59] Kristof Haneca et al., "Provenancing Baltic Timber from Art Historical Objects: Success and Limitations," *Journal of Archaeological Science* 32 (2005): 262.

[60] David Houbrechts and Marnix Pieters, "Tonnen uit Raversijde (Oostende, prov. West–Vlaanderen): Een goed gedateerd verhaal over water– en andere putten," *Archeologie in Vlaanderen* V (1995/1996): 244–49.

[61] Schillemans, "De houtveilingen van Zaandam in de jaren 1655–1811," 5.

[62] Schillemans, "De houtveilingen van Zaandam in de jaren 1655–1811," 15, 74.

[63] Wegener Sleeswyk, *De Gouden Eeuw van het fluitschip*, 27–28.

[64] Unger, "The *Fluit*," 126–27.

[65] Niels Bonde, Ian Tyers, and Thomasz Wazny, "Where Does the Timber Come From? Dendrochronological Evidence of the Timber Trade in Northern Europe," in *Archaeological Sciences 1995*, edited by Anthony Sinclair, Elizabeth Slater, and John Gowlett (Oxford: Oxbow Books, 1997), 202.

[66] Schillemans, "De houtveilingen van Zaandam in de jaren 1655–1811," 67, 74.

[67] Schillemans, "De houtveilingen van Zaandam in de jaren 1655–1811," 67.

[68] Schillemans, "De houtveilingen van Zaandam in de jaren 1655–1811," 5.

[69] Haneca et al., "Provenancing Baltic Timber from Art Historical Objects: Success and Limitations," 263.

[70] Due to the lack of historic documentation concerning wood and the trade of timber, as discussed in this chapter, there is almost no evidence for the price of oaks and other woods. Baltic oak from the Vistula region, however, must have been more expensive than other European oak since it was used for artworks, and not as a bulk commodity in northwestern Europe for building construction.

[71] Van Dam, *Beschrijvinge van de Oostindische Compagnie*, 457.

[72] Witsen, *Architectura navalis et reginem nauticum*, 199.

[73] Lemée, *The Renaissance Shipwrecks from Christianshavn*, 204, Fig. 4.3.22; and Phaneuf, "Angra C, une épave hollandaise en contexte Açoréen du XVIIe siècle," 64.

[74] Eckstein, Brongers, and Bauch, "Tree–Ring Research in the Netherlands," 8.

[75] Eckstein, Brongers, and Bauch, "Tree–Ring Research in the Netherlands," 8.

[76] Eckstein, Brongers, and Bauch, "Tree–Ring Research in the Netherlands," 8.

[77] Eckstein et al., "New Evidence for the Dendrochronological Dating of Netherlandish Paintings," 465–66.

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[78] Maris Zunde, "Timber Export from Medieval Riga and Its Impact on Dendrochronological Dating in Europe," *Dendrochronologia* 16–17 (1999): 122–23; and Wazny, "The Origin, Assortments and Transport of Baltic Timber," 122.

[79] Karl F. Olechnowitz, *Der Schiffbau der Hansischen Spätzeit: Eine Untersuchung zur Social– und Wirtschaftsgeschichte der Hanse* (Weimar: H. Böhlaus Nachfolger, 1960), 106.

[80] Robert G. Albion, "Timber Problems of the Royal Navy, 1652–1862." *Mariner's Mirror* 38:1 (1952): 14.

[81] An average oak refers to a century old tree. Abell, *The Shipwright's Trade*, 93.

[82] Albion, "Timber Problems of the Royal Navy, 1652–1862," 14.

[83] Nick Burningham, letter to author, 24 May 2007.

[84] Nick Burningham and Adriaan de Jong, "The *Duyfken* Project: An Age of Discovery Ship Reconstruction as Experimental Archaeology," *IJNA* 26:4 (1997): 282.

[85] Nick Burningham, letter to author, 24 May 2007.

[86] It was initially anticipated that for the *Duifje*'s construction approximately 200 cubic meters needed to be shipped as whole–sawn planks and logs flitched on either side. However, the suppliers in Latvia did less processing of the wood than originally agreed upon, which resulted in a larger volume of timber shipped to Australia. Nick Burningham, letter to author, 24 May 2007.

[87] This was calculated using a density for oak of 620 $kg/m^3$ (0.62 $tons/m^3$). See, Hoadley, *Identifying Wood*, 151.

[88] This number is based on the construction of 1,000 oceangoing ships in peak year of 1640, as discussed in Chapter II.

[89] Zunde, "Timber Export from Medieval Riga and Its Impact on Dendrochronological Dating in Europe," 126.

[90] Eckstein et al., "New Evidence for the Dendrochronological Dating of Netherlandish Paintings," 465–66.

[91] Eckstein et al., "New Evidence for the Dendrochronological Dating of Netherlandish Paintings," 466.

[92] Zunde, "Timber Export from Medieval Riga and Its Impact on Dendrochronological Dating in Europe," 119–30; and Wazny, "The Origin, Assortments and Transport of Baltic Timber," 119.

[93] Daalder et al., ed., *Goud uit graan*, 118–19.

[94] Daalder et al., ed., *Goud uit graan*, 8–27, 98–113, 118–19.

[95] J. Thomas Lindblad, "Nederland en de Oostzee 1600–1850," in *Goud uit graan: Nederland en het Oostzeegebied 1600–1850*, ed. Remmelt Daalder et al. (Zwolle: Waanders Uitgevers, 1998), 15.

[96] Lindblad, "Nederland en de Oostzee 1600–1850," 15.

[97] Lindblad, "Nederland en de Oostzee 1600–1850," 15.

[98] Porsius and De Munck, "Over hout, de herkomst, de kwaliteitseisen en de bewerking daarvan," 148; and Porsius, "Hout en schepen," 11.

[99] Sjoerd van Daalen and Jelle van der Beek, "Dendroprovenancing ship's timbers: A Pilot Study on a Dutch 18th Century 'Ventjager'," in *TRACE: Tree Rings in Archaeology, Climatology and Ecology*, ed. Esther Jansma et al. (Jülich: Forschungszentrum, Zentralbibliothek, 2004), 126–28.

[100] Maarleveld, Goudswaard, and Oosting, "New Data on Early Modern Dutch–flush Shipbuilding," 16; Lemée, *The Renaissance Shipwrecks from Christianshavn*, 164–66; André F.L. van Holk, "Jaarringonderzoek van scheepsresten" (M.A. thesis, University of Groningen, 1986), 23–26 and 60–61; and André F.L. van Holk, "Jaarringonderzoek van scheepsresten," in *Raakvlakken tussen scheepsarcheologie, maritime geschiedenis en scheepsbouwkunde: inleidingen gehouden tijdens het Glavimans symposion 1985*, ed. H. Reinder Reinders (Lelystad: Rijksdienst voor de IJsselmeerpolders, 1987), 77.

[101] Van Holk, "Jaarringonderzoek van scheepsresten " (M.A. thesis).

[102] Maarleveld, Goudswaard, and Oosting, "New Data on Early Modern Dutch–flush Shipbuilding," 13.

[103] Maarleveld, Goudswaard, and Oosting, "New Data on Early Modern Dutch–flush Shipbuilding," 16; and Van Holk, "Jaarringonderzoek van scheepsresten" (M.A. thesis), 61.

[104] Van Holk, "Jaarringonderzoek van scheepsresten" (M.A. thesis), 61.

[105] Maarleveld, Goudswaard, and Oosting, "New Data on Early Modern Dutch–flush Shipbuilding," 15–16; and Van Holk, "Jaarringonderzoek van scheepsresten" (M.A. thesis), 23–26, 60–61.

[106] Maarleveld, Goudswaard, and Oosting, "New Data on Early Modern Dutch–flush Shipbuilding," 16; Thijs J. Maarleveld, "Scheepsbouwkundige verkenning van de resten van een koopvaarder in de Waddenzee," in *Raakvlakken tussen scheepsarcheologie, maritime geschiedenis en scheepsbouwkunde: inleidingen gehouden tijdens het Glavimans symposion 1985*, edited by H. Reinder Reinders (Lelystad: Rijksdienst voor de IJsselmeerpolders, 1987), 73; Van Holk, "Jaarringonderzoek van scheepsresten" (M.A. thesis), 23 and 61; and Van Holk, "Jaarringonderzoek van scheepsresten," in *Raakvlakken tussen scheepsarcheologie, maritime geschiedenis en scheepsbouwkunde*, 77.

[107] Lemée, *The Renaissance Shipwrecks from Christianshavn*, 164–66.

[108] Lemée, *The Renaissance Shipwrecks from Christianshavn*, 66.

[109] Lemée, *The Renaissance Shipwrecks from Christianshavn*, 164–66; Van Holk, "Jaarringonderzoek van scheepsresten" (M.A. thesis), 23–24; and Van Holk, "Jaarringonderzoek van scheepsresten," in *Raakvlakken tussen scheepsarcheologie, maritime geschiedenis en scheepsbouwkunde*, 77.

[110] Lemée, *The Renaissance Shipwrecks from Christianshavn*, 217–18, 255–56; Manders, "The Mysteries of a Baltic Trader," 320. No extensive dendrochronological study on the Scheurrak SO1 has been conducted or published to date.

[111] Lemée, *The Renaissance Shipwrecks from Christianshavn*, 164–66; Van Holk, "Jaarringonderzoek van scheepsresten" (M.A. thesis), 23–24; and Van Holk, "Jaarringonderzoek van scheepsresten," in *Raakvlakken tussen scheepsarcheologie, maritime geschiedenis en scheepsbouwkunde*, 77.

[112] Several shipwrecks found closer to Poland are known to have hull timbers that match the NLARTP01 chronology well. The oldest one currently published, dates to the late fourteenth century and sank in Danish waters. It seems that one single wood sample has been studied, which cross–dates best with timber from the Vistula region. It is not known what specific hull member the sample was taken was from. See, Bonde, Tyers, and Wazny, "Where Does the Timber Come From?" 202.

Another example comprises a local log–boat from the Biebrza River in Eastern Poland dating to the second half of the sixteenth century. See, Thomasz Wazny, "Baltic Timber in Western Europe: An Exciting Dendrochronological Question," *Dendrochronologia* 20:3 (2002): 3.

Lastly, the Skaftö shipwreck, found in Swedish waters and dating to ca. 1440, was discovered more recently. The ship was built from Polish oak in a bottom–based construction method with lapstraked planking. The dendrochronological analysis has not been published yet. Staffan von Arbin, letter to author, 25 March 2007.

[113] Bill Leonard, letter to author, 15 February 2007.

[114] Bill Leonard, letter to author, 15 February 2007.

[115] Witsen, *Architectura navalis et reginem nauticum*, 199; and Van IJk, *De Nederlandsche scheeps–bouw–konst open gestelt*, 36–37.

[116] Van IJk, *De Nederlandsche scheeps–bouw–konst open gestelt*, 36.

[117] Van IJk, *De Nederlandsche scheeps–bouw–konst open gestelt*, 37.

[118] Witsen, *Architectura navalis et reginem nauticum*, 199.

[119] Hollstein, *Mitteleuropäische Eichenchronologie*, 38.

[120] Jansma et al., "Historische dendrochronologie in Nederland," 12.

[121] Josef Bauch and Dieter Eckstein. "Woodbiological Investigations on Panels of Rembrandt Paintings." *Wood Science and Technology* 15:4 (1981): 253; Eckstein, Brongers, and Bauch, "Tree–Ring Research in the Netherlands," 9 and 259; and Peter I. Kuniholm, "Dendrochronology (Tree–Ring Dating) of Panel Paintings," in *The Science of Paintings*, ed. W. Stanley Taft and James W. Mayer (New York: Springer, 2000), 211.

[122] Bauch and Eckstein, "Dendrochronological Dating of Oak Panels of Dutch 17$^{th}$ Century Painting," 47–48; and Kuniholm, "Dendrochronology (Tree–Ring Dating) of Panel Paintings," 211.

[123] Peter Klein, "Dendrochronologische Untersuchungen an Eichenholztafeln von Rogier van der Weyden," *Jahrbuch der Berliner Museen* 23 (1981): 122.

[124] Van Beylen, *Schepen van de Nederlanden, van de late middeleeuwen tot het einde van de 17e eeuw*, 24; and Sean McGrail and Eric McKee, *The Building and Trials of the Replica of an Ancient Boat: The Gokstad Faering* (Greenwich: National Maritime Museum, 1974), 40–41.

[125] Van Beylen, *Schepen van de Nederlanden, van de late middeleeuwen tot het einde van de 17e eeuw*, 24.

[126] Van Beylen, *Schepen van de Nederlanden, van de late middeleeuwen tot het einde van de 17e eeuw*, 24.

[127] Witsen, *Architectura navalis et reginem nauticum*, 203.

[128] Bonke, "Van Amsterdam tot Japara: Houtzagen voor de VOC," 157.

[129] Bonke, "Van Amsterdam tot Japara: Houtzagen voor de VOC," 157; Mostert, "Chain of Command," 53; and Bruijn, Gaastra, and Schöffer, *Dutch Asiatic Shipping in the 17th and 18th Centuries: Introductory Volume*, 24–25.

[130] Bruijn, Gaastra, and Schöffer, *Dutch Asiatic Shipping in the 17th and 18th Centuries: Introductory Volume*, 24.

[131] Adriaan de Jong, conversation with author, 23 April 2007. De Jong remembers this practice being used in his hometown, Linschoten, during the 1950s and 1960s.

[132] McGrail and McKee, *The Building and Trials of the Replica of an Ancient Boat*, 40.

[133] National Archives (NA) of the Netherlands, The Hague*, Archieven van de Verenigde Oostindische Compagnie, 1602–1795*, reference code 1.04.02, item number 229 (Resoluties van de ordinaris en extraordinaris vergaderingen van de kamer Amsterdam, 18 November 1617 and 25 May 1628).

[134] Schillemans, "De houtveilingen van Zaandam in de jaren 1655–1811;" Van Dam, *Beschrijvinge van de Oostindische Compagnie*; Witsen, *Architectura navalis et reginem nauticum*; Van IJk, *De Nederlandsche scheeps–bouw–konst open gestelt.*

[135] Esther Jansma, Elsemieke Hanraets, and Tamara Vernimmen, "Tree–Ring Research on Dutch and Flemish Art and Furniture," in *TRACE: Tree Rings in Archaeology, Climatology and Ecology*, ed. Esther Jansma et al. (Jülich: Forschungszentrum, Zentralbibliothek, 2004), 143, 146.

# CHAPTER VIII
# ANALYSIS OF *BATAVIA*'S HULL AND CONSTRUCTION

## Dimensions of VOC ships in the early seventeenth century

*Batavia*'s overall dimensions from the VOC archives indicate that it was a slender vessel with a length to beam ratio of 4.4:1. The ship measured 160 Amsterdam feet (45.3 m) in length over its upper deck and 36 Amsterdam feet (10.19 m) in beam.[1] It was stipulated to be built with a height between the top of its keel and its lower deck of 12.5 Amsterdam feet (3.54 m), but then the shipwright, Rijcksen, changed this to 14 Amsterdam feet (3.94 m). This dimension plus the height between the lower and upper deck, which was 5.25 Amsterdam feet (1.49 m), make a total structural height of 19.25 Amsterdam feet (5.45 m).[2] *Batavia*'s hold had a significant depth.

According to Witsen the general rule of thumb of Dutch seventeenth–century ships should be one quarter of the ship's length for the beam and one tenth for the height.[3] This would tally to 160 feet (45.3 m) by 40 feet (11.32 m) by 16 feet (4.53 m) for *Batavia*, instead of 160 feet (45.3 m) by 36 feet (10.19 m) by 19.25 feet (5.45 m). The *Batavia* was thus more slender and deeper in comparison to ideal ship proportions.

In the early seventeenth century, the overall dimensions of VOC ships deviated from this so–called norm. The VOC shipbuilding charter of 1603 also lists a noteworthy depth for a 130–foot VOC ship. Although this ship is beamier with a breadth of 35 Amsterdam feet (9.9 m), and a length to beam ratio of 3.7:1, it is nearly as deep as *Batavia* with 13 Amsterdam feet (3.68 m) for its hold, and 5 Amsterdam feet (1.42 m) for the upper deck, which tallies to 18 feet (5.1 m, see Appendix A). Furthermore, the VOC shipbuilding charter of 1616 lists a 142–foot ship with a beam of 36 Amsterdam feet (10.19 m) and a total hold of 19.25 Amsterdam feet (5.45 m, see Appendix A). Its length to beam ratio is 3.9:1. The heights of both decks of this ship are the same as *Batavia*'s. These examples illustrate that the structural height VOC ships of the early seventeenth century was —by Dutch standards that is— actually quite high.

Furthermore, they also demonstrate that the length–to–beam ratio of large VOC ships increased steadily between 1603 and 1628 making the ships more slender.

**Bottom–based construction method**

As discussed in Chapter IV, *Batavia* was assembled in a bottom–based tradition, characteristic of early seventeenth–century Dutch shipbuilding. The bottom of a ship was assembled in a shell–based fashion and the planks were kept together with temporary wooden cleats, after which the floors were inserted. After the temporary cleats and their nails were removed, the nail holes were plugged with wooden pegs. The rows of nail plugs in the lowest preserved hull planking strakes have provided conclusive evidence for a bottom–based construction method. Although nail plugs have only been observed in *Batavia*'s planking up to preserved hull planking strake 10, it may be assumed that the ship's bottom was assembled up to strake 12. As mentioned in Chapter IV, nail plugs were found on the interior and exterior surfaces of the inner layer of hull planking and the exterior surface of the outer layer of hull planking. The nail plugs on the interior of the inner layer hull planking were from cleats that kept the planking together, whereas those on the exterior surface were from additional cleats that provided extra reinforcement and those that kept the wooden shores bracing the ship's hull during construction. Wooden shores continued to be used once the frames were inserted and the second layer of hull planking was applied, basically after the hull planking was stabilized. *Batavia*'s first, second, and third futtocks were not fastened to each other, further evidence that the hull was assembled in a bottom–based tradition.[4]

The concept of bottom–based construction is also demonstrated by the multilayered nature of *Batavia*'s planking which consists of five layers, excluding the frames. In this multi-layering, starting from outboard to inboard, is included one layer of pine sheathing, two layers of hull planking, one layer of ceiling planking, and one layer of inner floor planking to protect and reinforce the ceiling planking below the lower deck (Fig. IV.24). The frames merely functioned as an extra layer in between, providing lateral stiffening. The remarkable thickness of *Batavia*'s lower hull, with its multiple

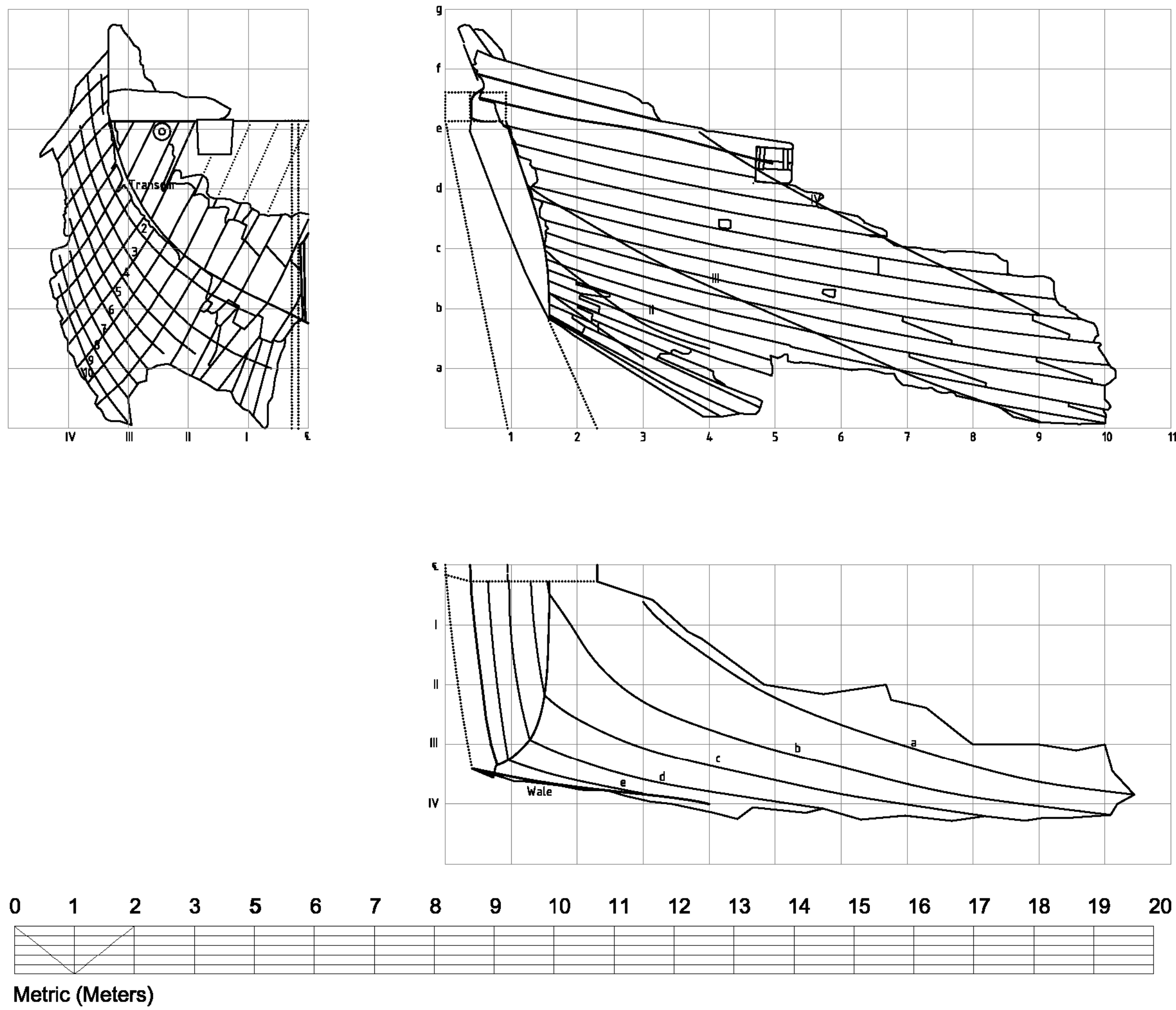


Fig. VIII.1 Lines plan of *Batavia*'s preserved hull section. The lines were taken off the exterior of the ship, and thus on the outside of the hull planking. Illustration: Cor Emke.

layers and high–quality oak timber used for planking, indicate that the skin was the starting point for creating a strong, durable, and water–tight vessel.

The bottom–based tradition is also demonstrated in *Batavia*'s construction by the discontinuity on the ship's side, where the shell–based bottom hull turns into the frame–based side (Fig. VIII.1). If reinforcement and design was obtained by the ship's frames, as in frame–based construction, and not by the bottom planking, such interruption would not be present as the ship's curvature would be faired more easily. This discontinuity was probably not the result of the change between the double–planked bottom to the single–planked side, for the outer layer of bottom planking was applied in the last stage of construction as discussed below after the curvature had already been created. In addition, *Batavia*'s lowest wale marks the change over between the two construction methods, and was the first timber above the bottom added in a plank–on–frame fashion. This wale is basically a thick plank and very difficult to bend in a shell–based construction. The shipwrights probably waited until the bottom was completed and the frames were installed to add the heavily wale as it can more easily be forced or bent into shape by pushing it onto the framing.

**Sternpost**

*Batavia*'s keel, stem, and sternpost would have been assembled first at the VOC shipyard of Amsterdam. The modest section of sternpost that has survived is the only fragment of the ship's central spine. Its sided dimension tapers from 0.42 m at its forward preserved face to 0.33 m at its after face, and its preserved molded dimension is 0.53 m. According to Witsen, the after end was 3/4 or 3/5 the size of the forward end, which is concomitant with *Batavia*'s sternpost, as 3/4 of 0.33 m is 0.44 m. *Batavia*'s sternpost may have been 0.02 m thicker at its forward end as the corners have been eroded, making a total of 0.44 m or roughly 16.5 Amsterdam thumbs at its forward face. This is, however, slightly thinner than the total 20 Amsterdam thumbs (0.51 m) and 18 Amsterdam thumbs (0.46 m) listed for inboard sided dimension in the construction charters for a 130–foot VOC ship in 1603 and 160–foot VOC ship in 1653, respectively. The 1603 charter adds that the sternpost tapers from fore to aft. The VOC shipbuilding charters of 1603 and 1653 list a total length of 27 to 28 Amsterdam feet (7.64 to 7.93 m) for the sternpost. From the waterline markings on *Batavia*'s sternpost one can calculate that 4.1 m is missing from the sternpost's lower end, whereas the upper edge of the wing transom marks the top of the sternpost. Taking these two factors and the angle of the sternpost into consideration, it is estimated that the linear or vertical height of the sternpost was 25.5 Amsterdam feet (7.2 m). The sided dimension of *Batavia*'s sternpost more or less corresponds with Witsen's suggestion that the thickness (sided) dimension of the sternpost had to be one thumb for every 10 feet of the ship's length. For *Batavia*, this would have been 16 Amsterdam thumbs.

The 1603 charter mentions that the angle of the sternpost should be one Amsterdam foot for every 7 Amsterdam feet in length. The sternpost here is listed to be 27 or 28 feet in length. This comes to an angle of 8 degrees to the vertical or 98 degrees to the keel (here and elsewhere in this paragraph the angle of the sternpost applies to the aftermost face of the sternpost). Witsen lists one foot for every four feet of length for the construction of the 134–foot *pinas*, the sternpost being 24.5 feet in length, which tallies to a rake of 104 degrees from the keel. He does say to use a rake of one foot for each six feet of sternpost length, and not to exceed this rule of thumb as it would be damaging. Witsen stressed that if the sternpost inclined too much, the stern assembly would lose its integrity. *Batavia*'s sternpost as displayed measures 107.5 degrees from the keel, which provides a slightly larger rake towards its after end. This angle is however not as steep as the angles provided for the construction of a ship in the English *Treatise on Shipbuilding* dating to the early 1620s. This treatise advices that the rake of the sternpost should: "never recline from the zenith more than an angle [of] 22 [degrees] no[r] less than 18 [degrees]…"[5] *Batavia*'s sternpost raked 17.5 degrees measured from the top of the vertical (corresponding to 107.5 degrees from the keel). It had quite a steep rake, which, according to the English treatise, would not have been considered sufficient. The sternpost rake of the Christianshavn B&W 2 shipwreck was close to that of *Batavia*, 103 degrees from the keel of the aftermost face.[6]

**Keel and transom assembly**

The keel of *Batavia* is not preserved, but probably had a double rabbet to accommodate the double layer of hull planking, as seen on the Scheurrak SOI, Christianshavn B&W 2, and *Mauritius* wrecks (Fig. IV.16).[7] Like the ship's sternpost, the keel was probably encased in a layer of oak cover planking and pine sheathing, and it probably had the same sided dimension, of 0.42 m (16.5 Amsterdam thumbs), as the sternpost's forward face.

After *Batavia*'s keel, stem, and sternpost were erected, the transom timbers were assembled including the lower fashion piece, transom beams, and wing transom. This assembly was fastened together with many iron bolts that reinforced the dovetail joints of the fashion piece at its after face in which the wing transom was seated, and the transom beams were slotted into the fashion piece's forward face. The upper fashion piece was added next, bolted to the forward face of the fashion piece over the highest transom beam, BAT 6358. It was erected before the hull planking was applied because the planks are nailed to it and it functioned as the terminus of the aftermost ends of the planking strakes. *Batavia*'s transom was located at a height of 3.8 m above the keel, slightly more than the 13 Amsterdam feet (3.68 m) stipulated in the 1603 VOC charter for a 130–foot ship (Fig. VIII.2). The molded and sided dimensions of the transom beams in the 1603 charter are listed as 11 Amsterdam thumbs by one Amsterdam foot (both 0.2831 m). *Batavia*'s transom beams have larger maximum dimensions, however, measuring 0.41 m sided and molded, which roughly corresponds to 1.5 Amsterdam feet. No height for the transom or dimensions for transom beams are provided in the 1653 VOC charter for the construction of a 160–foot ship. This charter does provide a length of 24 or 25 Amsterdam feet (6.79 m or 7.08 m) for the ship's wing transom, of which the latter correspond perfectly with *Batavia*'s original wing transom (Fig. VIII.2). Although its preserved dimension is only about 2.10 m in length, as reconstructed, the wing transom was 3.54 meter long on either side of the sternpost, making its overall length 7.08 m (25 Amsterdam feet).

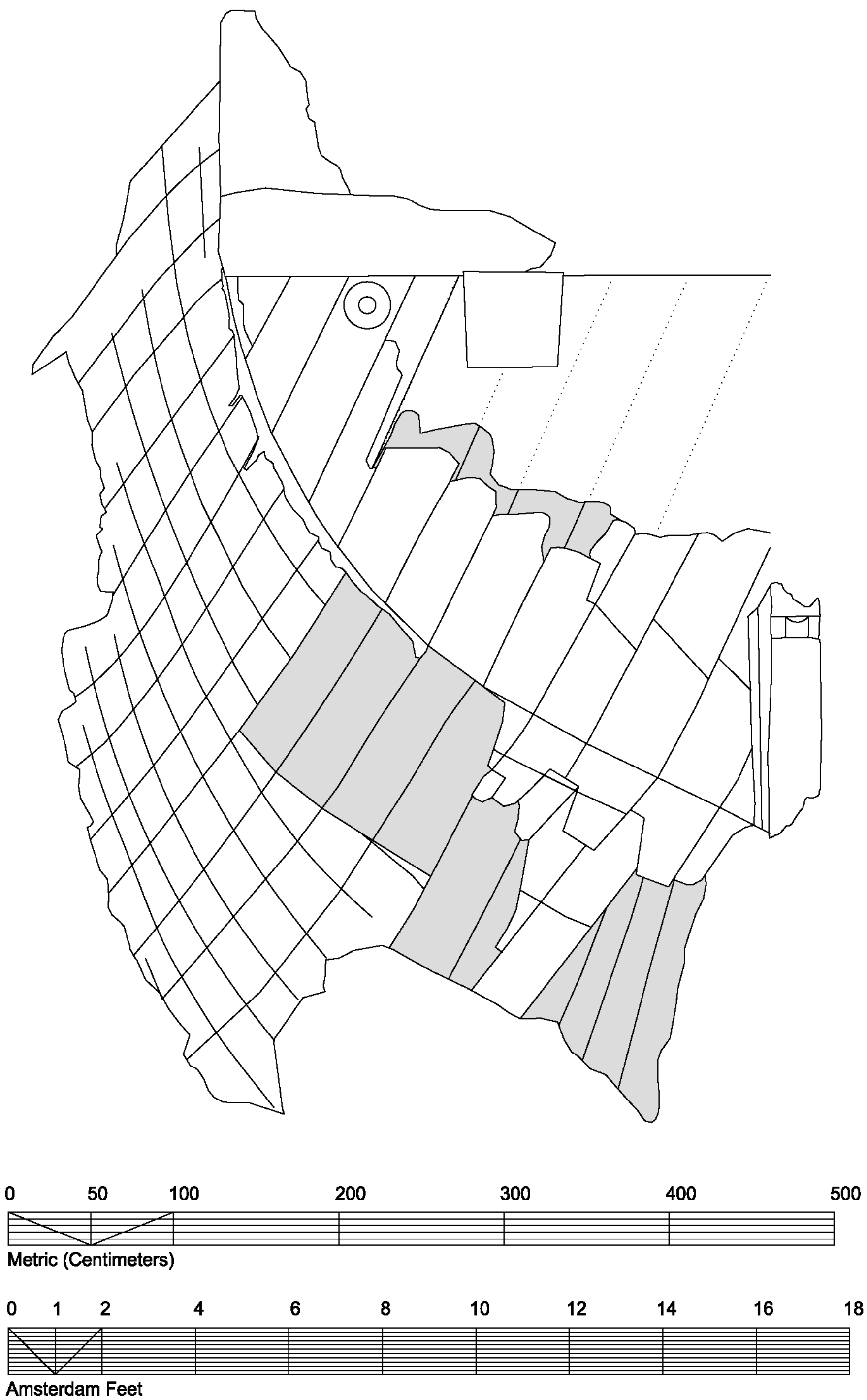


Fig. VIII.2 Preserved port side transom of *Batavia*, showing the ship's section lines of the body plan. Gray–colored planks represent inner layer of hull planking, where outer layer has eroded away. Illustration: Wendy van Duivenvoorde.

**Bottom hull strakes**

*Batavia*'s garboard strake and adjacent lowest planking strakes have not survived. On the port side, the remaining hull strakes from the ship's bottom include preserved strakes, numbered 1 to 12, extending from the flat bottom to above the turn of the bilge. The inner layer of hull planking was first assembled in a shell–based method up to strake 12. The plank ends of this layer were scarfed with flat scarfs that were not evenly spread over the ship's lower hull, as demonstrated by the concentration of seven flat scarfs in the forward end of the preserved section. According to the 1603 building charter for a large ship, the hull and ceiling were to be made of 'eastern' or oak planks that were one quarter of an Amsterdam foot (0.071 m) in thickness (Appendix A). It is also specifically mentioned that this thickness depended on the quality of the wood "being soundly flawless." The planking thickness recommended in the 1603 charter applied to the inner layer of hull planking, as the outer layer, for which no dimensions are listed, is only mentioned at the end of the charter (Appendix A). The 1653 charter for a 160–foot ship, lists 4 Amsterdam thumbs (0.103 m) for the planking thickness up to the first wale. This measurement also applies to the inner layer of planking. *Batavia*'s inner layer of hull planking correspond closer to the 1653 charter, as the preserved strakes have a maximum thickness of 0.090 m (3.5 Amsterdam thumbs).

**Floors and first futtocks**

After Rijcksen and the shipwrights working in the VOC shipyard of Amsterdam had assembled the inner layer of bottom planking, they reached a stage in *Batavia*'s construction where the bottom needed to be reinforced and stabilized before construction could proceed. When assembled by this method, the ship's bottom strakes still move and are flexible. Their rigidity and symmetry, therefore, was ensured by the installation of the floors and first futtocks.

*Batavia*'s floors and first futtocks were shaped and secured to the hull planks with treenails that were pegged at their exterior ends and most likely wedged at their interior ends also. It is not known whether *Batavia*'s floors and first futtocks were fixed in place first with a few iron spikes driven from the exterior planking prior to the insertion of the treenails, as seen, for example, on the Christianshavn B&W 5 shipwreck.[8] Such iron fasteners provided enough leverage for the floors to stay in place while being treenailed to the planking. Only one possible floor fragment and eleven heads of the first futtocks from *Batavia* have survived.

**Second futtocks**

The second futtocks were erected next and their heels, or lower halves, were fastened to the ship's bottom with treenails. Their heads or upper parts protruded above the ship's pre–assembled bottom. The ship was presumably constructed by first inserting a set of second futtocks at specific intervals (as known from Witsen, Ralåmb, or archaeological studies, such as that of the Christianshavn B&W 5 shipwreck).[9] These preset second futtocks were used to define the shape of the hull above the ship's bottom by affixing temporary ribbands or wales to their ends. After these base futtocks were erected and the temporary ribbands or wales added, the remaining second futtocks were installed.

As mentioned in Chapter IV, *Batavia*'s futtocks had an average sided dimension of 0.207 m (8 Amsterdam thumbs) and average molded dimension of 0.191 m (7.4 Amsterdam thumbs). According to the 1603 charter for a 130–foot long VOC ship, the futtocks up to the *scheergangen* (singular *scheergang*) should be eight thumbs sided and molded, whereas above the *scheergang* to the upper deck, seven thumbs, and up to the highest side of the hull, six thumbs, depending on the requirements of the ship (Appendix A). This *scheergang*, briefly discussed in Chapter II, should not be confused with the English term sheer plank or planksheer. In Dutch shipbuilding, it refers to a strake or temporary master ribband extending from the stem to the wing transom that was set up temporarily at the widest breadth of the hull to aid in constructing the ship. It defines the sheer of the first deck. Moreover, the placement of the deck beams, gunports, masts, and hatches would also be marked on the *scheerstrook*. This *scheerstrook* was re–used for the construction of similar ships with all the designated construction marks readily indicated.[10] In *Batavia*, the *scheergang* would have been situated near or at the third wale (strake 19). The sided and molded dimensions of *Batavia*'s lower futtocks up to the third wale do correspond to the 8 Amsterdam thumbs given in the 1603 charter. As only a few third futtocks have survived, it is not known whether the third futtocks or the futtocks higher up were of the slightly smaller dimension corresponding to 7 Amsterdam thumbs of the 1603 charter.

The 1603 charter also described that the ends of the first futtocks staggered 11 Amsterdam thumbs (equals one Amsterdam foot of 0.2831 m) and overlapped the floor heads and second futtock heels by 5 Amsterdam feet (1.416 m, Appendix A). It was noted in Chapter IV that *Batavia*'s futtock ends form an irregularly staggered band, which may be a result of the complicated curvatures and assembly in the stern section. Too few futtocks ends have, however, been preserved in the forward section to indicate a more consistently staggered pattern (Fig. VIII.3). *Batavia*'s frame ends overlap from 1.050 m (3.71 Amsterdam feet) to 1.807 m (6.38 Amsterdam foot), with an average of 1.34 m (4.7 Amsterdam feet). Its average overlapping dimension corresponds roughly to the 1603 VOC shipbuilding charter.

**Ceiling planking**

After *Batavia*'s second futtocks were installed, the ceiling planking was added to the bottom hull. This is similar to the construction sequence of the Scheurrak SOI and Christianshavn B&W 2 ships, where the ceiling planking was added after insertion of the frames, and was treenailed through frames into the inner layer of oak hull planking. Although *Batavia*'s preserved ceiling planks were nailed to the frames in the aftermost surviving section of the hull, the ceiling planks on the forward end of this section were treenailed to the planking and frames. Even though, ceiling planks have not survived on the forward section, the treenails used to fasten them to the hull are visible on hull planking and frames (Fig. IV.23, bottom right). These treenails were pegged on their exterior ends and possibly wedged on their interior, like the treenails used for securing external planks and frames together.

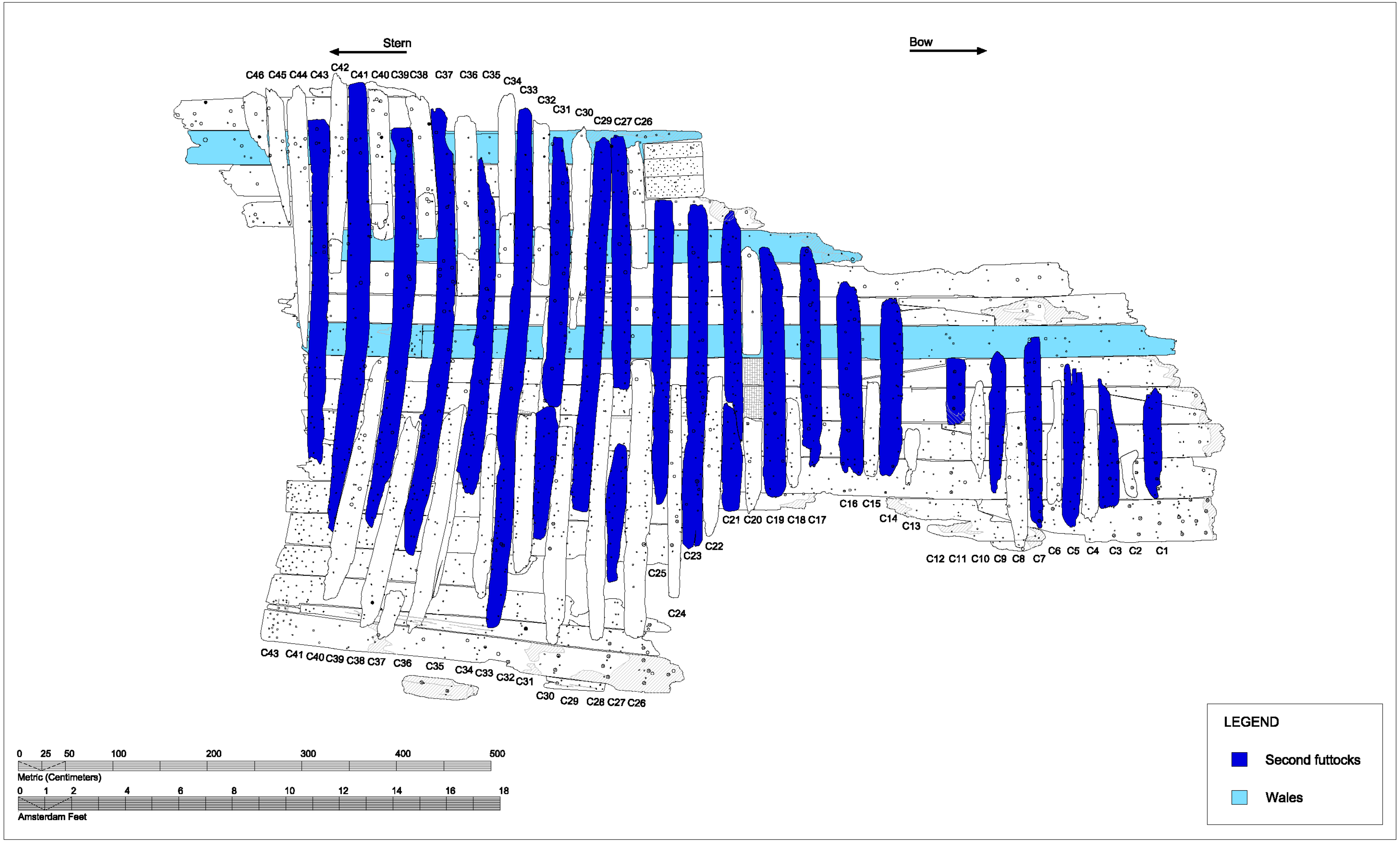


Fig. VIII.3 *Batavia*'s lower wales were fastened to the second futtocks with iron spikes. Illustration: Wendy van Duivenvoorde.

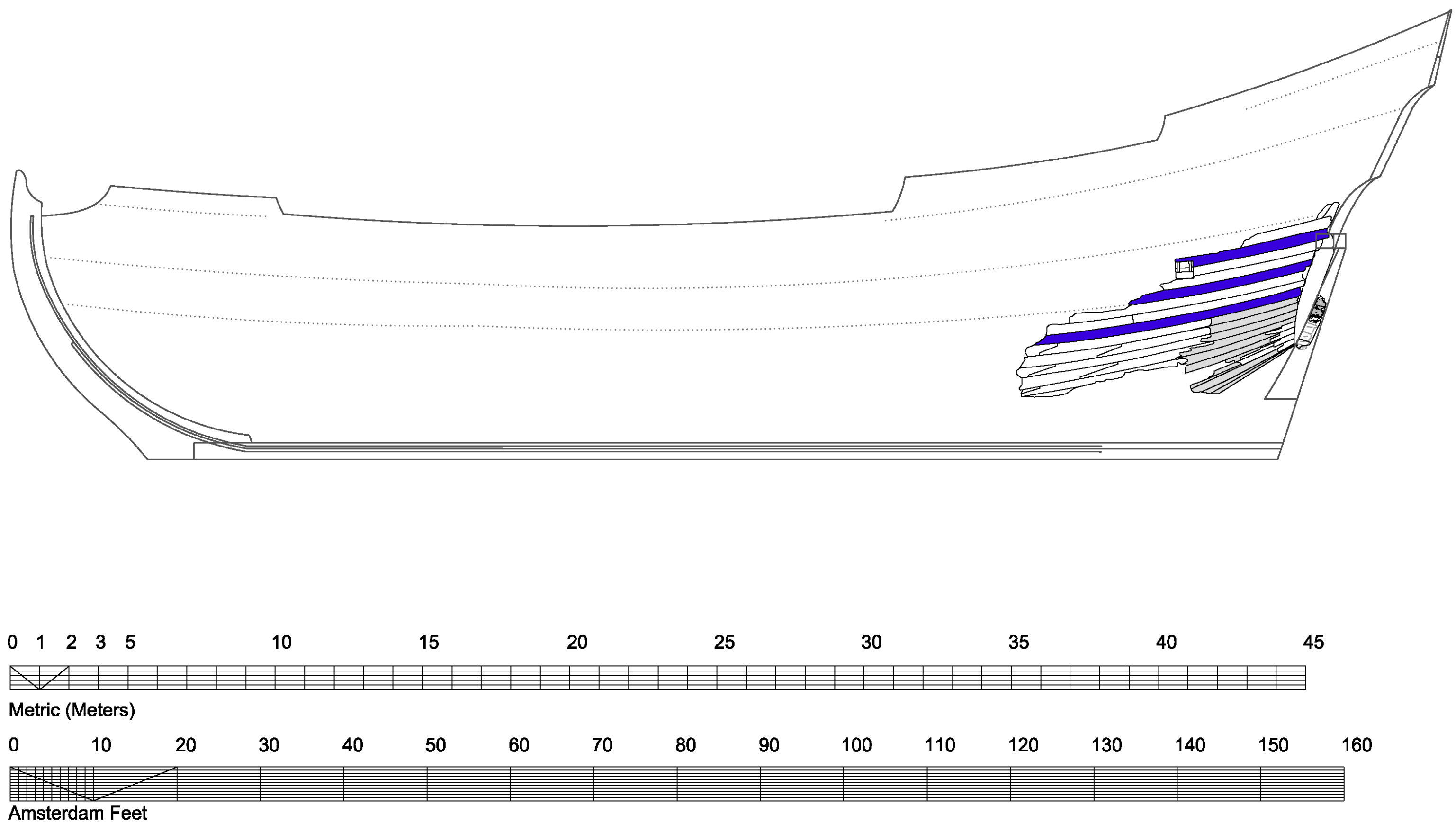


Fig. VIII.4 Preserved section of *Batavia*'s hull and reconstructed outline indicating its decks. The ship's wales are indicated in blue and inner layer of hull planking in light gray. Illustration: Wendy van Duivenvoorde.

The ceiling planking of *Batavia*'s bottom, up to its first wale (strake 13), varied in thickness from 0.060 m to 0.071 m, with an average of 0.064 m. This is in agreement with the thickness listed in the 1603 charter, which mentions one quarter of an Amsterdam foot for the ceiling planking (0.071 m), whereas no thickness seems to be provided for this in the 1653 charter (Appendix A). As discussed in Chapter IV, the ceiling planking above ceiling strake 7 is slightly thicker and varies in thickness from 0.080 m to 0.090 m, with an average of 0.087 m. Its thickness corresponds to that of the inner layer of hull planking of the ship's bottom. The ship's bottom ceiling planking was thinner than that of *Batavia*'s sides, but it did have an inner floor added to it with a maximum thickness 0.036 m (1.4 Amsterdam thumbs).

**Hull planking above the bottom: wales, filling strakes, and transom planking**

After *Batavia*'s bottom hull was assembled, the sides were finished with the plank–on–frame method. All preserved side strakes, from strake 13 up, were nailed onto the second futtocks, and the planking ends joined by vertical flat scarfs (Fig. IV.13). Strakes 13 to 21 of *Batavia*'s preserved port side include three wales (strakes 13, 16, and 19); each wale is separated by two filling strakes (Figs. VIII.3–VIII.4). These three wales are probably what were considered *spant berghouten* (or frame wales), which are essentially main wales or strakes of heavy planking on the side of the ship between the waterline and lower gundeck.[11] In the 1603 shipbuilding charter, the 130–foot ship was to be constructed with three frame wales of which the lowest two wales were to be fourteen Amsterdam thumbs wide (0.36 m) and their thickness had to correspond to two planks of the hull, whereas the third was supposed to be a foot (0.2831 m) wide and 4.5 Amsterdam thumbs (0.116 m) in thickness. The three wales of *Batavia* all measure 0.36 m in width. The lowest wale measures twice the thickness of the hull planking below and has a maximum thickness of 0.180 m (7 Amsterdam thumbs). The second wale may have had the same dimensions but its original thickness has not survived. The lower two wales, therefore, correspond to the 1603 VOC shipbuilding charter, but the third one does not. It is much wider than one Amsterdam foot (0.2831 m) and its thickness is much greater than the 4.5 Amsterdam thumbs called for in the charter. It measures

0.193 m (7.5 Amsterdam thumbs). Although *Batavia*'s third wale is placed at the lower gundeck over the surviving gunport, it can still be considered a frame wale as it was attached to the second futtocks, like the lower wales, and is associated with the lower gun deck level and not the upper deck (Fig. VIII.4). In the VOC shipbuilding charters specific dimensions are also given for the wales "above the gunports" and "other wale[s]." Strake 19 is technically placed "above the gunports" but it also forms the strake through which the gunports are cut. From this point of view, it is aligned with the gunports, only the wale above strake 19, which has not been preserved, can truly be considered the "wale above the gunports."

By 1653, the VOC charter for a 160–foot ship indicates that the three main wales have the same width (14 Amsterdam thumbs or 0.36 m) and thickness (7 Amsterdam thumbs or 0.18 m, Appendix A). This configuration is much closer to that of the *Batavia* than the dimensions provided in 1603.

The three frame wales, as listed in the VOC shipbuilding charters of the early–seventeenth century and seen on *Batavia*, are similar to the three wales below the level of the helm port characteristic for the flute ship (Chapter II).[12] The *Batavia* and VOC building charters suggest they were also characteristic for Dutch Indiamen of the early seventeenth century.

*Batavia*'s filling strakes 14, 15, 17, and 18 are situated in between *Batavia*'s frame wales and have an average thickness of 0.125 m. According to the 1603 and 1653 VOC shipbuilding charters, the lowest filling strake(s) should be 5 Amsterdam thumbs in thickness, which corresponds perfectly with *Batavia* (Appendix A).

The inner layer of transom planking could have been added at any point in the construction of the ship's hull, between the assembly of the ship's bottom to the application of the outer layer of hull planking. It is, however, likely that the transom was planked before or during the planking of the ship's sides, as supported by contemporaneous iconography (Fig. IV.92, left).

**Deck timbers**

After the ceiling planking was fastened onto the ship's sides, large transom knees were added to reinforce the transom assembly and the aftermost quarters of the hull. The decks were also assembled at this time. Not much of *Batavia*'s lower and upper decks have survived but the fragmentary deck elements demonstrate that they are similar in size to the dimensions provided by the VOC shipbuilding charters of 1603 and 1653, with the exception of the shelf clamps and waterways. According to both charters the shelf clamp of the lower deck should have been 0.142 m in thickness (half an Amsterdam foot or 5.5 Amsterdam thumbs), and the 1603 charter adds that it should be 2 Amsterdam feet (0.5662 m) wide at its narrowest point (Appendix A). *Batavia*'s preserved shelf clamp is much smaller both in thickness and width, measuring 0.428 m (1.5 Amsterdam feet) in width and 0.12 m (4.66 Amsterdam thumbs) in thickness. The same applies to the preserved waterway, which had a thickness of 0.107 m, whereas the 1603 and 1653 charters list thicknesses of 7 Amsterdam thumbs (0.18 m) and 5.5 Amsterdam thumbs (0.142 m), respectively.

The 1603 charter specifically mentions that ships had to have riders on the lower and upper deck for each deck beam, whereas 50 years later the number of riders had become less, one at every other deck beam. It is unknown at what interval *Batavia*'s riders were spaced and whether every other deck beam was accompanied by one. The interval between the riders can be observed from the bolt holes left behind in the frames and planking (frames C30, C27, C24, C23, C22, C17, C16, C14, C11, C7, and the foremost edge of the preserved hull), and the irregular room–and–space varies from 0.46 m to 1.73 m. It must be noted that too little of the hull remains to adequately understand their spacing and frequency, especially since the narrowing at the stern section of the ship may have required a diversion from the rider framing placement in comparison with the rest of the hull. Riders or rider frames consisted of a floor and a first futtock; the hanging deck knees were part of the rider frame assembly, as they basically functioned as second rider futtocks.[13] The preserved bolt holes found in *Batavia*'s hull remains support such a configuration.

The 1603 charter also mentions that all deck beams should be accompanied by knees that have a four–foot (1.13 m) overlap with the beam ends and ceiling planking. These knees could refer to both lodging and hanging knees. No mention is made for any such dimensions in the 1653 charter. *Batavia*'s decks knees are not well preserved where they overlap the deck beams, and the overlap of the two hanging knees with the ceiling planking is much larger. The two hanging knees recovered from *Batavia*, one to support the lower deck (BAT 6227) and the other for the upper deck (BAT 6130), are preserved to lengths of 1.52 m and 1.82 m, respectively (Fig. IV.24). This indicates that the hanging knee of the upper deck spanned almost the entire height between the two decks, which was higher aft due to the raised platform. *Batavia*'s preserved lodging knee separates the two deck beams by 1.31 m. This is also slightly larger than the distance of four feet from one deck beam to another in the ship's hold, as provided by the 1603 shipbuilding charter. Both the 1603 and 1653 charters mention a molded and sided dimension for the lower deck beams of 14 to 15 Amsterdam thumbs (0.36 m to 0.386 m), but *Batavia*'s two beams are not preserved well enough to make a good comparison.

As with the riders, the surviving lower deck pieces are too few and too poorly preserved to make a good comparison of dimensions, placement, and spacing in the charters, and the ship's narrow stern area may have required different dimension and assembly from the rest of the lower deck timbers. The only deck timbers that can be compared to the 1653 charter are the platform planks, which have a maximum preserved thickness of 0.075 m (3 Amsterdam thumbs). This dimension is a good match with the charter.

**Second layer of bottom planking**

Throughout *Batavia*'s hull, the outer layer of planking was nailed to the inner layer with iron spikes and the planking ends were scarfed together with flat scarfs. This outer layer had the same thickness as the inner layer and was added to the ship's bottom from its keel up to the first wale (strake 13). According to the 1603 shipbuilding charter for the construction of a 130–foot VOC ship, the vessel was covered with oaks planks after the hull was built up and the two full decks and quarterdeck were completed. The pegged treenails used to affix *Batavia*'s frames to the inner layer of planking, confirm that the second layer was attached to the inner layer of hull planking after the frames were inserted. In particular, the pegs on the ends of the inner planking treenails prove that the outer layer of hull planking was applied after the floors and futtocks of the bottom were already installed. Furthermore, *Batavia*'s rudder gudgeons must have been installed before the outer layer of planking was nailed to the hull, as the gudgeon ends were fastened to the inner layer of transom planking with iron spikes and were covered by the outer layer of transom planking (Chapter IV, 'Transom planking' section). The second layer of bottom hull planking was, thus, applied in the last stage of the ship's construction after the gudgeons were hung but before the ship was sheathed with pine boards and payed with hair and tar. After the outer layer of hull planking was added up to the first wale, the bottom hull had the same thickness as the first water line wale, which was then no longer distinct as a wale.

**Pine sheathing**

*Batavia*'s bottom hull was sheathed with a layer or two of pine sheathing. According to Witsen, a layer of "good" skin was added to ships sailing far away, which was fastened with numerous small nails. This skin was placed on top of a layer of cattle hair and sometimes a layer of copper or lead, which was all a measure to keep away the "vermin living off the wood."[14] Van IJk mentioned a 155–foot vessel (44 m) being built for the Indies with pine sheathing from the bottom to sides, below gunports and wales.[15] Elsewhere, he mentions that pine sheathing should be applied from the bottom to the sides, or above the waterline, and from the keel up to lower wale.[16] This technically corresponds with *Batavia* as the ship was certainly sheathed up to the second wale below the gunports. This second wale should be considered a 'lower wale' from the moment that the bottom hull had been double–planked. No traces of closely–set nail holes have been found on the exterior surface of *Batavia*'s planking on the strake above the second wale (strake 16). This is much lower than suggested in the 1603 VOC shipbuilding charter, in which it is mentioned that the hull should be sheathed with pine boards up to the underside of the quarterdeck wale (Appendix A).

## Conclusion

The dimensions of *Batavia*'s surviving timbers correspond closely to the dimensions provided in the VOC shipbuilding charter of 1653, except for the height of its sternpost. Although some of *Batavia*'s construction details and dimensions also correspond with the VOC shipbuilding charter of 1603, most proportions differ from this charter. This demonstrates that by 1628, when *Batavia* was built, the VOC shipwrights had moved away from constructional details as described in the earliest VOC shipbuilding charter of 1603.

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[1] National Archives (NA) of the Netherlands, The Hague*, Archieven van de Verenigde Oostindische Compagnie, 1602–1795*, reference code 1.04.02, item number 147 (Resoluties van de ordinaris en extraordinaris vergaderingen van de Heren XVII, 29 March 1626).

[2] National Archives (NA) of the Netherlands, The Hague*, Archieven van de Verenigde Oostindische Compagnie, 1602–1795*, reference code 1.04.02, item number 147 (Resoluties van de ordinaris en extraordinaris vergaderingen van de Heren XVII, 29 March 1626) and item number 7345 (Kopie–resoluties van de ordinaris en extraordinaris vergaderingen van de Heren XVII, Kamer Zeeland, 28 July 1628), point 8.

[3] Van IJk mentions the same length–to–beam ratio, but provides more information on the height of ships and the division of it. He explains that: "The height of the ship should be one quarter less than the beam, at the large *borstbalk* (at the upper bulwark), or said differently, where the ship is lowest. From this dimension, the depth is subtracted needed for the bulwark, which can be more or less depending on the type of ship. Then, the height of the deck below, for ships of war more than for merchant ships, but for both never more than 8 feet, leaving the remainder for the hold, that will not have enough integrity if too high, in which case beams or a *koebrug* can be added." Ab Hoving, letters to author, 13 and 29 April 2008; Witsen, *Architectura navalis et reginem nauticum*, 104–5; Van IJk, *De Nederlandsche scheeps–bouw–konst open gestelt*, 53.

In the early seventeenth century, the word *koebrugge* referred to the upper or weather deck. Later on, in the seventeenth century, *koebrugge* had become the term to designate the lowest continuing deck of the hull. Some two–decked ships in the seventeenth century, had a partial (temporary) floor also called *koebrugge,* situated between two decks, beneath the lowest gundeck, that was used as a storage place for sleeping gear and a sleeping area. This floor provided strengthening of the hull and made a ship heavier which subsequently caused it to have a deeper draft than a ship without a *koebrugge*. Then, *koebrugge* could also be the spar deck between the forecastle and quarterdeck of large men–of–war, which could be used as a fighting platform. Lastly, the *koebrugge* could a partial deck, four to five feet below the lower deck, in three–decked naval vessels, as was applied, for example, in the construction of 19 naval vessels between 1682 and 1721, see: Van Beylen, *Schepen van de Nederlanden, van de late middeleeuwen tot het einde van de 17e eeuw*, 39; and Van Dam, *Beschrijvinge van de Oostindische Compagnie*, 739. Van IJk has written that the word may derive from *koybrugge* which translates as cabin bridge, see: Van IJk, *De Nederlandsche scheeps–bouw–konst open gestelt*, 80, 85.

[4] Green, "The Planking–first Construction of the VOC Ship *Batavia,*" 70.

[5] Salisbury and Anderson, ed., *A Treatise on Shipbuilding and a Treatise on Rigging Written about 1620–1625*, 23.

[6] Lemée, *The Renaissance Shipwrecks from Christianshavn*, 202.

[7] Baker and Green, "Recording Techniques Used during the Excavation of the *Batavia*," 146.

[8] Lemée, *The Renaissance Shipwrecks from Christianshavn*, 174.

[9] Hoving and De Weerdt, *Nicolaes Witsens scheeps–bouw–konst open gestelt*, 102–3; Lemée, *The Renaissance Shipwrecks from Christianshavn*, 176; Åke C. Ralåmb, *Skeps Byggerij eller Adelig Øfnings Tionde Tom* (Malmö: A.B. Malmö Ljustrycksanstalt, 1943), fig. 9.

[10] Hoving and De Weerdt, *Nicolaes Witsens scheeps–bouw–konst open gestelt*, 102, 388; and Van Dam, *Beschrijvinge van de Oostindische Compagnie*, 746.

[11] Peter Goodwin, *The Construction and Fitting of the Sailing Man of War 1650–1850* (London: Conway Maritime Press, 1987), 53.

[12] Wegener Sleeswyk, *De Gouden Eeuw van het fluitschip,* 17–19.

[13] Hoving and De Weerdt, *Nicolaes Witsens scheeps–bouw–konst open gestelt*, 119.

[14] Witsen, *Architectura navalis et reginem nauticum*, 334.

[15] Van IJk, *De Nederlandsche scheeps–bouw–konst open gestelt*, 87.

[16] Van IJk mentions sheathing from the keel up to lower wales on another ship (page 289). Van IJk, *De Nederlandsche scheeps–bouw–konst open gestelt*, 91, 289. Van IJk mentions sheathing from the keel up to lower wales on another ship (page 289).

# CHAPTER IX
# CONCLUSIONS

*Batavia* was clearly the result of dynamic developments in the Dutch shipbuilding industry that occurred in the late sixteenth century. Like the flute for the Baltic trade, India ships and the smaller yachts were introduced for a special purpose, in this case the long–distance trade with Asia, a result of the country's socio–economic, technological, and political climates in the later sixteenth century. In the 1590s, when the Dutch started sailing to the far corners of the world, these new ship types had to be designed and constructed for the long–distance voyages to Asia and back.

Despite the relatively limited extent of *Batavia*'s hull available (about 3.5 %), this study provides a working hypothesis regarding the shape and construction of the vessel. The construction sequence and design of the ship generally matches the guidelines provided by Nicolaes Witsen, the early seventeenth–century VOC shipbuilding charters (in particular the charter of 1653), and the archeological remains of other, similar ships. Although many questions remain unanswered, *Batavia*'s timbers demonstrate typical Dutch shipbuilding practices of the late sixteenth and early seventeenth centuries and provide new information undisclosed prior to this study.

Iconography and historic sources, inform us that these fully rigged ships had physical features such as a flat transom, fore– and stern–castles, pine sheathing, a deck with gunports along the side of the hull, and heavy wales girdling the ships' sides to provide longitudinal and transverse strength. With the founding of the VOC in 1602, specific guidelines for its shipwrights were written down in so–called construction charters. These are important documents for the study of Dutch East India ships and yachts, as they demonstrate that the vessels were heavily constructed and had two full decks in the early seventeenth century. The charters were, however, basic instructions for the shipyards of the VOC Chambers and do not disclose the details that made Dutch India ships different from other merchant ships and what specific features were considered important on their long voyages to Asia.

Detailed information on VOC shipbuilding was not written down, probably to safeguard the secrets of the trade (as evidenced by the VOC's resistance to colonial shipbuilding and the export of Dutch shipbuilding knowledge). The overall dimensions provided by the VOC charters must have been sufficient for its shipwrights to know what proportional rules to apply, information that was evidently taught through apprenticeship and verbally passed on from generation to generation.

The overall dimensions of Dutch Indiamen and yachts provided in the VOC shipbuilding charters demonstrate that the ships were slender, with their length–to–beam ratio varying from 3.7:1 to 4.5:1 between 1603 and 1628. *Batavia* measured 160 Amsterdam feet (45.3 m) in length over its upper deck, 36 Amsterdam feet (10.19 m) in beam, and 14 Amsterdam feet (3.94 m) in height (Chapter IV). The vessel had a 4.4:1 length–to–beam and its hold had a significant depth. When compared to contemporary Dutch standards, the structural height of VOC ships was relatively high in the early seventeenth century.

*Batavia*'s hull remains indicate that the Dutch were not building their early Indiamen in a frame–based manner like other countries and assembled their ships with notably thick hulls when compared to later ships. This is consistent with the archaeological evidence for almost all shipwrecks discussed in this dissertation with the exception of VOC yacht *Avondster* (1656), which was a refitted English ship, most likely assembled using a frame–based construction method. The yacht of Willem Barents (1596), merchantman Scheurrak SOI (1590s), Dutch East Indiaman *Mauritius* (1609), VOC yacht *Vergulde Draak* (1656), Angra C ship (1620s), and Dutch–built Indiaman Christianshavn B&W 2 (1630) were all built according to the bottom–based construction method typical for northwestern continental Europe. This type of construction method entails the assembly of the keel, endposts, garboard strakes, and bottom planking, which are temporarily fastened with cleats before the framework of the hull is erected. It is likely that the VOC ship *Nassau* (1606) was constructed according to a bottom–based construction method, but not much information on this ship is available.

The remains of *Batavia* clearly demonstrate that the VOC shipwrights focused primarily on the ship's strength, waterproofing, and providing the utmost protection against teredo worms and marine organism. These three characteristics were added to the ship by creating a laminate–type hull consisting of five layers, excluding the frames. Most of the strength was provided by the two layers of oak hull planking, with additional strength added by one or two layers of pine sheathing, the ceiling planking, and the layer of cargo floor planking that protected and reinforced the ceiling planking below the lower deck. The frames had less focus and functioned as the layer that provided additional lateral stiffening. The unusual thickness of *Batavia*'s bottom hull built up with multi layers of high–quality oak timber indicate that the skin was the starting point for creating a strong, water–tight vessel.

The ship's bottom hull is remarkably thick as shown by the thicknesses, 0.18 m for the two layers of hull planking alone. These two layers added not only greater strength to *Batavia*'s hull but also provided extra waterproofing as their seams had a slight offset, like overlapping roof shingles.

Double–planked hulls seem to be unique to Dutch ships of exploration, as well as the Indiamen and yachts sailing to the Indies from 1595 to 1654. All wrecks of Dutch ships destined to sail long distances dating to this period, such as the yachts of Willem Barents (1596), *Nassau* (1606), and Dutch East Indiaman *Mauritius* (1609), indicate that they were built with a double layer of oak hull planking. Unlike the Dutch flute and other bulk cargo–carriers intended for use in European waters, the Indiamen were built much stronger than was believed to be the case by historians.

The hull remains of late sixteenth– and early seventeenth–century Dutch–built long–distance traders, with the exception of *Vergulde Draak* (1656), all have two layers of hull planking, each approximately of the same thickness. The use of double planking in certain types of Dutch–built ships was likely to have been directly influenced by the practice of lengthening ships, which occurred in the same period. Lengthened ships or *verlangers* were closely related to the development of the flute ship, but the term *verlanger* does not specifically refer to a type of ship but rather to the process of lengthening a vessel. It is known, for example, from the Christianshavn B&W 1 ship that an existing hull being lengthened could be strengthened by adding more planking to the ship's exterior and or by applying thicker ceiling planking. Lengthened vessels or *verlangers* were probably the first examples of Dutch merchant ships with two layers of hull planking. The primary reason for the extra planking was to longitudinally reinforce the hull.

Shipwrights who constructed Holland's first long–distance sailing vessels in 1595 probably followed the example of those building *verlangers* and built large merchantmen with a double layer of thick oak hull planking. Archaeological remains and VOC shipbuilding charters dating to the late sixteenth and early seventeenth centuries demonstrate that hull planking was thicker than called for in the late–seventeenth–century Dutch shipbuilding manuscripts of Witsen and Van IJk. Dutch builders faced with the need to build for voyages much longer and farther than anything they knew, opted to build much heavier ships at greater costs to meet the new challenges —essentially a conservative approach to protect cargoes, lives, and investments— whereas they were shifting to more inexpensive materials, building techniques, and outfitting costs for ships intended for local trades. As Dutch ships were still being built according to a bottom–based tradition in this period, dividing a thicker hull skin into two layers facilitated the bending of heavy oak planks and keeping them in place during construction. Two thinner layers of hull planking were probably stronger, too, than one very thick layer and more watertight. Double–hull planking is mentioned often in archival documents from the formative years of the VOC, 1602–22. Standard merchant ships were often purchased and put into service, particularly during the first years after the establishment of the VOC. If such ships were not originally provided with double planking, the Company believed it was necessary to fit them with an extra layer of oak planking for the voyage to the Indies.

In addition to double planking the hulls, the VOC often outfitted its ships with an additional layer of pine sheathing to protect the hull from the ravages of *teredo* worms. This pine sheathing was affixed to the outer layer of hull planking with iron nails, and the nails were closely spaced in order to create a layer of iron corrosion –rust– to provide additional protection for the hull against marine organisms. This became a standard worm–protection measure throughout the seventeenth and eighteenth centuries.

The archaeological remains of the VOC ships *Nassau*, *Mauritius*, *Batavia*, *Vergulde Draak*, and *Avondster*, and the Dutch–built Danish East Indiaman Christianshavn B&W 2 were all fitted with an additional layer of sacrificial planking or pine sheathing. *Batavia*'s hull was sheathed with pine planking with a maximum thickness of 0.040 m, up to at least its fifteenth preserved strake of hull planking. On the exterior surface of strake 14, the ship even had two layers of pine sheathing which were most likely applied to compensate for the 0.055 m loss of hull thickness above the turn of the bilge (between the ship's bottom and sides). The two layers of pine sheathing obscure the discontinuity in the ship's exterior surface.

In addition to pine sheathing, layers of goat hair were applied to *Batavia*'s hull with tar to all outboard surfaces of the hull planking (on both inner and outer layers), and some hair was also found on the outboard surfaces of the pine sheathing, to provide extra protection against teredo worms. Such a coating consisting of animal hair, tar, and sulphur, was typical for VOC ships. Lead sheathing was sometimes added between the hull planking and sheathing, as in the hull of *Nassau* and *Mauritius*. Lead use during the first few years of the VOC is revealed by several decrees dating between 1602 and 1606. After 1606, however, it became less and less common. Apparently, lead sheathing failed to provide the desired protection when the VOC was experimenting with multiple layers of hull planking and sacrificial sheathing in order to determine the most efficient hull protection for its East Indiamen. Or, equally, possible weight and maintenance problems drove it out of use.

Externally, *Batavia*'s hull was sheathed with pine boards held in place by closely–set iron filling nails, but the ship was also sheathed internally with a pine inner floor that was nailed to the ceiling planks over wooden laths. This floor extended over the ship's bottom up to the lower deck and had the same thickness as the pine sheathing on the ship's outside surfaces. This floor was probably to protect the ceiling planking from wear by shifting cargoes.

*Batavia*'s bottom hull consisted of layer upon layer upon layer, and even the modest remains of its sternpost demonstrate the application of multiple layers of reinforcement and protection. It was encased in one layer of oak cover planking, on top of which a layer of pine sheathing was nailed. Between these two layers a thin layer of copper sheets was applied, whereas the outboard surfaces of both layers were covered with hair and tar. Basically, every technique known or available on the shipyard was applied to the ship's sternpost, and presumably also its keel and stem, to protect it against teredo worms and against impact damage, thereby reducing the risk of injury to this vital element. The impact of galvanic corrosion caused by the iron nails of the protective planking and copper sheathing must have been problematic, despite the layers of goat hair in between. The graving pieces and other construction features, such as the attachment of the sternpost's gudgeon to the transom, also indicate that *Batavia*'s shipwrights were meticulous and skilled craftsmen who were very proficient in trying to make the vessel's assembly shipshape and sturdy.

Sometime after the 1650s, however, double hull planking was no longer employed in the construction of large merchantmen and warships, with the exception of whaling vessels. The *Vergulde Draak* (lost in 1656) may be the earliest example of a Dutch Indiaman from the seventeenth century with a single layer of oak hull planking.

The construction of large VOC ships, like *Batavia*, in a bottom–based construction method and with multiple layers of thick oak hull planking must have required vast quantities of high–quality timber. Based on dendrochronological and historic research, the import volume of Baltic timber, specifically from the Vistula region played an important role at VOC shipyards and those that were building ships for long–distance trade in the late sixteenth and early seventeenth centuries.

Looking at the excessive timber use in *Batavia*'s multiple–layered hull, it is easy to understand that this type of Dutch shipbuilding created a heavy demand upon the Baltic oak forests coupled with the enormous increase in the construction of large ocean–going vessels in the early seventeenth century. Ships built in this fashion required high–quality straight–grained oak with few growth defects or knots. Thus, the construction of ships with two layers of oak planking was expensive and likely depleted the Baltic oak forests, particularly those of the Vistula region, where the best quality oak seems to have come from.

The abandonment of two–layered oak planking in the construction of VOC ships (and other large merchant vessels) corresponds to the time when the bottom–based tradition was replaced with frame–based construction in most Dutch shipyards. When the frame–based method was adopted in the Netherlands in the late seventeenth century, planking thickness decreased significantly, reducing the need for high–quality straight oaks from the Baltic (Chapter VI). The *Vergulde Draak*, constructed with the bottom–based method but with much thinner hull planking than other VOC ships discussed in this thesis, may indicate the start of this trend towards single–layer planking. The discontinuation of double planking may as well have been directly related to the availability of large oaks for shipbuilding.

When frame–based construction became the basic principle of ship construction, compass timber began to play a much more important role at the VOC shipyards than straight–grained oak. As discussed in Chapter VII, large quantities of compass timber were imported into the Netherlands from Germany in the late seventeenth century, in particular from the Rhine and Wesel regions, as has been recorded by Witsen, Van IJk, Van Dam, and the account books of the Zaandam timber auctions. This conceptual change in shipbuilding philosophy in Dutch shipyards would also have changed the types of timber needed and caused a shift of Dutch import markets.

Recent dendrochronological study of Dutch and Flemish furniture and sculpture indicates that artists and artisans mainly used oak from the Baltic before 1600, whereas around 1660 a relative change occurred in the volume of the oak trade, with a shift from the Baltic region to south and central Germany. This trend most likely was a reflection of timber imports for shipbuilding.

Copper sheathing of the sternpost, as seen on *Nassau*, *Batavia*, *Vergulde Draak* and the Christianshavn B&W 2 ship, continued on VOC ships, as evidenced by the archaeological remains of the VOC ship *Buitenzorg* (880 tons), which was built at the Amsterdam shipyard in 1753. Archaeological evidence has shown that it was standard VOC practice to sheath the sternposts of its ships with copper sheets (fastened by copper sheathing tacks) throughout its entire existence. In the case of *Batavia*, the preserved sheathing on the sternpost consisted of one layer of copper sheets, whereas *Vergulde Draak*'s sternpost was covered with multiple layers of copper with a lead lining (discussed in Chapter V). No archaeological evidence has been found to date that demonstrates copper sheathing of the stem on any seventeenth– or eighteenth–century VOC ship.

The data from the shipwrecks discussed in this study is not abundant when trying to examine and understand Dutch shipbuilding techniques for large oceangoing ships intended to sail long distances. The modest surviving section of *Batavia*'s hull leaves many questions unanswered. No keel, keelson, stem assembly, floors, or master frames have survived. There is still more to learn from the wreck, for example, many fragments of *Batavia*'s rigging elements have been preserved and still await in–depth study.

VOC shipbuilding of the later seventeenth century is even more of an enigma because archaeological data from late seventeenth–century Dutch ships is virtually non–existent. This makes it hard to compare the archaeological data presented in this dissertation to VOC ships of a later period, to get a better understanding of the changes that occurred in the late seventeenth and early eighteenth centuries, and for the exact reason for the disappearance of double planking.

When analyzing *Batavia*'s constructional features with historical sources and archaeological data, it becomes evident that all Dutch *voorcompagnieën* and VOC ships had common traits. Nonetheless, a larger archaeological sample and in–depth analysis of shipbuilding documents, contracts, ship journals, and iconography is needed to get a clearer understanding of Dutch shipbuilding. In addition, parallel studies of English, French, and Iberian ships from this period would provide more defined characteristics of the shipbuilding techniques used to create similar ships for other European seafaring nations.

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# APPENDIX A

# VOC SHIP–CONSTRUCTION CHARTERS

**Introduction**

Translating excerpts from sixteenth– and seventeenth–century manuscripts on contemporaneous shipbuilding, written in Old Dutch, is a complicated task. The following translations of VOC shipbuilding charters must, therefore, be seen as a conjectural attempt, which undoubtedly will leave many questions unanswered.

Currently, these particular Dutch texts are difficult to understand, they do not provide clear answers to current research questions, and leave many unsolved problems. Interpreting Old Dutch terminology and style has proven to be challenging. Terms used in the charters can have more than one meaning, their meaning may have changed throughout time, and/or sometimes their denotation depends solely on the interpretation of contemporary scholars. Consequently, the English translation is even more vague and obscure. The charters translated below are literate translations, which merely reflect the interpretation of the author, and may only be of use to those interested in these important and little–known works, and those who do not possess sufficient mastery of the Dutch language.

**Ship–Construction Charters 1603**

[From: National Archives (NA) of the Netherlands, The Hague, *Archieven van de Verenigde Oostindische Compagnie, 1602 – 1795*, reference code 1.04.02, item number 99 RJ (Kopie–resoluties van de Heren XVII, 1602–1607), folio 63–67].[1]

In the original text a /–symbol indicates a pause in the text; these have been replaced occasionally with paragraph markers to space the text out. In the translation, they are deleted for clarity.

**Folio 63**

Charter resolved by the Gentlemen XVII on February 27, 1603, for the construction of ships of 600 tons, all measurements in Amsterdam feet and thumbs on the inside of the ship's hull and endposts.

Eerstelijk te besteeden een schip van 130 voeten / langh binnen de stevens
Primarily to apply for a ship of 130 feet / length within the endposts

Wijt binnen de huyt 35 voeten
Width within the hull 35 feet

Den overloop[2] geleyt op 13 voeten[3] / te meten op 16 voeten hols
The lower deck placed at 13 feet / measured on 16 feet deep

De koebrugghen[4] op 5 voeten
The upper deck at 5 feet

Dat deurgaende boevenet[5] op 6½ voeten / achter de mast soo hoogh datter kooyen
The continuing quarterdeck at 6½ feet, aft of the mast so high that the cabins

moghen staen met een open regeling ofte / rochgangh[6]
may be standing with open railing[7] or / caprail

Voor ende agter verheven plegten tot / besteeders will te weten 2½ voeten / agter en voor 3½ voeten daerop de / fortuyninge na eysch vant schip
Raised fore– and afterdecks,[8] after the investor's wish, 2½ feet aft and 3½ feet fore, above which to place the topside planking depending on the ship's requirements

Een goet gallioen met knies ende / regelingen wel besorght
A good beakhead well provided with knees and railings

Een vierkante gallerye puntigh / gemaeckt niet langh op de zyde
A square raking gallery, not made long on its side

De kiel sal breet sijn opt kruys 2 / voeten diep 20 duymen
The keel has to have a width of two feet and 20 thumbs deep on its cross[9]

De voorsteven 33 voeten hoogh ofte / datter de boeghspriet aengevestigt / wert hebbende omtrent 2 voeten / vallens boght na besteders will
The stem 33 feet high, so that the bowsprit will be attached, having about two feet drop [per foot] curvature, after the investor's wish[10]

De agtersteven 27 voeten hooghe / ofte 28 hebbende 7 voeten vallens/ behalve d'streeck die binnenkant / 20 duymen dick buyten toe gehouwen
The sternpost 27 feet in height or 28 having a seven–feet drop [per foot] except for the *streeck*,[11] whose inner face 20 thumbs thick, tapering towards the outside

Dat heck [balk] langh ofte wijt 16 voeten
That wing transom long or wide 16 feet

**Folio 64**
De spiegel geseth op 13 voeten hooch / wel besorgt met wulpen / vierkant elff duymen ende een voet / van een aen elcken ent een goet / knie insonderheyt aent heck [balck]
The [transom] stern placed at a height of 13 feet, well provided with transom beams, square 11 thumbs and a foot, on each end a good knee, especially against the wing transom

Twee knies over de wulpen ende / Langes scheeps
Two knees over the transom beams and alongships[12]

Een goet knie opden kiel aenden / steven / aen wedersyden van den knoop van de / voorsteven mede wel besorght
A good knee on the keel againt the endposts. On either side of the boxing[13] of the stem also well provided

Het vlack wijt 24 voeten op / 1½ voet rysens
The bottom of the hull 24 feet wide rising 1½ feet

Lenghen 't vlak 50[14] voeten lanck / te meten wijt in 't soch op / datter grof houdt om / laegh magh
*Lenghen* [hitch?] [at] the bottom 50 feet long, measuring wide in the hog[15] so heavy wood may go down

De twee eerste gangen drie / kimmen ganghen ende drie kimmen / wegers van swaere Oostersche / plancken
The first two strakes, three bilge strakes, and three bilge–ceiling strakes of heavy eastern[16] planks

De kimmganghen een / voet breet ende een planck dick / over d'ander in te komen De middelste / kimmeweger ½ voet dick om / ront aff te vlacken ende wel / inde kimmen aen te voegen
The bilge strakes one foot wide and a plank thick over one another coming into the centre bilge ceiling strake, half a foot thick, to smooth down roundly and fit flush into the bilges

Alle die gangen aen de streeck / binnengedreven
All those strakes driven onto the *streeck*

De buyckstucken op de kiel dick / 10 duymen ende inde kimmen oock / op de huyt wel aengevoeght / breet aght duymen
The floor timbers on the keel 10 thumbs in thickness and in the bilges inserted well, flush against the hull eight thumbs in width

De sitters elf duymen verschervende[17] / viercant houdt voorby den anderen / vyff voeten
The first futtocks eleven thumbs staggered, square timber beyond the others [floor timbers] five feet

De huyten wegers van Oostersche / plancken 4 uyt een voet behouwens / hout alle wel gaeff
The hull and ceiling of eastern planks four out of one foot, subject to all wood being soundly flawless

**Folio 65**
De balckwegers van overloop en koebrugghe / ½ voet dick, 2 voeten breet opt smalste endt / de boven kandt vande eerste weger daeraen / even dick beneden op 4 uyt een voet draems wijs
The shelf clamps of the lower and upper deck ½ a foot thick, 2 feet wide on their narrowest, the topside of the first ceiling [strake] above them equal in thickness [than the ones] below to four out of one foot *dreams wijs*[18]

De oplangen tot de scheergangen 8 duymen / dick breet 8 duymen en van de scheergangh / tot de koebrugge 7 duymen ende tot dat hoogste / boort 6 duymen breet nade eysch van ‘t schip
The futtocks up to the *scheergangen*[19] 8 thumbs thick, 8 thumbs wide, and from the *scheergang* to the upper deck 7 thumbs, and up to the highest side of the hull six thumbs wide depending on the requirements of the ship

‘t Schip boven aen elcke syde 3½ voet ingehaelt / tot besteders believen
The ship above on each side 3½ feet tumblehome after the investor’s wishes

De balcken vier voeten van den anderen in ‘t ruym / 15 duymen viercant opt smalste een voet / boths
The [deck] beams four feet from one another in the hold, 15 thumbs square on the narrowest [end] camber one foot

De koebrugge 14[20] duymen viercant, 8 duymen / boths
The upper deck [beams] 14 thumbs square, 8 thumbs tapered

Alle balcken wel met knies versorgt met / vier voeten misslaghs aen de balcken ende de / kimmen voort vant een waterboort / tot ‘t ander met een borst van twee / duymen onder de balcken / Nogh een klos onder de balcken als een carbeel
All [deck] beams well provided with knees having a four–feet overlap with the beams and bilges, forth from one waterway to another with a shoulder of two thumbs below the beams, as well as chock below the beams as a bracket [?]

Elk balk een spant stuyvens en katte / spoor loopende van beneden tot dat / waterboort vant boevenet ende aen elcke / balck 3 hoogh met een borst onder / 't waterboort dat wat stuyners / agter de dael sijn sullen oplopen tot / dat hoogste boort alle viercant tien duymen
[For] Each beam a rib, support [rider futtock] and a rider frame running from below, to the waterway of the quarterdeck, and to each beam 3 high, with a shoulder below the waterway so that the supports aft of the dale[21] run up to the highest side of the hull, all square 10 thumbs

Een kolsum breed 2 voeten diep een voet
A keelson two feet wide, one foot deep

**Folio 66**
De lijfhouten van den overloop ende koebrugge / dick 7 ende 6½ duymen breet
The waterways of the lower deck and upper deck 7 thick and 6½ thumbs wide

2 voeten op / 't smalste ent om die stuyners[22] gestreken met keepen / van drie duymen ende in de balcken / gesoncken daaragter gevolt met / klossen aen boort 4 duymen hoogh
2 feet on the smallest end scarved to the supports [rider futtock] with nothes of three thumbs and set in the beams aft of which filled with spacers [or chocks] against the side of the hull 4 thumbs high

Een geschulpte planck op sijn kant / voor de stuyvers ende klossen op den overloop gevoegt / daer 't langs wateren sal door een pijp
A notched plank on its side for[e of] the supports [rider futtock] and the spacers [or chocks] fayed on the lower deck, along which the water is drained through a pipe

Tusschen elcke balck drie / ribben 4 duymen viercant ende / die inde scheerstock ende lijfhouten / gelaten met een viercant / borst een duym diep ende een / lip daerbuyten soo in den overloop als koebrugge
Between each [deck] beam three ledges 4 thumbs square and inserted in the binding strakes and the waterways with a square shoulder, one thumb deep and a *lip* on the outside, as well in the lower and upper deck

Den overloop en koebrugge digt / gestreecken met droge eecken / Oostersche plancken alsoock / de plegten
The lower and main deck covered with dry oak eastern planks also the [fore and after] decks

Van den overloop tot dat boevenet / digt gestreecken met wagers op den anderen
From the lower upto the quarterdeck sealed with ceiling planks on one another

Twintigh of 24 poorten tot besteders will
Twenty or 24 [gun]ports after the investor's wish

Voor en agter een slemphout[23] van / beneden tot de cluysen ende agter tot dat heck
Fore and aft a deadwood from below up to the hawse holes and the aft upto the counter

Voor een goet fockespoor met / agt banden[24] 4 beneden 2 opden / overloop en 2 op de koebrugge / wel langh ende vast
Fore a good maststep with eight breast hooks [or riders] 4 below, 2 at the lower deck, and 2 at the upper deck long enough and fixed

Op de koebrugge verheeven schaerstocken / om de luycken ende daer beneven / drie paar knies van boort ende waterboort / tot verheven scheerstocken vant / boevenet
On the upper deck raised binding strakes at the hatches and, in addition, three pairs of knees [running] from the hull and the waterway upto the raised binding strakes of the quarterdeck

**Folio 67**
Drie spant berckhouten d'onderste / twee veerthien[25] duymen breedt dick 2 plancken / van de huyt dat derde een voet breet dick / 4½ duymen
Three frame wales, the lowest two fourteen thumbs wide, thick 2 planks of the hull, the third a foot wide, thick 4½ thumbs

Een raehout en regelingh inde huyt
A plankscheer and railing in the hull

Dat boevenet met de pleghten mede / eecken[26] waterboorden ende met goede Pruysche / deelen[27] digt gestreken tot de luycken de luycken / met tralien
That quarterdeck and the decks [smaller decks and platforms], also oak the waterways, and covered with good Prussian planks up to the hatches, the hatches with grating

Een voet hoger geschandeckt[28] met een / voet planks open regelinghs ende een / styve bosbanck van drie voeten ofte wat / meer voorscheen[29] te hebben ende verheven / scheerstocken
A foot higher spirketted with a foot planks, open railings, and a stiff pin rail of three feet or more to have bulwarked, and raised binding strakes

Een spilbetingh cruyshouten knegts / eecken vischien[30] om masten en spil bosbanck[31] ende / schiltbancken[32] clampen ende voort al wat / byll en boort eischt oock hier niet / gespecificeert staet
A capstan, kevels [also riding bitts], knightheads, oak partners around the masts and capstain, pin rail and windlass bitts, cleats, and everything else that *beam and board*[33] require, even if not specified here.

Twee kooyuyten / de bovenste soo laegh als ‘t vallen mach / ‘t schip verdreven herdeuttelt[34] versogt
Two cabins, the upper one as low as it may fall, the ship driven [caulked], dottled *versogt* [versorgt? verzocht? versagt? provided?]

Den overloop koebrugge ende boevenet wel / gedreven geteert ende gesmeert de masten gespoort
The lower deck, upper deck, and quarterdeck, well caulked, tarred and greased, the masts stepped

Daerna met des besteders loot ende haer / bekleet daerop met Oostersche plancken / verdubbelt tot d’onderkant vant / boevenets barckhout wederomme / gedreven ende geteert binnen ende buyten
After which sheathed with lead provided by the commissioner and hair covered with eastern planks [and] doubled up to the underside of the quarterdeck wale, again caulked and tarred inside and outside

[From: National Archives (NA) of the Netherlands, The Hague, *Archieven van de Verenigde Oostindische Compagnie, 1602 – 1795*, reference code 1.04.02, item number 99 RJ, folio 68]. February 1603.

**Folio 68**
Certer vande Jachten groot elck omtrent 80 lasten[35]
Charter of yachts each with a size of about 160 tons

Eerstelick langh binnen steven 96 voeten
First, length between the endposts 96 feet

| | |
|---|---|
| Wy | 25 voeten |
| Wide | 25 feet |
| | |
| Holl de overloop | 10 voeten |
| Height of the lower deck | 10 feet |
| | |
| De koebrugghe | 4 voeten |
| The upper deck | 4 feet |
| | |
| Achter een vast boevenet | 6 voeten |
| Aft a fixed quarterdeck | 6 feet |
| | |
| De achterplecht verheven | 2½ voeten |
| The afterdeck raised | 2½ feet |

| | |
|---|---|
| De voorplecht verheven | 2 voeten |
| The foredeck raised | 2 feet |
| Int heck langh | 11 voeten |
| The wing transom long | 11 feet |
| De Spiegel geset op | 10 voeten |
| The [transom] stern placed at | 10 feet |

De luycken soo wyt ende lanck als se vallen moghen om de sloep er beneden te strycken ende met tralies onder de dichte luycken om die bij goet weer altyt open te laeten staen
The hatches wide and long enough to lower a sloop through them and with grating underneath the sealed hatch covers in order to leave them open at all times in good weather

De bosschieters kamer soo hooch als die vallen mach om de slach vant cruyt te verminderen
The gunner's chamber high enough as it may fall to diminish the impact of the gunpowder

Achter t boevent wulft een galderytgen
Aft of the quarterdeck vaults a gallery

**Ship–Construction Charters 1614**

[From: National Archives (NA) of the Netherlands, The Hague, *Archieven van de Verenigde Oostindische Compagnie, 1602 – 1795*, reference code 1.04.02, item number 100, folio 271, point XIIII]. Kopie–resoluties van de Heren XVII, 9–20 September 1614.

Is verstaen dat voortaen de cameren der welcker beurte sal wesen eenige nieuwe schepen te timmeren de selve sullen doen maecken op een vande naervolgende Chartres tot keure vande geene die timmeren sal, maer niet grooter nochte buijten deselve Chartres.
Is understood that henceforth the Chambers, that are up for the construction of several new ships, shall construct following their own preferences, but not larger or outside this charter.

Te weten van eenhondert ende vijftich voeten lanck drijendertich voeten wijt ende derthien voeten hol oft diep met een Coebrugge van vijff voet ende een boevenedt daerboven van ses ende drij quart.
Namely of 150 feet in length, 33 feet in beam, and 13 feet in hold or depth, with an upper deck of 5 feet, and a quarterdeck of 6¾.

D'ander Charter van hondert (138) achtendertich voeten lanck, sesendertich voeten wijt, veerthien voeten hol, met een Coebrugge van vijff ende een halff voet, ende daer en boven een boevenedt van ses ende drijquaert voeten alles in Amsterdamsche maete, ofte daertegens gereduceert maeckende alsoo elck een schip van drijhondert lasten.
Another charter of 138 feet in length, 36 feet in beam, and 14 feet in depth, with an upper deck of 5½ feet, and a quarterdeck of 6¾ feet, all done with or converted to the Amsterdam feet, making each a ship of 600 tons accordingly.

Den minder soorte ofte Charter sal wesen van hondert ende dertich voeten lanck, sessentwintich voeten wijt ende twaelff hol met een boevenet van ses ende een halff voet. Ofte hondert en veertich voeten lanck, vier ende twintich voeten wijt, twaelff hol ende een boevenet van ses ende een halff voet tot een proeve maeckende naer gissinghe elcx een schip van hondert vijftich last.
The lesser type of charter shall be 138 feet in length, 26 feet in beam, and 12 in depth, with a quarterdeck of 6½ feet to, hereby, testing the approximation to make each ship 300 tons.

**Ship–Construction Charters 1616**

[From: National Archives (NA) of the Netherlands, The Hague, *Archieven van de Verenigde Oostindische Compagnie, 1602 – 1795*, reference code 1.04.02, item number 100, folio 329, no. 20]. Kopie–resoluties van de Heren XVII, 24 October 1616.[36]

De chartres vande schepen hier naer voorde Comp. te timmeren sijn gearresteert in voegen ende manieren als volcht
The charters of the ships after which to build for the Company according the following requirements and methods

De groote scheepen van 142 voet over steven
The large ships of 142 feet across the endposts

36 voet wijt binnen de huyt
36 feet wide on the inside of the hull planking

14 voet diep onder[37] den overloop
14 feet deep below the lower deck

5¼ voet tot de coebrughe
5¼ feet up to the upper deck

7 voeten tot het boevenet daargaende aen boort
7 feet to the quarterdeck continuing onto the hull

De mindere schepen ofte jachten sullen wesen van 130 voet lanck over stevens
The lesser ships or yachts should be 130 feet between the endposts

32 voet binnen de huyt
32 feet width on the inside of the hull

12 voet hol off diep onder de overloop
12 feet high or deep below the lower deck

5 voeten tot aen de coebrugge
5 feet upto the upper deck

6½ voet tot de boevenet doorgaende aen boort
6½ feet up to the quarterdeck continuing onto the hull

Alles op Amsterdamsche mate off daertegens gereduceert ende op dat de voors. chartres niet en werden geexcedeert is geresolveert dat de twee naest gelegen camers vande gene die timmeren sullen twee uijt den haren sullen committeren, omme 't nieuwe hol getimmert sijnde, perfectelijck te meten ende meerder als de voors. chartres bevindende sal 't selve schip blijven tot laste, coste ende schade vande Bewinthebbers in haer particulier die de voors. chartres geexcedeert ende eenige schepen in lengde, wijde ofte diepte grooter dan als voren sullen getimmert hebben alles in conformite vande resolutie dies aengaende ter laester vergaderinge genomen.

All done with or converted to the Amsterdam feet and so the previous charters will not be exceeded, is resolved that the two adjacent Chambers will take care of constructing two of those from theirs, to be build with the new height, to be measured perfectly, and, more so than with the previous charters, it shall be the same ship in tonnage, cost, and compensation of their respective administrators, who exceeded the previous charters and have built several ships in length, width, or depth greater than before, all conform to the decision considering these made in the last meeting.

**Ship–Construction Charters 1653**

[From: National Archives (NA) of the Netherlands, The Hague, *Archieven van de Verenigde Oostindische Compagnie, 1602 – 1795*, reference code 1.04.02, item number 103, folio 228–233]. Resoluties van de Heren XVII, 24 May 1653.[38]

(Rapport vande Gecommitteerdens wegen de charters)
(Report of the Delegates regarding the charters)

Gehoort het rapport vand'Hrn. op eergisteren gecommitteert omme mette scheepstimmerlieden vande respective Cameren te besoignieren over de Carters daer op de schepen vande Compagnie soo groote als kleijne nae desen sullen werden getimmert. is nae deliberatie goet gevonden ende verstaen der selver gebesoigneert te approberen ende dienvolgende 't selve hier onder te doen insereren met dien verstande dat de respective Cameren haer nae desen int timmeren van haer schepen nae d'onder gestelte Charters preciselijck sullen moeten reguleren.

Taking into account the report of the Gentlemen delegated the day before yesterday to commit, with the carpenters of the respective Chambers, to the Carters after which to build the large and small ships of the Company. After consultation is approved and recognized to approve this commitment and consequently insert it below with the understanding that the respective Chambers will have to regulate the following these [Charters] precisely as specified below and construct their ships accordingly.

*Charter van een Retourschip*
*Charter of a Return ship [or Homeward–bounder]*

Dat een retourschip sal wesen langh over steven 160 voet,
That a return ship will be long across the endposts 160 feet,

wijt 38 voeth,
wide 38 feet,

hol 13 voet,
high 13 feet,

sonder 'tselve te mogen excederen.
Without allowing this to be exceeded.

De koebrugge 5 voet,
The upper deck 5 feet,

't boevenet hoogh 7¼ voet,
The quarterdeck high 7¼ feet

dat het schip sal incomen aen ijder vanden schut overloop aff tot op de hoochte van het boeveneth toe 2½ a 3 voeth.
that the ship will have a tumblehome on either side from the lower gun deck onwards upto the height of the quarterdeck 2½ to 3 feet.

(Dickte en swaerte vant hout)
(Thickness and dimensions of timber)

De kiel sal wesen langh 130 voeth, voor dick 2 voeth;
The keel shall be long 130 feet, for thickness 2 feet;

de voorsteven hoogh 30 voet, dick 17 a 18 duijm;
the stem high 30 feet, thick 17 to 18 thumbs;

de achtersteven 27 a 28 voeth, dick 18 duijm;
the sternpost 27 to 28 feet, thick 18 thumbs;

de heckbalcken langh 24 a 25 voet;
the wing transoms long 24 to 25 feet;

de buijck stucken 4 voet, dick 12 a 13 duijm;
the floor timbers 4 feet, thick 12 to 13 thumbs;

de sitters int hart vande kimmingh 10 a 11 duijm,
the first futtocks in the heart of the bilges 10 to 11 thumbs,

op boeijsel dick 9 duijm, op de scheergangh 7½ duijm;
on the board thick 9 thumbs, on the *scheergangh*[39] 7½ thumbs;

kolsingh dick 10 a 11 duijm, breet 2¾ voet;
keelson thick 10 to 11 thumbs, wide 2¾ feet;

twee wegers neffens kolsingh ijder dick 5½ duijm;
two ceiling strakes next to keelson each 5½ thumbs thick;

2 kimwegers off 3;
two bilge strakes or 3;

de bantwegers[40] en ganghboorden dick 5½ duijm;
the shelf clamps and gangways 5½ thumbs;

de overlopers balcken 14 a 15 duijm;
the lower deck’s beams 14 to 15 thumbs;

de deckbalcken dick 11 duijm;
the [upper] deck beams thick 11 thumbs;

de driespant barchouten[41] 7 duijm dick, breet 14 duijm;
the three main wales 7 thumbs thick, wide 14 thumbs;

de onderste vollingh dick 5 duijm;
the lowest filling strake[s][42] thick 5 thumbs;

’t barchout boven de poorten breet 13 duijm, dick 6½ duijm;
the wale above the [gun]ports wide 13 thumbs, thick 6½ thumbs;

het ander barchout breet 12 duijm, dick 6 duijm;
the other wale wide 12 thumbs, thick 6 thumbs;

’t reehout breet 10, dick 5 duijm;
the planksheer wide 10, thick 5 thumbs;
d’huijt vant schip tot aent barckhout toe dick 4 duijm;
the hull of the ship upto the wale thick 4 thumbs;

de plancken inde breegangh[43] 3½ duijm dick, boven dick 3 a 2 ½ duijm;
the planks of the *breegangh* [strakes of hull planking between gunports] 3½ thumbs thick, above 3 to 2½ thumbs;

de plancken vande schut overloop dick 3 duijm;
the planking of the lower gun deck thick 3 thumbs;

de koebrugge van goede deelen[44] van 2 a 2½ duijm;
the upper deck of good boards [pine planks] of 2 to 2½ thumbs;

de deelen vant boevenet dick 2 duijm;
the boards [pine planks] of the quarterdeck thick 2 thumbs;

om de andre balck een steunder langh tot de knie toe vant boevenet aff de steunders in elcken gangh een off twee bouts nae sij breet sijn inde nebbe[45] vande onderste knie 5 a 6 bouten;
at every other beam a rider long up to the knee, from the quarterdeck down, the riders in each strake one or two bolts depending on its width, in the head [or beam arm] from the lowest [standing] knee 5 to 6 bolts;

de boevenets knies inde nebbe 4 bouts, het grote gat dick 1 duijm daer het ijser nae geront wort, het tweede gadt ¾ duijm dick.
the quarterdeck [standing] knees in the head [or beam arm] 4 bolts, the large hole 1 thumb thick after which the iron is rounded, the second hole ¾ of a thumb thick.

*Charter van een groot Oorlogsjacht*
*Charter of a large war–yacht*

Dat een jacht om ten Oorlogh te gebruijcken sal wesen
That a yacht to be used during war shall be

langh over steven 134 voeten,
long over its endposts 134 feet,

wijt 33 voeten,
wide 33 feet,

hol 13½ voet,
high 13½ feet,

het verdeck hoogh 7½ voet,
the upper [or main]deck high 7½ feet,

de bovenkant vant reehout 4 voet hol verbonden,
the topside of the planksheer attached 4 feet high,

d'incomen van het schip op de hoochte van het verdeck 2½ voet aen ijder sij.
the tumblehome of the ship at the height of upper deck 2½ feet on either side.

(Dicte en swaerte vant hout)
(Thickness and dimensions of timber)

De kiel sal wesen dick 18 duijm vierkant,
The keel shall be thick 18 thumbs square,

de voorsteven dick 15 duijm,
the stem 15 thumbs thick,

achtersteven van gelijcken,
the sternpost equally so,

de voorsteven hoogh 24 voet,
the stem high 24 feet,

de achtersteven 23 a 23½ voet,
the sternpost 23 to 23½ feet,

de heckbalck langh 21 a 22 voet,
the wing transom long 21 to 22 feet,

de buijckstucken 11 duijm;
the floor timbers 11 thumbs;

de sitters int hart vande kimmen 9½ duijm,
the first futtocks in the heart of the bilges 9½ thumbs,

op boeijsel dick 7½ a 8 duijm,
on the board thick 7½ a 8  thumbs,

op de scheergangh dick 6½ duijm,
on the *scheergangh*[46] thick 6½ thumbs,

boven op de dolboom[47] 4½ duijm;
on top of the gunwale 4½  thumbst;

kolssingh dick 9 duijm,
keelson thick 9 thumbs,
breet 2½ voeth;
wide 2½ feet;

wegers 2 neffens kolssingh ijder dick 5 duijm;
ceiling strakes 2 on each side the keelson each thick 5 thumbs;

de twee kimwegers ijder 5 duijm dick;
the two bilge ceiling strake each 5 thumbs thick;

bantwegers en ganghboorden dick 5 duijm;
the shelf clamps and gangways thick 5 thumbs;

overloopsbalcken 13 a 14 duijm dick;
lower deck beams 13 to 14 thumbs thick;

deckbalcken 10 a 11 duijm;
deck beams 10 to 11 thumbs;

2 span barckhouten 6½ duijm,
2 timber wales 6½ thumbs,

breet 13 a 14 duijm;
wide 13 to 14 thumbs;

’t barckhout boven de poorten dick 6 duijm, breet 12 duijm;
the wale above the [gun]ports thick 6 thumbs, wide 12 thumbs;

het opperste barckhout dick 5½,
the upper wale thick 5½,

breet 11 duijm;
wide 11 thumbs;

’t reehout dick 4½ duijm,
the planksheer thick 4½ thumbs,

breet 9 duijm;
wide 9 thumbs;

d’huijt vant schip dick 4 duijm tot onder de poorten toe;
the hull of the ship thick 4 thumbs upto the [gun]ports;

de plancken inde breegangh dick 3 duijm daer boven dick 2½ duijm;
the planks in the *breegangh* [strakes of hull planking between gunports] thick 3 thumbs above which thick 2½ thumbs;

de plancken van de schutoverloop dick 2½ duijm;
the planking of the lower gun deck thick 2½ thumbs;

de koebrugge van goede deelen van 2 duijm;
the upper deck of good boards [pine planks] of 2 thumbs;

7 a 8 spansteunders, de steunders in elcken gangh een bout;
7 to 8 rider frames, the riders in each strake a bolt;

inde knies van gelijcken inde nebbe vand’onderste knies 4 a 5 bouts;
similar in the [hanging] knees, in the head [or beam arm] of the lowest [standing] knees 4 to 5 bolts;

de boevenets knies, inde head 3 a 4 bouts;
the quarterdeck’s knees, in the head [or beam arm] 3 to 4 bolts;

’t groote gadt dick 1 duijm daer het ijser nae geront wort;
the large hole 1 thumb thick after which the iron is rounded

het tweede gadt ¾ duijm dick.
the second hole ¾ thumbs thick.

| | |
|---|---|
| de kiel sal wesen langh | 111 voeten |
| the keel shall be long | 111 feet |

| | |
|---|---|
| achter vallens | 3½ voeten |
| aft drop [curvature, per foot] | 3½ feet |
| voor vallens | 19½ voeten |
| fore drop [curvature, per foot] | 19½ feet |

*Charter van een Coopvaardijjacht om mede ten Oorlogh te kunnen gebruijcken.*
*Charter of a merchant yacht also to be used in war*

Dat een jacht om op Coopvaerdij te gebruijcken ofte ten Oorlogh soo 't gelegen is
That a yacht to be used for the mercantile or for war as is applicable

sal wesen langh over steven 126 voet,
shall be long across its endposts 126 feet,
wijt 28 voet,
wide 28 feet,

hol 12 voet
high 12 feet

het verdeck hoogh 6½ voet
The upper deck high 6½ feet

d'incomen vant schip op d'hoochte vant verdeck 2¼ voeth aen ijder zij.
the ship's tumblehome at the height of the upper deck 2¼ feet on either side

(Dicte en swaerte van't hout)
(Thickness and dimensions of timber)

De kiel sal wesen dick 17 duijm vierkandt,
The keel shall be thick 17 thumbs square,

de voorsteven dick 14 duijm,
the stem 14 thumbs thick,

achtersteven van gelijcken,
the sternpost equally so,

de voorsteven hooch 21½ voe
the stem high 21½ feet,

de achtersteven hooch 21 voet,
the sternpost hight 21 feet,

de heckbalcken 19 a 20 voet lanck;
the wing transom 19 to 20 feet long;

de buijckstucken 10 duijm;
the floors 10 thumbs;

de sitters int hart vande kimmen dick 8 ½ duijm,
the first futtocks in the heart of the bilges 8½ thumbs,

op boeijsel 7 duijm,
on the board 7 thumbs,

op de scheergangh 6 duijm,
on the *scheergang* 6 thumbs,
boven op de dolboom dick 4 duijm;
on top the gunwale thick 4 thumbs;

kolssingh dick 8 duijm, breet 2¼ voet;
keelson thick 8 thumbs, wide 2¼ feet;

2 kimwegers dick 4½ duijm;
2 bilge ceiling strakes thick 4½ thumbs;

bantweger 4½ duijm;
shelf clamp 4½ thumbs;

de balcken vanden overloop 12 a 13 duijm;
the beams of the lower deck 12 to 13 thumbs;

ganghboorden dick 5 duijm met een waterloop[48] aen boort uijtgehouden;
gangways thick 5 thumbs with a waterway cut out aboard;

deckbalcken 7 a 8 duijm;
deckbeams 7 to 8 thumbs;

twee spanbarckhouten dick 6 duijm,
two main wales thick 6 thumbs,

breet 12 a 13 duijm;
wide 12 to 13 thumbs;

’t barckhout boven de poorten dick 5½ duijm,
the wale above the [gun]ports thick 5½ thumbs,

breet 11 duijm;
wide 11 thumbs;

het opperste barckhout dick 5,
the upper wale thick 5,

breet 10 duijm;
wide 10 thumbs;

’t reehout dick 4 duijm,
the planksheer thick 4 thumbs,

breet 8 duijm;
wide 8 thumbs;
d’huijt vant schip 3½ dick tot het onderste barckhout toe,
the hull of the ship 3½ thick upto the lowest wale,

de plancken inde breegangh dick 2½,
the planks in the *breegangh* [strakes of hull planking between gunports] thick 2½,

daerboven 2 duijm; de deelen vanden schutoverloop dick 2½ duijm;
above which 2 thumbs; the boards of the lower gun deck thick 2½ thumbs;

het boevenet dick 2 duijm, in elcke gangh een bout;
the quarterdeck thick 2 thumbs, in each strake a bolt;

in de nebbe vande onderste knies 4 bouts,
in the head [or beam arm] of the lowest [standing] knees 4 bolts,

de bovenste knies inde nebbe 3 bouts,
the upper [hanging] knees in the head [or beam arm] 3 bolts,

de bouten met het gadt geboort van ¾ doorgaens.
the bolts drilled with a hole of ¾ generally.

*Charter van een kleijn jacht*
*Charter of a small yacht*

Dat een kleijn jacht sal wesen langh over steven 116 voet,
That a small yacht shall be long across its endposts 116 feet,

wijt 26 voet,
wide 26 feet,

hol 10 voeth,
high 10 feet,

het verdeck hooch 5½ voet d'incomen van dit schip op de hoochte van het verdeck 2¼ voet aen ijder sij.
the upper deck high 5½ feet to this ship's tumblehome at the height of the upper deck 2¼ feet on either side.

(Dicte en swaerte vant hout)
(Thickness and dimensions of timber)

De kiel sal wesen dick 16 duijm;
The keel shall be thick 16 thumbs;
de voorsteven dick 12 a 13 duijm,
the stem 12 to 13 thumbs thick,

achtersteven van gelijcken;
the sternpost equally s0;

de voorsteven hooch 20½ voeth,
the stem high 20½ feet,

d'achtersteven 19 a 20 voeth;
the sternpost 19 to 20 feet;

de heckbalck 18 a 19 voet;
the wing transom 18 to 19 feet;

de buijckstucken dick 8½ duijm;
the floors thick 8½ thumbs;

de sitters int hart van de kimmen 7½ duijm,
the first futtocks in the heart of the bilges 7½ thumbs,

op boeijsel 6½ duijm,
on the board 6½ thumbs,

op de scheergangh 5½ duijm,
on the *scheergang* 5½ thumbs,

boven op de dolboom dick 4 duijm;
on top the gunwale thick 4 thumbs;

kolssingh 7½ duijm dick,
keelson 7½ thumbs thick,

breet 2 voet;
wide 2 feet;

twee kimwegers dick 4 duijm;
two bilge ceiling strakes thick 4 thumbs;

balckweger dick 4½ duijm;
shelf clamp thick 4½ thumbs;

de balcken vande overloop dick 11 duijm;
the beams of the lower deck thick 11 thumbs;
ganghboort dick 4½ duijm,
gangway thick 4½ thumbs,

met den waterloop aen boort uijtgehouden;
with a waterway cut out aboard;

deckbalcken 6 a 7 duijm;
deck beams 6 to 7 thumbs;

twee spanbarchouten dick 5½ duijm,
two main wales thick 5½ thumbs,

breet 11 a 12 duijm;
wide 11 to 12 thumbs;

’t barchout boven de poorten dick 4½ duijm,
the wale above the [gun]ports thick 4½ thumbs,

breet 10 duijm;
wide 10 thumbs;

het opperste barckhout dick 4 duijm,
the upper wale thick 4 thumbs,

breet 9 duijm;
wide 9 thumbs;

’t reehout dick 3½ duijm,
the planksheer thick 3½ thumbs,

breet 7 duijm;
wide 7 thumbs;

d'huijt vant schip 3½ duijm geboeijt d'huijt deck van 3 duijms plancken,
the hull of the ship 3½ thumbs planked, the deck planking of 3 thumbs planks,

voors de plancken altemael twee duijm;
and then all the planks two thumbs;

het boevenet dick 1¾ duijm;
the quarterdeck thick 1¾ thumbs;

in elcke gangh een bout inde nebbe vande onderste knies 4 bouts;
in each strake one bolt and in the head [or beam arm] of the lowest [standing] knees 4 bolts;

de bovenste knies inde nebbe drie bouts a twee,
the upper [hanging] knees in the head [or beam arm] three bolts to two,

de bouten met het gadt geboort van ¾ doorgaens.
The bolts generally with a hole drilled of ¾.

Alles te meten met Amsterdamse voeten ende op de peenen begrepen inde resolutie vanden 2 octob 1651.
All to be measured according to the Amsterdam feet and on the penalties understood in the resolution of 2 October 1651.

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[1] A transcription of this charter can also be found in the following publications: Van Dam, *Beschrijvinge van de Oostindische Compagnie*, 458-59; and Hoving and Emke, *Het schip van Willem Barents*, 108-12.

[2] The term *overloop* also refers in late sixteenth and seventeenth century to the gundeck, as Dutch ships of exploration and long-distance merchantmen only had full two decks in this period. Hence, the lower deck functioned as the gundeck, see: Hoving and De Weerdt, *Nicolaes Witsens scheeps-bouw-konst open gestelt*, 138-39; Van Beylen, *Schepen van de Nederlanden, van de late middeleeuwen tot het einde van de 17e eeuw*, 39; and Van Dam, *Beschrijvinge van de Oostindische Compagnie*, 744.

[3] Van Dam has made a transcription error and mentions 30 feet instead of 13 feet. This error was detected by Cor Emke upon checking the original VOC manuscript in the National Archives, see: Hoving, and Emke, *Het schip van Willem Barents*, 108.

[4] For an explanation of the word *koebrugge*, see Chapter VIII, note 3.

[5] Around the turn of the sixteenth to the seventeenth century, when sterncastles had become well-integrated in the ships' hull, the term *boevenet,* or *bovenet —Engl.* upper net—, referred to the quarterdeck, as it does in this shipbuilding charter.

The word *boevenet* probably originates from the time that the waist of the ship was open and an anti-boarding netting or latticework could be attached to the walkways or beams in the waist to prevent the enemy from boarding a ship. In the waist, walkways connected the quarterdeck and forecastle. In the late sixteenth and early seventeenth century, the *boevenet* had become synonymous with a continuing quarterdeck (sometimes called halfdeck) that replaced part of the open space in the waist aft of the mainmast. By the eighteenth century, decking covered the entire waist to create a third full-deck above the lower and upper deck. In this period, *boevenet* refers to the weather deck.

Hoving and Emke, *Het schip van Willem Barents*, 36, 108; Van Beylen, *Schepen van de Nederlanden, van de late middeleeuwen tot het einde van de 17e eeuw*, 39; and Van Dam, *Beschrijvinge van de Oostindische Compagnie*, 728.

6 According to Hoving and Ketting, *rochgang* [or *rogboort*] refers to the open works between the topside planking of the poopdeck and the railing of the bulwark. Ketting adds that only the bulwarks of the poop and forecastle decks can be called *rogboort*. However, in Van Dam's publication it is referred to as a thick wooden railing that runs along the bulwarks, particularly on the sides of the poopdeck on which one can lean with ones arms. As the words *rogboort* and "rochgang" include the Dutch word for strake (gang, boord) and is part of the bulwarks, it could simply be the caprail [mainrail], gunwale, or the strake that was placed on the inside of the open bulwark directly below the caprail, see: Hoving and De Weerdt, *Nicolaes Witsens scheeps-bouw-konst open gestelt*, 388; Herman Ketting, Prins Willem*: Een zeventiende-eeuwse Oostindiëvaarder* (Bussum: Unieboek, 1979), 178; and Van Dam, *Beschrijvinge van de Oostindische Compagnie*, 745.

Witsen writes that the ship should be left open between the "rock-gangen", which also does not necessarily refer to this term as an open space, see: Hoving and De Weerdt, *Nicolaes Witsens scheeps-bouw-konst open gestelt*, 388; and Witsen, *Architectura navalis et reginem nauticum*, 80.

7 The Dutch term *open regeling* simply literally translates as open railings, which are simply the open bulwarks common on merchant ships. They only had a single thickness of planking on the outside (and were not planked on inner and outer sides like the solid bulwarks of warships). Charles G. Davies, *The Ship Model Builder's Assistant* (New York: Dover Publications, Inc., 1988), 30-31; and E.W. Petrejus, *Modelling The Brig-of-War* Irene*: A Handbook for the Building of Historical Shipmodels* (Hengelo: De Esch, 1970), 45.

8 Raised afterdeck is the poopdeck, whereas the fore raised deck refers to the foredeck or forecastle deck. The word *plecht* refers to a section of a deck or a platform, such as the helms deck (*stuurplecht*) which is part of the maindeck, or *luizeplecht* which is a small half-moon shaped platform directly aft of the beakhead, see: Hoving and De Weerdt, *Nicolaes Witsens scheeps-bouw-konst open gestelt*, 390; and Ketting, Prins Willem, 177, 180.

9 Cross probably refers to amidships (where the midship frame crosses the keel).

10 Two feet drop for each foot of length to define the angle of the sternpost is probably an error as it would create too large an angle, and other documents and charters usually refer to a six or seven feet drop for the sternpost angle. Ab Hoving, letter to author, 2 May 2008.

11 *Streeck* is a recessed surface at the bottom of the sternpost, which is thinner that the rest of the sternpost, to accommodate the lowest strakes along its full width, see: Hoving and De Weerdt, *Nicolaes Witsens scheeps-bouw-konst open gestelt*, 84, 120, 390. For archaeological evidence, see: Lemée, *The Renaissance Shipwrecks from Christianshavn*, 154.

12 These two knees are lodging knees fayed to ends of each transom beam and side of the hull.

13 *Knoop* is the scarf between stem and keel. It is also referred to as the *steven-knoop,* which is a timber that fills the obtuse-angled area between the stem and apron; most likely the deadwood, see: *VOC Glossarium: Verklaringen van termen, verzameld uit Rijksgeschiedkundige Publikatiën die betrekking hebben op de Verenigde Oost-Indische Compagnie*, 63.

14 Again, Van Dam made an error in his transcription and mentions 15 feet instead of 50 feet. This error was detected by Cor Emke upon checking the original VOC manuscript in the National Archives, see: Hoving and Emke, *Het schip van Willem Barents*, 109.

15 *Soch* [or *zog*] refers to the place where the bottom of the ship starts rising aft and where the peak starts narrowing, see: Van Dam, *Beschrijvinge van de Oostindische Compagnie*, 751; and *VOC Glossarium*, 125.

[16] "Oosterse planken" (Engl. Eastern Planks) are oak planks that were imported into the Lowlands from the countries on the *Oostzee* or Baltic Sea, see: Van Dam, *Beschrijvinge van de Oostindische Compagnie*, 457; and Porsius and De Munck, "Over hout, de herkomst, de kwaliteitseisen en de bewerking daarvan," 139. See also Chapter VI, note 10.

[17] *Verscherven* means to scarf a timber in such manner that the joints of the timbers are not all above one another, but are staggered, see: Van Dam, *Beschrijvinge van de Oostindische Compagnie*, 457, note 5.

[18] The word *dreams wijs* refers to sawing four planks out of a foot of timber. Ab Hoving, letter to author, 2 May 2008.

[19] The *scheerstrook* (or *scheergang*) should not be confused with the English term sheer plank or planksheer. In Dutch shipbuilding it refers to a strake or temporary master ribband from the stem to the wing transom that was set temporarily on the widest breadth of the hull to aid in the construction of a ship. It defines the sheer of the first deck. Furthermore, the placement of the deck beams, gunports, masts, and hatches would be marked on the *scheerstrook*. This *scheerstrook* was re-used for the construction of similar ships with all the designated construction marks readily indicated. See: Hoving and De Weerdt, *Nicolaes Witsens scheeps-bouw-konst open gestelt*, 102, 388; and Van Dam, *Beschrijvinge van de Oostindische Compagnie*, 746.

[20] Again, Van Dam made an error in his transcription and mentions 4 thumbs instead of 14 thumbs. This error was detected by Cor Emke upon checking the original VOC manuscript in the National Archives, see: Hoving and Emke, *Het schip van Willem Barents*, 110.

[21] Hoving refers to *dael* as the pump sump whereas Stapel interprets it in his edition of Van Dam's book, as a pipe in the deck through which the pumped up water is guided off the ship, see: Hoving and De Weerdt, *Nicolaes Witsens scheeps-bouw-konst open gestelt*, 382; and Van Dam, *Beschrijvinge van de Oostindische Compagnie*, 730. It is most likely the dale, which is according to the Oxford English Dictionary: "A wooden tube or trough for carrying off water, as from a ship's pump; a pump-dale"].

[22] Again, Van Dam made an error in his transcription and writes *stuyven*. This error was detected by Cor Emke upon checking the original VOC manuscript in the National Archives, see: Hoving and Emke, *Het schip van Willem Barents*, 111.

[23] Usually the word *slemphout* is translated as deadwood, see: Louis Th. Lehmann, *Galleys in the Netherlands* (Amsterdam: Meulenhoff, 1984), 52, 54. Hoving describes a *slemphout* as a straight standing knee on the inside of the stem that reinforces the stem assembly, see: Hoving and De Weerdt, *Nicolaes Witsens scheeps-bouw-konst open gestelt*, 120, 168, 389. In the *VOC-Glossarium,* the word *slemphout* is described as a block inserted where stem and stern post come together with the keel which forms the joint between those timbers, see: *VOC Glossarium*, 107. In the 1603-charter is specifically written that the *slemphout* runs from the bottom to the hawse hole in the bow, and the counter in the stern; it may, therefore, also refer to an apron or inner sternpost. Specifically since, a *zog* is mentioned earlier in the text which is a hog (rising wood or deadwood) to accommodate the Y-shaped floors in the stern, see: Witsen, *Architectura navalis et reginem nauticum*, pl. XXVII.

[24] In contemporaneous Dutch shipbuilding, the maststep of the mainmast is supported by riders of which the floor rider is called a *band,* see: Hoving and De Weerdt, *Nicolaes Witsens scheeps-bouw-konst open gestelt*, 119. However, in the bow where the fore maststep is placed, there maybe not enough space to insert riders as a support to the mast assembly. Therefore, the term *banden* in this charter may also refer breast hooks. In the Ralåmb's manuscript on shipbuilding, dating to 1691, the term *banden* is used specifically for the breast hooks in the bow, see: Ralåmb, *Skeps Byggerij Eller Adelig Öfnings Tionde Tom*, 27, plate H, nos. 16-17.

[25] Again, Van Dam made an error in his transcription and mentions 4 thumbs instead of 14 thumbs. This error was detected by Cor Emke upon checking the original VOC manuscript in the National Archives, see: Hoving and Emke, *Het schip van Willem Barents*, 110.

[26] Van Dam made an error in his transcription and writes *elcken* (Engl. each). This error was detected by Cor Emke when he checked the original VOC manuscript in the National Archives, see Hoving and Emke, *Het schip van Willem Barents*, 111.

[27] The Dutch word "deelen" (or "delen") refers to pine planks. See Chapter VI, note 10.

[28] The verb *schandekken* is used to indicate the sealing off of the highest decks in the vessel by placing a covering board above the upper waterway, as a noun (*schandek*) it used to indicate the covering board itself, or the deck area directly next to the bulwarks. Van Dam, *Beschrijvinge van de Oostindische Compagnie*, 728, 745; and Petrejus, *Modelling The Brig-of-War* Irene, 45.

[29] According to Ketting, *voorscheen* is the distance from the maindeck to the bottom of the mainsail, see: Ketting, Prins Willem, 180. However, Hoving refers to it as bulwark, see: Hoving and De Weerdt, *Nicolaes Witsens scheeps-bouw-konst open gestelt*, 391.

[30] The term *vischien* may be the same as *visscher,* which is the mast hole, and refers to the beams that would support and define the rake of the mast. See, Ketting, Prins Willem, 180. Based on Witsen's manuscript, Hoving describes it as a heavy plate with the mast hole at deck height, situated above the mast step that could be shifted fore or aft to define the right rake of the mast. Hoving and De Weerdt, *Nicolaes Witsens scheeps-bouw-konst open gestelt*, 391. These are mast partners; as in the 1603-charter, it is specifically referred to the *vischien* being made of oak.

[31] Hoving and De Weerdt, *Nicolaes Witsens scheeps-bouw-konst open gestelt*, 208, 381.

[32] Heavy support beams on which the windlass is situated, see: Van Dam, *Beschrijvinge van de Oostindische Compagnie*, 746.

[33] An alliterate expression to denote all that belongs on a wooden ship, probably translates into *biels en boort* (Engl. beam and board), see: Van Dam, *Beschrijvinge van de Oostindische Compagnie*, 458.

[34] The word *herdeuttelt* is a verb deriving from plural noun *deutels*, which are dottles (treenail pegs or wedges; small square pins of oak that were driven in the ship's treenails to secure them in place. Before a ship was tarred, its treenails needed to be dottled (wedged), see: McCarthy, *Ships' Fastenings*, 66; and Maarleveld, *Archaeological Heritage Management in Dutch Waters*, 107-8, 129.

[35] One *last* equals two tons, weighing 2,000 kg, see: Bruijn, Gaastra, and Schöffer, *Dutch Asiatic Shipping in the 17th and 18th Centuries: Introductory Volume*, 42-44.

[36] Van Dam, *Beschrijvinge van de Oostindische Compagnie*, 460.

[37] Van Dam made an error in his transcription, as he specifies a *width* of 14 feet for the lower deck whereas the original VOC manuscript in the National Archives states a height of 14 feet.

[38] Van Dam, *Beschrijvinge van de Oostindische Compagnie*, 460.

[39] See note 19.

[40] *Bandweger* (also called *balkweger*) is the shelf clamp. This is a thick ceiling strake, which supports or seats the ends of the deck beams with dovetailed joints. See, Van IJk, *De Nederlandsche scheeps-bouw-konst open gestelt*, 81-82.

[41] *Spant berghout* refers to the wales below the gundeck. These are essentially main wales that are the strakes of heavy planking on the side of the ship between the waterline and lower gun deck. See, Goodwin, *The Construction and Fitting of the Sailing Man of War 1650-1850*, 53.

[42] Strakes of hull planking situated between the wales.

[43] Ketting, Prins Willem, 28.

[44] See note 25.

[45] *Nebbe* is the horizontal arm of a knee fastened to the ship's beam. See, Goodwin, *The Construction and Fitting of the Sailing Man of War 1650-1850*, 75; and Ketting, Prins Willem, 29.

[46] See note 19.

[47] *Dolboom* in this context means the same as the word *dolboord*, which refers to the ship's gunwale. See, Van IJk, *De Nederlandsche scheeps-bouw-konst open gestelt*, 271-73.

[48] *Waterloop* (*lijfhout*, *waterboort*) refers to waterway. See: Goodwin, *The Construction and Fitting of the Sailing Man of War 1650-1850*, 30-31; and Ketting, Prins Willem, 31.

# APPENDIX B

## CATALOG OF *BATAVIA* HULL REMAINS

All measurements are linear dimensions taken from *Batavia*'s timbers, with the exception of knees for which length and thickness measurements are aligned with the timber. For frame, sternpost, and transom timbers, the width measurement represents the sided dimension, and the thickness the molded dimension.

| ID | Catalog Nr. | Description | Locality | Field Nr. | Max. Pres. L. (meters) | Max. Pres. W. (meters) | Max. Pres. Th. (meters) |
|---|---|---|---|---|---|---|---|
| 1 | BAT 0582 | Copper sheathing fragment | Sternpost | - | 0.340 | 0.400 | 0.003 |
| 2 | BAT 3149 | Copper sheathing fragment | Sternpost | - | 0.175 | 0.146 | 0.002 |
| 3 | BAT 3232 A | Copper sheathing fragment | Sternpost | - | 0.196 | 0.070 | 0.003 |
| 4 | BAT 3232 B | Copper sheathing fragment | Sternpost | - | 0.165 | 0.060 | 0.002 |
| 5 | BAT 3270 | Copper tack | Sternpost | - | 0.032 | 0.005 | 0.005 |
| 6 | BAT 3438 | Copper sheathing fragment | Sternpost | - | 0.345 | 0.095 | 0.003 |
| 7 | BAT 3484 | Copper tack | Sternpost | - | 0.030 | 0.005 | 0.005 |
| 8 | BAT 3649 | Copper sheathing fragment | Sternpost | - | 0.134 | 0.070 | 0.003 |
| 9 | BAT 3724 | Copper tack | Sternpost | - | 0.034 | 0.005 | 0.005 |
| 10 | BAT 3754 | Copper sheathing fragment | Sternpost | - | 0.185 | 0.102 | 0.002 |
| 11 | BAT 3776 | Copper tack | Sternpost | - | 0.030 | 0.006 | 0.006 |
| 12 | BAT 3792 A | Copper tack | Sternpost | - | 0.034 | 0.005 | 0.005 |
| 13 | BAT 3792 B | Copper tack | Sternpost | - | 0.031 | 0.006 | 0.006 |
| 14 | BAT 3827 | Copper sheathing fragment | Sternpost | - | - | - | - |
| 15 | BAT 3829 | Copper sheathing fragment | Sternpost | - | 0.185 | 0.115 | 0.003 |
| 16 | BAT 3831 | Copper tack | Sternpost | - | 0.028 | 0.006 | 0.006 |
| 17 | BAT 6001 | Frame timber | C2 | C2 | 0.513 | 0.184 | - |
| 18 | BAT 6003 | Frame timber | C1 | C1 | 1.170 | 0.195 | 0.146 |
| 19 | BAT 6011 | Hull planking, inner layer | Strake 10 | P3A/D3 | 2.782 | 0.366 | 0.095 |
| 20 | BAT 6012 | Hull planking, inner layer | Strake 12 | P5A/D5 | 3.440 | 0.324 | 0.090 |

Appendix B Continued.

| ID | Catalog Nr. | Description | Locality | Field Nr. | Max. Pres. L. (meters) | Max. Pres. W. (meters) | Max. Pres. Th. (meters) |
|---|---|---|---|---|---|---|---|
| 21 | BAT 6013 | Hull planking, inner layer | Strake 11 | P4A/D4 | 3.238 | 0.383 | - |
| 22 | BAT 6014 | Hull planking, outer layer | Strake 12 | P5B/E6 | 1.092 | 0.279 | 0.060 |
| 23 | BAT 6015 | Hull planking, inner layer | Strake 11 | P4A/D4 | 1.085 | 0.245 | 0.098 |
| 24 | BAT 6017 | Frame timber | C17 | C17 | 2.340 | 0.225 | 0.195 |
| 25 | BAT 6018 | Frame timber | C16 | C16 | 2.070 | 0.255 | 0.215 |
| 26 | BAT 6020 | Frame timber | C9 | C9 | 1.490 | 0.180 | 0.185 |
| 27 | BAT 6021 | Frame timber | C10 | C10 | 1.032 | 0.155 | 0.160 |
| 28 | BAT 6022 (2 fragments) | Frame timber | C3 | C3 | 1.370 | 0.218 | 0.182 |
| 29 | BAT 6023 | Frame timber | C15 | C15 | 0.995 | 0.170 | 0.215 |
| 30 | BAT 6024 | Frame timber | C7 | C7 | 2.025 | 0.180 | 0.210 |
| 31 | BAT 6025 (2 fragments) | Frame timber | C4 | C4 | 1.178 | 0.183 | 0.160 |
| 32 | BAT 6027 | Frame timber | C8 | C8 | 1.442 | 0.226 | 0.200 |
| 33 | BAT 6028 (2 fragments) | Frame timber | C5 | C5 | 1.732 | 0.221 | 0.178 |
| 34 | BAT 6029 | Frame timber | C14 | C14 | 1.900 | 0.240 | 0.205 |
| 35 | BAT 6030 | Hull planking, inner layer | Strake 8 | P1A/D1 | 2.429 | 0.451 | 0.087 |
| 36 | BAT 6031 | Hull planking, inner layer | Strake 9 | P2A/D2 | 3.099 | 0.444 | 0.086 |
| 37 | BAT 6032 | Hull planking, outer layer | Strake 7 | P0B/E1 | 1.997 | 0.313 | - |
| 38 | BAT 6033 | Hull planking, outer layer | Strake 9 | P2B/E3 | 2.500 | 0.355 | - |
| 39 | BAT 6034 | Hull planking, outer layer | Strake 8 | P1B/E2 | 2.305 | 0.365 | 0.085 |
| 40 | BAT 6035 | Frame timber | C6 | C6 | 1.318 | 0.155 | 0.200 |
| 41 | BAT 6037 | Frame timber | C13 | C13 | 0.605 | 0.163 | 0.115 |
| 42 | BAT 6038 | Hull planking, outer layer | Strake 8 | P1B/E2 | 0.708 | 0.181 | 0.075 |
| 43 | BAT 6039 | Frame timber | C18 | C18 | 0.950 | 0.175 | 0.188 |
| 44 | BAT 6040 | Frame timber | C19 | C19 | 2.657 | 0.248 | 0.200 |

Appendix B Continued.

| ID | Catalog Nr. | Description | Locality | Field Nr. | Max. Pres. L. (meters) | Max. Pres. W. (meters) | Max. Pres. Th. (meters) |
|---|---|---|---|---|---|---|---|
| 45 | BAT 6041 | Frame timber | C20 | C20 | 1.025 | 0.205 | 0.205 |
| 46 | BAT 6042 | Frame timber | C21 | C21 | 1.150 | 0.225 | 0.205 |
| 47 | BAT 6043 | Frame timber | C22 | C22 | 1.692 | 0.185 | 0.205 |
| 48 | BAT 6044 | Frame timber | C23 | C23 | 1.440 | 0.225 | 0.205 |
| 49 | BAT 6045 | Frame timber | C24 | C24 | 1.265 | 0.144 | 0.220 |
| 50 | BAT 6047 | Frame timber | C26 | C26 | 1.510 | 0.260 | 0.225 |
| 51 | BAT 6048 | Frame timber | C27 | C27 | 0.628 | 0.135 | 0.112 |
| 52 | BAT 6049 | Frame timber | C28 | C28 | 1.870 | 0.210 | 0.229 |
| 53 | BAT 6052 | Frame timber | C26 | C26 | 1.440 | 0.269 | 0.255 |
| 54 | BAT 6053 | Frame timber | C28 | C28 | - | - | - |
| 55 | BAT 6055 | Frame timber | C23 | C23 | 2.030 | 0.220 | 0.197 |
| 56 | BAT 6056 | Frame timber | C21 | C21 | 2.445 | 0.215 | 0.210 |
| 57 | BAT 6057 | Ceiling planking | Strake 4 | 1 | 1.235 | 0.267 | - |
| 58 | BAT 6058 | Ceiling planking | Strake 4 | 2 | 0.620 | 0.163 | 0.060 |
| 59 | BAT 6059 | Ceiling planking | Strake 4 | 3 | 0.694 | 0.151 | 0.071 |
| 60 | BAT 6060 | Ceiling planking | Strake 5 | 4 | 0.623 | 0.139 | - |
| 61 | BAT 6061 | Ceiling planking | Strake 6 | 5 | 1.009 | 0.183 | 0.066 |
| 62 | BAT 6062 | Ceiling planking | Strake 7 | 6 | 1.431 | 0.313 | - |
| 63 | BAT 6063 | Ceiling planking | Strake 7 | 7 | 0.901 | 0.192 | 0.080 |
| 64 | BAT 6064 | Ceiling planking | Strake 9 | 13 | 0.415 | 0.154 | 0.190 |
| 65 | BAT 6065 | Frame timber | C20 | C20 | 1.149 | 0.198 | 0.188 |
| 66 | BAT 6069 | Frame timber | C27 | C27 | 0.890 | 0.210 | 0.215 |
| 67 | BAT 6071 A | Hull planking, inner layer | Strake 8 | P1A/D1 | 1.251 | 0.224 | - |
| 68 | BAT 6071 B | Hull planking, inner layer | Strake 7 | P1A/D1 | 0.539 | 0.105 | - |
| 69 | BAT 6072 | Hull planking, second wale | Strake 16 | P7A/D9 | 1.487 | 0.338 | 0.140 |
| 70 | BAT 6073 | Hull planking | Strake 15 | P8A/D8 | 2.408 | 0.343 | 0.104 |
| 71 | BAT 6074 | Hull planking, inner layer | Strake 11 | P4A/D4 | 2.749 | 0.367 | 0.084 |

Appendix B Continued.

| ID | Catalog Nr. | Description | Locality | Field Nr. | Max. Pres. L. (meters) | Max. Pres. W. (meters) | Max. Pres. Th. (meters) |
|---|---|---|---|---|---|---|---|
| 72 | BAT 6075 | Hull planking | Strake 15 | P8A/D8 | 1.257 | 0.356 | 0.112 |
| 73 | BAT 6076 | Hull planking, inner layer | Strake 10 | P3A/D3 | 2.427 | 0.384 | 0.095 |
| 74 | BAT 6077 | Hull planking, inner layer | Strake 9 | P2A/D2 | 2.285 | 0.276 | 0.086 |
| 75 | BAT 6078 | Hull planking, first wale | Strake 13 | P6A/D6 | 2.392 | 0.345 | 0.180 |
| 76 | BAT 6079 | Hull planking, inner layer | Strake 8 | P1A/D1 | 0.711 | 0.224 | - |
| 77 | BAT 6082 | Hull planking | Strake 14 | P7A/D7 | 2.371 | 0.294 | 0.125 |
| 78 | BAT 6083 | Hull planking, inner layer | Strake 10 | P3A/D3 | 0.911 | 0.365 | 0.092 |
| 79 | BAT 6084 | Hull planking | Strake 14 | P7A/D7 | 1.996 | 0.326 | 0.080 |
| 80 | BAT 6085 | Hull planking, inner layer | Strake 8 | P1A/D1 | 0.429 | 0.234 | 0.087 |
| 81 | BAT 6086 A | Hull planking, inner layer | Strake 9 | P2A/D2 | 1.235 | 0.116 | 0.086 |
| 82 | BAT 6086 B | Hull planking, inner layer | Strake 8 | P1A/D1 | 1.087 | 0.191 | 0.086 |
| 83 | BAT 6087 | Hull planking, inner layer | Strake 9 | P2A/D2 | 1.200 | 0.121 | 0.086 |
| 84 | BAT 6088 | Pine sheathing | Unknown, forward section | - | 1.361 | 0.282 | 0.017 |
| 85 | BAT 6089 | Cargo floor | Strake 8 | 9 | 0.333 | 0.356 | 0.016 |
| 86 | BAT 6091 | Hull planking | Strake 17 | D10 | 0.459 | 0.284 | 0.120 |
| 87 | BAT 6095 | Hull planking, first wale | Strake 13 | P6A/D6 | 1.573 | 0.356 | 0.130 |
| 88 | BAT 6096 | Hull planking, first wale | Strake 13 | P6A/D6 | 1.304 | 0.359 | 0.170 |
| 89 | BAT 6097 | Hull planking, inner layer | Strake 12 | P5A/D5 | 2.362 | 0.289 | 0.090 |
| 90 | BAT 6098 | Hull planking, outer layer | Strake 8 | P1B/E2 | 2.704 | 0.363 | 0.085 |
| 91 | BAT 6099 | Hull planking, outer layer | Strake 10 | P3B/E4 | 3.100 | 0.322 | 0.080 |
| 92 | BAT 6100 | Hull planking, outer layer | Strake 9 | P2B/E3 | 2.982 | 0.332 | - |
| 93 | BAT 6101 | Hull planking, outer layer | Strake 8 | P1B/E2 | 0.659 | 0.143 | - |
| 94 | BAT 6102 | Hull planking, outer layer | Strake 11 | P4B/E5 | 2.687 | 0.336 | 0.070 |
| 95 | BAT 6103 | Hull planking, outer layer | Strake 11 | P4B/E5 | 2.371 | 0.423 | 0.086 |
| 96 | BAT 6104 | Hull planking, outer layer | Strake 9 | P2B/E3 | 1.268 | 0.267 | 0.070 |
| 97 | BAT 6105 | Hull planking, outer layer | Strake 11 | P4B/E5 | 0.662 | 0.156 | 0.070 |

Appendix B Continued.

| ID | Catalog Nr. | Description | Locality | Field Nr. | Max. Pres. L. (meters) | Max. Pres. W. (meters) | Max. Pres. Th. (meters) |
|---|---|---|---|---|---|---|---|
| 98 | BAT 6106 | Hull planking, outer layer | Strake 12 | P5B/E6 | 2.387 | 0.351 | 0.070 |
| 99 | BAT 6107 | Hull planking, outer layer | Strake 11 | P4B/E5 | 1.168 | 0.266 | - |
| 100 | BAT 6109 | Hull planking, outer layer | Strake 12 | P5B/E6 | 2.378 | 0.342 | - |
| 101 | BAT 6110 | Hull planking, outer layer | Strake 10 | P3B/E4 | 2.111 | 0.337 | 0.080 |
| 102 | BAT 6113 | Frame timber | C24 | C24 | 1.180 | 0.130 | 0.225 |
| 103 | BAT 6130 | Hanging knee, upper deck | At C31 | 14 | 1.82 | 0.276 | 0.305 |
| 104 | BAT 6131 | Hull planking, outer layer | Strake 10 | P3B/E4 | 1.178 | 0.343 | - |
| 105 | BAT 6136 | Pine sheathing, inner layer | Strake 15 | SK1A | 1.382 | 0.384 | - |
| 106 | BAT 6137 | Pine sheathing, inner layer | Strake 14 | SK1B | 1.280 | 0.295 | - |
| 107 | BAT 6138 | Pine sheathing, inner layer | Strake 12-13 | SK1C | 0.606 | 0.197 | - |
| 108 | BAT 6139 | Pine sheathing, inner layer | Strake 12-13 | SK1D | 1.449 | 0.275 | - |
| 109 | BAT 6140 | Pine sheathing, inner layer | Strake 12-13 | SK1E | 0.277 | 0.125 | - |
| 110 | BAT 6141 | Pine sheathing, inner layer | Strake 15 | SK2A | 1.271 | 0.373 | 0.029 |
| 111 | BAT 6142 | Pine sheathing, inner layer | Strake 15 | SK2B | 0.945 | 0.177 | - |
| 112 | BAT 6143 | Pine sheathing, inner layer | Strake 14 | SK3A | 2.228 | 0.339 | - |
| 113 | BAT 6144 (2 fragments) | Pine sheathing, inner layer | Strake 14 | SK3B | 0.869 | 0.160 | - |
| 114 | BAT 6145 | Pine sheathing, inner layer | Strake 14 | SK3B | 0.551 | 0.054 | - |
| 115 | BAT 6146 | Pine sheathing, outer layer | Strake 13-14 | SK4 | 2.550 | 0.487 | - |
| 116 | BAT 6147 | Pine sheathing, inner layer | Strake 12-13 | SK5A | 0.490 | 0.284 | - |
| 117 | BAT 6148 | Pine sheathing, inner layer | Strake 12-13 | SK5B | 0.409 | 0.130 | - |
| 118 | BAT 6149 | Pine sheathing, inner layer | Strake 12-13 | SK5C | 1.434 | 0.441 | 0.029 |
| 119 | BAT 6150 | Pine sheathing, inner layer | Strake 12-13 | SK6A | 0.912 | 0.316 | - |
| 120 | BAT 6151 | Pine sheathing, inner layer | Strake 12-13 | SK6B | 0.576 | 0.170 | - |
| 121 | BAT 6152 | Pine sheathing, inner layer | Strake 12-13 | SK6C | 1.303 | 0.471 | - |
| 122 | BAT 6153 | Pine sheathing, inner layer | Strake 12-13 | SK5D | 0.786 | 0.218 | - |
| 123 | BAT 6160 | Hull planking, outer layer | Strake 2 | E-7 | 3.425 | 0.303 | 0.070 |

Appendix B Continued.

| ID | Catalog Nr. | Description | Locality | Field Nr. | Max. Pres. L. (meters) | Max. Pres. W. (meters) | Max. Pres. Th. (meters) |
|---|---|---|---|---|---|---|---|
| 124 | BAT 6161 | Hull planking, outer layer | Strake 1 | E-8 | 2.809 | 0.361 | - |
| 125 | BAT 6162 | Hull planking, outer layer | Strake 2 | E-7 | 1.667 | 0.264 | - |
| 126 | BAT 6163 | Hull planking, outer layer | Strake 2 | E-7 | 0.621 | 0.113 | - |
| 127 | BAT 6167 | Frame timber | C29 | C29 | 3.972 | 0.206 | 0.228 |
| 128 | BAT 6168 | Hull planking | Strake 17 | D10 | 1.509 | 0.352 | 0.123 |
| 129 | BAT 6169 | Frame timber | C27 | C27 | 2.695 | 0.202 | 0.190 |
| 130 | BAT 6170 | Frame timber | C30 | C30 | 2.358 | 0.219 | 0.212 |
| 131 | BAT 6171 | Wedge | C26 | C26 | 0.420 | 0.189 | 0.135 |
| 132 | BAT 6172 | Frame timber | C23 | C23 | 0.750 | 0.213 | 0.203 |
| 133 | BAT 6174 | Frame timber | C26 | C26 | 1.340 | 0.169 | 0.190 |
| 134 | BAT 6175 | Hull planking | Strake 18 | D11 | 0.745 | 0.338 | 0.100 |
| 135 | BAT 6176 | Hull planking, third wale | Strake 19 | D12 | 1.386 | 0.361 | 0.193 |
| 136 | BAT 6177 | Frame timber | C30 | C30 | 2.146 | 0.214 | 0.190 |
| 137 | BAT 6178 | Gunport lid | Strake 18-19 | D11-D12 | 0.615 | 0.585 | 0.160 |
| 138 | BAT 6179 | Knee or floor from stern | Loose find | W10 | 1.300 | 0.300 | 0.400 |
| 139 | BAT 6180 | Hull planking, outer layer | Strake 4 | E-5 | 1.531 | 0.326 | 0.070 |
| 140 | BAT 6181 | Frame timber | C25 | C25 | 3.217 | 0.220 | 0.230 |
| 141 | BAT 6182 | Hull planking, inner layer | Strake 3 | D-6 | 2.095 | 0.397 | 0.085 |
| 142 | BAT 6183 | Hull planking, outer layer | Strake 3 | E-6 | 2.875 | 0.408 | 0.050 |
| 143 | BAT 6184 | Hull planking, inner layer | Strake 4 | D-5 | 1.260 | 0.254 | 0.085 |
| 144 | BAT 6185 | Shelf clamp | Strake 8 | 8 | 1.189 | 0.415 | 0.120 |
| 145 | BAT 6188 | Ceiling planking | Strake 11 | 11 | 0.777 | 0.263 | 0.080 |
| 146 | BAT 6192 | Hull planking, inner layer | Strake 4 | D-5 | 0.583 | 0.214 | 0.089 |
| 147 | BAT 6194 | Hull planking, inner layer | Strake 5 | D-4 | 1.042 | 0.323 | - |
| 148 | BAT 6195 | Hull planking, inner layer | Strake 5 | D-4 | 0.847 | 0.316 | 0.066 |
| 149 | BAT 6196 | Ceiling planking | Strake 10 | B9 | 1.010 | 0.340 | - |
| 150 | BAT 6200 | Hull planking, inner layer | Strake 3 | D-6.2 | 0.648 | 0.122 | 0.082 |

Appendix B Continued.

| ID | Catalog Nr. | Description | Locality | Field Nr. | Max. Pres. L. (meters) | Max. Pres. W. (meters) | Max. Pres. Th. (meters) |
|---|---|---|---|---|---|---|---|
| 151 | BAT 6202 | Hull planking, outer layer | Strake 11 | E4 | 1.449 | 0.320 | 0.038 |
| 152 | BAT 6203 | Hull planking, outer layer | Strake 12 | E5 | 1.498 | 0.305 | 0.037 |
| 153 | BAT 6204 A | Hull planking, inner layer | Strake 9 | D2, D1 | 1.557 | 0.394 | - |
| 154 | BAT 6204 B | Hull planking, inner layer | Strake 8 | D0 | 1.595 | 0.233 | 0.070 |
| 155 | BAT 6204 C | Hull planking, inner layer | Strake 8 | D-1 | 1.618 | 0.198 | 0.070 |
| 156 | BAT 6206 | Hull planking, inner layer | Strake 11 | D4 | 0.939 | 0.258 | 0.086 |
| 157 | BAT 6207 | Hull planking, outer layer | Strake 9 | E2 | 0.520 | 0.105 | 0.040 |
| 158 | BAT 6208 | Hull planking, outer layer | Strake 10 | E3 | 1.436 | 0.318 | 0.040 |
| 159 | BAT 6209 | Hull planking, inner layer | Strake 11 | D4 | 1.293 | 0.338 | 0.091 |
| 160 | BAT 6210 | Hull planking, inner layer | Strake 10 | D3 | 1.497 | 0.381 | 0.092 |
| 161 | BAT 6211 | Hull planking | Strake 15 | D8 | 1.537 | 0.359 | 0.125 |
| 162 | BAT 6212 | Hull planking, inner layer | Strake 12 | D5 | 1.491 | 0.288 | - |
| 163 | BAT 6213 | Hull planking, inner layer | Strake 7 | D-2 | 1.340 | 0.420 | - |
| 164 | BAT 6214 | Hull planking, inner layer | Strake 7 | D-2 | 0.414 | 0.176 | - |
| 165 | BAT 6215 | Hull planking, first wale | Strake 13 | D6 | 1.499 | 0.355 | 0.130 |
| 166 | BAT 6216 | Hull planking | Strake 14 | D7 | 1.472 | 0.294 | 0.125 |
| 167 | BAT 6217 | Hull planking, second wale | Strake 16 | D9 | 1.467 | 0.340 | 0.15 |
| 168 | BAT 6218 | Margin plank or waterway | Lower deck | - | 1.701 | 0.312 | 0.107 |
| 169 | BAT 6219 | Hull planking, outer layer | Strake 10 | E3 | 0.572 | 0.153 | 0.040 |
| 170 | BAT 6220 | Cleat, 3 sections | Transom knee | - | 0.856 | 0.551 | 0.088 |
| 171 | BAT 6221 | Planking, same as BAT 6222 | On BAT 6223 A | - | 1.318 | 0.294 | 0.036 |
| 172 | BAT 6222 | Planking, same as BAT 6221 | On BAT 6223 A | - | - | - | - |
| 173 | BAT 6223 A | Transom knee | Transom/side | A7 | 3.632 | 0.363 | 0.620 |
| 174 | BAT 6223 B | Transom knee, wing | Transom/side | A8 | 3.400 | - | - |
| 175 | BAT 6224 | Filling wedge | Underneath 6223 | A7-2 | 1.161 | 0.339 | 0.108 |
| 176 | BAT 6225 | Transom ceiling planking | Between T3 and T7 | - | 0.945 | 0.244 | 0.073 |

Appendix B Continued.

| ID | Catalog Nr. | Description | Locality | Field Nr. | Max. Pres. L. (meters) | Max. Pres. W. (meters) | Max. Pres. Th. (meters) |
|---|---|---|---|---|---|---|---|
| 177 | BAT 6226 | Plank, diagonally placed, between transom and side ceiling planking | Between A5 and A7 | - | 1.393 | 0.249 | 0.076 |
| 178 | BAT 6227 | Hanging knee, lower deck | At C31 | A6 | 1.517 | 0.240 | 0.304 |
| 179 | BAT 6228 | Transom knee | Transom/side | A1 | 2.646 | 0.346 | 0.312 |
| 180 | BAT 6229 | Lodging knee, lower deck | Transom/side | A3 | 1.492 | 0.284 | 0.488 |
| 181 | BAT 6230 | Deck beam, lower deck | Shelf clamp, fore | - | 0.605 | 0.332 | 0.325 |
| 182 | BAT 6232 | Cargo floor | Below A2 | - | 1.758 | 0.270 | 0.092 |
| 183 | BAT 6233 | Platform planking | On BAT 6223 A | A3-2 | 0.411 | 0.103 | 0.075 |
| 184 | BAT 6235 | Bung from hawse hole | Transom | - | 0.248 | 0.130 | 0.081 |
| 185 | BAT 6240 | Pine sheathing | Sternpost, starboard | - | 0.566 | 0.349 | 0.028 |
| 186 | BAT 6241 | Pine sheathing | Sternpost, starboard | - | 0.527 | 0.453 | 0.028 |
| 187 | BAT 6242 | Pine sheathing | Sternpost, starboard | - | 0.458 | 0.431 | 0.027 |
| 188 | BAT 6243 | Pine sheathing | Sternpost, starboard | - | 0.412 | 0.443 | 0.026 |
| 189 | BAT 6244 | Pine sheathing | Sternpost, starboard | - | - | - | - |
| 190 | BAT 6245 | Pine sheathing | Sternpost, starboard | - | 0.193 | 0.159 | 0.027 |
| 191 | BAT 6246 | Cover planking | Sternpost, starboard | - | 0.403 | 0.438 | 0.058 |
| 192 | BAT 6247 | Cover planking | Sternpost, starboard | - | - | - | - |
| 193 | BAT 6248 | Cover planking | Sternpost, starboard | - | 0.404 | 0.315 | 0.049 |
| 194 | BAT 6249 | Cover planking | Sternpost, starboard | - | 0.429 | 0.331 | 0.049 |
| 195 | BAT 6250 | Cover planking | Sternpost, starboard | - | 0.477 | 0.342 | 0.045 |
| 196 | BAT 6251 | Cover planking | Sternpost, starboard | - | 0.643 | 0.268 | 0.045 |
| 197 | BAT 6259 | Ceiling planking | Strake 13 | B13 | 2.286 | 0.328 | 0.085 |
| 198 | BAT 6260 | Ceiling planking, subfloor | Strake 12 | B12 | 2.150 | 0.471 | 0.035 |
| 199 | BAT 6260 | Ceiling planking | Strake 12 | B12 | 2.150 | 0.471 | 0.090 |
| 200 | BAT 6261 | Ceiling planking | Strake 11 | B11 | 2.014 | 0.252 | 0.067 |
| 201 | BAT 6262 | Ceiling planking | Strake 12 | B12 | 0.951 | 0.247 | 0.085 |

Appendix B Continued.

| ID | Catalog Nr. | Description | Locality | Field Nr. | Max. Pres. L. (meters) | Max. Pres. W. (meters) | Max. Pres. Th. (meters) |
|---|---|---|---|---|---|---|---|
| 202 | BAT 6263 | Ceiling planking | Strake 10 | B10 | 2.911 | 0.400 | 0.090 |
| 203 | BAT 6264 | Ceiling planking | Strake 10 | B10 | 2.271 | 0.400 | 0.090 |
| 204 | BAT 6267 | Ceiling planking | Strake 4 | B5 | 2.412 | 0.357 | 0.066 |
| 205 | BAT 6268 | Ceiling planking | Strake 3 | - | 0.928 | 0.165 | 0.066 |
| 206 | BAT 6269 A | Cargo floor | Strake 2-3 | - | 1.896 | 0.352 | 0.026 |
| 207 | BAT 6269 B | Ceiling planking | Strake 3 | - | 1.665 | 0.619 | 0.063 |
| 208 | BAT 6270 | Ceiling planking | Strake 2 | - | 1.991 | 0.281 | 0.070 |
| 209 | BAT 6271 A | Cargo floor | Strake 1-2 | - | 1.877 | 0.560 | 0.026 |
| 210 | BAT 6271 B | Ceiling planking | Strake 1 | - | 0.857 | 0.166 | 0.060 |
| 211 | BAT 6272 | Ceiling planking | Strake 1 | - | 1.466 | 0.328 | 0.062 |
| 212 | BAT 6273 | Cargo floor | Strake 1 | - | 1.713 | 0.524 | 0.036 |
| 213 | BAT 6276 | Ceiling planking, subfloor | Strake 12 | B12 | 0.158 | 0.183 | 0.049 |
| 214 | BAT 6286 | Gunport frame or sill fragment | Transom | T7-A | 0.565 | 0.163 | 0.227 |
| 215 | BAT 6288 | Cross beam | Transom | T7-1 | 0.668 | 0.144 | 0.147 |
| 216 | BAT 6289 | Frame timber | C37 | C37 | 0.546 | 0.195 | 0.207 |
| 217 | BAT 6290 | Wedge | C40 | C40 | 0.184 | 0.264 | 0.090 |
| 218 | BAT 6291 | Cross beam | Transom | T7-2 | 0.636 | 0.117 | - |
| 219 | BAT 6294 | Cardinal’s hat, half (joins BAT 6347 and BAT 6348) | Transom | TP13/TP14 | 0.322 | 0.322 | - |
| 220 | BAT 6295 | Transom knee | Transom/side | A2 | 3.069 | 0.357 | 0.555 |
| 221 | BAT 6296 | Transom knee | Transom/side | A5 | 3.178 | 0.353 | 0.484 |
| 222 | BAT 6297 | Ceiling planking | Strake 5 | B6-1 | 2.497 | 0.385 | 0.060 |
| 223 | BAT 6298 | Platform planking | On BAT 6223 A | A3-1 | 0.619 | 0.277 | 0.070 |
| 224 | BAT 6299 | Frame timber | C32 | C32 | 0.771 | 0.174 | 0.172 |
| 225 | BAT 6300 | Frame timber | C32 | C32 | 1.105 | 0.178 | 0.174 |
| 226 | BAT 6301 | Wedge | C32 | C32 | 0.616 | 0.188 | 0.150 |
| 227 | BAT 6304 | Frame timber | C38 | C38 | 1.414 | 0.230 | 0.180 |

Appendix B Continued.

| ID | Catalog Nr. | Description | Locality | Field Nr. | Max. Pres. L. (meters) | Max. Pres. W. (meters) | Max. Pres. Th. (meters) |
|---|---|---|---|---|---|---|---|
| 228 | BAT 6305 | Wedge | C38 | C38 | 0.498 | 0.186 | 0.175 |
| 229 | BAT 6306 | Frame timber | C34 | C34 | 1.559 | 0.186 | 0.183 |
| 230 | BAT 6307 | Wedge | C34 | C34 | 0.535 | 0.167 | 0.145 |
| 231 | BAT 6308 | Frame timber | C36 | C36 | 1.891 | 0.232 | 0.174 |
| 232 | BAT 6309 | Frame timber | C40 | C40 | 1.614 | 0.235 | 0.175 |
| 233 | BAT 6310 | Wedge | C42 | C42 | 0.365 | 0.145 | 0.150 |
| 234 | BAT 6311 | Frame timber | C42 | C42 | 1.956 | 0.194 | 0.174 |
| 235 | BAT 6312 | Frame timber | C43 | C43 | 1.177 | 0.228 | 0.133 |
| 236 | BAT 6313 | Frame timber | C39 | C39 | 0.762 | 0.212 | 0.175 |
| 237 | BAT 6314 | Ceiling planking | Strake 9 | B9 | 2.910 | 0.385 | 0.090 |
| 238 | BAT 6315 | Frame timber | C32 | C32 | 1.699 | 0.205 | 0.215 |
| 239 | BAT 6316 | Frame timber | C34 | C34 | 1.738 | 0.181 | 0.205 |
| 240 | BAT 6317 | Frame timber | C36 | C36 | 2.478 | 0.275 | 0.260 |
| 241 | BAT 6318 | Frame timber | C38 | C38 | 2.278 | 0.232 | 0.183 |
| 242 | BAT 6319 | Ceiling planking | Strake 6 | B6-2 | 1.875 | 0.264 | 0.060 |
| 243 | BAT 6322 | Shelf clamp | Strake 8 | B8 | 2.715 | 0.428 | 0.120 |
| 244 | BAT 6324 | Deck beam, lower deck | Shelf clamp, after | A2-1 | 0.978 | 0.372 | 0.273 |
| 245 | BAT 6325 | Ceiling planking | Strake 7 | B7 | 2.554 | 0.317 | 0.090 |
| 246 | BAT 6327 | Frame timber | C33 | C33 | 0.997 | 0.213 | - |
| 247 | BAT 6328 | Wedge | C36 | C36 | 0.453 | 0.236 | 0.148 |
| 248 | BAT 6329 | Frame timber | C31 | C31 | 0.572 | 0.223 | - |
| 249 | BAT 6330 | Frame timber | C37 | C37 | 2.581 | 0.220 | 0.189 |
| 250 | BAT 6331 | Frame timber | C37 | C37 | 2.651 | 0.206 | 0.175 |
| 251 | BAT 6332 | Frame timber | C35 | C35 | 3.578 | 0.253 | 0.185 |
| 252 | BAT 6333 | Frame timber | C33 | C33 | 2.337 | 0.190 | 0.175 |
| 253 | BAT 6336 | Frame timber | C31 | C31 | 1.414 | 0.238 | 0.195 |
| 254 | BAT 6337 | Frame timber | C31 | C31 | 2.615 | 0.207 | 0.195 |

Appendix B Continued.

| ID | Catalog Nr. | Description | Locality | Field Nr. | Max. Pres. L. (meters) | Max. Pres. W. (meters) | Max. Pres. Th. (meters) |
|---|---|---|---|---|---|---|---|
| 255 | BAT 6338 | Frame timber | C33 | C33 | 2.416 | 0.195 | 0.175 |
| 256 | BAT 6339 | Frame timber | C39 | C39 | 2.867 | 0.215 | 0.195 |
| 257 | BAT 6340 | Frame timber | C41 | C41 | 3.844 | 0.225 | 0.165 |
| 258 | BAT 6341 | Frame timber | C41 | C41 | 0.945 | 0.193 | 0.204 |
| 259 | BAT 6342 | Frame timber | C40 | C40 | 2.647 | 0.270 | 0.235 |
| 260 | BAT 6344 | Frame timber | C43 | C43 | 2.758 | 0.191 | 0.165 |
| 261 | BAT 6345 | Frame timber | C44 | C44 | 2.802 | 0.210 | 0.165 |
| 262 | BAT 6346 | Frame timber | C45 | C45 | 1.473 | 0.185 | 0.155 |
| 263 | BAT 6347 | Cardinal's hat, fragment (joins BAT 6294 and BAT 6348) | Transom | TP13/TP14 | - | - | - |
| 264 | BAT 6348 | Cardinal's hat, fragment (joins BAT 6294 and BAT 6347) | Transom | TP13/TP14 | - | - | - |
| 265 | BAT 6354 | Hull planking | Strake 21 | D12 | 1.127 | 0.166 | 0.069 |
| 266 | BAT 6355 | Frame timber | C46 | C46 | 0.717 | 0.255 | 0.130 |
| 267 | BAT 6356 | Futtock of fashion piece | Transom | FP | 2.798 | 0.682 | 0.238 |
| 268 | BAT 6358 | Transom beam | Transom | T7 | 2.175 | 0.340 | 0.374 |
| 269 | BAT 6361 | Transom beam | Transom | T1 | 1.710 | 0.317 | 0.358 |
| 270 | BAT 6364 | Transom beam | Transom | T2 | 2.185 | 0.332 | 0.405 |
| 271 | BAT 6365 | Deck transom, lower deck | Transom | T3 | 1.999 | 0.364 | 0.359 |
| 272 | BAT 6367 | Hull planking, inner layer | Strake 3 | D-6 | 2.408 | 0.328 | 0.080 |
| 273 | BAT 6369 A | Frame timber | C39 | C39 | 1.128 | 0.217 | 0.195 |
| 274 | BAT 6369 B* | Wing transom | Transom | T8 | 2.103 | 0.501 | 0.483 |
| 275 | BAT 6370 A | Transom planking, inner layer | Transom | TP12 | 1.282 | 0.155 | 0.090 |
| 276 | BAT 6370 B | Transom planking, inner layer | Transom | TP13/TP14 | 1.424 | 0.423 | 0.091 |
| 277 | BAT 6374 | Lowest transom | Transom | T0 | 0.796 | 0.269 | 0.295 |
| 278 | BAT 6375 | Hull planking, inner layer | Loose find | - | 0.811 | 0.224 | 0.082 |
| 279 | BAT 6387 | Hull planking, third wale | Strake 19 | D10 | 4.072 | 0.357 | 0.193 |

Appendix B Continued.

| ID | Catalog Nr. | Description | Locality | Field Nr. | Max. Pres. L. (meters) | Max. Pres. W. (meters) | Max. Pres. Th. (meters) |
|---|---|---|---|---|---|---|---|
| 280 | BAT 6388 | Hull planking, inner layer | Strake 6 | D-3 | 2.762 | 0.350 | 0.087 |
| 281 | BAT 6389 | Hull planking, inner layer | Strake 7 | D-2 | 2.895 | 0.391 | 0.077 |
| 282 | BAT 6390 | Hull planking, inner layer | Strake 4 | D-5 | 2.088 | 0.179 | 0.086 |
| 283 | BAT 6391 | Hull planking, inner layer | Strake 8 | D-1 | 1.438 | 0.369 | 0.070 |
| 284 | BAT 6392 | Hull planking, inner layer | Strake 4 | D-5 | 0.349 | 0.056 | 0.089 |
| 285 | BAT 6393 | Hull planking, inner layer | Strake 5 | D-4 | 2.402 | 0.341 | 0.090 |
| 286 | BAT 6394 | Hull planking | Strake 20 | D11 | 2.806 | 0.355 | 0.125 |
| 287 | BAT 6395 | Hull planking, inner layer | Strake 11 | D2 | 2.922 | 0.323 | 0.091 |
| 288 | BAT 6396 | Hull planking, inner layer | Strake 12 | D3 | 2.889 | 0.279 | 0.091 |
| 289 | BAT 6397 | Hull planking, first wale | Strake 13 | D4 | 0.962 | 0.069 | 0.072 |
| 290 | BAT 6398 | Hull planking, first wale | Strake 13 | D4 | 2.151 | 0.349 | 0.129 |
| 291 | BAT 6399 | Hull planking | Strake 15 | D6 | 2.995 | 0.353 | 0.124 |
| 292 | BAT 6400 | Hull planking | Strake 18 | D9 | 3.778 | 0.344 | 0.122 |
| 293 | BAT 6401 | Hull planking, second wale | Strake 16 | D7 | 3.015 | 0.361 | 0.119 |
| 294 | BAT 6404 | Hull planking, first wale | Strake 13 | D4 | 1.332 | 0.351 | 0.098 |
| 295 | BAT 6405 | Hull planking | Strake 14 | D5 | 3.030 | 0.289 | 0.129 |
| 296 | BAT 6406 | Hull planking | Strake 17 | D8 | 3.573 | 0.349 | 0.113 |
| 297 | BAT 6409 | Hull planking, inner layer | Strake 9 | D0 | 2.875 | 0.396 | 0.083 |
| 298 | BAT 6410 | Hull planking, inner layer | Strake 10 | D1 | 2.826 | 0.343 | 0.093 |
| 299 | BAT 6411 | Hull planking, inner layer | Strake 8 | D-1 | 1.812 | 0.354 | 0.084 |
| 300 | BAT 6412 | Transom planking, outer layer | Transom | OP1 | 1.297 | 0.224 | 0.090 |
| 301 | BAT 6413 A | Transom planking, outer layer | Transom | OP2 | 1.933 | 0.410 | 0.086 |
| 302 | BAT 6413 B | Transom planking, outer layer | Transom | OP2 | 0.603 | 0.313 | 0.086 |
| 303 | BAT 6414 | Transom planking, inner layer | Transom | TP0 | 0.910 | 0.315 | 0.095 |
| 304 | BAT 6415 | Transom planking, inner layer | Transom | TP1 | 1.616 | 0.392 | 0.094 |
| 305 | BAT 6416 | Transom planking, inner layer | Transom | TP2/TP3 | 1.594 | 0.426 | 0.098 |
| 306 | BAT 6417 A | Transom planking, outer layer | Transom | OP3 | 0.996 | 0.476 | 0.094 |

Appendix B Continued.

| ID | Catalog Nr. | Description | Locality | Field Nr. | Max. Pres. L. (meters) | Max. Pres. W. (meters) | Max. Pres. Th. (meters) |
|---|---|---|---|---|---|---|---|
| 307 | BAT 6417 B | Transom planking, outer layer | Transom | OP3 | 1.010 | 0.438 | 0.086 |
| 308 | BAT 6418 | Hull planking, outer layer | Strake 5 | OP4 | 2.084 | 0.302 | 0.090 |
| 309 | BAT 6419 A | Hull planking, outer layer | Strake 6 | OP5 | 1.048 | 0.224 | 0.080 |
| 310 | BAT 6419 B | Hull planking, outer layer | Strake 6 | OP5 | 1.749 | 0.287 | 0.071 |
| 311 | BAT 6420 A | Transom planking, inner layer | Transom | TP5 | 1.478 | 0.420 | 0.094 |
| 312 | BAT 6420 B | Transom planking, inner layer | Transom | TP6 | 1.379 | 0.387 | 0.094 |
| 313 | BAT 6420 C | Transom planking, inner layer | Transom | TP7 | 0.192 | 0.335 | 0.094 |
| 314 | BAT 6421 | Transom planking, outer layer | Strake 6-7 | OP6 | 0.790 | 0.347 | 0.091 |
| 315 | BAT 6422 A | Hull planking, outer layer | Strake 7 | OP7 | 1.122 | 0.294 | 0.090 |
| 316 | BAT 6422 B | Transom planking, outer layer | Transom | OP7 | 1.314 | 0.370 | 0.094 |
| 317 | BAT 6422 C | Transom planking, outer layer | Transom | OP7 | 0.489 | 0.212 | 0.091 |
| 318 | BAT 6423 | Transom planking, outer layer | Transom | OP8 | 2.360 | 0.359 | 0.091 |
| 319 | BAT 6425 | Transom planking, outer layer | Transom | OP9 | 1.164 | 0.397 | 0.080 |
| 320 | BAT 6427 | Transom planking, inner layer | Transom | TP8/TP9 | 1.271 | 0.373 | 0.090 |
| 321 | BAT 6428 | Transom planking, inner layer | Transom | TP10/TP11 | 1.154 | 0.513 | 0.093 |
| 322 | BAT 6428 C | Transom planking, outer layer | Transom | OP11 | 0.779 | 0.344 | 0.092 |
| 323 | BAT 6429 | Transom planking, outer layer | Transom | OP10 | 0.917 | 0.348 | 0.084 |
| 324 | BAT 6433 A | Pine sheathing | Sternpost, port | - | 0.406 | 0.253 | 0.033 |
| 325 | BAT 6433 B | Pine sheathing | Sternpost, port | - | 0.398 | 0.619 | 0.035 |
| 326 | BAT 6433 C | Cover planking | Sternpost, port | - | 0.218 | 0.084 | 0.049 |
| 327 | BAT 6433 D | Cover planking | Sternpost, port | - | 0.398 | 0.449 | 0.058 |
| 328 | BAT 6433 E | Copper sheathing | Sternpost, port | - | 0.746 | 0.423 | 0.003 |
| 329 | BAT 6434 | Cover planking | Sternpost, port | - | 0.403 | 0.256 | 0.049 |
| 330 | BAT 6434 | Sternpost | Sternpost | SP3 | 1.815 | 0.419 | 0.528 |
| 331 | BAT 6435 | Cover planking | Sternpost, port | - | 0.322 | 0.193 | 0.053 |
| 332 | BAT 6436 | Cover planking | Sternpost, port | - | 0.418 | 0.360 | 0.058 |
| 333 | BAT 6437 | Cover planking | Sternpost, port | - | 0.381 | 0.477 | 0.058 |

Appendix B Continued.

| ID | Catalog Nr. | Description | Locality | Field Nr. | Max. Pres. L. (meters) | Max. Pres. W. (meters) | Max. Pres. Th. (meters) |
|---|---|---|---|---|---|---|---|
| 334 | BAT 6438 | Cover planking | Sternpost, port | - | - | - | - |
| 335 | BAT 6439 | Cover planking | Sternpost, port | - | 0.353 | 0.183 | 0.058 |
| 336 | BAT 6441 A | Pine sheathing | Transom | TSK1 | 1.132 | 0.150 | 0.040 |
| 337 | BAT 6441 B | Pine sheathing | Transom | TSK2 | 1.703 | 0.540 | 0.040 |
| 338 | BAT 6444 | Fashion piece | Transom | FP | 4.608 | 0.600 | 0.320 |
| 339 | BAT 6445 A | Transom planking, inner layer | Transom | TP15 | 1.183 | 0.283 | 0.100 |
| 340 | BAT 6445 B | Transom planking, inner layer | Transom | TP16 | 0.631 | 0.379 | 0.104 |
| 341 | BAT 6451 | Pine sheathing | Transom, unknown | - | 1.030 | 0.230 | 0.032 |
| 342 | BAT 6452 | Pine plank | Transom, unknown | - | 0.870 | 0.210 | 0.032 |
| 343 | BAT 6454 | Pine plank | Transom, unknown | - | 1.070 | 0.170 | 0.022 |
| 344 | BAT 6482 | Pine sheathing | Transom, unknown | - | 0.970 | 0.220 | 0.032 |
| 345 | BAT 6483 | Pine sheathing (four fragments | Transom, unknown | - | 2.020 | 0.310 | 0.028 |
| 346 | BAT 6484 | Pine sheathing | Transom, unknown | - | 1.600 | 0.280 | 0.032 |
| 347 | BAT 6485 | Pine sheathing | Transom, unknown | - | 1.050 | 0.220 | 0.032 |
| 348 | BAT 6486 | Pine sheathing | Transom, unknown | - | 1.080 | 0.310 | 0.032 |
| 349 | BAT 6487 | Pine sheathing (3 fragments) | Transom, unknown | - | - | - | - |
| 350 | BAT 6501 | Pine sheathing | Transom, unknown | - | 0.825 | 0.085 | 0.039 |
| 351 | BAT 6513 | Frame timber | C11 | C11 | 0.710 | 0.210 | 0.170 |
| 352 | BAT 80104 | Gudgeon concretion | Sternpost | - | - | - | - |
| 353 | BAT 80041 | Gunport hinge concretion | Sternpost | - | - | - | - |
| 354 | BAT 80395 | Gudgeon concretion | Sternpost | - | 0.360 | 0.155 | 0.055 |
| 355 | BAT 80395 R | Cast from gudgeon concretion | Sternpost | - | 0.360 | 0.155 | 0.055 |

* Number 6369 was accidently given to two timbers, a frame fragment and the remains of the wing transom.
** Number also given to sternpost.

# APPENDIX C

# BIBLIOGRAPHY FOR IDENTIFIED DUTCH SHIPWRECK SITES

Dutch shipwrecks are only included in this appendix if their existence is confirmed and their identification positively ascertained by published sources. Shipwrecks such as *Middenrak* and *Rodenrijs*, both sank in South Africa, are claimed to be located and salvaged by divers but are not included here as no publications verify these shipwrecks and their finds. The same can be said for *Negotie*, for example, which sank near Texel in 1790; it is reported that its bullion still washes ashore in Texel. This ship is, however, is not listed in this appendix due to lack of conclusive written evidence.

**Shipwrecks *Voorcompagnieën* (1595–1602)**

1. Willem Barents' ship, yacht, 1597, Nova Zembla (Russia), 60 or 100 tons

Hoving, Ab J., and Cor Emke. *Het schip van Willem Barents: Een hypothetische reconstructie van een laat–zestiende–eeuws jacht,* 33–34. Hilversum: Verloren, 2004.

Gawronski, Jerzy H.G., and Peter V. Boyarsky. *Northbound with Barents: Russian–Dutch Integrated Archaeological Research on the Archipelago Novaya Zemlya in 1995*, 89–92, figs 4.5.1–2. Amsterdam: J. Mets, 1997.

**VOC Shipwrecks (1602–1795)**

1. *Adelaar*, Indiaman, 1728, Barra (Hebrides, U.K.), 810 tons (*DAS* 2, no. 2729.3)[1]

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Muckelroy, Keith, ed. *Archeology Under Water: An Atlas of the World's Submerged Sites*, 127. New York: McGraw–Hill, 1980.

2. *Akerendam,* Indiaman, 1725, Ålesund (Norway), 850 tons
(*DAS* 2, no. 2609.1)

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3. *Amsterdam*, Indiaman, 1748, Hastings (U.K.), 1150 tons
(*DAS* 2, no. 3437.1)

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(*DAS* 2, no. 0823.1; *DAS* 3, no. 5448.2[2])

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(*DAS* 2, no. 0372.1)

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(*DAS* 2, no. 4069.4)

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(*DAS* 2, no. 0786.1)

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(*DAS* 2, no. 2151.5)

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(*DAS* 2, no. 0098.2; *DAS* 3, no. 5077.2)

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(*DAS* 2, no. 4360.1; *DAS* 3, no. 8073.1)

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30. *Nieuwerkerk,* Indiaman, 1748, Sulawesi (Indonesia), 1135 tons
(DAS 2*,* no. 3337.4)

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31. *Nieuwe Rhoon*, Indiaman, 1776, Cape Town (South Africa), 1150 tons
(*DAS* 2, no. 4213.5; *DAS* 3, no. 7955.5)

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32. *Oosterland,* Indiaman, 1697, Cape Town (South Africa), 1123 tons
(*DAS* 2, no. 1693.4; *DAS* 3, no. 5975.4)

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33. *Prinses Maria*, Indiaman, 1686, Scilly Isles (U.K.), 1140 tons (*DAS* 2, no. 1513.2)

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(*DAS* 2, no. 2623.2)

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35. *Reigersdaal*, Indiaman, 1747, Springfontein (South Africa), 850 tons
(*DAS* 2, no. 3399.3)

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36. *Risdam*, flute, 1727, Mersing (Malakka, Malaysia), 520 tons (*DAS* 2, no. 2357.2)

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(*DAS* 2, no. 3173.2)

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38. *Slot ter Hoge*, Indiaman, 1724, Madeira, 850 tons
(*DAS* 2, no. 2600.1)

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39. *Vergulde Draak*, yacht, 1656, Western Australia (Australia), 580 tons (*DAS* 2, no. 0833.2)

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40. *Vis*, Indiaman, 1740, Tafelbaai (South Africa), 650 tons
(*DAS* 2, no. 3174.4)

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41. *Vliegend Hert*, Indiaman, 1735, Zeeland (Netherlands), 850 tons
(*DAS* 2, no. 2978.2)

American Numismatic Rarities, LLC. *The Classics Sale: The Thomas H. Sebring Collection*, 285. Auction held on 5–6 January 2004. Orlando, 2004.

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42. *Waddinxveen*, Indiaman, 1697, Cape Town (South Africa), 751 tons (*DAS* 2, no. 1733.2; DAS 3, no. 5973.2)

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43. *Witte Leeuw*, yacht, 1613, St. Helena, 540 tons (*DAS* 2, no. 0139.3; *DAS* 3, no. 5100.3)

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*Impressionistische scholen en hedendaagse kunstenaars. Voorts vele antiquiteiten, kunstvoorwerpen, tapijten, meubelen en een collectie zilver, juwelen en objets de vertu. Bovendien een bijzondere collectie porselein en artefacten afkomstig uit het wrak van de in 1613 bij het eiland St. Helena gezonken Hollandse Oost–indiëvaarder* Witte Leeuw*, geborgen door Dr. R. Sténuit*, 232–49. Auction held on April 26–28, 1977. Amsterdam, 1977.

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# APPENDIX D
# TERMINOLOGY FOR DENDROCHRONOLOGICAL RESEARCH
By Elsemiek Hanraets

**Species**

Wood species are solely identified for the purpose of dendrochronological dating. Usually only the *genus* (i.e. *Querqus* sp. or *Pinus* sp.) is listed, unless it is known or obvious in some way what species the wood is.

**Pith**

Number of rings missing from the sample (or the measured tree ring series) up to the very first (oldest) ring that was formed by the tree.

**Sapwood**

Number of sapwood rings that were measured. The average number of sapwood rings in oak is 16±5 for a tree of up to 100 years old, 20±6 for a tree of between 100 and 200 years old and 26±8 for a tree of more than 200 years old.[1] In oaks from the Baltic region, the average number of sapwood rings is somewhat lower than in oaks from Western Europe: 15 (+8/-6).[2] Scots Pine (*Pinus sylvestris*) has clearly visible sapwood, but an estimation of the felling date is not possible as the number of sapwood rings varies too much. Norway spruce (*Picea abies*) and Silver Fir (*Abies alba*) have no sapwood. Of course the presence of the wood wane/edge or *waney edge* on a sample always gives the exact year of felling.

**Wood edge**

Estimated number of rings until the wood/waney edge or last-formed tree ring (directly under the bark) necessary to obtain the true felling date.

**Felling date**

The year in which a tree was felled. Only if the waney edge on the sample is present an absolute date for the felling of the tree can be given. When there is sapwood present (or when the sapwood border is visible) the felling date can be calculated. For example: when a sample of an oak of between 100 and 200 years old (with an average of 20±6 sapwood rings, see above) contains 4 sapwood rings, the average number of sapwood rings that are missing is 16±6. This number is added to the date of the last/youngest measured ring. If no sapwood rings are present on the sample, the number of missing heartwood rings is unknown. The felling date of that particular tree is an *unknown* number of years after the date of the youngest ring on the sample+the estimated number of missing sapwood rings.

***n***

Total number of rings on the sample.

**%PV**

"Gleichlaufigkeit" (German) or "Percentage of Parallel Variation" (English); Percentage of rings in the ring pattern of the sample and the chronology, which show an identical increase or decrease in ring width at the given position. Whether this value is meaningful depends on the length of the overlap between the series.

**t**

The value resulting from a Student's t-test on the cross correlation between the sample and the chronology.

**P**

The possibility (as a fraction of 1) that the value for %PV is coincidental and not a valid date.

**NLARTP01**

Chronology for oak from the Baltic region based on Dutch panel paintings.[3]

1 Hollstein, *Mitteleuropäische Eichenchronologie*, 33-35.
2 Wazny, "Aufbau und Anwendung der Dendrochronologie für Eichenholz in Polen," 185-87.
3 Eckstein, Brongers, and Bauch, "Tree-ring Research in the Netherlands," 1-13 (Chronology II).

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