THE ORIGIN OF THE LOST FLEET OF THE MONGOL EMPIRE

A Thesis

by

RANDALL JAMES SASAKI

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

MASTER OF ARTS

December 2008

Major Subject: Anthropology

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Approved by:

Chair of Committee,	Louis Filipe M. Vieira de Castro
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ABSTRACT

The Origin of the Lost Fleet of the Mongol Empire. (December 2008)

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In 1281 C.E., under the rule of Kublai Khan, the Mongols sent a fleet of more than 4000 vessels to subjugate the island nation of Japan. A powerful typhoon, called *kamikaze*, dashed the invading fleet into pieces on the shores of Japan and thus saved the nation from foreign rule. Historical sources suggest there were three principal vessel types involved in this event: V-shaped cargo ships for transporting provisions to the front, constructed in China's Fukien Province; miscellaneous flat and round bottomed vessels made along the Yangtze River; and flat bottomed landing craft from Korea.

In the recent past, the remains of the fleet were discovered at the Takashima underwater site in western Japan, unveiling numerous artifacts including weaponry, shipboard items, and sections of hull; however, between 1281 and the late twentieth century the site has seen major disturbances, and the artifacts are often in poor condition. Because the site contains the remains of ships built in China and Korea, the interpretation of the artifacts is also extremely complex. In order to determine the origin of the vessels, a logical framework is necessary. The author has created a timber category database, analyzed methods of joinery, and studied contemporary approaches to shipbuilding to ascertain the origins and types of vessels that composed the Mongol fleet.

Although no conclusive statements can be made regarding the origins of the vessels, it appears that historical documents and archaeological evidence correspond well to each other, and that many of the remains analyzed were from smaller vessels built along the Yangtze River Valley. Large, V-shaped cargo ships and the Korean vessels probably represent a small portion of the timbers raised at the Takashima site. As the first research project of its kind in the region, this study is a starting point for understanding the real story of the Mongol invasion of Japan, as well as the history of shipbuilding in East Asia.

To Sharon, my mother, without your support, this study would not have been possible.

To my father, who said my research was just a piece of junk.

ACKNOWLEDGMENTS

There are many who I wish to thank for their help and guidance in preparing this thesis. I apologize in omitting those friends, colleagues, and mentors who deserve to be noted here, but unfortunately are not listed. Kenzo Hayashida, a leading scholar in the field of underwater archaeology in Japan must be mentioned first. Without his effort in promoting the field of study, the Takashima underwater site would not have been known to the world. I will always be grateful for his support and direction. I owe many thanks to the Matsuura Board of Education who allowed me to analyze the timbers and provided access to their facilities while I conducted my research.

This research would not have been conducted without financial support by the Institute of Nautical Archaeology at Texas A&M University and RPM Nautical Foundation. The faculty members at the Nautical Archaeology Program, Committee Members, and colleagues were always helpful in providing a fresh look at my project. I appreciate the advice that our committee members provided me when I most needed it. Dr. James Delgado, who introduced this exciting project, must also be mentioned. I owe a thanks to those who proof-read my thesis, including Drs. Filipe Castro and Kevin Crisman. Finally, Dr. George Bass, you were always my source of motivation.

Many people participated in the timber recording project in Japan. I appreciate their time and effort in coming to the remote island for my research. The people of Takashima must not be forgotten. The warm welcome that they showed me became the treasure of my life; the

island of Takashima became my “third home town.” Last but not least, I owe everything to my parents. Thank you for your support.

TABLE OF CONTENTS

LIST OF FIGURES

FIGURE Page

FIGURE Page

FIGURE Page

LIST OF TABLES

CHAPTER I

INTRODUCTION

In the twelfth and thirteenth centuries C.E., East Asia experienced great expansion in maritime commerce because of the powerful Chinese state of the Southern Song dynasty (960-1279 C.E.).[1] At the same time, a nomadic tribe known as the Mongols became a powerful empire and began to threaten the civilizations of East Asia.[2] In 1274 C.E., Kublai Khan, the emperor of the Mongols, sent 900 Korean-made vessels to attack Japan, but was successful only in burning the international trade port of Hakata.[3] After this invasion, Kublai set his eyes on conquering the maritime nation of the Southern Song. He was successful in defeating the state and established the Yuan dynasty (1279-1368 C.E.).[4] Again in 1281 C.E., Kublai sent a massive fleet, this time consisting of more than 4000 vessels from southern China and Korea. When they approached the island of Takashima in western Japan, a great typhoon known as a *Kamikaze*, or divine wind, destroyed the vessels. It is said that only one of ten ships survived the ordeal.[5] Kublai never recovered from this failure and the power of the Yuan dynasty as well as the maritime activities of the region gradually declined.[6]

This thesis follows the style of *American Journal of Archaeology.*

[1] Lo 1969; Levathes 1997.

[2] Man 2006, 15-22.

[3] Saeki 2003, 89-98.

[4] Ōta 1997, 41.

[5] Saeki 2003, 140-9.

[6] See fig. 1 for a map of East Asia.

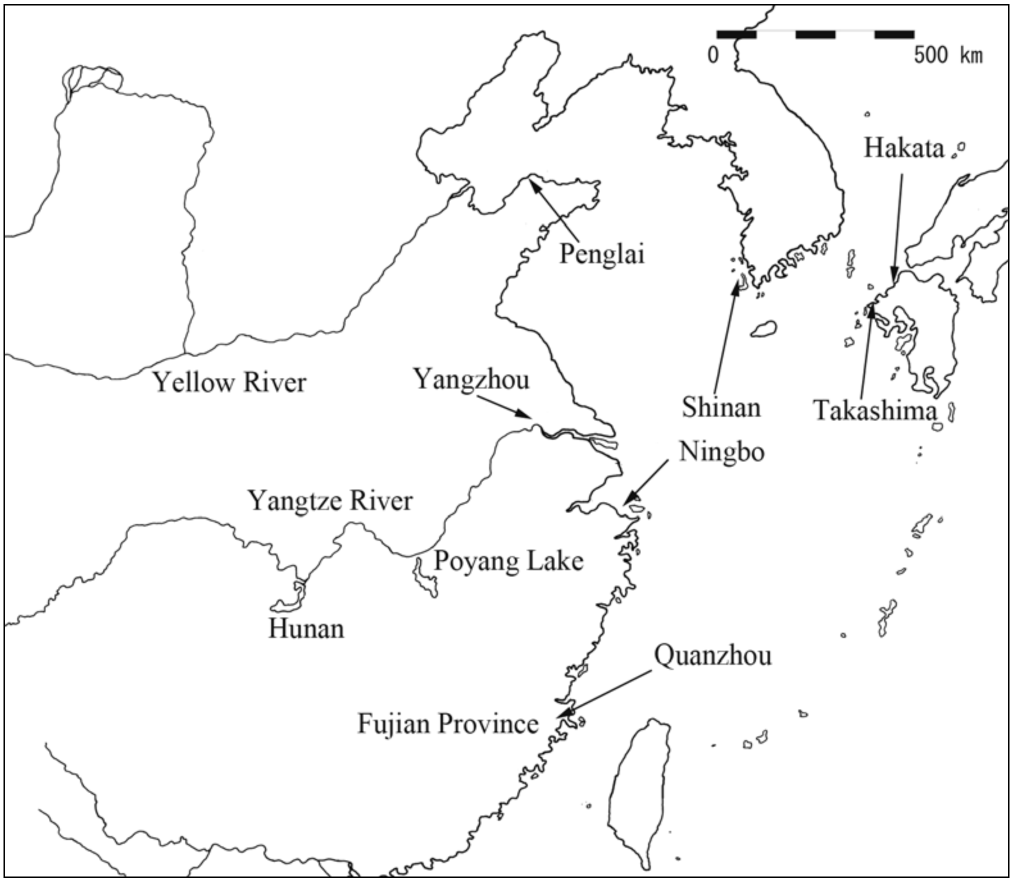

Fig. 1. A Map of East Asia.

Seven hundred years after the event, people in Japan still remember the story, but much of the history has been lost. The location where the Mongolian fleet met its end, the island of Takashima, is documented in historical records.[7] The development of underwater archaeology allowed the archaeologists to search for the lost fleet, but it was not until the 1980s that a full scale survey took place.[8] As a result, the Takashima underwater site containing various artifacts

[7] Takashima Board of Education, 1992, 1.

[8] Takashima Board of Education, 1984.

from the invasion was discovered.[9] Archaeologists can now study the physical evidence from the event that profoundly affected the course of Japan's history. More than 500 fragments of vessels were excavated and these timbers were recorded and analyzed by the author. The study, presented herein, based on archaeological remains and historical documents, describes how Kublai organized the second invasion of Japan. Particular attention is given to where the vessels were built and what types were involved in the invasion.

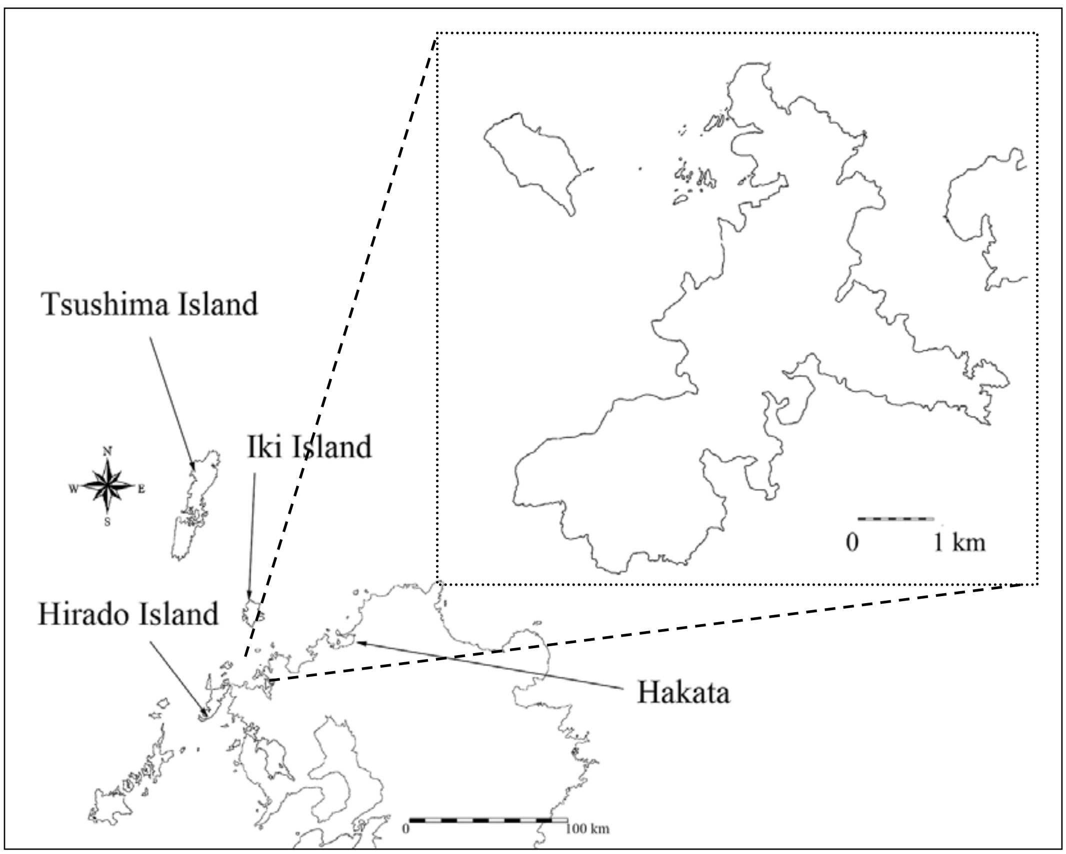

Fig. 2. A Map of Northern Kyūshū and Takashima Island.

[9] Takashima Board of Education, 1992, 1. See fig. 2 for the map of Takashima and western Japan.

In order to study the origin and types of the vessels involved in the invasion, it is important to know how the invasion was organized. It is apparent that from a careful reading of historical materials regarding Kublai Khan's campaigns that he was a master in organizing the resources and people needed to efficiently execute his missions.[10] Kublai probably knew that taking over the island nation was not going to be easy. The most logical approach in conquering Japan was therefore to establish a strong base in Japan in order to slowly advance inland while minimizing the loss of troops.

Kublai sent two separate armies for the invasion: the Eastern Army from Korea in 900 vessels, and the *Jiangnan* Army, or Southern Army, from Ningbo at the mouth of the Yangtze Delta in more than 3000 vessels.[11] The main fighting force, the Eastern Army, was comprised of Mongols, northern Chinese, and Koreans. Small landing craft built in Korea appears to have been used to carry these troops across the Tsushima Straits. The main purpose of the Southern Army was to transport grain and other supplies to the frontline. Large cargo vessels made in the province of Fujian, as well as vessels for reconnaissance and small special purpose boats built along the Yangtze River were likely used to transport the Southern force. The focus of this research is to employ historical documents as well as archaeological data from the Takashima underwater site to confirm the origin and types of vessels used by both armies. Archaeological evidence indicates that large V-shaped cargo vessels from Fujian Province were present in the fleet, as well as large and small vessels built in the Yangtze River area. Finally, the site also contained the remains of vessels that originated in Korea.

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[10] For a detailed life of Kublai, read Rossabi 1988; Man 2006.

[11] Saeki 2003, 140-2.

Although the study of historical documents provided a clear model for the fleet's composition, the interpretation of the archaeological remains from the Takashima underwater site required a careful research plan. Only a small percentage of the site has been excavated, and most of the hull remains were less than 50 cm long and were clearly broken pieces; indeed the site is essentially a scatter of broken, isolated fragmented timbers and artifacts from many lost vessels. These artifacts have been kept by the Takashima Board of Education for conservation (fig. 3). The author initiated the project to analyze the timbers in order to glean all possible information about the vessels. Considering the fragmented nature of the site, a logical research design had to be made, and ultimately, three methodologies were developed for this purpose.

Fig. 3. A Photo of Excavated Timbers kept at the Takashima Board of Education.

The first approach, the Timber Category Database, was created to identify how each timber functioned within a hull including beams, bulkhead, and planks. Each category was

analyzed separately in detail and compared with excavated shipwrecks in East Asia. The second approach was to organize the timbers into joinery groups. The joinery groups were categorized by those timbers with nails, complex wood joining technology, and the other fastening types. The study of joinery revealed the general nature of the types of ships present at the site. The third approach was to focus on several selected hull elements in order to study the construction sequence and methodology to reveal the identity of a particular fragment. When a unique construction feature is revealed, a vessel type may be identified.

This thesis is organized into chapters that discuss a specific aspect of the research. Chapter II provides the historical context in which the invasion took place as well as the strategy that Kublai followed. The next chapter discusses the naval organization and ship types along with the research at the Takashima underwater site. The following three chapters focus on the three approaches that the author took in analyzing the wooden remains from the site, the timber category database, a typology of joinery, and approach to shipbuilding philosophy. Chapter VII summarizes all approaches and discusses the significance of the invasion and this research.

CHAPTER II

A BRIEF HISTORY OF EAST ASIA

Before the Invasion

Beginning in the sixth century C.E., Arab and Persian merchants began to trade with China.[12] Later, Chinese merchants also became involved in the business of international commerce.[13] The fame of the Tang dynasty (618-907 C.E.) stems from the expansion of an extensive trade network. This is the time when the Silk Road flourished, both on land and at sea. This network brought goods from India and Southeast Asia to China and from China to the rest of Asia. The trade was based on a tribute system where officials from a country brought goods to the Tang court and the government sold the items to private individuals.[14] In exchange, the country that brought the goods came under the protection of China.[15] Japanese also imported numerous goods from China, which appear in contemporary Japanese documents as well as in the archaeological record.[16]

The glory of the Tang dynasty did not last forever. The government was weakened by internal struggle and by 960 C.E., the new dynasty of the Song was established. Initially, the

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[12] Flecker (2000) reports a possible Indian or Arabic vessel with Chinese cargo discovered in Southeast Asia, alluding to the strong maritime connection between China and the Indian Ocean.

[13] Flecker 2001, 348-50; Levathes 1997; So 2000.

[14] The tribute system obligated smaller surrounding countries to pay tribute to a larger or more powerful entity, in this case the Tang imperial family. Merchants had to accept Chinese over-lordship and culture, including the written language and calendar, to be listed as a legitimate trader. This was the official avenue for trade between the countries. See Cheng 1991.

[15] Anno 1999, 2-4; Kamei 1986, 4-21.

[16] Mori 1972, 4.

Song dynasty held the country in unity, but invaders from the north took over the northern half of the country. In response, the Song moved their capital south and the Southern Song dynasty was created.[17] In order to defend and finance the country, the court encouraged overseas trade and maritime commerce became a dependable source of income.[18] A powerful merchant class emerged, and the tribute system was abandoned by the state. In 1132 C.E., a professional navy was established, and prizes were offered for new naval inventions. It was by this route that major nautical inventions appeared, including the compass, which Chinese called the "south pointing needle."[19] International trade flourished, and cities such as Quanzhou and Ningbo became major centers of trade.[20]

The Southern Song's status as a maritime empire was, however, gradually destroyed by powerful invaders from the north, the Mongols. When Temujin, better known as Genghis Khan, took power in the late twelfth century, the number of his troops grew. His well-trained cavalry units swept the plains of Asia, Eastern Europe, the Middle East, South Asia, and East Asia creating the Mongol Empire.[21] The Mongols gradually spread their control into northern China and Korea. Northern China was administered by Kublai, a grandson of Genghis.[22] Kublai

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17 Roberts 2006; 90-106.

18 Sakuma (1995, 170) points out that the tax revenue from the maritime trade provided 5-10% of the government's income. Though this tax percentage seems small, it only represents the profit gathered by the government. Many people in the coastal areas also profited from mercantile, smuggling, and pirate activities. A similar argument can be found on Lo 1969, 64-9; Shiba 1983, 105-6.

19 Levathes 1997, 42-3; Van Tilburg 1994, 2.

20 Shiba 1983.

21 Man 2006, 20, 30-1.

22 Rossabi 1988, 28.

became involved with Chinese politics and embraced Chinese culture.[23] His aspiration was to conquer the Southern Song dynasty and become the reigning emperor of the Chinese civilization (fig. 4).[24]

The Southern Song Empire was a strong nation and conquering it did not take place overnight. Although the power of the empire was waning as a result of a long period of warfare, the dynasty still had an extensive naval force supported by the revenues from overseas trade.[25] The Mongols, on the other hand, lacked an organized naval force and were thus kept at bay by the Chinese Navy along the Yangtze River, the border of the Southern Song region. “Without ships, the Mongols could not subjugate the Song,” notes Morris Rossabi, a modern authority on Mongolian history.[26] To defeat the naval empire of the Song, it was necessary to curb the profits from trade in order to weaken them.[27] Kublai’s strategy for weakening and isolating the Southern Song cities was to initiate a campaign to invade two of the Song’s principal trading partners, Korea and Japan.

Korea suffered from Mongol invasions beginning in 1231 C.E. For the next twenty years the Mongols continued their advance down the peninsula, battling Korean resistance. It is recorded that more than 200,000 people were killed in Korea alone.[28] Korea’s king ultimately decided to make an alliance with the Mongols, accepting that their troops be stationed in his country. The Korean king also tried to maintain his authority by a marriage alliance with the

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[23] Man 2006, 55.

[24] Rossabi 1988, 53, 76.

[25] Lo 1969.

[26] Rossabi 1988, 82.

[27] Saeki 2003, 72.

[28] Saeki 2003, 55.

Mongol imperial family.[29] Many in Korea opposed his decision and revolted against both the Mongols and the king. This uprising, known as the revolt of *Sambyolcho*, lasted three years but it ultimately failed.[30] Finally, after a long period of suffering, Korea was under firm Mongol control by 1273 C.E.[31] The time was ripe to invade Japan.

Fig. 4 A Map Showing the Land Controlled by Kublai Khan prior to 1270 C.E.

At this time, Japan was ruled by a feudal military government, or *Bakufu,* a loose confederation of many clans that vowed to obey the shogun, who in turn bestowed land as a token of the good relationship. Although merchants from China frequently visited Japan, the Japanese government prohibited its citizens from traveling to foreign countries except as a

[29] Hatada 1965, 82.

[30] Nahm 1988, 88.

[31] Saeki 2003, 74.

student, monk, or for official trade.[32] Still, private smuggling was known and perhaps more common than available documents may suggest.[33] Hakata on Kyūshū Island became a major international city where merchants from the Southern Song visited frequently.[34] Many Chinese lived in Hakata, creating what might be called a "China Town."[35]

In 1267 C.E., the Mongols sent an emissary to Japan. Copies of the letter he carried survive to this day, and according to its contents, the Mongols asked for a trading relationship. More ominously, the emissary told Japan to accept the Mongols as a superior power, and warned that the Mongols would use force if Japan did not comply.[36] The *Bakufu* sent back the envoy without providing an answer.[37] The Mongols sent similar missions several more times, but Japan showed no change in its policy. After suppressing the revolt of *Sambyolcho* in 1273 C.E., Kublai gave the people of Korea no time to rest. In January of the next year the Mongols ordered the Koreans to build 900 ships: The vessels were ready by the beginning of summer.[38] The main fighting force was made up of Mongols and northern Chinese who had already been stationed in Korea for several years. The Mongols and Chinese numbered 20,000 troops, while Korea provided 6,000 men.[39] Somewhere between 6,700 and 15,000 sailors from Korea were also

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[32] Kamei 1986, 5-7.

[33] Mori 1972, 5-11; Sakuma 1995, 173; Shiba 1983, 106.

[34] Batten 2006; Saeki 2003, 24-5.

[35] The detail discussion of Hakata as "China Town" is discussed in Batten (2006).

[36] Saeki 2003, 57.

[37] Saeki 2003, 59.

[38] Hatada 1965, 108; Ōta 1997, 17-20. The vessels that were used during the revolt may have been refitted and deployed to be used for the invasion.

[39] Saeki 2003, 90.

employed in manning the vessels of the invasion fleet.[40] These combined forces left Korea in the late summer of 1274 C.E. They soon took control of Tsushima and Iki Islands, then quickly advanced to Hakata Bay.[41] The Mongols landed, burned the city of Hakata and proceeded further inland.

The *Mōko Shūrai Ekotoba* scroll depicts the event of the 1274 invasion with remarkable detail (fig. 5).[42] This painted scroll was drawn by a Japanese artist probably soon after the events took place.[43] It shows colorful troops representing various ethnic groups, and also depicts weapons used by the Mongols, including *Tetsuhau,* a ceramic ball filled with scrap iron and gun powder.[44] The Mongolian troops carried drums and gongs to send orders to the units. According to the scroll's descriptions of the first invasion, most of the battles were fought on land.

The Mongols initially fought well, but despite their new weapons and organized tactics, they began to falter and retreated back to their ships. The true reason for this retreat is difficult to identify. The official history of the Yuan dynasty, *Yuan Shi*, describes the event, mentioning "the troop was not organized" and "all the arrows had been used." [45] The combined forces of Mongols, northern Chinese, Koreans, and possibly other ethnic groups were numerous, but not able to fight well against united Japanese forces. Another hypothesis for the retreat is that the

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[40] Different sources give different numbers of troops. For example, Rossabi (1998, 102) gives different numbers. Ōta 1997, 48; Hatada 1965, 111. See also Table 1

[41] Saeki 2003, 94.

[42] Although it is certain that the original *Mōko Shūrai Ekotoba* scroll (蒙古襲来絵詞) was made immediately after the invasion, the creator is not known. See Conlan 2001.

[43] Conlan 2001, 1-9.

[44] The *tetsuhau* have been found at the Takashima underwater site. Takashima Board of Education, 2003.

[45] Yuan Shi (元史) History of the Yuan dynasty written by Song Lian (宋濂), See Ōta 1997, 6.

main reason for the first landing was more in the nature of a raid than a full-scale invasion and that its goal was to attack the town of Hakata and weaken an important source of income for the Southern Song cities. In this respect, the first invasion was not a total defeat for the Mongols.

Fig 5. An Illustration of a Vessel in the *Mōko Shūrai Ekotoba* Scroll.

(Courtesy of the Museum of the Imperial Collections, *Sannomaru Shozokan*)

The Hakata-centered trade was profitable for the Chinese mainly because Japan based the value of coin on the value of its metal, while China minted coin to collect taxes and its value was artificially fixed by the government.[46] Thus, even the coin that stopped circulating in China centuries before was still valuable in Japan.[47] By cutting off this trade, Chinese cities lost their source of wealth and finance, which significantly weakened the empire.

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[46] Schottenhammer 2001; 130-40; The significance of this different approach to precious metals was that the value of copper and brass coin might decline in China while the price was more stable in Japan. See also Yamamura and Kamiki, 1983.

[47] Kamei (1986, 183-6) mentions that the Shinan ship, which originated in China and was shipwrecked during the Yuan dynasty, had seven million brass and copper coins on board, including the earliest coin dating from 14 C.E.

After the first invasion, the Japanese feared that the Mongols might soon return with a greater force, and even considered mounting a counter-attack on Korea to disrupt any preparations that might be taken place; however, this plan never materialized. Instead, the *Bakufu* ordered the construction of stone walls along the coast where the Mongols might land.[48] The Mongols again sent emissaries demanding submission, but this time the *Bakufu* had them beheaded.[49] While sending troops to attack Japan, Kublai was not distracted from his ultimate objective: conquering the Southern Song Empire. Kublai successfully convinced his opponent's naval officers to join forces with the Mongols which eventually led to the fall of the Southern Song dynasty in 1279 C.E.[50] After the victory, Kublai established the Yuan dynasty, and became the ruler of the China. He became Kublai Khan, the ruler of both the Mongol and the Chinese empires.

The Strategy for the Second Invasion of 1281

Kublai's legitimacy as a ruler was always contested.[51] He was chosen as the Mongolian Great Khan, not in his homeland but in China; and he was an emperor of China, but he was not Chinese. To prove his authority and to gain strong support, it was necessary for him to conquer foreign lands.[52] In the manner of authoritarian rulers throughout history, Kublai saw

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[48] Hatada 1965, 118.

[49] Hatada 1965, 130.

[50] Rossabi 1988, 208.

[51] Rossabi 1988, 53.

[52] Rossabi (1998, 76) mentions that in Mongolian tradition, the ruler's ability was judged by the wealth, or the land that he controlled. In China, the authority of the emperor was reflected by bringing foreigners to accept Chinese cultural and economic supremacy.

a major military effort against an outside foe as a way to unify his subjects and maintain his position as an emperor. Soon after conquering the Southern Song, Kublai decided to invade Japan yet again; the unfavorable result of the first invasion might have given Kublai a feeling that this was an “unfinished” job.

Historical documents make it apparent that Kublai organized the invasion fleet with a purpose; it was not a conglomeration of randomly-chosen ship types. Identifying the plan and organization of the invasion is useful for determining the origin and types of vessels that the Mongols used for the project. The possible strategy the Kublai employed is discussed below. First, one must study how Kublai led other campaigns to victory, and the method of his success can be used to deduce the plan used for the invasion. For this, Kublai’s campaigns against Dali, Song cities, and the first invasion of Japan are worth discussing.

The campaign against the city nation of Dali, located southwest of the Song territory, was Kublai’s first major military operation; the success of this campaign made him the most prominent successor for the Mongolian throne. The primary reason for invading Dali was to weaken the Southern Song Empire. By taking Dali, Kublai cut the important trade that benefited the Song cities, and at the same time established strategic positions for launching his army into the interior. Kublai began his Dali campaign planning in July 1252 C.E., but did not set out until September of the next year. The important aspect of the preparation was that Kublai established military farms for supplying his troops, even creating a specific bureau for the purpose.[53] This shows his careful plan and calculated strategy. On the surface, this almost seems to be a waste of

[53] Rossabi (1988, 22-4) discusses this campaign in detail.

time in creating the needed supplies, considering that the purpose of the invasion was only to weaken the Southern Song. Yet, in the end, Kublai was successful and came to rule the land.

The attacks on the Chinese cities also exhibited tactics similar to those Kublai used in his conquest of Dali. His campaign's success rested on making towns and regions self-sufficient in providing troops and supplies. The Mongols were not always on the attack and the stereotypical image of always-invading and fierce Mongols must be dismissed. Kublai used many foreign advisors to rule his empire efficiently, and they often provided strategies for battles.[54] Kublai also cooperated with local populations to topple the Southern Song Empire. At the city of Quanzhou, the superintendent of maritime trade was persuaded by Kublai to assist in ending the Southern Song rule.[55] The Mongols were quick in adopting military technologies, such as siege weapons, and using them for efficient battle tactics. The power of the Mongols in general, and Kublai in particular, was based on flexibility in accepting the tactics most suited for the purpose of the campaign. Kublai also studied the nature of local populations, available technologies, environments, and other factors that could affect the outcome of a battle. This is why the Mongols, a land-bound population based on the Asian steppes, were able to conquer the maritime empire of the Southern Song.

The 1274 invasion of Japan was the first time that the Mongols engaged in a true invasion across an open sea.[56] Supplying troops with enough provisions was, in many ways, more important than the operation on land. Nevertheless, the Korean peninsula is not as fertile a land as the Southern Song area. One year before the invasion, Kublai ordered a survey of Korea

[54] Man 2006, 52-6; Rossabi 1988, 131-52.

[55] Rossabi 1988, 92.

[56] Approximately 160 km had to be crossed between Korea and the Island of Tsushima.

to determine the number of troops, amount of grains, and ships that could be used for the expedition.[57] *Goryeo-sa*, the history of the Korea, mentions that three types of vessels were selected for the first invasion.[58] These are one-thousand-*Liao* vessels, *Baator* Fighting vessels, and water transport boats; it is said that 300 vessels were built for each type, totaling 900 vessels. The one-thousand-*Liao* vessels are considered to be transport vessels, much like a merchant ship. *Liao* is a unit of measurement for a volume or a weight, estimated to be 29 liters. One thousand *Liao* is thus close to 30000 liters or 300 tons. [59] *Baator* is a word for brave warrior in the Mongolian language, and this is most likely a landing craft.[60] The water transports can be considered as miscellaneous boats.

Kublai's strategies for these and many other military expeditions demonstrate his emphasis on the efficient organization of troops and the importance of carrying adequate supplies of provisions. In order to create a foothold in Japan, Kublai had to analyze the strength and weakness of each ethnic group and region to fully utilize the resources at his disposal. To accomplish its tasks, the army would be divided into several special purpose groups. First, combat troops had to land on the Japanese homeland and gain control over a piece of land. Once this was achieved, the next unit comprised of army-farmers had to be settled.[61] Until the community became self-sufficient, a considerable quantity of provisions would have to be

[57] Saeki 2003, 89.

[58] *Goryeo-sa (高麗史)* was compiled during the fifteenth century. See Nahm 1988 and Ōta 1997.

[59] Ōta 1997, 14. This is based on the assumption that 1000 *Liao* is a measurement of cargo capacity. Furthermore, the 1000 *Liao* seems to be a convenient way to say "cargo ship with great carrying capacity," and not the actual volume of the cargo that the vessel can carry.

[60] Yamagata 2004, 48-9.

[61] A possible farming tool has been found at the Takashima underwater site. See Matsuura Board of Education 2008, fig. 58.

brought in. Thus, logically there should be two main forces; one dedicated to fighting and acquiring territory, and the other, the supporting unit to ensure an amply supply of grain.

Many of the historical documents can be presented as supporting this hypothesis. Kōki Ōta, a Japanese historian is one of the major proponents of this theory.[62] Written sources mention two separate armies were organized for the second invasion; the Eastern Army set out from Korea and the Southern Army sailed from the Yangtze River mouth. The Eastern Army was the principal fighting force, while the main purpose of the Southern Army was to support the operation, to carry the grain and other supplies to the front.[63] This becomes clear when we realize the difference in circumstances, physical environment, and types of ships built in these two regions.[64]

As mentioned above, the Korean king became a close ally of the Mongol Empire.[65] The balance of power was far from being equal; the king had to prove his loyalty to the Mongols. If the invasion was successful, his effort would be rewarded by gaining higher status within the empire. For this reason the Korean king supported Kublai's endeavor by building vessels. The past relationship between Korea and Japan had not been amicable, and it is possible that many Koreans were willing to fight against the Japanese.[66] Despite its willingness to aid in the invasion, Korea lacked resources to support the troops. The mountainous peninsula did not possess large areas of fertile land required to grow grain to feed the large number of soldiers.[67]

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[62] Ōta 1997.

[63] Ōta 1997.

[64] A detailed discussion of different ship types will be discussed in the following chapter.

[65] Rossabi 1988, 95-9.

[66] Batten 2006, 91-8.

[67] Ōta 1997, 49.

Furthermore, ever since the first Mongols advanced into Korea, the country had been engaged in continuous warfare and its resources were depleted.[68] Korea did not possess large vessels because its coastline, dotted with numerous islands, was complex and did not allow large vessels to develop. Small, strongly-built vessels were much more suited for such an environment. For the second invasion, all 900 vessels sent out from Korea were simply called "Fighting Ships."[69] These vessels must have been robust, flat-bottomed boats typical of those vessels built in Korea. Flat-bottomed designs were suited for protected inland waters, and were best used as a landing craft.

The circumstances of the Southern Song, on the other hand, were the opposite. As a result of the Mongol conquest just a few years prior to the second invasion of Japan, a large number of people from the Southern Song region may not have been content with a foreign emperor ruling over them. There was a possibility that a powerful leader could take control of the navy and try to bring native Chinese rule back to China. The navy and army were still functioning, but it was no longer necessary to defend the country from the Mongols who now ruled them. Kublai did not find it expedient to dismiss soldiers because this would flood the country with a newly unemployed population. A simple solution to these problems was to send Chinese forces to conquer other lands. The former Southern Song territory possessed considerable resources, particularly grain. The delta of the Yangtze River was a rich and fertile landscape, and was the main grain producing region in China. The grain trade from south to north China was a profitable trade, either by canals or by sea.[70]

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68 Nahm 1988, 90.

69 Ōta 1997, 63.

70 Rossabi 1988, 188-9.

It is known that Kublai ordered shipwrights in two major areas, along the Yangtze River and Fujian Province, to construct vessels for the Southern Army. The Yangtze River was famous for its shipbuilding tradition, and thousands of different ship types existed in this part of the world.[71] The vessels built along the Yangtze River were probably best used for miscellaneous purposes, for reconnaissance, and for transporting materials and soldiers near shore. Vessels from the region were designed to be used on inland waters and may not have been suited for long voyages. Fujian Province was famous for its building of cargo ships, especially V-shaped vessels suited for long voyages, and ships built here frequently visited Japan.[72] By utilizing its ample resources and wealthy seafaring merchants, the people of the Southern Song once ruled the sea. The vessels constructed in southern China may not have been as sturdy as their Korean counterparts, for according to Kublai: "Ships from the Song are big but not strong; Korean ships are small but strong."[73] Thus, the Southern Song were not willing to fight, but they had an amply supply of provisions and other resources, and they possessed large cargo vessels.

The records of the event reflect the plan of the invasion, for the number of ships and troops, and the amount of grain that they carried are listed. Table 1 provides estimates by scholars of the total numbers of troops and ships for the second invasion. These records can be used for reconstructing the general nature of the fleet.[74] One estimate has the Eastern Army at 40,000 troops and 17,029 non-fighting crew on 900 ships, and the Southern Army with 100,000

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[71] Worcester (1971) illustrates numerous drawings and plans of the Chinese crafts along the Yangtze River.

[72] Batten 2006, 112-21.

[73] Ōta 1997, 76.

[74] Ōta 1997, Rossabi 1988, and Saeki 2003 all report different numbers of troops, depending on historical sources and the number of non-combat support personnel.

Table 1. Estimates of the Number of Troops and Ships.

1st Invasion (1274)

Estimate by Rossabi (1988)

300 Large Vessels and 4-500 Small Vessels

15000 Mongols/Chinese Soldiers, 6-8000 Korean Soldiers, and 7000 Korean Sailors

Estimate by Ōta (1997)

900 Vessels (one-thousand-*Liao*, *Baator* Fighting, and water transport vessels)

26000 Mongol/Chinese Soliders and 6700 Korean Sailors/Soliders

2nd Invasion (1281)

The Eastern Army

Estimate by Rossabi (1988)

40,000 Mongol/Chinese Soldiers, 25,000 Korean Soldiers and Sailors in 900 vessels

Estimate by Ōta (1997)

40,000 Soldiers and 17029 Korean Sailors in 900 vessels

The Southern Army

Estimate by Rossabi (1988)

Number of vessels not specified

100,000 Soldiers

Estimate by Ōta (1997)

3500 Vessels

100,000 Soldiers and 42572 Sailors

troops and 42,572 non-fighting crew on 3,400 to 3,600 ships.[75] The number of troops divided by the number of vessels can be used as a rough estimate for the function of the troops. The Eastern army had 55 persons per ship, and the Southern Army had 27 persons. The large number of troops on a vessel suggests a unit whose purpose was to carry the main fighting force to the front while the number of 27 persons per ship seems too small for this purpose. If a ship's main cargo was provisions and necessary materials to create a base of support for the field army, then the small number of people on board can be explained; they were sailors who operated the ship along with soldiers to garrison the base. From the amounts of grain carried, Ōta estimates the amounts of provisions allocated to feed the Kublai's army and concludes that the Eastern Army carried grain to last five to six months while the Southern Army carried thirteen to sixteen months worth of grain. These numbers reflect the fact that the Eastern Army had an inadequate supply of grain, while the Southern Army had a smaller number of troops but carried more grain and other resources for creating a base for the conquest and occupation of Japan.

The 1281 Invasion and Its Aftermath

In the original plan of the 1281 invasion, the two armies were to meet at Iki Island off Kyūshū around mid-June.[76] In May or June, 900 ships from Korea crossed to Tsushima and Iki Islands, taking control of the Tsushima Strait. The Eastern Army waited for the arrival of the Southern Army; however, the commander of the Southern Army, Arahan, was struck ill and

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[75] *Yuan Shi* and *Goryeo-sa* mention different numbers of men. One source includes the number of non-troops in the total, while the other source mentions the combined number. Furthermore, it is not certain if these represent the actual or the ideal number of men. See detailed discussion by Ōta 1997, 48.

[76] Saeki 2003, 140; Hatada 1965, 139.

Atahai took charge in his place.[77] The Southern Army left the port in late June, the date designated to meet the Eastern Army.[78] While waiting, the Eastern Army complained that their ships were rotting and the troops had no food to eat.[79] In late July, the two armies finally met at Hirado Island. They remained there for several days, and then advanced to Takashima Island in Imari Bay.[80] The Mongolian Army took control of the island, wiping out its inhabitants. Only a handful of people survived the massacre, and legends of the event are still told on the island to this day.[81]

The depictions from the *Mōko Shūrai Ekotoba* scroll of the second invasion are mostly of battle scenes fought at sea. Several scholars, including Thomas Conlan, have suggested that the stone walls constructed between the first and second invasion, as well as the small fast boats that the Japanese used to attack one vessel at a time, prevented Mongolian troops from successfully landing.[82] After a few days of fighting, a typhoon struck the area, crushing the invading fleet. The *Goryeo-sa* mentions, "about 100,000 troops of the Southern Army came, met with large wind, and all the Southern Army died."[83] Most sources agree that the majority of the damage was inflicted upon the Southern Army; one source estimates that 70,000 of the initial

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77 Saeki 2003, 142.

78 Hatada 1965, 142.

79 Ōta 1997, 49.

80 Hatada 1965, 142.

81 One woman was hiding in the forest when the Mongols heard a rooster. They thought someone was hiding inside the forest and thus she was found and killed. To this date, people in this village do not raise chickens.

82 Conlan 2001.

83 Ōta 1997, 42.

100,000 troops died.[84] Most of the Eastern Army, on the other hand, returned safely to Korea.[85] The Eastern Army used smaller vessels that could have been beached during the storm, or the Korean sailors may have anticipated the coming of the storm and returned to Korea before it struck (Fig 6). Many who survived the typhoon fought against each other to get on board the vessels that survived.[86] The Japanese took the great wind as an opportunity to hunt down enemies who survived the storm, and the 1281 campaign ended in a total Japanese victory. The people of Japan believed the wind was brought by the gods to protect the nation from foreign invaders and thus the Japanese were the chosen people of the gods. Temples and shrines demanded that the *Bakufu* pay rewards for their continuous prayers that brought the divine intervention.[87]

Despite their victory, the Japanese continued to believe that the Mongols would attack their nation again; the *Bakufu* ordered a continuous patrol of the waters of Japan.[88] This threat was real, as Kublai had actually put plans for a third invasion forward. Southern China did not have enough resources to prepare for the next invasion, however, and the people revolted.[89] Kublai therefore ordered the areas unaffected by the two previous attempts, northern China and north of Manchuria, to prepare ships for the invasion.[90] Many of the Mongol Empire's high-ranking officials advised against Kublai's plan and he was finally persuaded to abandon

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[84] Ōta 1997, 72-8.

[85] Ōta 1997, 72-9.

[86] Saeki 2003, 148.

[87] Saeki 2003, 186-7.

[88] Saeki 2003, 182.

[89] Ōta 1997, 169.

[90] Ōta 1997, 169

Fig. 6. A Depiction of Possible Landing Craft in the *Mōko Shūrai Ekotoba* Scroll.

(Courtesy of the Museum of the Imperial Collections, *Sannomaru Shozokan*)

further attacks on Japan. When the third invasion was officially canceled, it is said that the sound of celebration was like the sound of thunder.[91] Vessels already being built for the third invasion were sent to invade Sakhalin, Vietnam, and Southeast Asia instead.[92] The maritime legacy of the Mongol dynasty is one of continuous invasions, but all of Kublai's attempts to subjugate his foes with seaborne armies failed. Kublai died soon after hearing the failure of his overseas expeditions in Southeast Asia, and weak rulers succeeded him. The power of the Mongols in

[91] Hatada 1965, 162.

[92] Saeki 2003, 191-2.

China began to wane, and the new empire of the Ming was established in 1368. C.E. The maritime power that China had once possessed gradually declined.

It can be said that the greatest damage caused by the Kublai's Japanese invasions was inflicted upon the Koreans, who first suffered from the invasion of their country, and then from the preparation efforts for the Japan ventures. One account in *Goryeo-sa* mentions that the forests along the coastline of Korea were depleted during the preparation for the Japanese invasions and vessels could no longer be constructed.[93] On the other hand, Japan suffered little compared to the toil that the people of Korea had to endure. The "China Town" in Hakata declined after the invasions, but Japanese merchants compensated by sailing directly to China for trade.[94] The Japanese were able to move more freely around the sea because Korean merchant activities had declined.[95] One result of this new trading pattern was that elements of Chinese culture, such as tea and ceramics, became popular in Japan.[96]

The decline of naval power in China and Korea, along with strong Japanese private mercantile activities, led to the emergence of the pirates known as *Wako.*[97] Although it uses the term *"wa,"* the ancient word meaning people from Japan, in reality the *wako* consisted mainly of marginal populations that lived along the coastal regions of Japan, Korea and China.[98] Beginning in the 1300s, these pirates began to burn and pillage villages along the Korean and

93 Ōta 1997, 283.

94 Mori 1975, 558-9.

95 Sakuma 1995, 196; So 2000, 94.

96 Saeki 2003, 215.

97 Mori 1975, 14.

98 Anno 1999, 7.

Chinese coasts.[99] The power of the *Wako* grew and, as a result, maritime activities in East Asia were severely disrupted. The activities of *Wako* also led to the neglect of the navy, and governments had to rely on civilians and merchants to secure the coastline.[100]

In China, continuous warfare during the Song and Yuan dynasties led to a decline in productivity and distrust of foreigners. Over the years, the Ming court gradually became xenophobic, prohibiting private overseas trade and construction of large vessels.[101] The voyages of the Ming admiral Cheng He in the early fifteenth century with his treasure fleet are often quoted as the height of East Asia's maritime legacy.[102] However, a negative view of maritime expansion seems to have grown during the Mongol rule, and by the early Ming period, the ruling class suddenly stopped their support of oversea expansions.[103] Although envoys were sent to India and the Middle East, shipping in China was in decline long before this time.[104] The main concern of those missions was to recreate the glory of the Tang dynasty and its tribute system. Recreating the private shipping that flourished during the Song dynasty was not their main focus.[105] Another factor that led to the decline of maritime activity was the major restoration of

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[99] Tanaka 1986, 125-69.

[100] Anno (1999, 4-8) and Lo (1958, 160) point to an interesting phenomena. When the Ming banned private maritime trade, the activities of the *Wako* became active. On the other hand, when the court eased restriction, pirate activity declined.

[101] Van Tilburg 1994, 28.

[102] The story of admiral *Cheng He* is written in numerous journals and books. See Levathes (1997) and Needham et al. (1971, 480-526) for more information.

[103] So 2000, 119.

[104] Cheng 1991, 28.

[105] One of the reason that the Tribute system was not effective for the Ming dynasty is that the countries that once relied on protection from China during Tang dynasty no longer needed such support because they had become economically and politically stable. Cheng 1991; Levathes 1997; Lo 1958, 154-8.

the Grand Canal in the fifteenth century. Until this time, grain grown in southern China was brought to northern China by sea using large grain transport vessels. The opening of the Grand Canal connected southern and northern China by an interior waterway and led to the decline of this sea route and the construction of large draft vessels.[106] Small shallow draft vessels were required to transport grain over canals and rivers.

By the end of sixteenth century, large seagoing vessels were no longer made in China and the great shipbuilding tradition was lost from the country.[107] Many Chinese traders and shipwrights migrated to Southeast Asia where the Chinese shipbuilding tradition continued.[108] This led to the development of new trade routes and the mix of people and cultures created a new Southeast Asia. As seen here, Kublai's intractable desire to invade Japan and the disastrous failures that followed had a profound impact on the maritime history of East Asia as a whole.

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[106] Lo 1958, 159.

[107] The Bakau ship from the middle Ming Dynasty is interesting in this respect. This vessel was built in Fujian Province, that used to build a V-shaped vessel. However, this wreck shows many construction features that are used in Fujian Province, but the vessel is a flat-bottom boat. See Flecker 2001.

[108] Cheng 1991; The Phu Quoc ship, found in Vietnam and dating to the fourteenth or early fifteenth centuries, is thought to be Southeast Asian in origin but with its construction guided by Chinese shipwrights. See Blake and Flecker 1994.

CHAPTER III

MONGOLIAN-ERA SHIPBUILDING TECHNOLOGY

East Asian Naval Organization

G.R.G. Worcester, an expert on traditional Chinese river craft of the Yangtze River, once wrote: "China holds scholarship in high honor, but apparently they did not concern themselves with naval history or nautical lore."[109] Other scholars, including Joseph Needham, were also aware of the apparent lack of historical documents regarding naval architecture and shipbuilding; Needham noted that comprehensive nautical treatises were rarely written in China.[110] Nonetheless, numerous naval battles took place throughout the history of East Asia on rivers, lakes, and open seas. Both inland and ocean maritime trade had also played a vital role in Asian economies. Although historical accounts do not contain detailed information regarding construction techniques, some useful information regarding shipbuilding, outfitting, and handling practices can be ascertained. Instead of attempting a literature review from all periods, I have focused on several accounts that are most relevant for the study of the Mongol invasions of Japan.

The Chinese wrote extensively on warfare with a particular emphasis on who was involved, how many soldiers were in a battle, and the course of the event. Historical documents generally record the number of ships present in naval engagements; however, it is difficult to interpret this number because there are no means to verify the exact count and the figures appeared to be exaggerated in many instances. The types of ships are rarely mentioned, and thus

[109] Worcester 1971, 335.

[110] Needham et al. 1971, 380.

the modern day scholar cannot tell if the number includes all the vessels, including ship's boats, or if only the large vessels were counted. When the Mongols attacked along the Yangtze River, numerous accounts stated the number of ships involved and the number of ships that they captured. According to these accounts the Mongols usually captured or confiscated from 100 to 2,000 ships per engagement, but one recorded instance mentions 50,000 vessels taken by them.[111] Several documents also mention the number of ships produced in a specific shipyard, for example, at Mingzhou, Wenzhou, and Taizhou. These cities had close to 20,000 vessels registered in 1257 C.E..[112] Such accounts give an idea of the size of the naval forces usually involved in Mongol campaigns. According to these figures, the size of the fleet assembled to invade Japan, 4000 ships, is not that much different from other Mongol campaigns.

In the era of the Mongol invasions, some vessels were made at government shipyards, and some were ex-pirate vessels, but most were converted from merchant vessels. The employment of merchant craft for naval purposes is recorded as a common practice of the time.[113] We can assume that captured vessels as well as conscripted pirate and merchant vessels needed to be repaired or refitted to be used for naval service. This is also evidenced from a wooden tag found at the Takashima underwater site, upon which was written, "In the first year of…has inspected, repaired, and approved its use."[114] It is not certain what was actually repaired and inspected, but it can be assumed that it was large equipment that needed repair, perhaps a vessel.

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[111] Takashima Board of Education 2003, 63.

[112] Lo 1969, 95-6.

[113] Ōta 1997, 119-201.

[114] Takshima Board of Education 2003, 60-8.

Vessels used by a navy were generally organized by size, but could also be organized by function. A document from the eleventh century C.E. notes that the vessels were divided into three size classifications according to transverse dimension or their beam. The first class consisted of ships with beams greater than approximately 7.3 m and required crews of more than 40 sailors. The second class is encompassed ships with beams of approximately 6 m, and the third class approximately 5.5 m or less.[115] Perhaps the most detailed account of the naval vessels is in *Tai Bai Yin Jie*, originally written in the eighth century C.E. and reproduced and reprinted in later centuries.[116] This text illustrates six types of vessels: tower ships, combat junks, sea-hawk ships, covered swoopers, flying barques, and patrol boats.[117] The documents do not specify any construction method, but descriptions are based on the vessels' function in naval campaigns. These vessels were most likely built at different shipyards and thus even when called a similar name, each vessel was slightly different from the other.

The tower ship had three levels and was fully protected against arrows. Instead of having several deck levels, it seems that a superstructure or fighting platform was constructed above the deck to contain the soldiers. This vessel was large and perhaps acted as a flagship with the main fighting conducted with combat junks. The combat junk was a smaller vessel with ramparts or bulwarks built on deck to provide a protected fighting space. Another interesting vessel was the sea-hawk ship, which was equipped with floating boards, or perhaps what might

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[115] Lo 1969, 82.

[116] *Tai Bai Yin Jie (太白阴经)* was originally written during Tang dynasty by Li Quan (李荃). See Wang and Zhang 2004

[117] Translation of the name of the vessel is based on terminology by Needham et al. 1979, 424-5. 楼船 (tower ship), 戦艦(combat junk), 海鶻(sea-hawk ship), 蒙衝(covered swooper), 走舸(flying barque), 遊艇(patrol boat).

be considered a leeboard. Both the covered swooper and the flying barque were fast ships that carried troops; a covered swooper was much larger and longer in size than a flying barque. A patrol boat was, as the name suggests, a small boat that was not used for fighting but for reconnaissance.[118] The document does not provide information comparable with archaeological evidence, but the description clearly suggests that fleets were organized with several types of special-purpose vessels.

The accounts of foreign travelers to China are worth mentioning here. The Italian merchant Marco Polo visited China during Kublai's reign. He described Chinese vessels, shipbuilding practices, and naval organization in remarkable detail. According to Polo's descriptions the large vessels could carry 300 men, and up to 360 ton of cargo. A large vessel carried two or three large tenders and was also able to take up to ten small boats. Most of these boats were lashed to its sides and two or three astern. Some of the larger ships towed a full-sized vessel which had its own mariners and sailors.[119] Ibn Battuta, an Arab traveler who visited China around 1347 C.E., described naval practices at the time. According to Battuta, large ships carried 1,000 men, 600 sailors and 400 marines, had four decks and twelve sails, and were followed by three small vessels.[120] Polo's and Battuta's accounts illustrate how a naval flotilla might have been organized with one large vessel followed by many smaller vessels to create a complete unit.

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[118] Wang and Zhang 2004, 225-9.

[119] The work by Polo can be found in several editions. See Yamagata 2004, 55; Yule 1993, 250-1.

[120] The original account of Battuta can be found on several reprints. See Defremaery, C., and B.R. Sanguinetti 1856, 172; Mackintosh-Smith 2002, 223-4; Needham et al. 1971, 468-70.

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From this brief survey in Chinese naval organization, the way in which Kublai organized the fleet for the second invasion of Japan can be seen. Some vessels were newly built, and some were gathered, repaired, and refitted from the old Song navy, and from merchants and pirate ships. The vessels were made in various areas. The fleet was organized into a group, probably by size and by function. A large vessel carried several small boats, either towed or carried on board. This practice enabled the vessels not suited for open sea to be brought safely to Japan. Large vessels were not suited for battle once they reached the enemy's shore and so the small and swift vessels were used more extensively on shallow waters.

Ship Types

Historical, ethnographical, and archaeological evidence can provide insight into what types of vessels were constructed in East Asia. In this section, the description of archaeological evidence will be kept to a minimum, and details of ship construction will be discussed at length when analyzing specific timbers recovered from the Takashima underwater site.[121] First, the vessels built in Korea used for the Eastern Army will be discussed followed by vessels built in China used for the Southern Army.

The traditional Korean flat-bottom watercraft developed from a log boat and relied upon heavy, robust hull timbers (fig.7).[122] Ethnographic, historical, and archaeological records point to a tradition of shipbuilding based on using wooden fasteners instead of iron nails. Particular attention must be paid to the Wando Boat; this small local vessel, less than ten meters

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[121] Appendix A on page 184 provides a basic scantlings of the East Asian vessels mentioned in text.

[122] Kim 1994, 8-37.

in length, was discovered in southern Korea and dates to the eleventh century.[123] The vessel features heavy bottom planks with L-shaped chine strakes connecting bottom planking and side planking, giving the vessel a box-like appearance in cross section. All components were joined by complex carved joineries, including mortise and tennon joints, and locking pins along plank seams (fig. 8).[124] The strength of the vessels derived from the heavy planks as well as the heavy transverse beams. Other excavated vessels exhibited similar characteristics with minor differences; for example, the Wando Boat had five bottom strakes with chine strakes, the Talido Boat had only three bottom strakes and no chine strake, and the Sibidongpado Boat had three bottom strakes with four L-shaped chine strakes two on each side.[125]

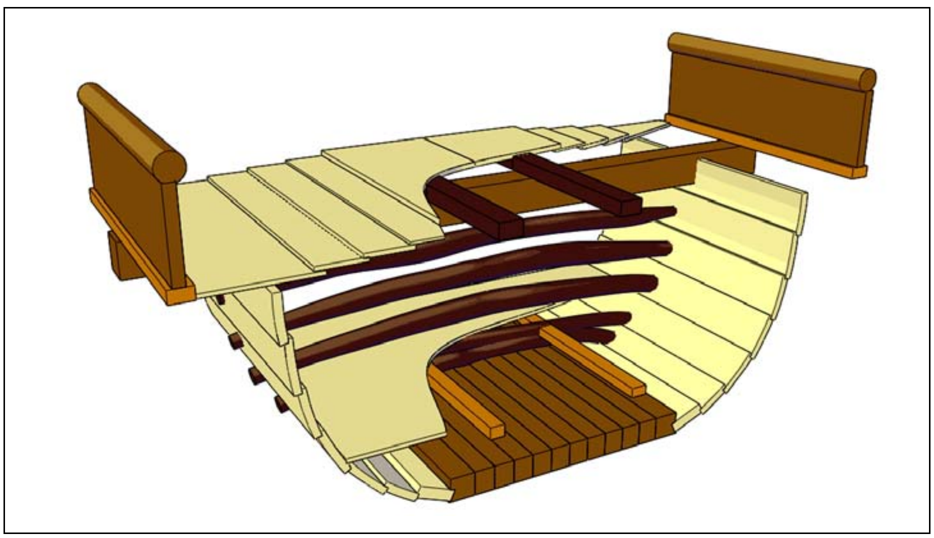

Fig. 7. A 3D Reconstruction of a Traditional Korean Vessel.

(Adopted from Kim 1994, fig. 5)

123 Kim (1994, 41-82).

124 Kim 1994, 57-82; Green and Kim 1989.

125 Yuan 2006, 8-11.

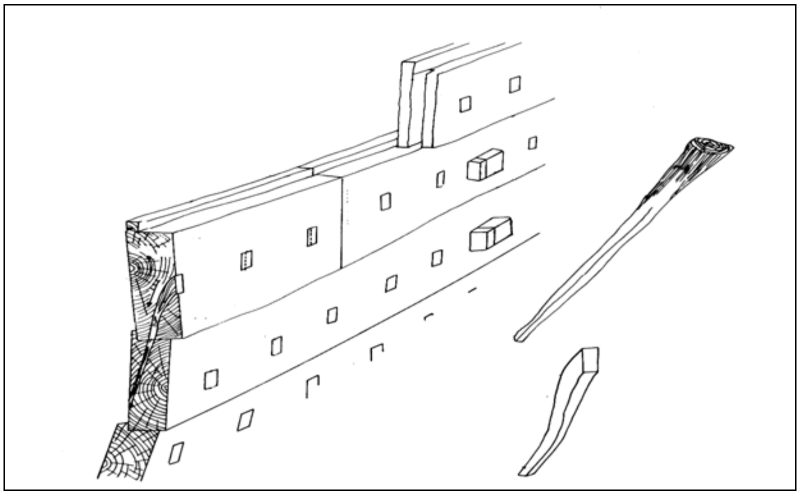

Fig. 8. Traditional Korean Vessel Plank Joining Methods Using Wooden Nails.

(After Kim 1994, fig. 9)

As with the Eastern Army, ship types are seldom mentioned for the Southern Army. The main naval unit would be the large capacity grain transporter and several smaller types of ships carried on board, sailed along side, or towed as it has been mentioned above. A document mentions that the provinces and towns of Yangzhou, Hunan, Kanzhou, and Quanzhou were ordered to build 600 vessels.[126] It is not certain if other provinces also received similar orders. Nonetheless, this is a very important document because we know at least some of the vessels were built in the named provinces. A brief overview of the shipbuilding traditions and archaeological evidence of these areas is discussed below.

Yangzhou, located where the Grand Canal and the Yangtze River met, was a city with a great shipbuilding tradition.[127] Many types of vessels were built there, and some of these may

[126] Ōta 1997, 62.

[127] Reischauer 1946, 143-4.

have been large ships. It is known that sea-going junks sailed upstream as far as Nanking, and that the Cheng He treasure ships of the early fifteenth century Ming dynasty were built at Yangzhou.[128] Due to its proximity to the ocean, and its role as a major center of trade by way of canals, ships of many types and sizes must have traveled through Yangzhou, influencing the shipbuilding tradition of the region. Worcester illustrated various types of vessels built in the area in the early twentieth century; however, almost all were flat-bottom or gently curved-bottom vessels.[129] Many sea-going cargo ships came to Yangzhou, and their goods were transferred to smaller inland craft. It is known that the city of Yangzhou had a strong connection with Japan. Foreigners engaged in trade were required to register at the office of maritime affairs, and most Japanese visitors registered at Yangzhou.[130] Large vessels built at Yangzhou in the late Song or the early Yuan period could have been fighting ships, perhaps similar to the tower, combat junk, or sea-hawk ships described in *Tai Bai Yin Jie.*

The contribution of other regions of China to Kublai's shipbuilding efforts must remain speculative, although the possibility of such involvement seems very strong. At first glance, Hunan Province does not seem likely to possess a great shipbuilding tradition because of its inland location. No archaeological evidence of shipbuilding has been reported in this area, but the word Hunan means "south of the lakes" and the area has several major lakes. Watercraft surely played a major role in transporting goods and people in this area; in fact, later ethnographic studies do show a thriving shipping industry, usually associated with the timber

[128] Worcester 1971, 40.

[129] Worcester 1971, 277-313.

[130] So 2000, 232-3.

trade, as well as the manufacture of bamboo cables that were used on board vessels.[131] An ample supply of wood made it easy to construct large numbers of vessels. For the preparation of the third invasion of Japan, Kublai ordered the northern most regions of China including the former territory of Jurchens to construct ships, not because a developed shipping industry existed here, but because of the availability of the wood needed to construct vessels.[132] Small, flat-bottomed inland craft must have been built in Hunan Province, and were probably used for collecting and carrying supplies for the Japan's invasions down river to the Yangtze Delta.

Kanzhou is a town located near Poyang Lake in inland China. The lake actually consists of a series of channels and lakes, extending 145 km with a maximum breadth of about 32 km.[133] This area saw a development of shipping because it was a major porcelain production center. Ships requiring a cargo capacity of 100 to 200 tons were developed, and ethnographic studies suggest they were flat-bottom vessels suited for inland waters.[134] As with Hunan Province, flat-bottom boats for the invasion were likely built in Kanzhou, perhaps for transporting water and food between larger vessels or for use as patrol and reconnaissance craft. Some may have been made specifically to serve as ship's boats.

In contrast with Hunan and Kanzhou, numerous historical references survive regarding the shipbuilding traditions of Quanzhou in Fujian Province. Quanzhou was the major trading center in the Song and Yuan periods; Marco Polo mentions a great deal about shipbuilding in the

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[131] Worcester 1971, 434.

[132] Ōta 1997, 187-8.

[133] Worcester 1971, 384.

[134] Worcester 1971, 388, 394-5.

town of Quanzhou.[135] Large merchant vessels were built here, and it seems that V-shaped vessels capable of trading overseas were specific to this province. In the early Song period, officials who lived in the north ordered vessels built in Quanzhou specifically to travel overseas. Quanzhou shipwrights replied by saying that the flat-bottom types specified were not suited for open seas, thus implying that V-shaped hulls should be used.[136] The importance of the large transport vessels made in the area and the numerous historical accounts pertaining to this subject leave no doubt that Quanzhou built V-shaped vessels with large holds.

Archaeological evidence provides much needed information regarding the shipbuilding technologies in the areas being discussed. Three basic types of vessels have been found in China: flat-bottom boats, rounded hull vessels, and V-shaped cargo vessels. Archaeological evidence is usually the only reliable source for understanding the joinery and dimensions of each component in hull construction, but existing archaeological reports do not provide detailed descriptions for each timber from a vessel. The only way of acquiring this information is to directly measure the archaeological remains, but this option was not possible given the limited amount of time and funding available to go to China and Korea to record excavated vessels. Nevertheless, some useful information can be gathered from the available archaeological reports.

Several important archaeological discoveries shed light on shipbuilding technologies of the Lower Yangtze River where rounded hull vessels were commonly built. The Song dynasty's Ningbo Ship, a rounded bottom boat found at the shipyard near the port of Ningbo, represents an excellent example of lower Yangtze shipbuilding tradition (fig. 9).[137] Several vessels discovered

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[135] Yamagata 2004, 55; Yule 1993, 250-1

[136] Lo 1969, 79.

[137] Lin et al. 1991.

at Penglai from Shangdong Province in the northern China may be a close relative to the rounded bottom boats because of its similar construction features (fig. 10).[138] The Penglai Ship is considered by archaeologists to be a patrol boat that guarded the canals.[139] Both the Ningbo and Penglai Ships utilized transverse bulkheads as well as wales for strengthening the hull.

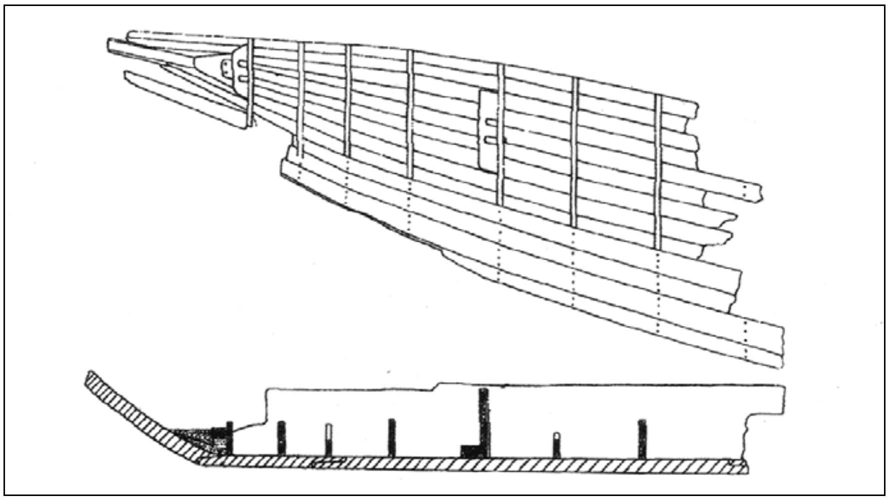

Fig. 9. Plan and Profile Views of the Ningbo Ship. (From Lin et al. 1991, fig. 11)

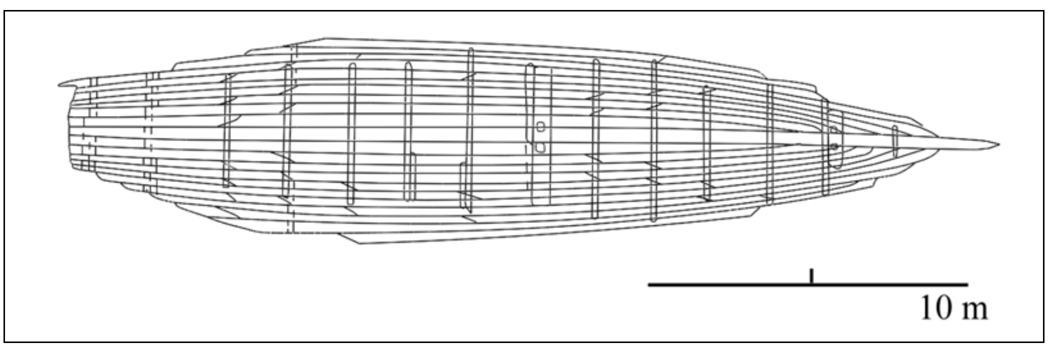

Fig. 10. A Plan View of the Penglai Ship. (After McGrail 2004, fig. 10.19)

[138] For detail discussion, see Cultural Relics Bureau of Penglai City 2006.

[139] McGrail (2004, 371-3) gives a concise review of this vessel.

Flat-bottom boats from other areas within China may provide some possible comparisons. The Jinghai Boat discovered near Tianjin shows characteristics unique among Chinese vessels; it did not utilize a bulkhead, but instead the hull derived its major strength from cross beams similar to Korean vessels.[140] Researchers believe this flat-bottom boat provides an excellent example of local inland water craft in northern China.[141] Despite this claim, the similarity to Korean vessels is striking, and further research may reveal a relationship between Korean and Chinese shipbuilding traditions. Another vessel discovered near Shanghai is also a flat-bottomed hull, but this vessel utilized bulkheads. This ship possibly dates to the early Song dynasty (fig. 11). Only a small section of the hull was discovered and one report was published.

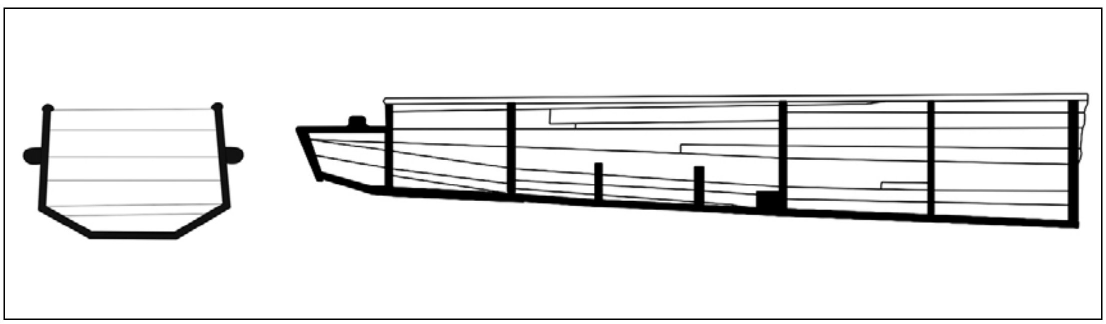

Fig. 11. A Section and Interior Profile of the Shanghai Ship. (After Ni 1979, fig. 2)

In contrast to other areas of China, much evidence is available for the vessels built in Fujian Province. The famous Quanzhou Ship of the late Song dynasty discovered near Quanzhou, and the Shinan Ship of the Yuan dynasty discovered in Korea were both built in Fujian Province

[140] Tianjing City Cultural Relics Administration 1983. The vessel sunk no earlier than 1111 C.E. based on the coin discovered within the hull.

[141] Tianjing City Cultural Relics Administration 1983.

and were large V-shaped cargo vessels.[142] These vessels were more than 20 m long, constructed with heavy transverse bulkheads. The Quanzhou Ship utilized multiple layers of plankings while the Shinan Ship had only one layer but built with think planks.[143] Figure 12 shows a typical vessels of Korea and China.

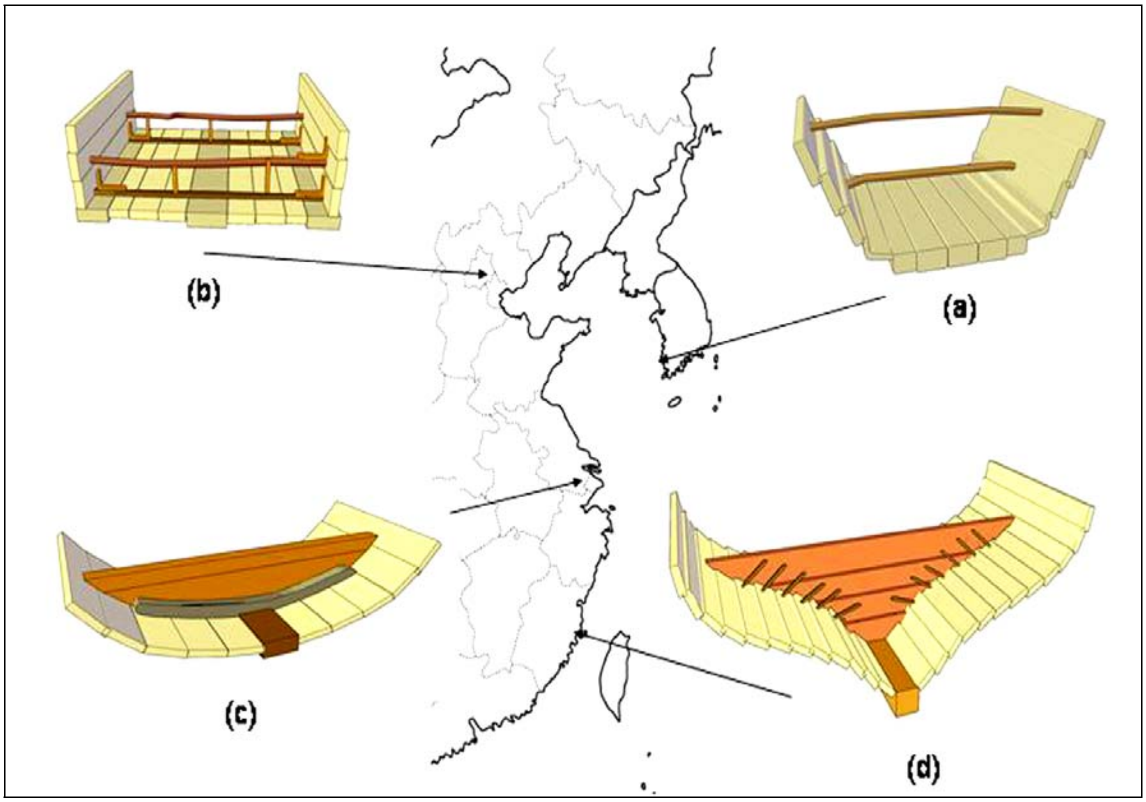

Fig. 12. Sections of Typical Vessels from East Asia.
(a) Korean Type (b) Possible Northern China Type
(c) The Lower Yangtze Type (d) Fujian Province Type

[142] For the Quanzhou Ship consult Green et al. 1998. The information regarding the Shinan ship can be found in the report compiled by the excavation team. See Office of the Cultural Property Management 1984.

[143] Green et al. 1998 and Cultural Property Management 1984.

The Discovery of the 1281 Invasion Fleet

From historical documents, the island of Takashima in western Japan was known as the place where the Mongolian fleet from the second invasion met its end. It was not until the 1970s, however, that Nenko Koga, a local historian, first voiced the possibility of finding the lost Mongolian fleet under water.[144] He noted that fishermen from Takashima Island often found Chinese ceramic pots in their fish nets.[145] Furthermore, a bronze statue of Buddha, most likely made in Korea, was raised from the sea in the late nineteenth century. This statue is now housed in a local shrine. Koga proposed that an underwater investigation of the bay be conducted and Torao Mozai, a marine engineer, answered the call.[146]

The legacy of Mozai is key to understanding the later development of maritime archaeology in Japan. Mozai developed a color sonar system to search for sunken vessels and began a survey of Imari Bay in the early 1980's.[147] He did not find a shipwreck, but found many artifacts from the Mongol invasion, including storage jars, anchor stones, and bricks. The survey was well publicized, and a fisherman presented a bronze square seal to Mozai's research team (fig. 13). This bronze seal had *Pagspa* script, the official script used by the Mongolian court in China.[148] Despite the site's potential for further study, Mozai had little understanding of archaeological research. He raised these artifacts without recording their provenience and

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[144] Koga 1982.

[145] Takashima Board of Education 1984, 1.

[146] Mozai 1982.

[147] Takashima Board of Education 1984, 1.

[148] Takashima Board of Education 1996, 116-7. Rossabi (1998, 154-60) explains that Kublai ordered Phags-pa lama, a Tibetan monk to create a script to be used for official documents based on the Tibetan alphabet suitable for Mongolian language and Chinese phonetics. However, this script did not see wide use.

features, donated some to the local museum, and distributed the rest to the local community and possibly beyond.[149] For this reason, the survey was viewed by many Japanese archaeologists as not being real archaeology but merely a salvage operation without scholarly merit. Thus, the development of nautical archaeology in Japan had a rocky start.

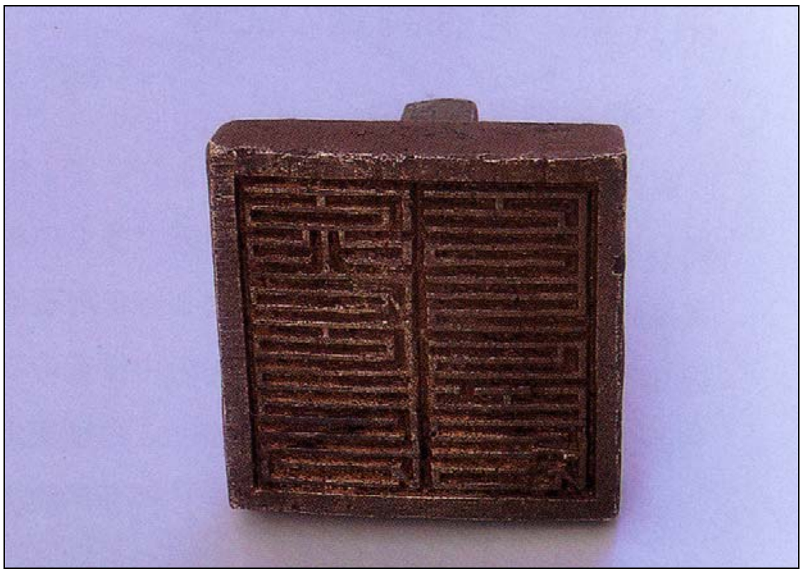

Fig. 13. The Bronze Seal Discovered at Takashima.

(Takashima Board of Education 2002, Pl.11)

Although Mozai's project may be considered as a failure by some, his survey showed a great potential for further investigations. He was successful in designating the shoreline of Takashima as an archaeological site. The registered area covers 7.5 km of the southern coast, extending from the shore 200 m out to sea. Once a site is registered in Japan, survey and

[149] When the author interviewed residents from the Island, several person mentioned that Mozai had given them artifacts raised from the sea.

excavation is required by law prior to any development.[150] It was also decided that the site would be managed by the Takashima Board of Education.[151] In 1984, construction of a harbor in the Tokonami area was proposed, and a survey and excavation followed. From Mozai's previous survey it was known that silt had accumulated up to 3 m above the layer that contained artifacts from the Mongol invasion. Heavy equipment was used to remove the silt overburden first. Modern debris was mixed amongst the archaeological finds indicating that objects dropped or lost in the sea tended to migrate through the silt.[152] Several small scale excavations followed intermittently for the next decade. The majority of the artifacts recovered was from southern China, and included stone anchor stocks, storage jars known as *sijiko,* and small fragments of wooden hulls fragments. These exploratory excavations, although limited in scale, proved to the Japanese public that an underwater excavation could be successfully conducted.

In 1994, a plan for the development of Kōzaki harbor was proposed. Kōzaki harbor is located on southeastern shore of Takashima Island (fig. 14). The north side of Takashima is rocky, and the prevalent *Tsushima* current makes the area unfavorable for navigation and safe anchorage. The south side of Takashima, however, has slow currents and moderate waves. Even today, when a typhoon comes near the Kyūshū region many ships find safe harbor in this well protected bay. It appears that the Kublai's fleet sought a safe harbor inside the protected bay when the Kamikaze struck. This area has the highest concentration of recovered artifacts related

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150 Takashima Board of Education 1984, 1.

151 In Japan, the Board of Education of a local government usually manages any site with archaeological potential. The site may be managed by the prefecture or by the national government after the local board of education produces significant results and meets certain criteria.

152 Takashima Board of Education 1984, 2-19.

to the invasion. The Kōzaki harbor is, in all probability, situated directly facing the area where the Mongolian fleet was riding at anchor during the fateful typhoon.

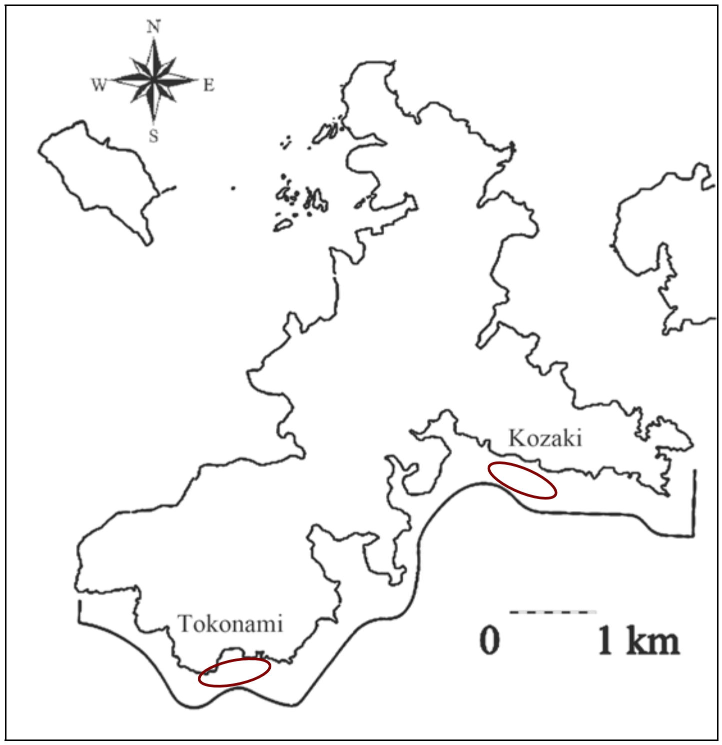

Fig. 14. A Map of Takashima with Excavated Areas and Registered Area Indicated.

The excavation at Kōzaki was conducted by the Takashima Board of Education and the Kyūshū Okinawa Society for Underwater Archaeology (KOSUWA), directed by Kenzō Hayashida. Prior to the harbor construction, another rescue survey was organized. Kōzaki is where the local fisherman had found the bronze seal, and where even today many ceramic sherds can be found along the shore. Based on this, the potential of finding a shipwreck was considered to be high. The surveyed area was 6,000 m². The survey was initially conducted using a sub-bottom profiler, and four anomalies were detected. Following this, heavy equipment was

used to remove the overlying silt deposit. Several artifacts relating to the Mongol invasion, including fireplace bricks and storage jars from southern China, were found during the process. A large grid system was laid over the entire area, and divers were sent to carefully excavate each square.[153]

Approximately 100 m from the shore four wooden anchors fitted with stone stocks were found aligned in the same direction towards the shore.[154] This was clearly a sign of an undisturbed layer where anchors were set during the storm to prevent the ships from striking against the shore (fig. 15). A total of eight anchors were found during this season. These anchors are some of the most significant finds at the Takashima underwater site. The large number of anchors and their structure provided useful information regarding the position of the Mongol fleet, suggesting that several large vessels were present near the shore when the typhoon struck the area.

Several stone anchor stocks have been found in Hakata and in other regions of Japan, but all of them had single stocks. The stone stocks found at Takashima were cut in half and lashed to a wooden frame to attach them to the body of the anchor. This type of anchor has not been discovered before and is termed the Takashima Type Anchor.[155] The wooden shank and arms are fitted together with mortise and tenon joints, and the supporting wooden plates nailed at the crown (fig. 16).

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[153] Takashima Board of Education, 1996.

[154] Takashima Board of Education 1996, 32.

[155] Takashima Board of Education 1996.

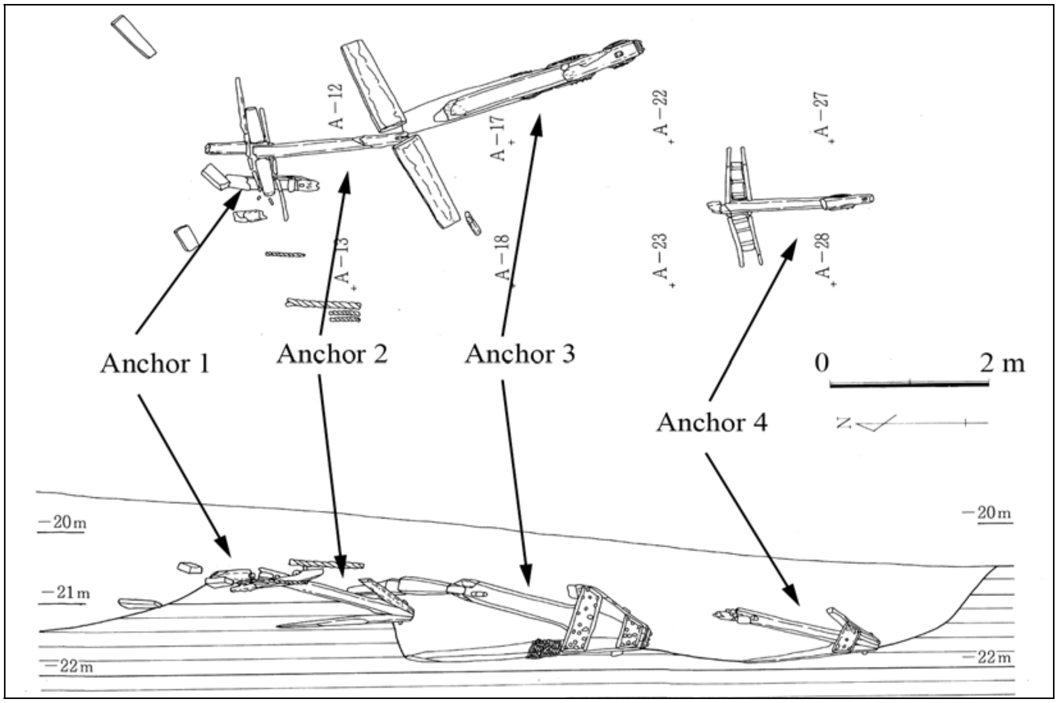

Fig. 15. A Drawing of Four Aligned Anchors.

(After Takashima Board of Education 1996, fig. 13)

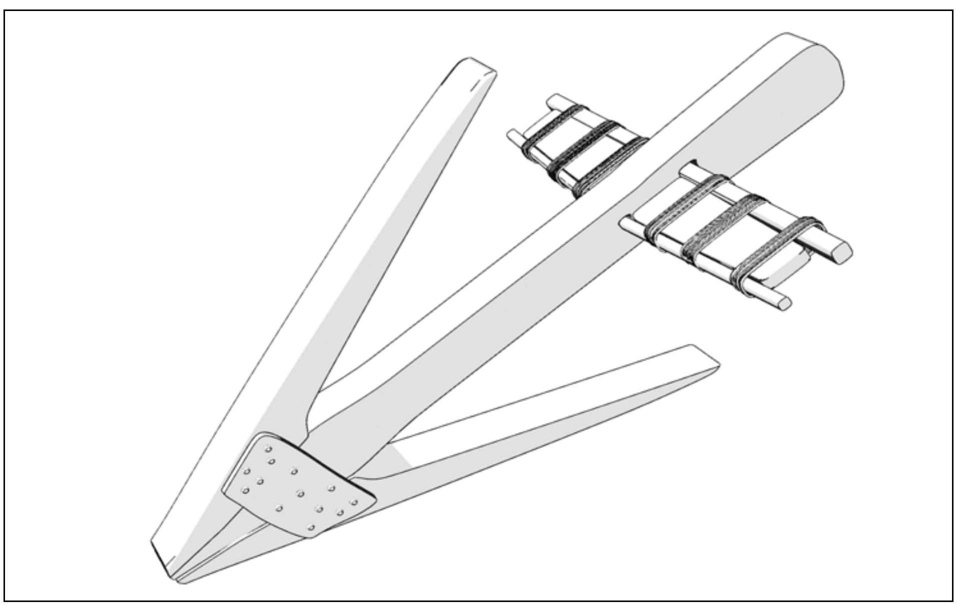

Fig. 16. A Schematic Reconstruction of a Takashima Type Anchor.

The anchors are unique and important finds, and therefore warrant a detailed discussion of their features. Table 2 below provides lists of weights and dimensions of the four large anchors. The largest anchor had a shank 3.15m long, and stocks that together weighted over 330 kg.[156] The anchors varied in size, possibly indicating different types of vessels were present at the site. The weights between the smallest and largest stocks differed by a factor of ten. A study conducted by naval historian Kinya Yamagata analyzes a military treatise written in 1606 C.E. that documents the sizes of anchors and lists the sizes of vessel that carried them. The three hundred year gap between the time the 1281 invasion vessels were built and the time the treatise was written cannot be ignored. Nevertheless, it gives an idea of the possible size of the vessels that came to Takashima. Based upon the various sizes of anchors, Yamagata estimates that the smallest vessel was less than 15 m in length, while the largest vessel may have been about 40 m in length.[157]

Wood from the anchors has been dated using the carbon-14 method, and the results obtained were within the time range of the Mongol invasion.[158] The wood species that made up the anchor's pieces were also analyzed. The large majority of the wooden samples were identified as oak (*Quercus*) but other species were also found; these species can be found in Kyūshū and in southern Korea, but are more commonly found in southern China.[159] It is almost certain that the stone stocks were not made of local material, and were brought from southern

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[156] Takashima Board of Education 1996, 43.

[157] Yamagata 1996, 128-30.

[158] Three samples were taken from the wooden anchors and dated in years before present as follows: 790±100, 940±90, and 740±90. For detail discussion, consult Takashima Board of Education 1996, 63.

[159] The wood species include *Cinnamomum camphora, Osmanthus heterophyllus,* and *Castanposis cupsidata.* Mitsutani 1996, 73-80.

China. Samples of granite were traced to an area near Quanzhou.[160] This is the area where Kublai's large transports were built, confirming that the remains found at Kōzaki likely represent at least one large vessel.

Table 2. Anchor Data. (Adapted from Takashima Board of Education 1996)

Anchor No.	1	2	3	4
Shank Length (cm)	NA	255	274	210
Shank Width	NA	17x17 (20)	30x30 (50)	17x17 (19)
Arm Length	120	170/83	315	171/80
Arm Thickness	13	11	20	16
Arm Width	15-18	16-23	30-37	10-16
Stock Length L	70.5	52.5	132	52
Stock Length R	68	52	131	52.5
Stock Dimension L	19.5/16 x 11	19/14 x 7/10	37/26 x 24/15	19/17 x 11
Stock Dimension R	18/13.5 x 11	19/13 x 7/10.5	37/27 x 23/15	19/13 x 10
Stock Weight L (Kg)	26.05	16.8	163.5	20.35
Stock Weight R	26.05	17.75	174.5	17.75

In 2000, a further expansion of Kōzaki harbor provided yet another chance to investigate the site. The most significant find was a bottom plank, possibly from a Korean vessel (fig. 17). The plank has a large carved cleat, where another transverse element was placed to hold the

[160] For detail discussion, see Suzuki et al. 2000.

planks to the side. It is 195 cm long and 62 cm wide.[161] A similar structure can be seen on a vessel excavated at Anapuchi Pond in Korea.[162] This vessel has been dated between the seventh and ninth centuries C.E. (fig. 18).[163] Considering the close geographical location between Korea and Takashima Island, it cannot deny the possibility that a boat in Japan could be built in a similar manner, or a Korean ship may have visited the island at some point other than the 1281 invasion, however, Carbon-14 dating of the Kōzaki plank indicates that the wood is from the time of the invasion or slightly earlier.[164] The species identification indicates that the wood maybe from Korea or Japan.[165]

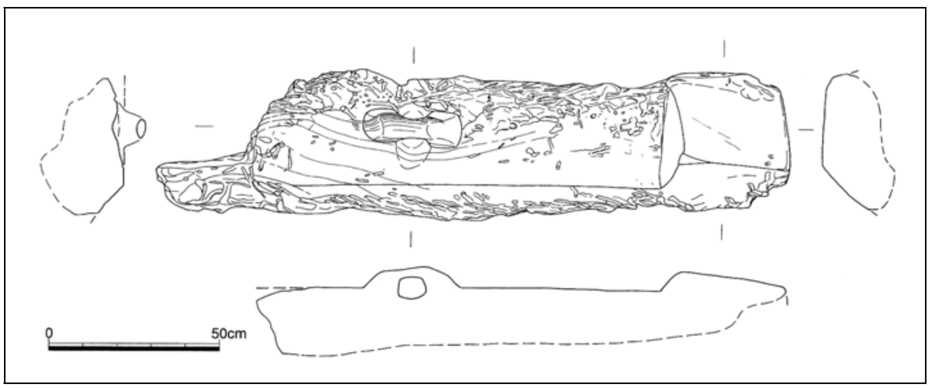

Fig. 17. Possible Korean Bottom Plank Found at Takashima.

(From Takashima Board of Education 2001, fig. 20)

[161] Takashima Board of Education 2001, 4-41.

[162] Takashima Board of Education 2001, 42-7.

[163] Kim 1994, 41-4.

[164] The date was given in years before present as 864±18. For detailed results of the C14 dates, consult Takashima Board of Education 2001, 51.

[165] The timber has been identified as camphor tree (*Cinnamomum camphorsa).* The camphor can be found in southern China, Japan, Cheju Island of Korea, Taiwan, and Vietnam. Therefore, it cannot be used to specify the origin of the wood or where a vessel was built.

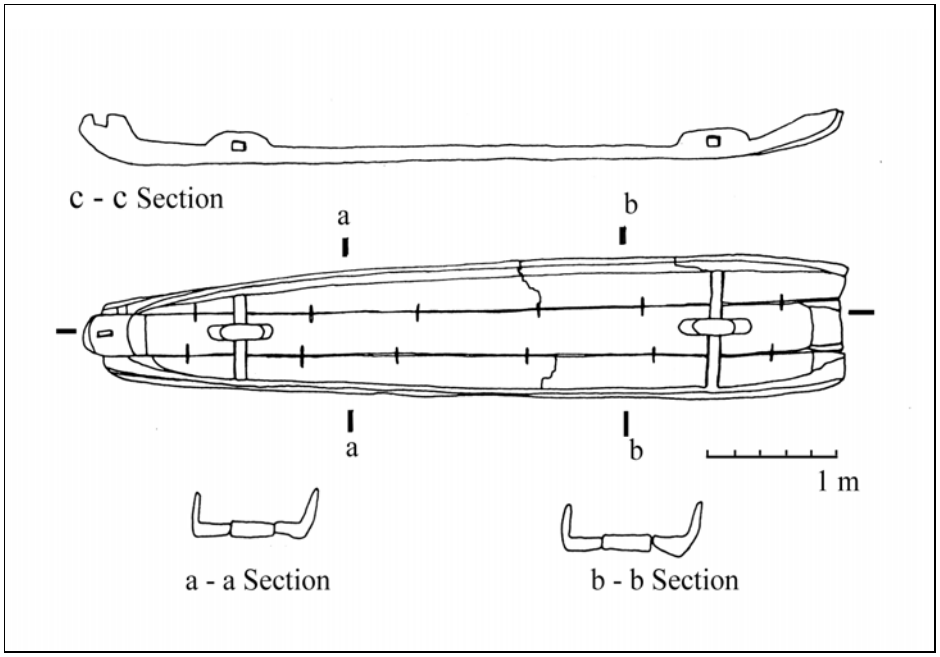

Fig. 18. The Plan of the Anapuchi Boat. (After Kim 1994, fig. 22)

The excavation season of 2000 revealed a concentration of artifacts, and as a result, it was decided that most of the artifacts within the planned construction area had to be excavated and raised. For this reason, the 2001-2002 excavation seasons were organized.[166] This was the first time the Takashima underwater site produced a substantial amount of a ship's hull that could be studied. An area of approximately 950 m^2, or about 30 m by 35 m, was excavated. Nearly 2000 artifacts were raised; nearly one fourth of them wooden fragments. Part of a bulkhead, a mast step, and other large and small timbers were recovered. Coins, lacquer ware, storage jars, and ceramic bowls were also found. Artifacts related to battle included swords, arrows, and helmets (fig.19)[167] Perhaps the most significant finds were several *tetsuhau,* ceramic

[166] Takashima Board of Education 2003, 1.

[167] See Takashima Board of Education 2003 for detailed results of the excavations.

balls filled with scrap iron and gun powder (fig. 20 and 21). This ceramic ball was probably thrown from a catapult, and when it exploded, sharp scrap iron pierced the enemy's skin. The *Mōko Shūrai Ekotoba* scroll illustrates an exploding *tetsuhau.*[168]

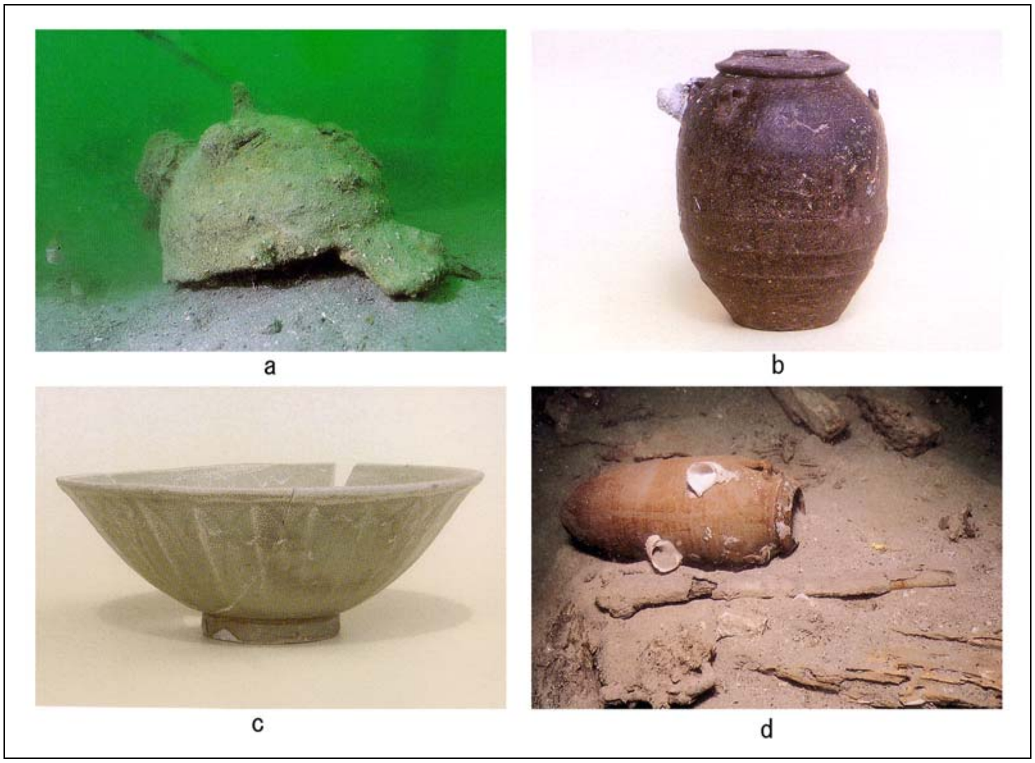

Fig. 19. Sample of Artifacts Discovered at Takashima Underwater Site.

a. Iron Helmet (From Takashima Board of Education 2003 Pl. 13-5)

b. Sijiko Jar (From Takashima Board of Education 2003 Pl. 23-1)

c. Porcelain Bowl (From Takashima Board of Education 2003 Pl. 17-1)

d. Sijiko and Iron Sword (From Takashima Board of Education 2002 Pl. 60)

[168] This exploding stoneware was packed with scrap iron and gunpowder. When the powder exploded, the sphere burst scattering scrap iron with an effect similar to shrapnel. The bottom of the bomb was made flat so that it would not roll over on board of a ship.

The success of the 2001and 2002 excavations was recognized by many terrestrial archaeologists, and a research grant was provided by the national government. In 2003 and 2004, further excavations were organized again to explore the Kōzaki harbor area. Although smaller areas were excavated compared to the previous seasons, a large number of artifacts was discovered.[169] The four years of excavations yielded over 500 timber pieces, and it is these artifacts that provide the basic information analyzed in this thesis.

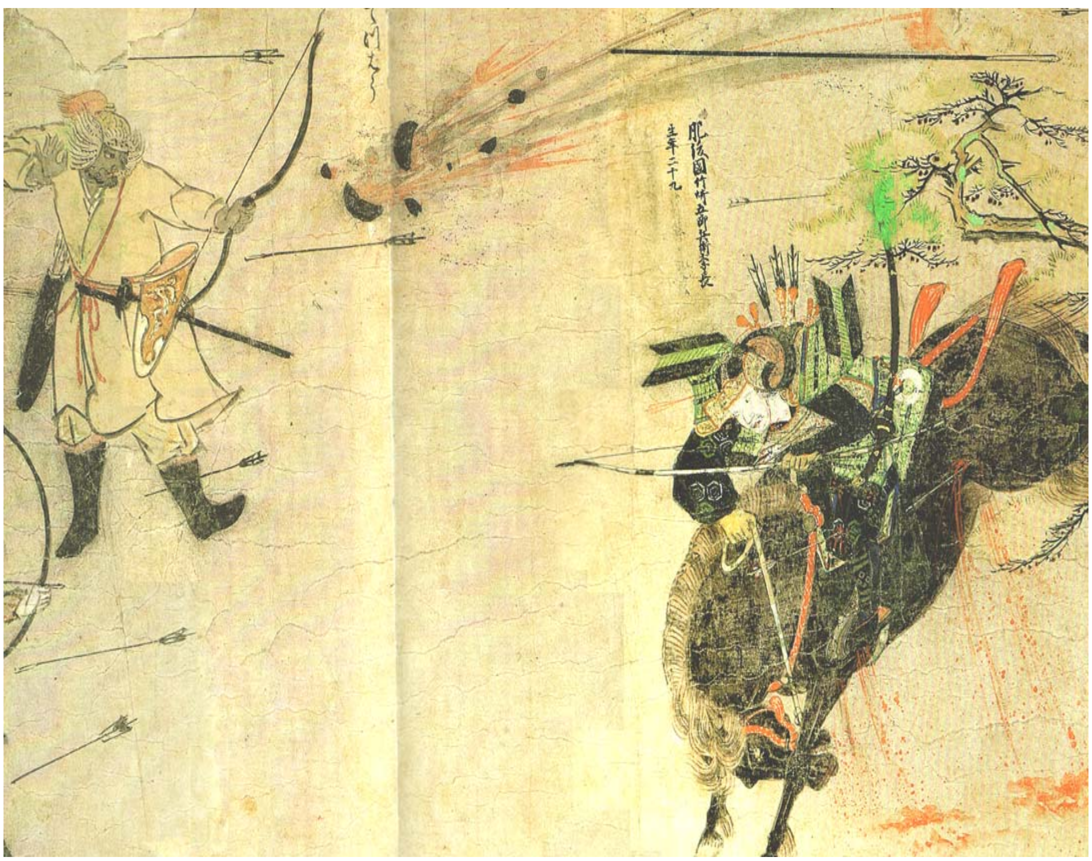

Fig. 20. The Exploding *Tetsuhau* in the *Mōko Shūrai Ekotoba* Scroll.

(Courtesy of the Museum of the Imperial Collections, *Sannomaru Shozokan*)

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[169] Takashima Board of Education 2004, 2005.

Fig. 21. A Photo of *Testuhau* found at Takashima.

(From Takashima Board of Education 2003, Pl. 28-2)

The Research Project

The author participated in the excavation at Kōzaki harbor in 2003 and 2004. The timbers raised during the previous seasons were all stored in a large container waiting to be recorded, analyzed, and conserved. At that time no researcher in Japan had a plan for recording this important discovery. The author discussed the possibility of studying the artifacts with the Takashima Board of Education and his plan was approved. The timber recording was conducted in the summer and fall of 2004, and again during the summer of 2005. This project was supported by the Institute of Nautical Archaeology (INA), the RPM Nautical Foundation, the Asian Research Institute of Underwater Archaeology (ARIUA),[170] and the Takashima Board of Education. The aim of the project was to investigate, identify, and understand the hull fragments

[170] In 2005, KOSUWA became a national registered non-government organization and changed its name to ARIUA.

raised during the 2001 to 2004 seasons; for this research, a total of 502 pieces of timber was recorded. [171] A brief description of each timber can be found in Appendix B.

Because all the excavations were conducted as a rescue operation for the Kōzaki harbor renewal construction, the area excavated was close to the shoreline. The excavated area is located within 30 m to 40 m from the shore line, at the depth of 9 m to 12 m. At this depth, the sea floor is directly affected by the current, and the site presumably has been heavily disturbed. Modern trash is often mixed in with the artifacts from the invasion and covered by 1m to 1.5 m of heavy silt deposit. Below this is a layer of compacted sand mixed with shells, which contains modern debris and some artifacts from the invasion. A 10 m by 10 m grid was established, with letters assigned to the east-west line and numbers assigned to north-south lines. Artifacts were distributed throughout the grid, showing higher or lower concentrations in certain squares (fig. 22). Almost all of the artifacts were isolated finds. Ceramics, arrows, timbers, and various other objects were spread over the excavated area.

To understand the nature of the site, the reader should first know that of 502 timbers recovered, only four were found still joined together. Two fragments found 20 m apart at the site were later determined to compose a single item. Although it was not confirmed, most of the timbers started as parts of larger components. After recording the maximum surviving lengths of the timbers, it was realized that 230 of them were less than 25 cm in length, and 110 were

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[171] In 2004, George Schwartz, a graduate student in the Nautical Archaeology Program at Texas A&M University, and Kazuma Kashiwagi, a university student at Ibaraki University in Japan participated in the recording project. In 2005, Andrew Roberts, a graduate student in the Texas A&M University Nautical Archaeology Program joined the project, and Kazuma Kashiwagi again assisted the timber study.

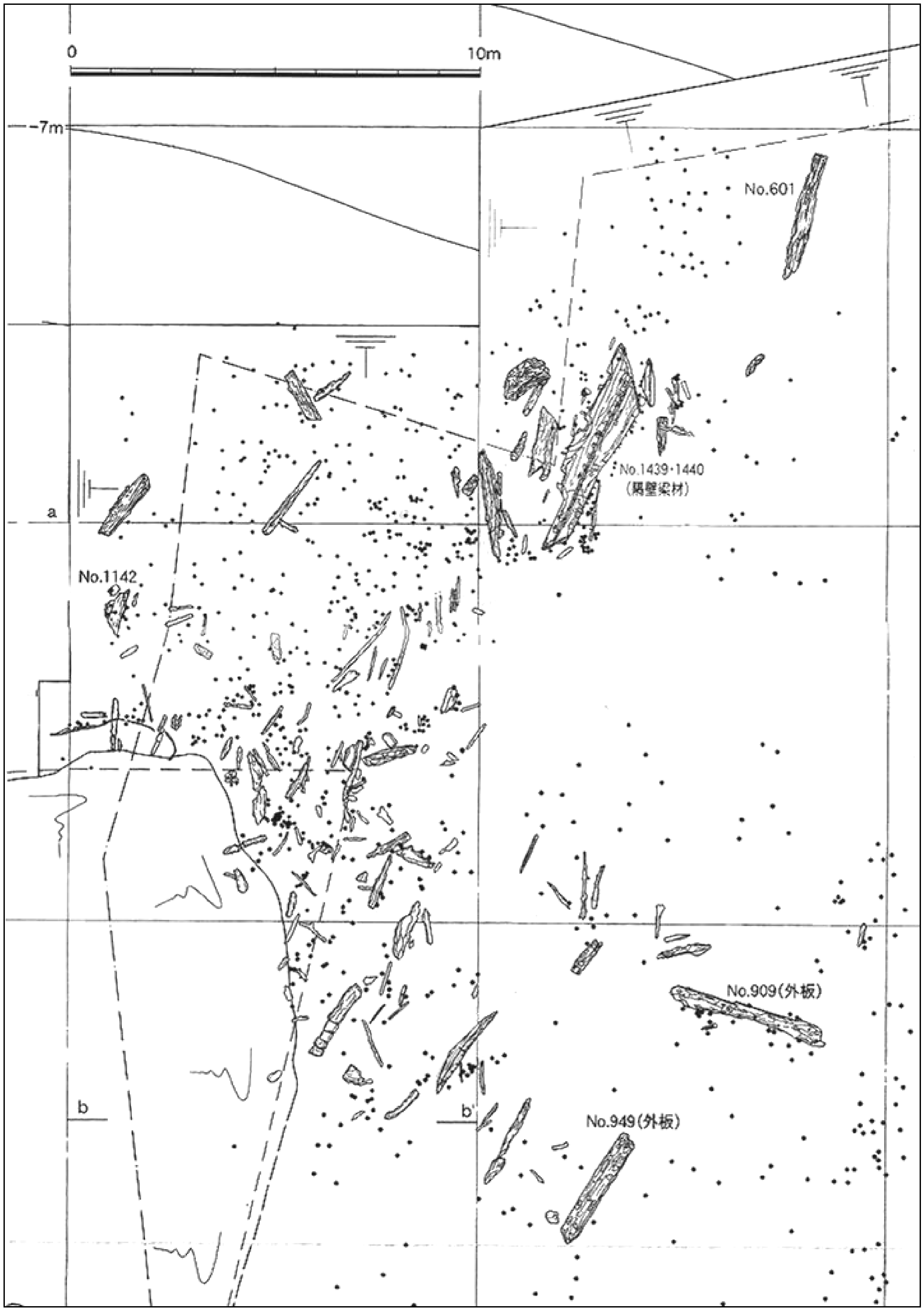

Fig. 22. Site Plan of the Takashima Underwater Site at Kōzaki Harbor.
(From Takashima Board of Education 2003: 9-10)

between 25 cm and 50 cm. Only nine timbers were 200 cm or longer. In other words, more than 90% of the timbers were 100 cm or smaller, while less than 2% of the items were larger than 200 cm.[172] The dimensions of the surviving wood are good indications of the turbulent conditions that affected the site.

To assess the nature of degradation of the timbers, each artifact was divided into a system of five ranks, according to the preservation of the original shape. Rank 1 was assigned to the timbers where the original length, width, and thickness were complete. Rank 2 was assigned when the hull element was broken in one plane, usually broken in half. The original length may be lost, but the original width and thickness could be recorded, and thus the timbers from Rank 2 still held valuable information. Rank 3 was attributed to timbers that were broken in two planes or directions; the original length and width were lost in this case. Rank 4 were unidentified timbers preserving at least a nail or a modified surface. Rank 5 comprised all unidentified fragments, having no trace of human use and modification. These could include drift wood or a small fragment of a larger component. Only 32 timbers were assigned to Rank 1, and 162 timbers to Rank 5. Nearly 60% of the timbers were included in Ranks 4 and 5.[173] This demonstrates that almost all the timbers were broken and degraded when they were found.

The dimensions of the timbers along with the ranking clearly reveal that the site has seen major disturbance. The chaotic artifact distribution suggests that this area may have been where the current brought many artifacts and deposited them along the shore. The aim of the recording

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[172] Smaller than 25 cm: 230 timbers (45.82%). 25-50 cm: 110 timbers (21.91%). 50-75 cm: 95 timbers, (18.92%). 75-100 cm: 27 timbers, (5.38%). 100-50 cm: 20 timbers, (3.98%). 150-200 cm: 11 timbers, (2.19%). 200 cm or larger: 9 timbers, (1.79%).

[173] Rank 1: 32 timbers (6.37%). Rank 2: 90 timbers (17.93%). Rank 3: 78 timbers (15.54%). Rank 4: 140 timbers (27.89%). Rank 5: 162 timbers (32.27%).

project was to briefly examine all wooden, possibly hull-related pieces, in order to understand construction features of the vessels that brought Kublai's armies to Japan. Although all of the excavated artifacts from the site have been briefly studied, this particular research does not discuss other artifacts in any detail.[174] The timbers had to be organized in a systematic manner to reveal their secrets. The research followed several steps. The first step, already described above, was to number all timbers with a brief description, assign ranking, record dimensions, and take a photograph. The next step was to make sketches and drawings of artifacts that had the potential to yield insights into ship construction. The majority of the timbers that showed diagnostic characteristics were recorded. Most of the drawings were made by 1:1 tracings. As the recording project was being conducted, a research method was also being developed, and three approaches to analyzing the data gathered from the site were developed. These included a timber category database, a joinery typology study, and an examination of the philosophy of shipbuilding. This systematic approach made the information gleaned from the site easier to compare with other archaeological and historical evidence.

The timbers had to be organized in order to glean any useful information. Because the context of the site provided no clear answer regarding which timber belonged to which vessel, each timber had to be examined and organized by some method. The focus was placed on trying to identify how the piece may have functioned within a hull. All timbers were separated into categories for hull construction, or components, including planks, bulkheads, and wales. The

[174] Each artifact had a number assigned during the excavation. This number followed the order in which it was discovered. Thus, the original artifacts numbers published in the excavation reports are not useful in examining only timbers. Therefore, new numbers were assigned to the timbers. Those who wish to consult the original site reports must check the original artifact numbers.

shape of each piece and its nail patterns were the primary means used to organize timbers. By separating the timbers into certain "best guess" categories, it was easy to compare them within the category as well as compare them with archaeological evidence from other sites. In Chapter IV, the description of the categories will be given first, followed by examples from the site.

The second approach was to group the timbers according to the joinery type. Due to the destructive nature of the site, the remains of joinery was often one of the only features that could be studied on a timber. The major division was between those using iron nails and those without the use of nails or a complex wooden joinery system. The data was again compared to archaeological evidence from other excavated East Asian vessels. Complex wooden joinery systems were grouped into locks and locking elements, rabbets, scarfs, and recesses/notches. Each group was compared with other archaeological evidence. Other unique joinery features were also investigated. The use of *chunam*, a putty made with *Tung* oil, and widely used in China, was also studied.[175] The study of joinery is further discussed in the chapter V.

Chapter VI concerns the third and final approach. This method was employed to achieve a deeper understanding of the nature of the vessels by looking at specific hull elements that revealed the philosophy of shipbuilding, or how the vessels were constructed and how the shipwrights perceived a vessel when constructing. In western shipbuilding traditions, a so-called "shell first" and "skeleton first" construction sequence paradigm exists. The building sequence of a vessel and how people conceived what a vessel should be is regarded as one of the most important topic discussed in the field of nautical archaeology.[176] Ancient ships were

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[175] Li 1986.

[176] For further discussion of this topic, consult Steffy 1994; Hocker and Ward 2004

usually built plank first, and frames were inserted after (shell first). The building sequence gradually changed to constructing a framework first, and later attaching planks around this structure (skeleton first). The building sequence also reflects what people thought about a vessel. A vessel may be a skin bolstered by frames, or water-tight framed structure. This study is one of the first to direct this paradigm toward the analysis of East Asian vessels.[177]

[177] Green et al. 1998 is one of the best example of an attempt to explain the shipbuilding technology of a vessel in light of the building sequence and the how a shipwright thought about constructing a vessel.

CHAPTER IV

THE TIMBER RECORDING PROJECT

Timber Category Classification

The timber category database separates all timbers into categories for hull construction. Categories for hull components include beams, bulkheads, deck planking, planks, railings, fashioned timber, fasteners, wales, unknown/other, logs and cut logs, unidentifiable, and featureless timbers. In the following chapter, the criteria for assigning for each category are discussed with examples provided from the Takashima site.

Ship reconstruction expert J. Richard Steffy defines a beam as "a timber mounted athwartship to support decks and provide lateral strength."[178] A beam is typically a long component that is rectangular or square shaped in cross-section and only a small number of nails, if any, are present. When a component other than deck planking is attached to a beam, that component will be spatially limited (for example, where the beam is attached to the hull, a stanchion, a longitudinal beam, or other such components). In other words, a beam should be free standing and independent from most of the components within a hull. Nails found along the length mean the timber cannot be a beam, as this implies that it was attached along another component. The beam should not have a rabbet or other joinery along its length.

The bulkhead is one of the most characteristic and prominent features of the Chinese shipbuilding tradition.[179] It is a major component and one of the largest timber elements of the hull. Bulkheads give lateral support to the vessel, like beams, and at the same time they

[178] Steffy 1994, 267.

[179] Kieth and Christian 1981, 10.

compartmentalize the hull. All excavated ships from China, except the Jinghai boat, have bulkheads.[180] A bulkhead plank should have nails at the top and bottom, connecting it to other bulkhead planks, with the nails inserted diagonally from both sides. The end where the bulkhead connects to the hull planking should have traces of joinery as well. The side of the bulkhead may be angled to fit the curve of the hull.

Deck planking should have a relatively thin section when compared to regular hull planking.[181] Although deck planking can be seen on the *Mōko Shūrai Ekotoba* scroll and other iconography, it is impossible to determine how the planks were attached.[182] These planks were probably not connected to each other, but to the beams or bulkheads. Thus, a deck plank should have nails that extend beyond the thickness of a plank. A plank having a diagonal nail will be considered as either regular planking or bulkhead, regardless of the thickness. It is difficult to say with certainty that all the timbers assigned as deck planks were actually functioned as deck planking. Some of examples of deck planks found at Takashima may be from wooden containers or other large shipboard objects.

It was not easy to define the plank category because a plank-like timber may be either from a bulkhead or hull planking. Defining characteristics are needed to distinguish the two. Shipwrights in East Asia used diagonal nails to hold hull planks together. These nails were only placed from the outside. The hull plank category for this research has a general plank-like shape, having diagonal nails placed only from one side. If the nails were placed from both sides, it will be included in the bulkhead category.

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[180] The Tianjin City Cultural Relics Administration 1983, 55-7.

[181] One of the criteria for the deck planking category is that the thickness must be less than 3 cm.

[182] See Conlan 2001, 157-74.

Railings were used to support planks or other components, much like the two-by-fours of a modern house.[183] The cross-sectioned shape of timbers was used as a general guide. Because railing may appear similar to planking, the author made an arbitrary decision to include timbers in this category when their thickness was less than three times the width. The function of the railing was to attach two or more hull elements together to give strength to the joining component. Railings were used like a small frame, perhaps for the hull or for superstructure above the deck level. The function of railings differed piece by piece.

Archaeological evidence indicates that traditional Korean vessels were built using complex, carved wood joinery with no iron nails: on the other hand, Chinese vessels were built using nails.[184] Thus, a timber having a nail is unlikely to be a part of a vessel which originated in Korea. Furthermore, a vessel built in China may not have nails in all areas of the hull. The fashioned timber category was created as an arbitrary way of determining the presence of Korean vessels. Timbers in this category either have a maximum dimension larger than 50 cm and lack any trace of nails, or have a distinctive complex joinery suggesting construction without the use of nails. Although it is an arbitrary value, 50 cm seems to be sufficient to suggest that nails were not used.

A wale is a thicker plank, usually a split log, attached to the outside of the hull to provide longitudinal strength for a vessel. Wales can be seen on many ships depicted in ethnographic records from China.[185] Wales are one of the characteristic features of a Chinese

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[183] The author used the term "railing" to describe a type of timber component found at Takashima.

[184] For Korean vessels, consult Kim 1994 and for the Chinese vessels, consult Xi 1999.

[185] Worcester (1971) provides excellent drawings of Chinese traditional vessels.

vessel, which typically have gently curving hull and no keel. The main longitudinal strength comes from the heavy wales affixed to the hull.

Fasteners are wooden elements utilized to connect other components. These include tenons, treenails, dowels, and other such components. Koreans used complex wooden joinery, and the use of wooden nail fasteners was common.[186] Although the Chinese mainly used iron nails for shipbuilding, they did not do so exclusively and the presence of fasteners on a timber does not exclude Chinese origin.[187]

The unknown/other category includes timbers that are relatively well preserved, but cannot be included in the categories described above. Some of the timbers may have been part of a frame, mast step, windlass, or other components. Unique features can be found on all items in the unknown/other category, such as a presence of joinery and other evidence of human modification or use attributable to a specific purpose. The functions of many of the timbers are still unknown. In theory, the real function of all artifacts in this category could be found through rigorous research, and as additional research on East Asian shipbuilding technology progresses, timbers from this category may become important.

Not all wooden artifacts were hull components; rather, some appeared to be driftwood. The close examination of driftwoods revealed that some had straight cut ends, indicating that these wood fragments may have been utilized for a specific task. The cut required an explanation, and the most logical was that these pieces were firewood. All timbers with round driftwood-like features were isolated. These pieces were then divided into two categories: logs and cut logs.

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[186] Kim 1994, 13-9, 74, 76.

[187] For example, McGrail (2004, 371) reports the mortise and tenon joints used on bulkheads from the Penglai ship. Fitzgerald (1943, 135) describes vessels built in Hunan known to use mortise and pegs.

Uncut wood may be driftwood, broken firewood, or wood meant to be used for another purpose. Although artifacts from these categories were not hull components, they comprised a large portion of the total number of timbers. Close analysis of all wood may ultimately contribute to our understanding of how the invasion was organized.

The unidentifiable category includes timbers having no diagnostic features to reveal how they functioned. In other words, these fragments show traces of nails, other joinery, or modified surfaces, but one cannot tell from where in the vessel they came. An example of the unidentifiable timber category is a degraded wood with one nail or a timber that is a square in cross-section without any other diagnostic features. These timbers may have been a part of a larger component; however, unlike the unknown/other timbers, it is not possible to identify the original function of the particular artifact.

Featureless timber is, as the name suggests, composed of wooden pieces having no archaeological significance other than the fact that they were excavated from the site. These are pieces of wood that have no joinery and no modified surfaces. Further investigation of these timbers will not likely produce information regarding the origin of the vessels.

Beams

Thirteen timbers fit the beam category.[188] This category represents 2.59% of the total. The average rank is 2.85.[189] Only one timber is assigned to rank 1. All items were 50 cm or longer and five were longer than 80 cm; the average length for the category is 74.46 cm. The

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[188] See Appendix B for the dimensions and descriptions for the timbers from each category.

[189] The ranking system was discussed in the previous chapter. It denotes the status of preservation, Rank 1 being complete, and Rank 5 being the most degraded timber.

average width is 8.96 cm and average thickness is 6.27 cm. Except for three timbers that had square cross-sections, the width to thickness ratio showed small variations with an average of 1.64.

Identifying the origin of the vessels from the study of beams is a difficult task, since beams were not commonly used for Chinese shipbuilding (bulkheads were usually used to provide sufficient strength to the hull). One vessel that may be of interest is the small flat-bottomed Jinghai boat from North China.[190] This vessel used multiple beams of natural wood to support the hull. The beams were 10 to 17 cm thick and 13 to 20 cm wide (fig. 23).[191] From Takashima, only one timber from the beam category had both width and thickness larger than 10 cm. Therefore, it does not seem that the timbers from Takashima were actually from a large vessel.[192] As seen on the Wando ship and other Korean vessels, the beams on their vessels were more rounded in cross-section and often larger than 10 cm.[193] Korean vessels, including traditional boats, used internal fasteners to lock the bottom planks together to act as a frame.[194] The dimensions of the beams in this category are similar to those of locking timbers found on Korean vessels. Fig. 24 shows a photo of a bottom plank from the Wando ship with an internal bracing timber still in place; this timber is surprisingly similar to the timbers from the Takashima beam category. Based on this evidence, the possible presence of Korean vessels cannot be eliminated.

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[190] Tianjin City Cultural Relics Administration 1983, 54.

[191] Tianjin City Cultural Relics Administration 1983, 54, 57, and fig. 6.

[192] Tianjin City Cultural Relics Administration 1983, 55 figs. 3, and 7.

[193] Kim 1994, fig 26.

[194] Kim 1994, 8-13.

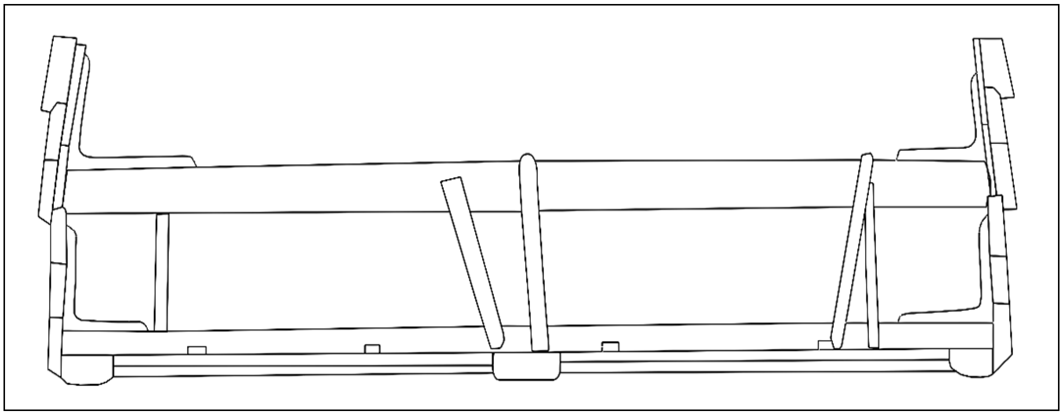

Fig. 23. A Cross Section of the Jinghai Boat.

(After Tianjin City Cultural Relics Administration 1983, fig. 5)

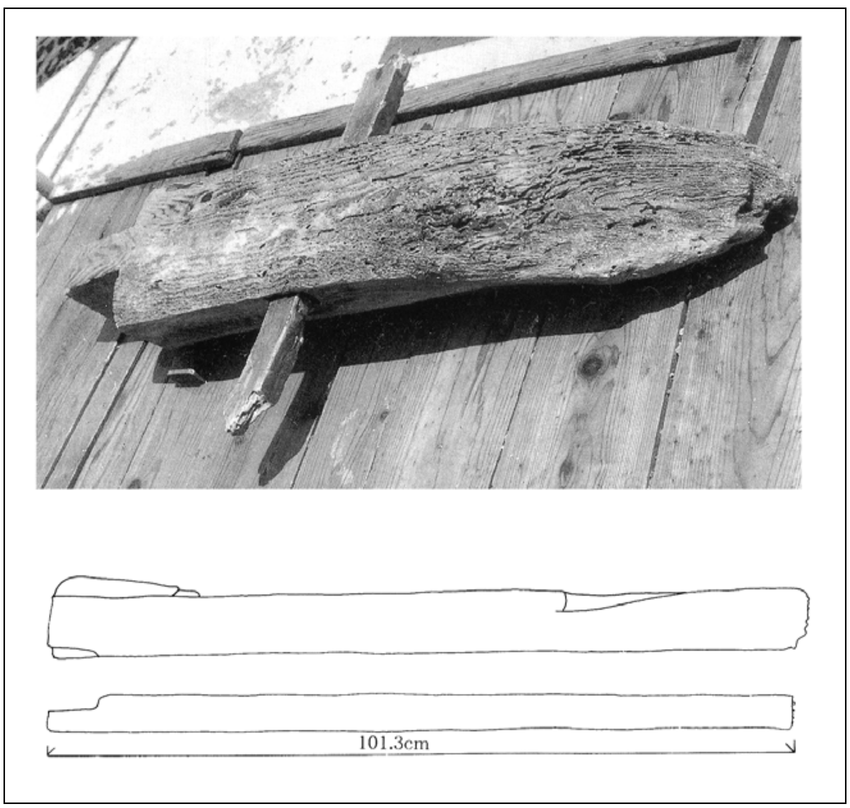

Fig. 24. The Internal Bracing of the Wando Boat. (After Kim 1994, fig. 39)

Timber No. 126 (Original No. 959)[195]

This is the most complete timber within the beam category (fig. 25). Its surviving length is 82 cm. One end is 9 cm by 9 cm square in cross-section, and it is stepped down to a cross-section of 9 cm by 6 cm at the smaller end, which may have been broken or snapped, leaving a clean cut. The change in shape suggests something was hooked to one end, perhaps to fit in a notched section of the hull. Part of the beam may have projected through the hull. Based on the shape and dimensions, this beam must come from a small vessel and could not have been a major component of a larger vessel.

Fig. 25. A Photo of Timber No. 126.

Timber No. 495 (Original No. 2004-25)

The surviving length of this timber is 64 cm, the width is 10 cm and the thickness is 6 cm (fig. 26). It is well preserved, but broken at both ends. This seems to be the most typical beam from the site. The width to thickness ratio is 1.66, which is close to the average ratio for this category. Considering its size, this piece was possibly part of a very small vessel built in the

[195] All artifacts recovered from the site have been given a number by Takashima Board of Education and KOSUWA excavation team. This numbering system includes all types of artifacts. For convenience, the author assigned a Timber number to all recorded wooden artifacts. Those who are interested in further investigation of the timber using the original archives in Japan should refer to the original number.

middle Yangtze River. The possibility also remains that it may be a fastener used to join the bottom planks of a Korean vessel.

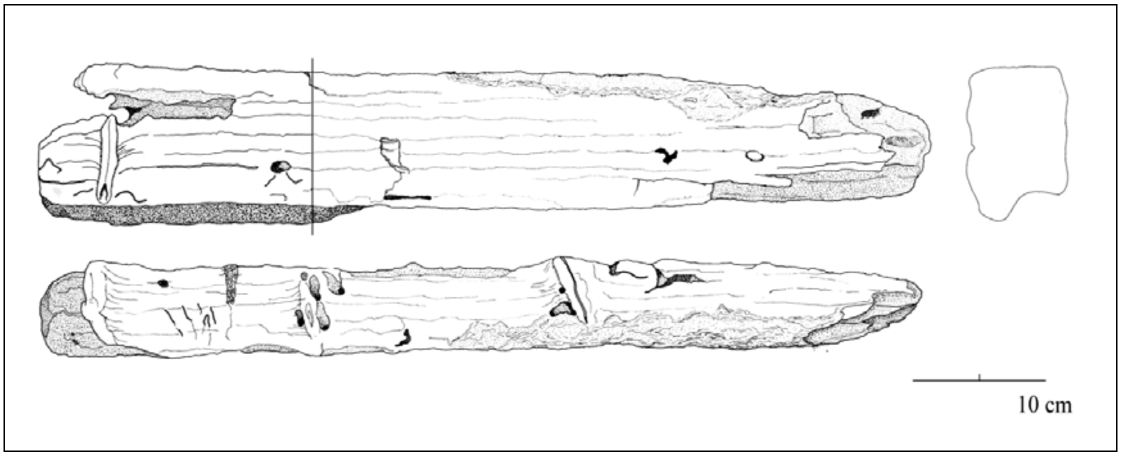

Fig. 26. A Drawing of Timber No. 495.

Bulkheads

Despite the importance of bulkheads in Chinese shipbuilding technology, only fifteen timbers were assigned to the bulkhead category. This is 2.98% of the total number of timbers found. The average rank for the category is 2.4, the best average next to the fasteners category. There is a large variation in size with the bulkhead timbers under analysis, ranging from 59 and 9.5 cm in width.[196] The thickness exhibits a range between 16.5 cm and 4 cm. The bulkheads show numerous small differences between them including the possible use of stiffeners as well

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[196] A bulkhead plank "width" is the same as "height" of the bulkhead when constructed, and the "length" refers to the transverse length, or beam, of a vessel.

as small wooden plugs to fill nail holes (fig. 27).[197] Eight timbers were assigned to Rank 1 and 2.[198] These timbers can be further divided into two groups: a small bulkheads with widths under 25 cm, and larger bulkheads with widths of 45 cm or greater.[199] This separation was apparent: there are no bulkheads with widths between 26 and 45 cm. Although somewhat less apparent, this statement seems to hold true for Ranks 3, 4, and 5. The length also shows distinctions between groups. All the timbers from the small group are less than 150 cm in length, while all timbers from the large group were 300 cm or longer.

This clear division of bulkhead width gives the impression that there were two distinct types of vessels. Archaeological evidence from the Shinan shipwreck indicates that the vessel had a large bulkhead size.[200] Bulkhead planks in other excavated vessels are usually between 15 and 25 cm in width.[201] Thus, it seems certain that at least one large vessel, similar in size to the Shinan ship wrecked at the Takashima site. In addition, smaller vessels made in other areas were also present. The available evidence cannot narrow down the origin of the smaller bulkheads to a specific area.

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[197] Green and Kim (1989, 35) describes stiffeners as "…pointed wooden pegs that penetrate each strake from the outside of the hull planking, thus locking the opposite side of the bulkhead to the frames, and are attached to the face of the bulkhead."

[198] These are Timber Nos. 25 (Original No. 221), 121 (No. 909), 123 (No. 949), 161 (No. 1035), 205 (No. 1142), 322 (No. 1439), 323 (No. 1440), and 420 (No. 1866).

[199] Timber Nos. 25, 161, 205, and 420 are in a small group and Timber Nos. 121, 123, 322/323 are in a large group.

[200] Office of the Cultural Property Management 1984, 135, fig. 6.

[201] Yamagata (2004, fig.3/10) shows a drawing of the Penglai ship with scales; Lin et al. (1991, 306-8) describes the bulkhead and framing structure of the Ningbo ship.

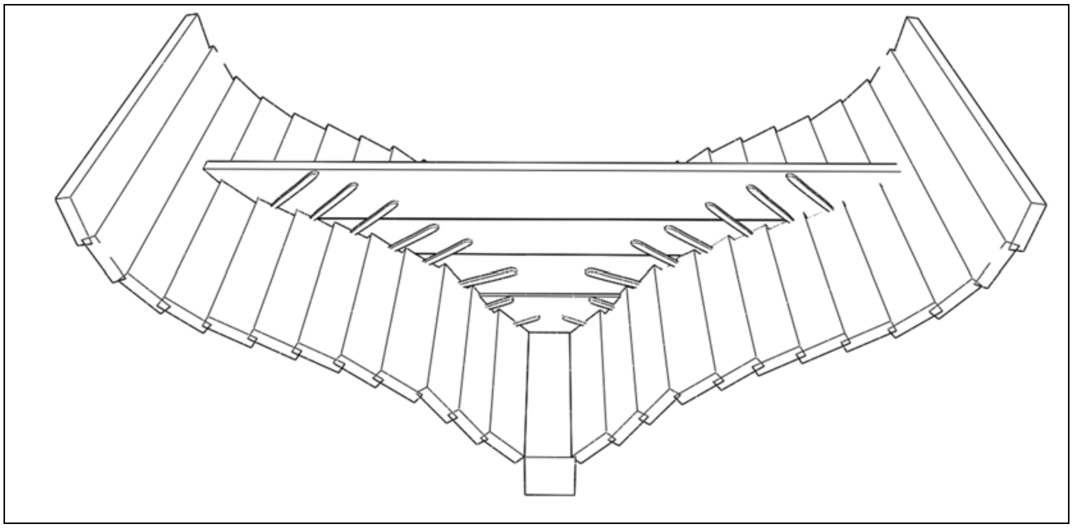

Fig. 27. A Cross-Sectional Reconstruction of the Shinan Ship with Stiffeners.

Timber No. 322/323 (Original No. 1439 and 1440)

These two timbers are definitely part of a bulkhead from a large vessel. They are two of the few hull elements that were still connected when found. This set is considered to be the upper-most, perhaps even from deck level, of a vessel's bulkhead. The maximum length is 570 cm, and the bottom length, where it connects to the lower section, is 465 cm. The width is 60 cm, and the thickness is between 16 and 18 cm. The bottom of the lower section is 370 cm, and the maximum width is 59 cm. The thickness of the bulkheads from archaeological records are about 12 cm or less, and the width of each plank did not exceed 25 cm, except that of the Shinan ship, in which it was 40 cm.[202] The shape and width of the bulkheads from Takashima do not exceed the expected value of the ships built in Fujian province. The bulkhead seam is joggled or made irregular to reduce the stress that is placed on any one point. On the other hand, the joinery

[202] The Office of the Cultural Property Management 1984, 134-5.

between the upper and lower sections is straight and has a notch carved to fit along the length (fig. 28).

The top surface has two rectangular notches located near the center that are about 30 cm in length and 18 cm in height. These two notches are set 115 cm apart. A hatch cover might have been placed here, as depicted by a ladder leading to the lower deck in the *Mōkō Shūrai Ekotoba* scroll.[203] Another interpretation is that these notches were made to fit two longitudinal beams, or carlings, as seen in the traditional watercraft from north China including Hangzhou Bay and Antung Traders (fig. 29).[204] These flat bottom ships are rarely seen in the South. It is interesting to note that this bulkhead from a possible V-shaped vessel had notches to fit carlings.[205]

The seams between the two bulkhead planks are fastened with diagonally oriented nails inserted from both sides. The surface of the bulkhead into which the nails are set is carved, or recessed.[206] The nails are set about 13 to 15 cm apart and seem to be carefully spaced. Almost all the nails are covered with concretions, but they present square sections of about 1 to 1.5 cm.[207] The Quanzhou ship had irregular nail spacing, often more than 20 cm apart, driven from both sides.[208] The Shinan ship also had irregularly placed diagonal nails, as well as broad

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[203] One can see a person in a hold looking above the deck. Conlan 2001, 158-9.

[204] Waters 1947, 29; 1938, 68.

[205] More on this subject is discussed in Chapter VI under Evidence from Takashima Underwater Site.

[206] Green et al. (1998, 286) describes the recess cut in the bulkhead.

[207] Because all nails found at Takashima were square nails, the dimension of the nails always refers to the one edge of the nail, unless otherwise specified.

[208] Green et al. 1998, 286.

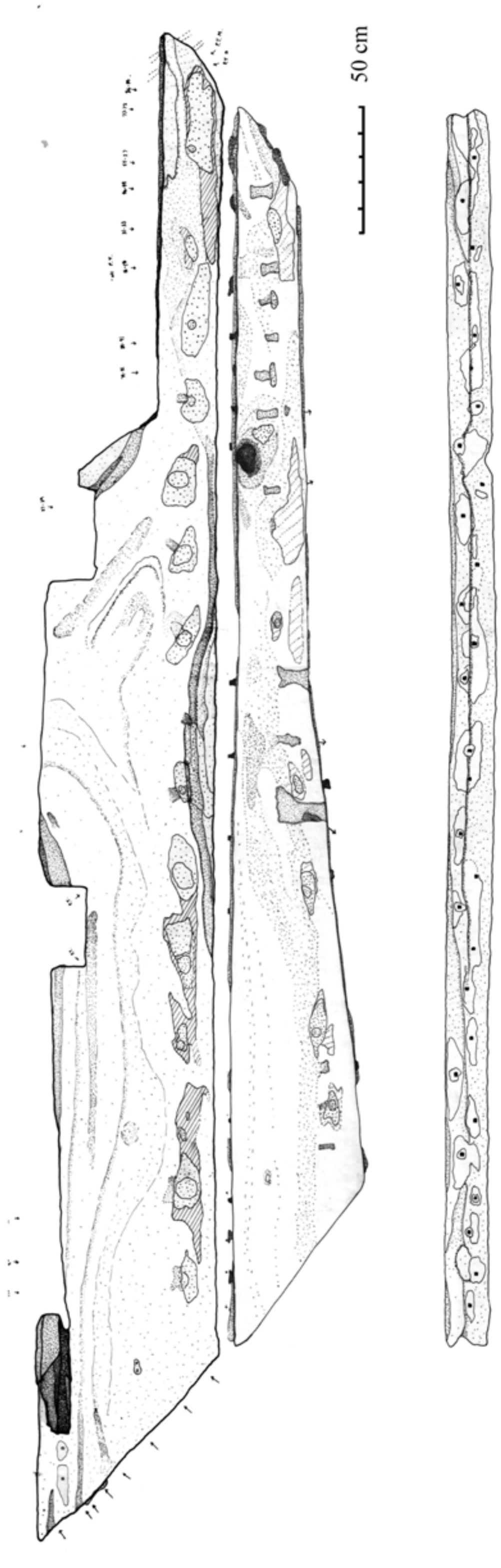

Fig 28. A Drawing of Timber No. 322/323.

Fig. 29. A 3D Model of a Traditional Chinese Vessel with the Longitudinal Beams.

dovetail joints and treenails on some of the seams.[209] The connection of the lower section to the missing bulkhead plank is similar. It uses nails set diagonally from both sides, but the spacing of the nails is wider and more random compared with the bulkhead connection above. There are broad and shallow dovetail-like carvings on the surface as well. The lack of substantial joinery, except for small nail holes where the deck planking may have been laid along the top of this bulkhead assembly, indicates that no additional bulkhead timber was placed above this one. There were several small nail cavities on the surface of the upper bulkhead timber, but the functions of these are not known. These nails are too small to have supported substantial structures.

The fastenings of the bulkhead to the hull planking are also important to note here, as some of the excavated vessels provide excellent parallels for such joining methods. As a general rule, nails or bolts are driven from the outside. A concretion was present at one of the nail locations, but for all the others it appeared that the nails were pulled out before the concretion

[209] McGrail 2004, 370.

could form. Square holes can be seen clearly along the side, spaced 10 to 15 cm apart. These holes measured approximately 10 cm in depth. The Quanzhou ship used *gua-ju* nails for fastening the bulkhead to the planks; these are L-shaped iron brackets set from the outside of the plank going through the thickness and attached to the surface of the bulkhead (fig. 30).[210] The Shinan ship used stiffeners, which are a wooden versions of these iron brackets.[211] Contrary to what might be expected, no trace of such joinery was found on Timber No. 322/323.

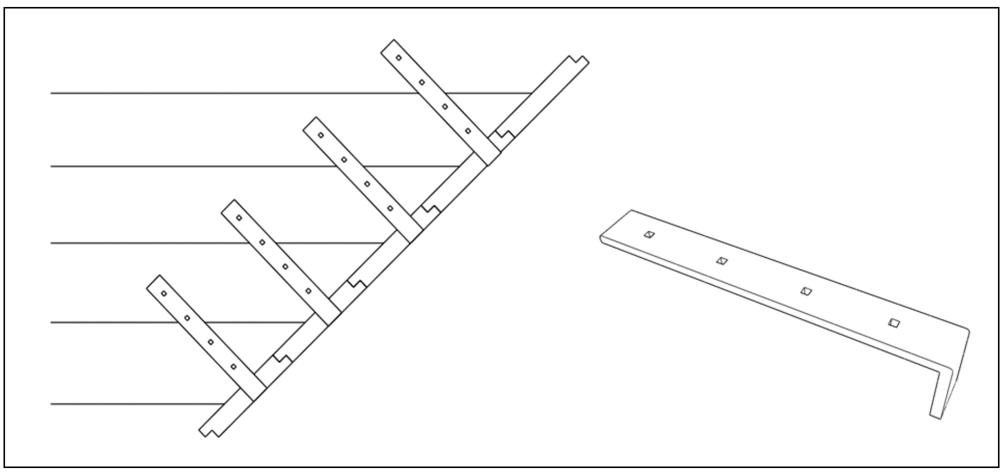

Fig. 30. A Drawing of a *Gua-Ju* Nail. (Adopted from Li 1989, fig. 9)

The vessel from which this bulkhead Timber No.322/323 originated was most likely built in Fujian Province. A slight bevel at the side of the bulkhead may indicate that this assembly was located closer to the bow or stern, and it was likely the upper part of a bulkhead. Although the notches made for the carlings suggest that this was the upper timber of a bulkhead, it is not possible to be certain that there were no other timbers above this one. Despite the

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[210] Green et al. 1998, 289-91.

[211] Green and Kim 1989, 34-5.

uncertainty, this interpretation is the most plausible. I have used the lines drawing of the Quanzhou ship made by Jeremy Green as a template to fit the curve of this bulkhead and the bevel at its side to find a possible position in the hull (fig. 31). The scale of the lines was changed with a fixed proportion for that purpose. A line created from Timber No. 322/323 was overlapped on the lines drawing. The best fit of the two lines was found at the second station from the stern, with a slightly larger proportion than the original Quanzhou lines. This suggests that the Takashima vessel may have been larger than the Quanzhou ship, perhaps longer than 35 m. This interpretation is based on the assumption that the vessel was built using similar lines as the Quanzhou ship. Even if this was not the case, this bulkhead still suggests a fairly large cargo ship.

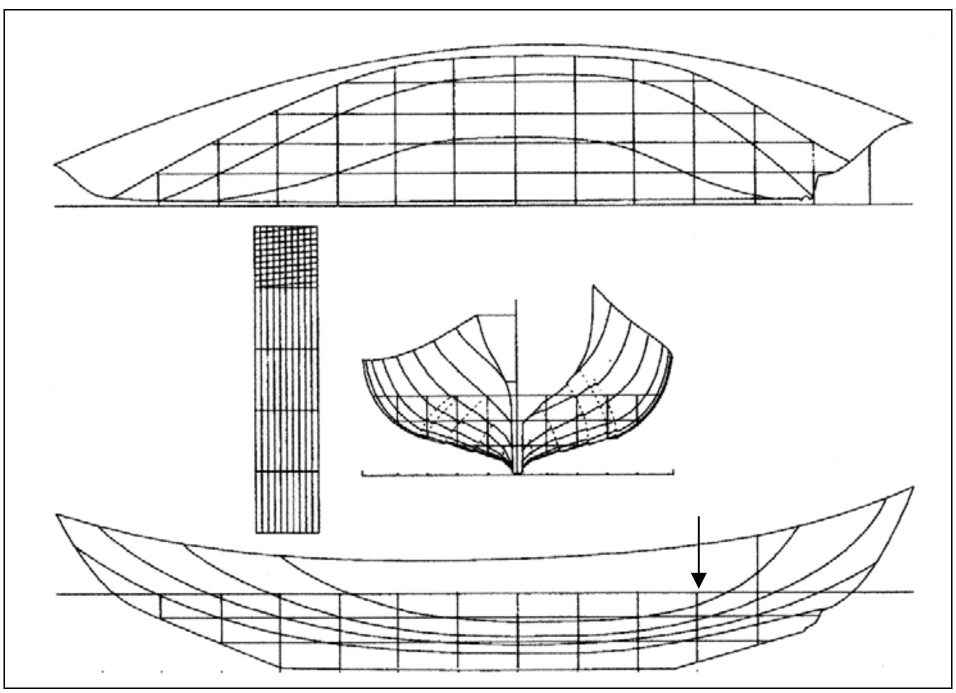

Fig. 31. A Reconstructed Lines Drawing of the Quanzhou Ship. (From Green et al. 1998, fig. 20)

Timber No. 123 (Original No. 949)

This timber presents a maximum dimension of 320 cm, width of 45 cm, and thickness of 16 cm (fig. 32). It is straight and has the general shape of a bulkhead of a V-shaped hull. The thickness of 16 cm suggests a sturdy construction. Considering that the bulkhead of the Quanzhou ship was only 8 cm in thickness, this timber may come from a much larger transport vessel probably built in Fujian Province.[212]

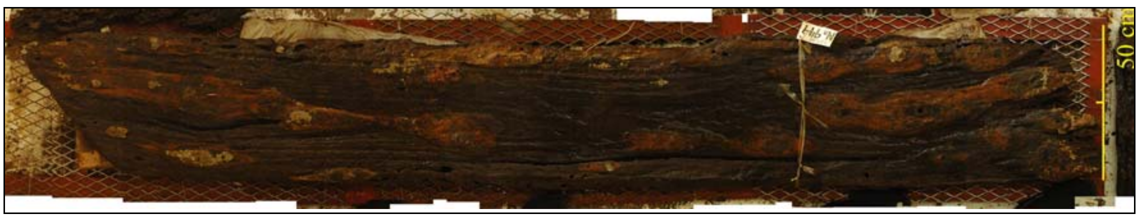

Fig. 32. A Photo Mosaic of Timber No. 123.

One enigmatic problem regarding this timber was not solved: no component was attached above or below it. Furthermore, there are no nails set at the outer edges. Prominent joinery is present on one of its faces. Several long lines of discoloration from rust and nail holes are present on two of its surfaces. This line of rust is narrow, and the nail holes are regularly spaced. The first possibility that may explain this line is the trace of a *gua-ju* nail or stiffener. The nails are driven in from both sides, however, some pass through completely, making the possible use of such joinery unlikely. The lack of joinery at the side of the bulkhead where it connects to the hull planks as well as the lack of joinery from plank to plank is a peculiar feature and cannot be explained at this time.

[212] Green et al. 1998, 292.

Timber No. 161 (Original No. 1035)

This timber is 97 cm long, 21 cm wide, and 4 cm thick. It is thought to belong to a bulkhead from a small vessel. The timber has small square nails driven diagonally from one side, as well as nails from below. This timber may have served as a support of the bulkhead. In China, bulkheads were doubled at some locations to give more strength.[213] One fascinating feature is that all diagonal nails were set into carefully cut rectangular recesses, and wooden plugs were used to fill these holes to make a smooth surface (fig. 33). This is evidence of the care the shipwright took when building the vessel. This timber may have been a sheathing plank for a small vessel, but there is not enough evidence to confirm either hypothesis.

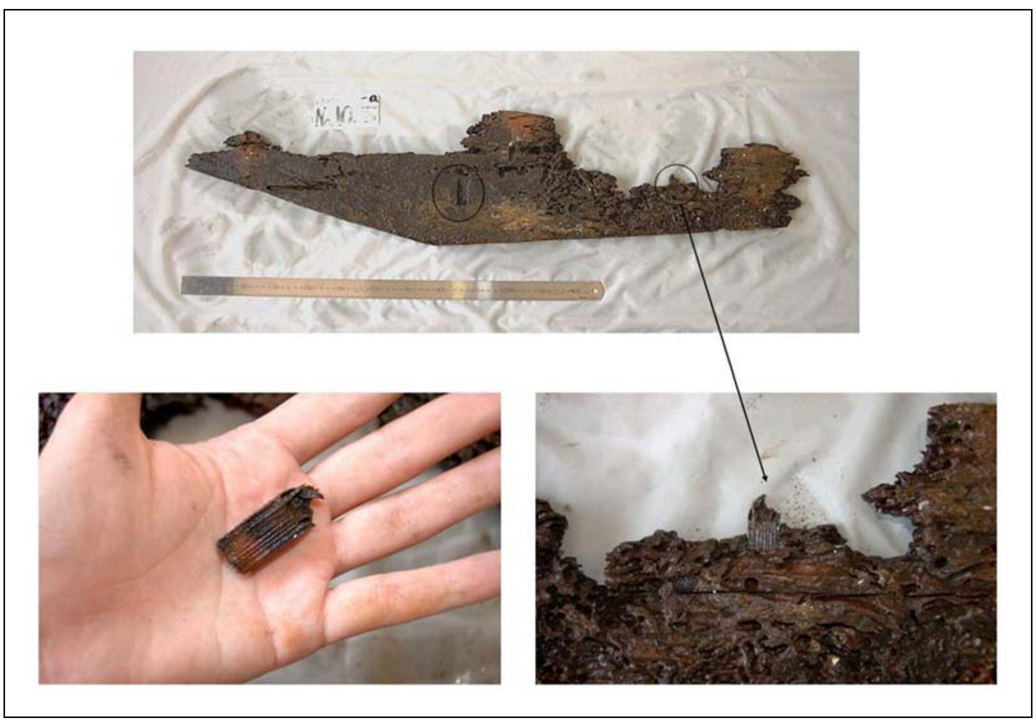

Fig. 33. A Photo of Timber No. 161 with the Details of the Wooden Plug.

[213] Waters 1939, 67.

Deck Planking

Fourteen timbers are assigned to the deck planking category. More than half of the timbers were Ranks 1 and 2, and no Rank 5 was assigned to the category. As a whole, timbers in this category are well preserved. The average width is 12.96 cm and the thickness 2.41cm. The average length is 50.16 cm, but many of the timbers are broken. The average size of the nails from this category is about 0.6 cm, while the majority of the nail sizes from other types of hull timbers are 0.8 to 1.2 cm. This is one of the distinctive characteristics of this category.

Although this category is termed “deck planking,” some may be ceiling or other thin planks. There is no detailed documentation of deck planking from the archaeological record. Historical records suggest that deck planks and ceiling planks were interchangeable and often loosely fitted on watercraft made on the Yangtze River.[214] Some thin planks used for sheathing may be included in this category as well; the Shinan ship had sheathing with a thickness comparable to that of timbers in this category.[215] The thin planking may have been used on superstructures above the deck or it could be from containers. Many small and large objects needed for the invasion and shipboard life may have had these thin planks. The analysis of the deck planking category was not successful in revealing the identity of vessels.

Timber No. 413 (Original No. 1859)

This timber is well preserved; all but one original surface survived (fig. 34). It is 24 cm wide and 4 cm thick as preserved. The surviving length is 51 cm; it may have been longer and broken with a clean snap. One small nail cavity is present, but it is placed at the plank’s edge and

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[214] Worcester 1971, 219.

[215] Office of the Cultural Property Management 1984, 130.

the original size of the nail cannot be determined. Another nail, placed at the center goes through the entire thickness of the plank and is 1.2 cm, which is the largest nail found in this category. This timber could be a sheathing plank rather than part of the deck planking. The timber has too few nails to be considered a structural support, and it is most likely from a piece of shipboard equipment.

Fig. 34. A Photo of Timber No. 413.

Timber No. 141 (Original No. 988)

As one of the best examples of the deck planking category, Timber No. 141 demonstrates almost all of its diagnostic features (fig. 35). The plank's overall length is 115 cm, the width is 20 cm, and the thickness is 2.5 cm. Two nails were found, 61 cm apart and at the same distance from the edge. These nails are 0.6 cm and 0.8 cm. Perhaps beams or bulkheads were placed 61 cm apart.

Fig. 35. A Photo of Timber No. 141.

Planks

A total of fifteen timbers were assigned to this category – a surprisingly low 2.99% of the total timbers. Many timbers that were not included in this category may be hull planks, but because of their degraded nature, they were not identified as such. To be considered as a plank, a timber must have at least one diagonal nail. This criterion excludes many timbers from this category. The average rank for the category is 3.2, and no timber was assigned to Rank 1. The majority of the timbers were Ranks 2 and 4. The category as a whole represents one of the lowest ranks among the major components of the hull. The average length is 71 cm, one of the largest lengths compared to other categories. None of the planks found at Takashima were complete, thus the size of a vessel cannot be determined from surviving lengths.

The average width was 18.32 cm, but this measurement may not be useful in determining the origin of the vessels. The archaeological evidence suggests that East Asian ships were built using various plank widths within the same hull. For example, the Penglai ship had a plank width between 20 and 44 cm,[216] and the Ningbo ship had a plank width of 21 to 42 cm.[217]

[216] McGrail 2004, 372.

This makes the interpretation of the finds from Takashima difficult. The largest width from this category comes from Timber No. 330 (Original No. 1456), which is 42 cm. This degraded plank may be from a large hull, but this cannot be confirmed. Planks are typically thin, easily broken timbers, and therefore not surprising that none survived intact in the Takashima collection. In addition, planks are often made of softwood.[218] This wood tends to degrade faster than hardwood under water when exposed, which explains the lack of planks from the site.

The average thickness of pieces in the plank category is 7.04 cm. The planks usually retain their original thickness. The thickness of 7 cm seems to be well within the range of variation for planks from excavated vessels from East Asia, although the excavated vessels demonstrate a wide range of thicknesses. The plank from the Ningbo ship had a thickness of 6 to 8 cm, the Shinan ship 8 cm, and the Penglai ship 12 to 28 cm.[219] The Quanzhou ship had multiple layers of planks with a variety of thicknesses.[220] Considering the various plank thicknesses, the origin of the vessels wrecked at Takashima are different to trace from this attribute.

Because of the degraded nature of most timbers in this category, in addition to the possibility that these boards may not be planks, and plank-type finds do not appear to be useful for comparative archaeological studies. Despite this, a few timbers clearly display plank-like characteristics and may be used for further studies when more comparative data is available from the archaeological record.

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217 Herron 1998, 270.

218 Worcester 1971, 30; Donnely 1923; 226.

219 For overview of excavated vessels in China, see Wang 2000 and Xi 1999.

220 Green et al. 1998, 285. The plank inside the hull was 8 cm, the next layer was 5 cm, and the outer layer had 2.5 cm thick plank.

Timber No. 14 (Original No. 202)

This relatively well preserved timber is 64 cm long, 12 cm wide, and 5.5 cm thick. It has several diagonal nails and one round nail hole that goes through the thickness. The diagonal nails are in a peculiar configuration. The diagonal nails seem to be placed from below and above as in an X-shaped configuration, indicated with red arrows in Fig. 36. No direct parallel example is accounted for in the archaeological record.

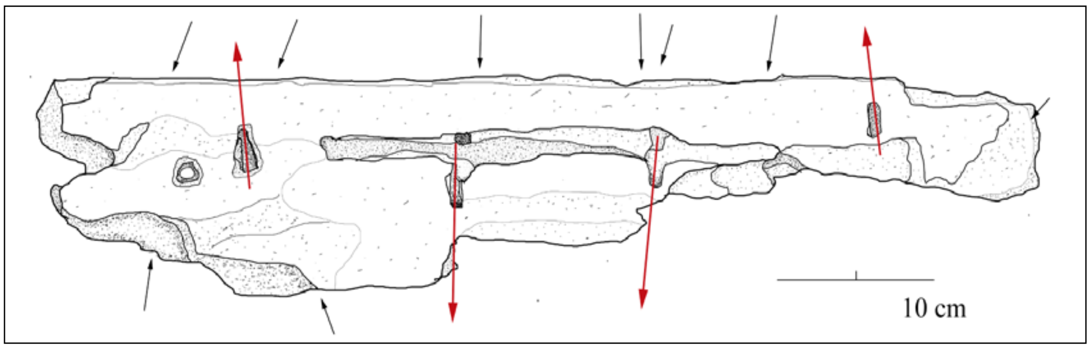

Fig. 36. A Drawing of Timber No. 14 with Arrows Indicating the Location of Nails.

Timber No. 406 (Original No. 1852)

Timber No. 406 has the characteristic features of hull planking. It is 92 cm long, 14 cm wide, and 4 cm thick. Compared to the other timbers, this plank seems to be thinner and narrower (fig. 37). It has diagonally placed nails 25 to 30 cm apart. Extra nails are set through the thickness of the timber. These nails alternate along the top and bottom edge of the plank, and are set 15 cm apart in a zigzag pattern. This nailing pattern may indicate the presence of frames or be evidence for double planking. Compared to ethnographic and archaeological records, it seems too small for a regular plank. The timber may be from a small boat, sheathing, or double

planking, as suggested by the peculiar nailing pattern. The middle layer of plank on the Quanzhou ship had a thickness of 5 cm and the outer layer had a thickness of 2.5 cm.[221]

Fig. 37. A Photo Mosaic of Timber No. 406.

Timber No. 465/466 (Original No. 2003-16 and 17)

These two artifacts are among the most notable finds from the 2003 season. The two components were found connected. The planks preserved a section of what appears to be part of a diagonal scarf, or possibly a stealer (fig. 38). The top section is Timber No. 465 while the bottom section is timber No. 466. Although the bottom section is highly degraded, the upper section of the scarf is well preserved. Timber No. 465 is 80 cm long, 32 cm wide, and 8.5 cm thick. The upper surface has nail cavities placed 10 cm apart. These nails are thought to be diagonally driven from a plank above. Nails are also set diagonally along the lower surface. These are placed from one side only and thus indicate that this is a part of the hull planking.

The shape of the scarf is similar to one from the Quanzhou ship, but this does not mean that the associated vessel was built in Fujian Province; ships built in the Yangtze River also had similar scarfs.[222] The inner plank of the Quanzhou ship and a plank of the Ningbo ship each had

[221] Green et al. 1998, 285. The Quanzhou shipwreck had a triple plank assembly.

[222] Green et al. 1998, 287.

a thickness of 6 to 8 cm in width.[223] The Penglai ship and other craft built for inland waters were often designed with robust, rectangular-shaped planks.[224] This indicates this timber may be from a vessel built for the open sea or an estuary, and not for inland use. The width of 32 cm is again similar to the Quanzhou and Ningbo ships.

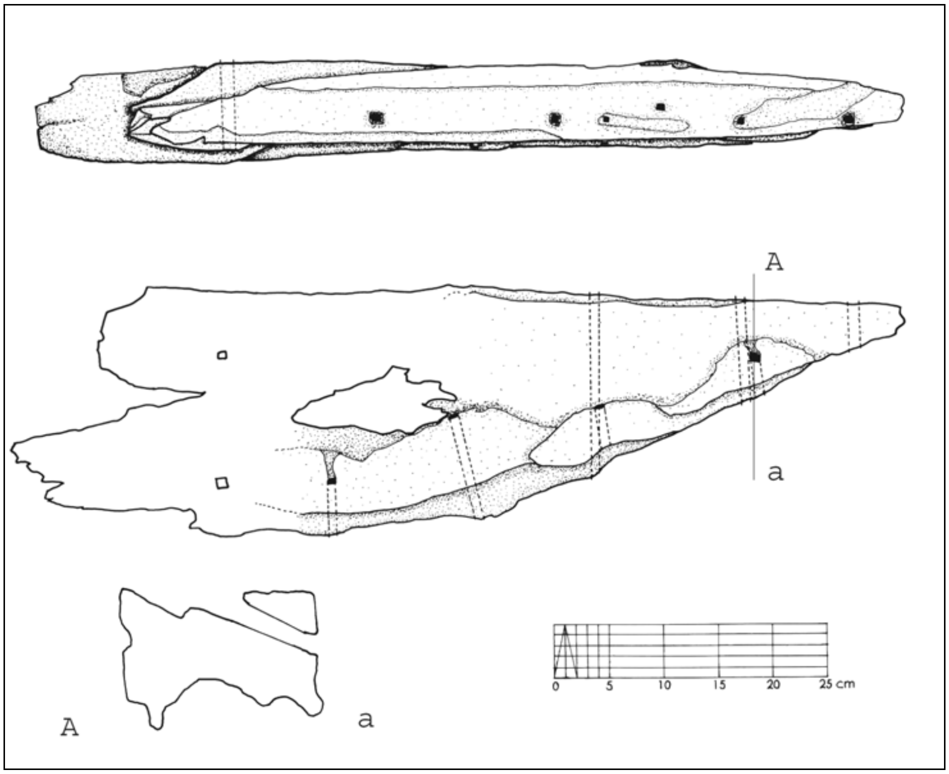

Fig. 38. A Drawing of Timber No. 465/466.

Railings

A total of thirty-four timbers are included in this category, consisting 6.77% of the total timbers recorded, making this one of the most prominent categories. The average rank is 2.76.

223 See Green et al. (1998, 285) for the Quanzhou ship, and Herron (1998, 270) for the Ningbo ship.

224 McGrail 2004, 372.

The average surviving length is 47.66 cm, the average width 6.75 cm, and the average thickness 4.60 cm, but many of the timbers are all similar in size, around 8 cm in width and 4 cm in thickness. One interesting aspect of this category is that it has the highest number of occurrences of nails set close to each other or nails in random order, suggesting repairs. If these "two-by-four"-like timbers were used as bracing or framing for small vessels, it is not surprising to see many recycled and repaired elements. The interpretation of this category is challenging because these fragments may not be from a vessel. They could be from an upper structure, ship-board items, or part of an item such as a shield as depicted on the *Mōko Shūrai Ekotoba* scroll (fig. 39).

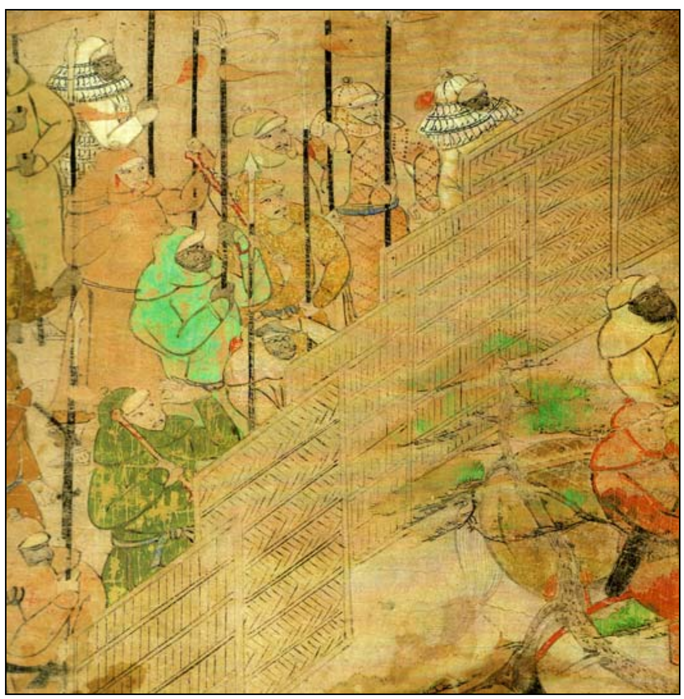

Fig. 39. Shields Depicted in the *Mōko Shūrai Ekotoba* Scroll.

(Courtesy of the Museum of the Imperial Collections, *Sannomaru Shozokan*)

The first impression of the timbers in this category is that they are too small to have been used on a large vessel, if it was indeed used as a part of hull. The Antung Traders are said to have frames of approximately 10 cm by 16 cm.[225] The frames of the Ningbo ship are also much larger, 16 to 25 cm sided and 7 to 10 cm molded.[226] Another feature that must be noted for this category is that none of the timbers were curved. This is not surprising because curved timbers were not widely used in the East Asian shipbuilding tradition. The use of the bulkhead to hold the hull in shape seems to be a logical and efficient method for avoiding the use of curved timbers. These railings may have been used for bracing planks together and probably did not provide major structural strength to the hull. Some may have been used as vertical supports or beams as seen in the Jinghai boat.[227] Vessels from Poyang Lake are also known to use vertical supports.[228] The inland craft seem to utilize smaller wooden pieces to support the hull than vessels built for overseas trade.

The sizes of the timbers from the railing category suggest most of them were used on small vessels possibly built along the Yangtze River. As for the Shinan ship, no component of the hull used pieces of wood as small as those found at the Takashima underwater site. The Quanzhou ship used fairing strips laid along the seam of the strakes.[229] Some of the small timbers from the railing category may have had a similar function. Some may also be from above deck.

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[225] Waters 1938, 52.

[226] Lin et al. 1991, 306.

[227] Ni 1979, 33-5.

[228] Worcester 1971, 394.

[229] Green et al. 1998, 291. These are small strips of timbers laid along the seam of strakes of the lap-joint. The fairing strip thus fit to the “step” made by the overlapping strakes.

Timber No. 66 (Original No. 639)

Timber No. 66 has a square cross-section of 6 cm and a surviving length of 82.5 cm (fig. 40). The timber is well preserved, and three nails of the same size are placed approximately 25 cm apart at the same angle. It could be a stiffener as seen in the Shinan ship; the thickness of the timber and the intervals of nails seem to be similar to the stiffeners from that vessel.[230] It is difficult to validate this claim without having seen two components, stiffeners and bulkhead, attached together. Instead, this piece of timber could have been used to hold another hull component, including planks or bulkhead together. Unfortunately, the origin of the vessel cannot be determined.

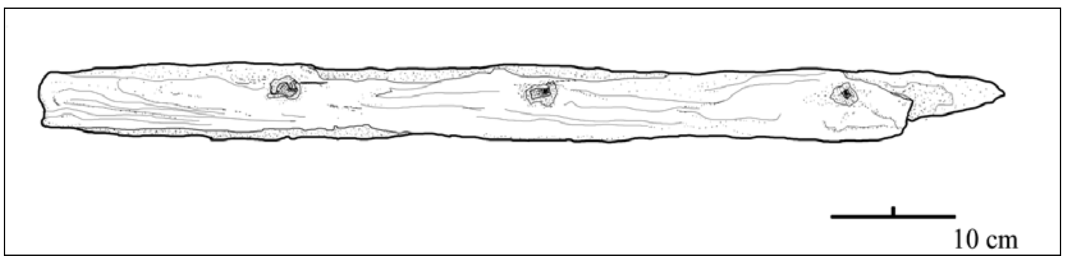

Fig. 40. A Drawing of Timber No. 66.

Timber No. 425 (Original No. 1880)

This timber is 78 cm long, 7.3 cm wide, and 4.3 cm thick. It seems to be a timber used for bracing plank. Close examination revealed a dozen nails driven in the plank (fig. 41). These nails were placed at various angles, and the sizes of the nails varied. Some are placed as close as 3 cm apart. It is not necessary to place so many nails in such close proximity, suggesting the

[230] Green and Kim 1989, 33-4.

piece saw repair or reuse.[231] Despite being an informative artifact in this respect, the timber offers no information regarding the origin, size, and type of its vessel.

Fig. 41. A Photo of Timber No. 425 Showing Multiple Nails.

Timber No. 327 (Original No. 1447)

Timber No. 327 is degraded, but retains a square cross-section of 8 cm with rounded edges and a length of 125 cm. The surface is literally "plagued" with numerous nails holes with more than thirty nails were driven into wooden piece from every angle (fig. 42). There is no order in the placement of nails, with some going through while others stop halfway in. It is apparent that these nails were not used to hold another component or as a structural support. The timber resembles a spiked club with protruding nails, and it is possible that it was part of a defensive strategy to stop the enemy from boarding. The nail-spiked rail was placed on a gunwale, along the side of a hull to prevent enemies trying to board the vessel from entering. Yamagata mentions that a Chinese treatises state that such defensive mechanism was used.[232]

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[231] Ōta (1994, 70-1) describes the historical documents saying Kublai made sure that the vessels were well built and repaired for the third invasion. This shows that the use of an old vessel was a common practice

[232] Yamagata 2004, 88

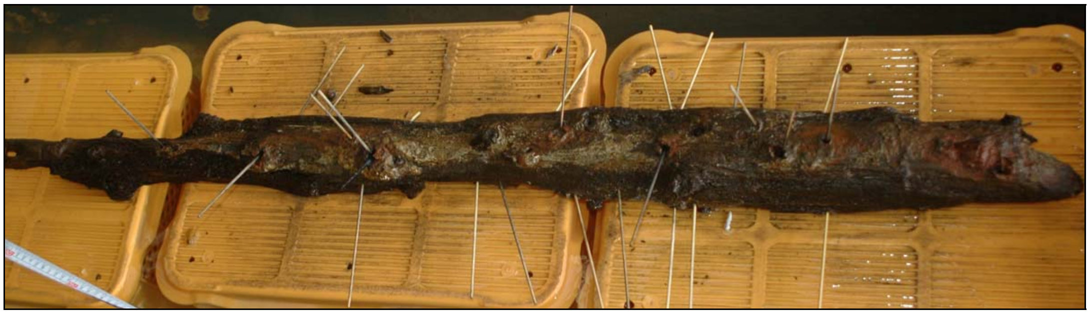

Fig. 42. A Photo of Timber No. 327 with Multiple Nails.

Fashioned Timbers

Presumably, timbers from this category were from vessels that originated in Korea. A total of twenty-nine pieces have been classified as fashioned timber – a number that is fairly high when compared to other categories. They are 5.78% of the total timbers recorded. Although by definition this is nail-less timber larger than 50 cm, the average length is only 65.05 cm. The average rank of 3.93 makes them one of the most degraded categories. Many of the timbers are ranks 4 and 5. No timbers are assigned to Rank 1 and only two pieces are in Rank 2.

The average timber width is 19.19 cm and the thickness is 9.77 cm. A one-to-two width-to-thickness ratio can be assumed, much like the timbers in the railing category. The average width is similar to that of the plank category, but the average thickness is much greater, and these pieces sometimes have rectangular cross-sections. Assuming these were bottom or side planks, the vessels must have been built for inland or shallow waters. The average thickness of the planks of the Wando boat is about 10 cm, indicating some timbers found at Takashima may indeed have been from a similar vessel.[233]

[233] McGrail 2004, 362.

It is unfortunate that many of the timbers in this category were poorly preserved, and may not derive from vessels at all. Nevertheless, the presence of this category itself is significant. The lack of iron joinery does not prove the timber fragments were from Korea, but Korean vessels of the time were known for using wooden joinery to connect planks. The Talido boat found in Korea shows extensive use of this method (fig. 43).[234] Contrary to what might be expected, none of the timbers in this category showed any traces of joinery. Thus, no timber from this category can be confirmed to be from Korea. This disappointment is somewhat mitigated, however, as the historical sources imply that most of the damage from the storm was inflicted on the ships built in China.[235] The Korean vessels should therefore represent only a small percentage of the finds. The lack of nails and the lack of any joinery for these timbers must be explained, but with the available information it is difficult to determine the origin of timbers in this category.

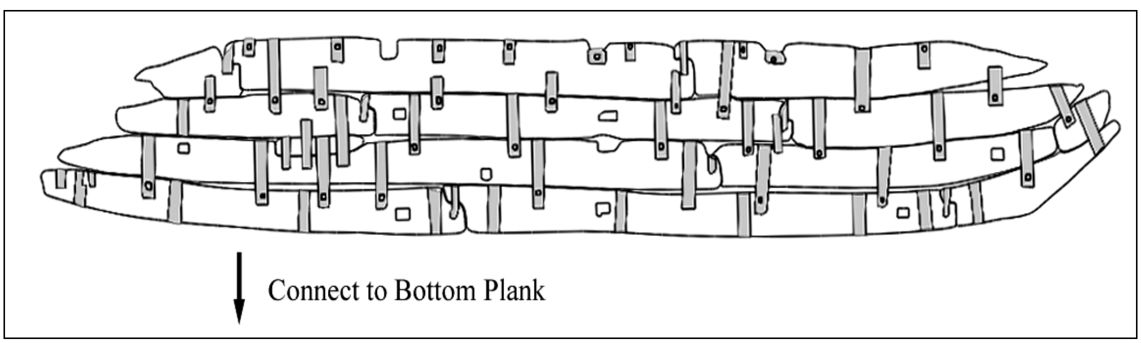

Fig. 43. A Partial Reconstruction of Strakes of the Talido Boat. (After Yuan 2006, Pl. 6)

[234] Yuan 2006, pl 9.

[235] Ōta 1994, 124-30.

Timber No. 11 (Original No. 199)

The timber is 63 cm long, with a square cross-section of 10 cm (fig. 44). This timber may have been broken, and had wider dimensions originally. The Wando boat had bottom planks that were 30 to 35 cm wide and 18 to 20 cm thick. The side planks had a thickness of 10 cm.[236] The dimension of Timber No. 11 is similar to the dimension of the side planking.

Fig. 44. A Photo of Timber No. 11.

Timber No. 31 (Original No. 304)

The maximum length of the timber is 73 cm, and the cross-section is approximately 13 cm by 31 cm (fig. 45). It is a large, highly degraded piece with a natural curve. The only feature is a rectangular cut or notch found in one area. It may be the frame of a vessel or it could be deadwood or another filling piece. Chinese shipwrights used grown timbers for ribs, knees, and some rudder parts.[237]

[236] Green and Kim 1989, 39.

[237] Waters 1946, 158.

Fig. 45. A Photo of Timber No. 31.

Wales

Despite the image of wales being the prominent feature of the Chinese junks, only five timbers collected from the site were identified as wales and many of the wales may have been placed in the railings or unknown/other categories. With a small number of artifacts, it is not useful to generalize a category; instead, specific examples can better illustrate the significant characteristics. The lack of wales at the site requires explanation. The archaeological and historical evidence suggests that vessels built on the Yangtze River had definite wales, while vessels built in Fujian Province did not. The Quanzhou ship had multiple layers of planks giving longitudinal strength to the hull.[238] The presence of wales would suggest that the vessel was made in the lower Yangtze estuary and was not constructed using multi-layered planks. As discussed above, the planks were probably easy to break and were the first section of a hull to be lost. The wales might have suffered a similar fate.

[238] Herron 1998, 274.

<u>Timber No. 22 (Original No. 214)</u>

This possible wale is over 160 cm long, 14.5 cm wide, and 6 cm thick (fig. 46). The dimension of the wale of the Ningbo ship was 9 cm by 14 cm, and was perhaps similar to this timber.[239] It is flush on one side and has the natural curve of wood on the other side. When carefully observed, the flat surface exhibits tool marks from an adze or plane. It has three nailing patterns. The first type has nails driven diagonally from a timber above, spaced about 6 to 10 cm apart, and driven into the wale, just like the typical nailing pattern found in a plank. The second nail pattern is the opposite; nails are set diagonally from this timber and driven into the timber below. The function of the diagonal nails is clear: they firmly attach the wales to components above and below. The third pattern has nails set straight and driven though the thickness. These nails are set 30 to 40 cm apart, and not all nails go through the wale completely. It is curious that some of the nails stop half way. Perhaps another component was attached on the rounded surface.

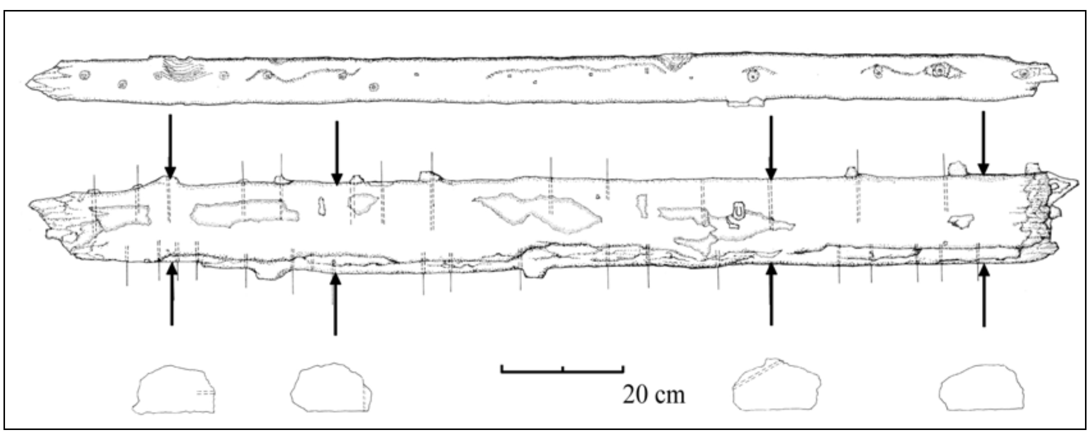

Fig. 46. A Drawing of Timber No. 22.

[239] Lin et al. 1991, 309.

Timber No. 37 (Original No. 317)

The surviving dimensions of this timber are 116 cm long, 25 wide, and 11 cm thick. The naturally curved wood surface survives, and a leveled surface can be seen on the opposite side. Three nails were detected, but because of the deteriorated nature of the artifact, the locations of many other nails are now lost. One nail goes through the thickness near the center, and most likely connected the timber to the plank. This plank may have been laid on top of the assembled hull. Timber No. 22, on the other hand, was probably assembled together with the planks as suggested by the presence of diagonals from both top and bottom surfaces. The width suggests a fairly large size of ship when compared to the size of the Ningbo ship, which had a wale width of 14 cm.[240] If this timber was a wale, a large vessel built on the lower Yangtze River was present at the site.

Timber No. 45 (Original No. 354)

The surviving length is 51 cm, the width is 8.5 cm, and the thickness is 4 cm (fig. 47). There appear to be tool marks on both surfaces. This piece is not a simple split log; it is purposefully carved into shape. It had five nails, all likely driven from the rounded surface to the flat surface. All nails were 0.7 cm with square cross-sections, and set at the same time. The nails were placed at various angles, but all tips came out close to the center line of the flat surface, about 10 cm apart. This might have been used as a gunwale. The size of the timber seems to suggest that it was for a small vessel and was nailed directly on top of an existing plank.

[240] Lin et al. 1991.

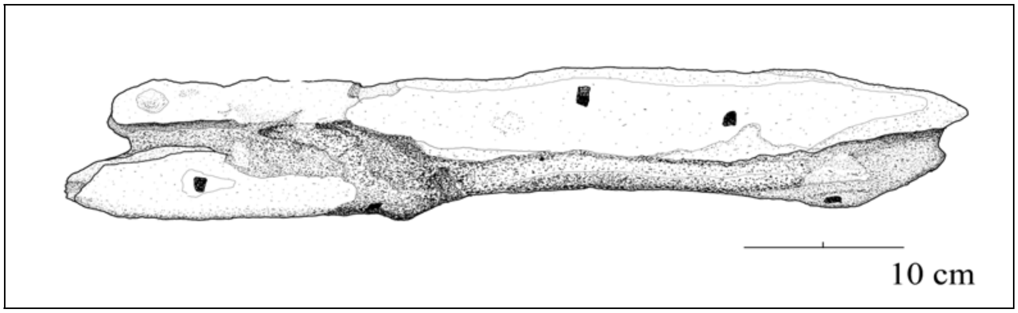

Fig. 47. A Drawing of Timber No. 45.

Fasteners

Eight timbers were included in the category.[241] These timbers are divided into two groups. One group represents timbers with a rounded shape, like a peg, dowel, or treenail (fig. 48). The other group is the timbers with a rectangular shape, including tenons. Timber No. 69, 158, 255, and 444 are in the round shape group and Timber Nos. 94, 318, 365, and 366 are in the rectangular shaped group.[242]

Timber No. 69 is a possible round plug. Both sides are crudely cut, preserving the original shape; the cut is made at angle, and the function is not clear. The length is 15 cm, having 8 cm diameter. Timber No. 158 is 5 cm in diameter and 17 cm in length. Timber No. 255 appears to be a treenail and is 3 cm in diameter, with a surviving length of 11 cm. The last piece identified in the rounded fasteners group is Timber No. 444, which is similar to Timber No. 69. The diameter is 3 cm and it is 5.5 cm long. Both sides are cut, one side straight and the opposite side diagonally.

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[241] The various fasteners are discussed in next chapter under joinery typology; this chapter only presents a description of the general nature of the timbers.

[242] Timber No. 69 (Original No. 645): No. 158 (No. 1028): No. 255 (No. 1297): No. 444 (No. 1811-c): No. 94 (No. 828): No. 318 (No. 1433): No. 365 (No. 1677): No. 366 (No. 1678).

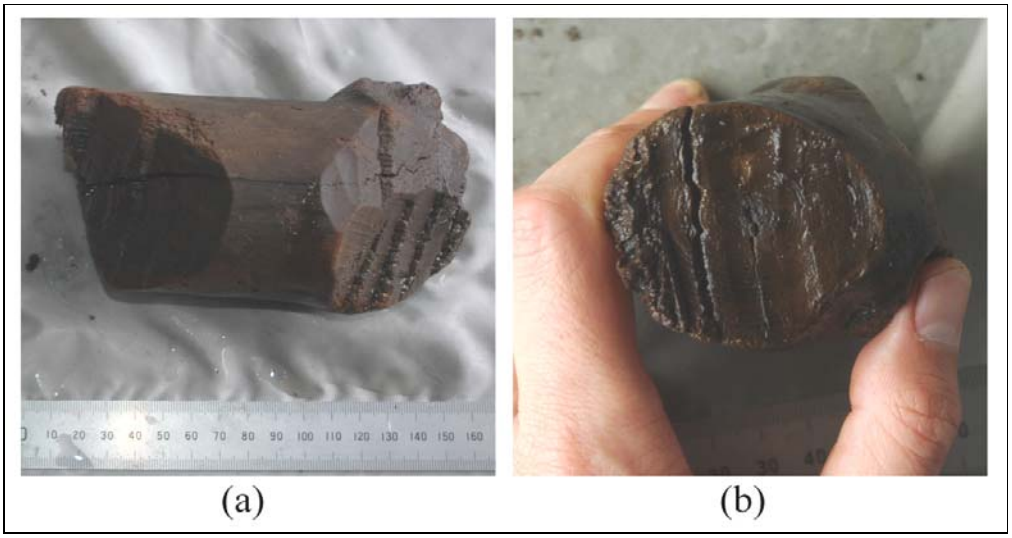

Fig. 48. Photos of (a) Timber No. 69 and (b) Timber No. 444.

Timber No. 94 is the most “tenon-like” fastener. It is 7 cm wide and 17 cm of its length survived. It is only 1 cm thick and heavily charred. One or possibly two round holes were found, and these may be where pegs were inserted to hold the tenons in place. The function of Timber No. 318 is unknown. It has a blocky appearance with the maximum dimension of 20 cm, width of 5.8 cm, and thickness of 3.5 cm. One section is cut to create an indentation. It was most likely placed inside a cut rectangular hole to hold two or more components together like a pin. Timber No. 365 is well preserved with a width of 7 cm, a length of 16 cm, and a thickness of 2 cm. A rectangular hole is placed off-center; the dimensions of the hole is 1.4 cm by 1.1 cm. If this is indeed for a peg, it means that the joinery was loosely fastened with only one side of the tenon locked with a peg to prevent movement. Timber No. 366 has a L shaped appearance, but originally it may have had a C-like shape (fig. 49). It is 12.5 cm long, 6.5 cm wide, and 1.8 cm thick. The timber is carefully crafted, with a cut-out of 2.5 cm. A very small nail is set through

the width. Great skill and precision was required to place a nail through the 1.8 cm thick timber, showing the care that the Chinese shipwright took when crafting this timber. This cannot be a part of a large structure; it is more likely a part of a small piece of equipment.

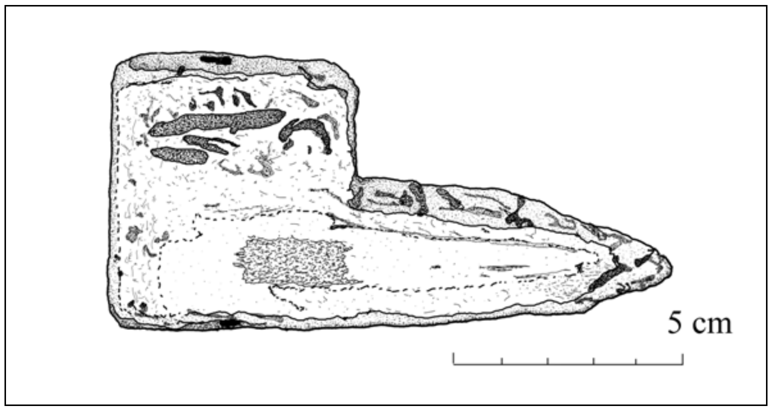

Fig. 49. A Drawing of Timber No. 366.

Unknown/Other

The unknown/other category cannot be generalized because each timber is unique. A total of 52 timbers were recorded, representing more than 10% of the total timbers found. This category includes frames, knees, mast steps, and rudder posts. Several examples from the category are described below.

Timber No. 6 (Orginal No. 193)

This timber is important because it helps determine the size of a vessel and because it can be compared to other excavated vessels as well as historical records. It is a mast step, or perhaps should be called a tabernacle step. It is 130 cm long, 31 cm wide, and 16 cm thick. Two

rectangular openings are located close to one end, and there is one natural hole at the other end (fig. 50). Tabernacles inserted in the rectangular openings hold up the mast. One of the openings is 13.5 cm by 10 cm, while the other opening is 12 cm by 9 cm. The distance between the openings is approximately 35 cm. This does not represent the maximum diameter of the mast as it may have tapered at the heel or the tabernacle may have been notched.[243]

Fig. 50. A Photo of Timber No. 6.

Tabernacles are secured by a locking pin inserted from the side of the mast step. The pins pass through the tabernacle and into a small mortise cut halfway into the opposite side of the step. Based on the size of the mortise and the hole located at the side, the pins were approximately 4.5 cm square. Small nails were driven diagonally into the base of the tabernacles to secure them to the mast step. The bottom of the mast step was made straight. There are large holes at several locations along the side, but these might be either intentionally crafted or created by teredo worms. A number of small nails were used to secure the mast step to the bottom of the

[243] Donnely 1923, 228.

hull. These small nails would have been insufficient to secure the mast step. Instead, a wooden pin may have firmly affixed the mast step to the bottom. A diagonal groove was cut into the base of the step, 8 cm wide and 5 cm high and filled with a chalky white putty-like substance, most likely *chunam*.[244]

At first glance, the step appears to be in poor condition and made without much attention to detail. Indeed, the two tabernacle holes are not aligned, and the shape is not symmetrical. A third hole, which is a natural opening of the wood, suggest that the shipwright who made this step did not place much importance on selecting high quality wood, or they did not have access to a high quality wood. Some may view this as evidence of hasty preparation for the invasion. Another possibility is that a mast step may not have played an important role in securing the mast in the Chinese shipbuilding tradition. Many of the traditional vessels of the Yangtze River described by Worcester used carved branches to secure tabernacles.[245] Furthermore, the tabernacles and the bulkhead were used to firmly affix the mast. Thus, the step may have played only a minor role in holding the mast in place, with the real strength of the arrangement being derived from the bulkhead.[246] The tabernacles, bulkhead, mast, and hull were an integrated system that distributed the stresses applied by the sail.

The shape and size of the mast step is an important clue for determining the shape of the hull. If this mast step was placed directly at the bottom of a hull, the bottom of the hull must have been level for more than 130 cm across. The diagonal notch at the bottom suggests another

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[244] Chunam is a lime and Tung oil based paste used for water-proofing the hull. It is discussed in detail in the next chapter.

[245] Worcester 1971, 282.

[246] In fact, all excavated vessels from Medieval China had the mast step abutted to the bulkhead.

interpretation. The mast step may have been a composite structure, and this timber was the upper section. The Shinan ship had an elaborate structure for its mast step (fig. 51).[247] If this was the case, a V-shaped vessel can still have a flat mast step component placed on top of a lower component that is fitted to the shape of the hull.

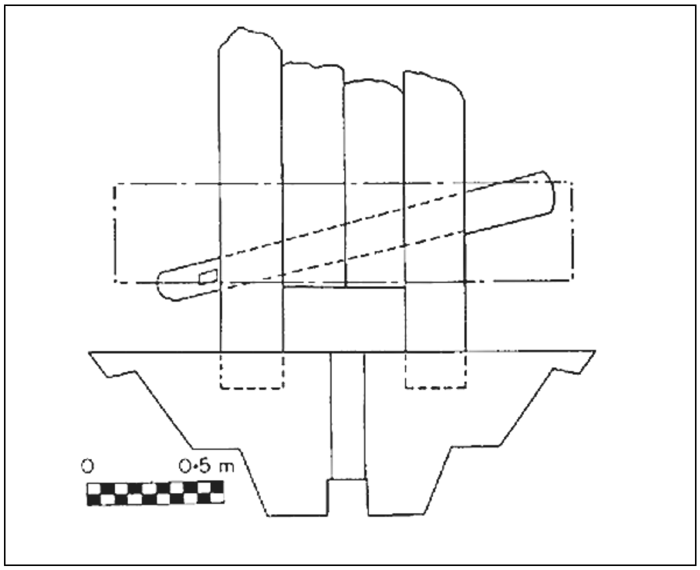

Fig. 51. The Mast Step of the Shinan Ship. (From Green and Kim 1989, fig. 10)

The size of the mast step can be compared with excavated vessels. The maximum dimension of the main mast step of the Quanzhou ship is about 260 cm, or twice as large as the timber from Takashima. The maximum dimension of the foremast step of the Quanzhou ship is about 200 cm.[248] Both the main and secondary mast steps are larger than that found at Takashima, as are the mast steps from other vessels.[249] The mast step of the Ningbo ship,

[247] Green and Kim 1989, 38.

[248] Green et al. 1998, 281.

[249] See Appendix A.

measuring approximately 100 cm, is similar in size.[250] Considering the flat shape at the bottom of the mast step and its size, Timber No. 6 may be from a vessel built in the Yangtze estuary.

Although the distance between the tabernacles does not directly represent the diameter of the mast, the distance can still be compared to give some basic idea of the size of the vessel. The diameter of the foremast of the Quanzhou ship is 37 cm, and is closest to the size of the mast step recovered from Takashima, which is about 35 cm.[251] The distance between the tabernacles of the Ningbo ship is much smaller.[252] The shape of the vessel, its purpose, and the location of the mast contribute to a wide range of mast sizes. What can be said from the comparative study is that the mast step itself is small, but the size of the mast may have been comparable to that of the Quanzhou ship. Perhaps the step played a minor role in providing support for the mast, or the shipwright thought he needed to craft a large mast for the voyage to Japan.

Timber No. 34 (Original No. 307)

This timber is carefully made and well preserved with a length of 176 cm, width of 18 cm, and thickness of 8 cm (fig. 52). It is part of a windlass support post and it may be important in determining the size and type of the vessel to which it belonged. It represents one of the only archaeological examples of recovered windlass parts. A rectangular hole is located on the timber directly below where the width changes. This may correspond to where it was notched into the deck, and a locking pin is located below to secure the windlass to the deck. The hole for the locking pin is approximately 6.5 cm by 3.5 cm. This is the only joinery that has been found on

[250] Lin et al. 1991, 308-9.

[251] Green et al. 1998, 281.

[252] Lin et al. 1991, 308-9.

the piece. The diameter of the circular opening where the windlass shaft was placed measures 12 cm.

Fig. 52. A Photo of Timber No. 34.

There were two basic types of windlasses in medieval East Asia: one that was attached to the mast and one that was independent. The type that attached to the mast was often a part of the tabernacle and used to operate the sail. The independent windlass was located at the bow and used to hoist the anchor cables (fig. 53). The reconstructed figure of the windlass presented by Yamagata is almost exactly the same as the timber recovered from Takashima.[253] Because the windlass is a common element on many sailing vessels, it is not helpful for determining a vessel's origin. This issue is compounded by the fact that the upper sections of hulls are rarely found in the archaeological record.

The reconstruction and experimental studies will be useful for determining the size of an anchor that this windlass could carry, since no written records indicate a correlation between the size of the shaft of a windlass and the size of a anchor or a vessel. One characteristic of Timber No. 34 is that the surface is charred. This is an important fact because it may imply that the

[253] Yamagata 2004, pl. 6/12.

vessel was burned before it sank. It is interesting to consider if this particular vessel was set on fire by the Japanese. The vessel may not have been destroyed by the great typhoon, but by the Japanese counter force.

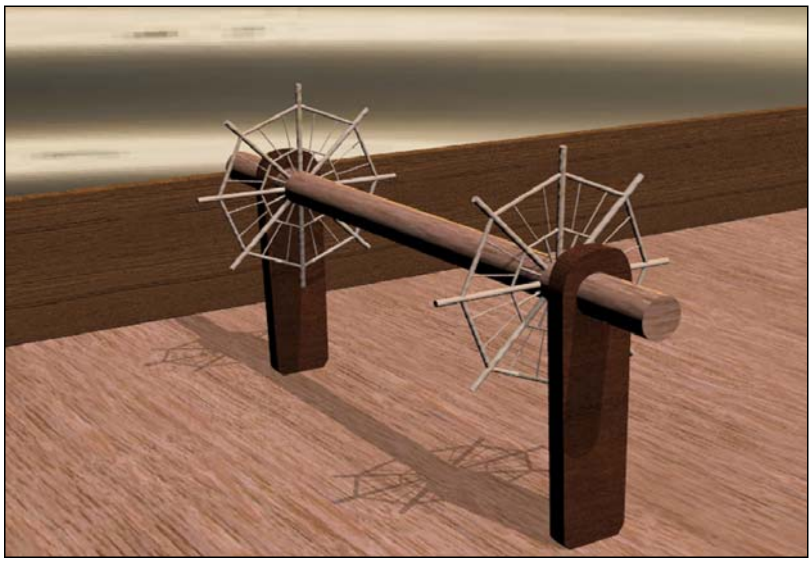

Fig. 53. A Hypothetical Reconstruction of the Windlass.

<u>Timber No. 51 (Original No. 601)</u>

This 300 cm long timber is 48 cm wide and 16 cm thick; it is wider than any planks from an excavated East Asian vessel, including the bottom plank of the Wando boat (fig. 54).[254] The timber has a large rectangular opening at one side, located close to the edge. The rectangular opening is more than 20 cm long and 20 cm wide, with several small nails placed around it. Because the nails are covered with concretion, the size, direction, and shape of the nails were not observed. Indeed, it is not certain if there are actually nails or just concretions attached to the

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[254] Green et al. 1989, 39.

wood. These nails were too small to provide any structural strength and no other trace of joinery was detected on the timber. It may be part of a hull, but a logical explanation for not having any joinery must be given.

Fig. 54. A Photo Mosaic of Timber No. 51.

Timber No. 227 (Original No. 1236)

The original brief analysis conducted by the Takashima Board of Education concluded that Timber No. 227 was part of a bulkhead, but this was later found to be incorrect. It probably functioned as a frame (fig. 55).[255] It consists of two connected parts, and has a V-shaped appearance with a pointed tip. The timber is 130 cm long with a maximum thickness of 22 cm. A description of the upper section of the timber is given first and the bottom part later.

The upper surface of the upper timber is curved and smoothed. A small nail located at the center close to the bottom is set into but does not go through the thickness. Two nails are set on one side of the tip. All of these nails seem too small to provide any support. The timber also has three nail holes which do not pass all the way through. Corresponding nails in the lower section indicate that the nails were driven in from below. The lower section is triangular in shape. Although the surface has several spots of rusty orange discoloration, no nails are present except

[255] Takashima Board of Education 2003, 56.

for the three that connect to the upper timber. The nails have 0.8 cm square cross-sections. These nails were all set with similar angles. Two nails were found on one side of the triangle and one on the other. This implies that the timbers were not located at the bottom of the vessel, but perhaps located to a side.

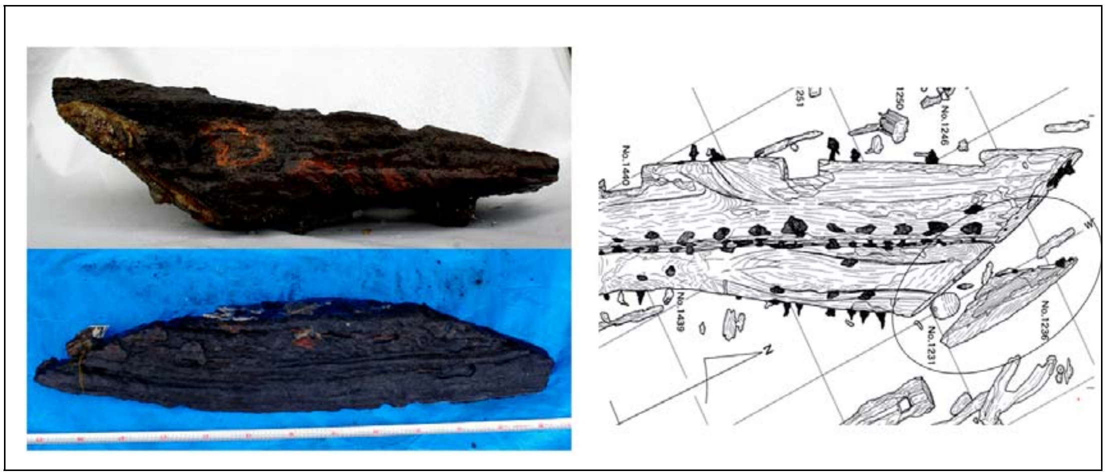

Fig. 55. A Photo of Timber No. 227 and Part of the Site Plan.

It is difficult to determine the function of Timber No. 227, although it is most likely a frame or a deadwood piece from a large vessel. There is no indication that another timber was connected to the top. The minimal number of fasteners indicates that the timber did not play an important structural role but was probably inserted after the shape of the hull was formed. If this was placed on the side of a vessel, like a frame, it indicates a vessel with a hard chine. It may be a part of a turret built vessel, like the Kiangsu Trader, or other traditional vessels from northern China.[256] Vessels such as these utilized frames and other large supporting timbers (fig. 56). It

[256] For example, see Waters 1939, 6-9; Worcester 1971, Plate 2 and 5.

could have fit into many locations within the hull. Despite its large size, the function and origin of the timber cannot be determined.

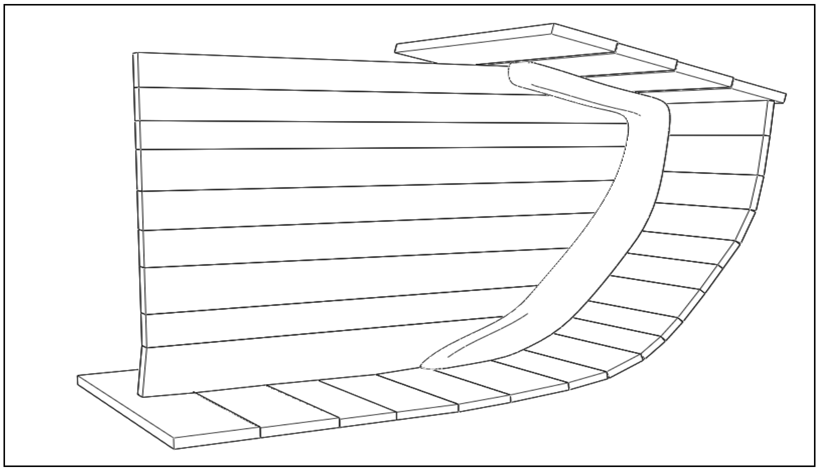

Fig. 56. A Possible Reconstruction of a Frame/Knee.

Timber No. 335 (Original No. 1476)

This artifact was used as a frame or a support for a large vessel (fig. 57). It is 260 cm long and demonstrates a changing angle of curvature. Several nails pass through the thickness of the timber, suggesting it was connected to another supporting component, likely a bulkhead. Nails connecting to planks were only found only at the ends. The curve is not symmetrical and it was most likely placed on one side of the hull like a futtock or a knee. One area shows an abrupt change or a step at the curve. This implies lapstrake construction, but the rest of the line is smooth. One possible suggestion is that this may have been where the keel and garboards were connected. If this was the case, the shape of the hull would have had a steep angle of deadrise. The timber could have been situated either at the stern or bow. Comparative analysis between the

curve of the timber and the available lines from excavated vessels was not conducted because the location and the angle of the timber could not be determined.

Fig. 57. A Photo Mosaic of Timber No. 335.

Timber No. 415 (Original No. 1861)

This charred timber is considered to be a part of a rudder stock, but the identification cannot be confirmed (fig. 58). The surviving length is 225 cm, and it has a 16 cm square cross-section at the top that gradually tapers and breaks where blades might have been attached. One mortise located near the top is 10 cm by 8 cm, which tapers to a smaller 8 cm by 4 cm at the other side. Second mortise is 10 cm by 8 cm and tapers to 7.5 cm square towards the other side. Both holes are at the same angle and taper towards the same side. The rectangular opening at the top is where the tiller was inserted. The purpose of the second opening is not known, but it might have been where part of a blade was inserted. There is a rectangular recess 3 cm deep of indeterminate function at the tip. Archaeological information regarding the size of the tiller and rudder blades is lacking. According to historical and ethnographical accounts, one of the characteristics of a Chinese Junk is its larger size compared to vessels constructed in the West.[257]

[257] Worcester (1971, 97) argues that the larger proportion of the rudder acts as a keel to keep the vessel to the wind.

The size and shape of the rudder and the rudder post vary according to where the vessel was built, its function, and size. The timber from Takashima seems small. The only suggestion that can be made is that Timber No. 415 is a rudder post from a small vessel. The timber is charred and perhaps it came from one of the vessels set on fire by Japanese samurai.

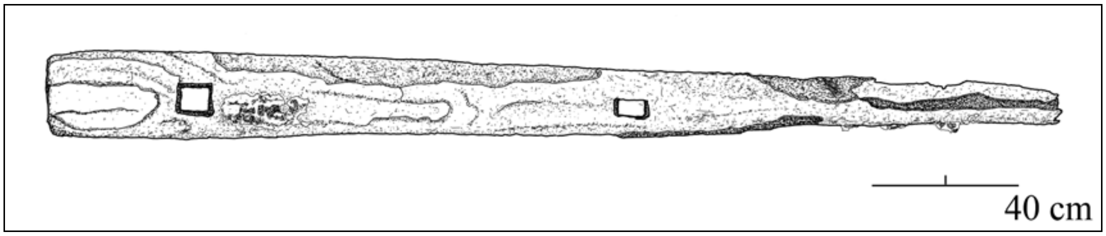

Fig. 58. A Drawing of Timber No. 415.

Logs and Cut Logs

The categories logs and cut logs include timbers with round cross-sections and no nails. Those showing a modified surface, such as a cut, are assigned to the cut log category; a timber without a cut is assigned to the log category. Each category has forty timbers assigned. The two categories add up to 15.94% of the total timbers from the site. In other words, close to one sixth of the timbers excavated at the site appears to be simple driftwood. Other than describing samples of this category, an overall description of the timbers are provided below.

Timber Nos. 68, 176, and 398 are more than 1 m long, and Timber Nos. 175 and 399 exceed 2 m.[258] These timbers most likely served a similar function. Timber No. 176 has a peculiar feature; one end is pointed. This is probably a piling or stake. In the *Mōko Shūrai*

[258] Timber No. 68 (Original No. 644); No. 176 (No. 1070): No. 398 (No. 1805): No. 175 (No. 1069): No. 399 (No. 1812).

Ekotoba scroll*,* a solider holds a long stick that probably served as a stand for his shield (fig. 59). It is known that grown timbers were used as frames and knees on vessels made along the Yangtze River, and some of the timbers from this category may function as such.[259] Some of the long logs may be beams on certain small inland craft.[260]

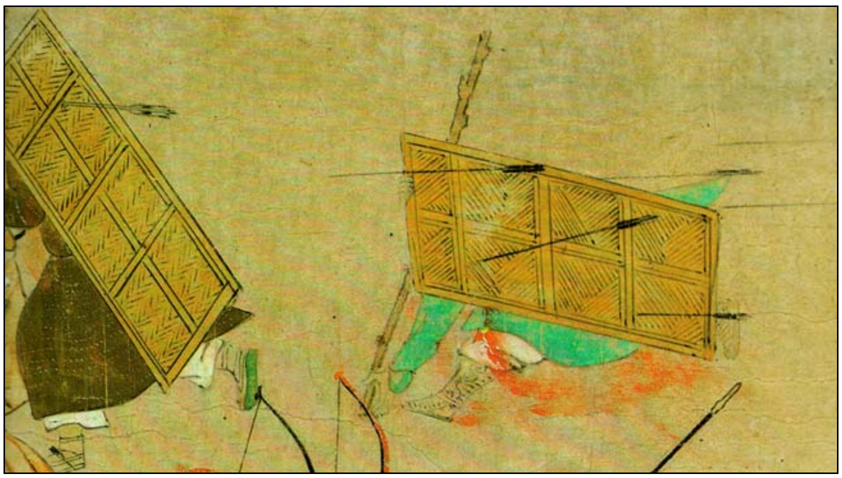

Fig. 59. Possible Use of Long Logs Found on the *Mōko Shūrai Ekotoba* Scroll.

(Courtesy of the Museum of the Imperial Collections, *Sannomaru Shozokan*)

The average length of the timbers excluding these five timbers is 49.34 cm, and as all are similar in size and shape, they must have had a similar use (fig 60). The most logical use for these logs is as firewood. There is no archaeological example of firewood from East Asia, but ethnographic examples from Canton mentions that ships carried bundles of firewood 38 cm long.[261] Firewood could have served several purposes on board, but cooking comes to mind first.

259 Waters 1938, 51.

260 Yuan 2006.

261 Lovegrove 1932, 252.

The voyage to Japan would have been long and it required a large amount of firewood to last the entire trip. Another use for firewood was communication between ships. The distance and direction of the vessels during the day was easy to detect; at night, however, it was difficult to know the position of one ship relative to another. Several ships may have become lost during the night, and by the time they reached Japan, reducing the fleet's number. It was important to keep the fleet as organized as possible. To accomplish this task, fire was the obvious and most logical solution. A vessel could use fires on deck to guide the fleet at night. The use of fire to communicate on board was a well known practice at the time, and this method is noted in several historical documents.[262] Emissary vessels sent from Japan to China often used fire to communicate.[263] Another use of the firewood may be considered, and that would be used by the counter-attacking Japanese forces. The Samurai may have used small boats as fire-ships, setting them on fire and sending towards the larger Chinese fleet. The charred timbers previously described may indicate some vessels were lost due to fire on board.

Fig. 60. An Example of a Cut Log.

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[262] Batten (2006, 83) mentions the use of fire as a means to communicate when on sea for the Korean Pirates.

[263] Ōba 2001, 1.

According to ethnographic and historical records, Hunan Province was a major supplier of wood and Fujian Province was also mentioned as a center for the firewood trade.[264] Kublai ordered both of these provinces to construct vessels; perhaps he was also thinking about the supply of fire wood when making the decision. Considering the large number of timbers from the logs category, supplying these vessels with enough firewood was perhaps a major concern. While building vessels, many trees were cut down. Pieces not fit for building vessels were possibly collected and used as firewood. Researchers have not focused on the use of firewood on board a ship and its importance. This analysis suggests that when examining an invasion of this scale, even firewood may provide useful information once it is properly studied.

The identification of species for these timbers is currently underway. Once these data is available, they can provide information on where firewood were collected and possibly where the vessel originated. It is logical to suspect that the firewood was gathered near a vessel's original port or shipyard. Although it is just firewood, it may therefore be key to understanding an important aspect of the invasion.

Unidentifiable

The unidentifiable category is defined as a timber that has a trace of joinery or original surface, but the function cannot be identified (fig.61). Unfortunately, with 129 timbers, the unidentifiable category has the largest number of entries. This number represents 25.70% of the timbers excavated from the site. Only the dimensions of select timbers were recorded, as the information was not expected to reveal any significant insights. Most of the timbers fall between

[264] Worcester 1971, 41, 74.

10 to 25 cm in length. Several timbers, including Timber No. 70 and No. 155, had different sized nails driven in various directions.[265] These may have been a part of a railing, plank, or bulkhead. Several timbers may be identified as part of a larger timber. Many timbers may be filler pieces, like a chock, used to fill a gap between hull elements. Many small pieces were likely used to construct some of the vessels.[266] There may be some archaeological significance for these timbers but they must be analyzed with full detail. However, these timbers are all out of context, and the new information they are likely to provide about the East Asian shipbuilding technology is minimal. With the scope of this project, it is simply too difficult to glean any useful data from the timbers in this category.

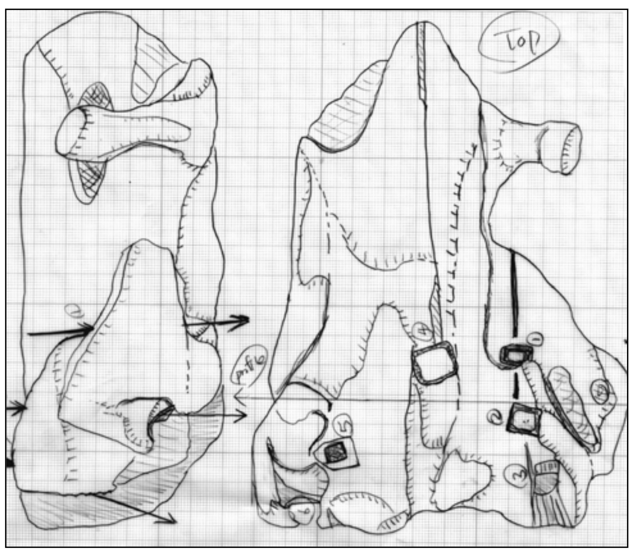

Fig. 61. An Example of Original Drawing of an Unidentifiable Category Timber.

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[265] Timber No. 70 (Original No. 653): No. 55 (No. 612)

[266] Donnely (1923, 228), Waters (1938, 51:1939, 72: 1946, 158), and Worcester (1971) describe the use of grown timber and small pieces of wood used for building a typical Chinese vessel.

Featureless Timbers

This category contains timbers that show no modification or features. All timbers here are highly degraded and have no original surface (fig. 62). These timbers may have been part of a larger component and some timbers in this category were close to 50 cm, but most were smaller than 25 cm. A total of 112 timbers are recorded, 22.31% of the total timbers recorded. Combined with the unidentifiable category, these two categories represent nearly 50% of the timbers discovered at the site. These timbers are heavily damaged by shipworms, and this suggests that the timbers were exposed on the seabed at some point in the past. Unfortunately, nothing more can be said about these degraded timbers. This demonstrates the nature of the Takashima underwater site's formation process and clearly explains why it is difficult to build a model that can explain the nature of the invasion and the types and origin of ships utilized.

Fig. 62. An Example of a Featureless Timber.

CHAPTER V

A SURVEY OF JOINERY

Fastening with Nails

Among the 502 timbers analyzed, 190 (37.84%) can trace evidence of one or more nails. While this does not seem to be a large number, many of the wooden artifacts from the site including firewood, are not from a hull. For this reason, the 177 timbers from the beams, bulkheads, deck planking, planks, railings, wales, and some unknown/other categories were isolated. Among those, 122 timbers had nails. In other words, 69% of the timber is hull elements with nails. The majority of the remaining 55 wooden fragments represent fashioned timber and unknown/other categories. The large number of timbers with nails suggests that the nails were the primary fastening method used for the vessels represented at the site. The majority of the nails found were placed diagonally, through the width or thickness. There was no evidence for the use of iron straps, or other types metal fasteners. In addition, all nails appears to be of iron and no other metal, such as copper and copper alloys, has been found.

Because only a few hull components were found connected to each other, it is not possible to determine how the nails were used on certain components, except in the case of certain well defined artifacts, such as bulkheads and the mast step. Determining the actual size of the nails may be difficult as iron did not survive long underwater at this site and the surfaces are covered with concretion. X-ray scanning, casting, and other conservation methods are required before a study can begin on the concreted artifacts. Although the author did not have access to equipment needed for examining and casting nails, he was able to observe that the

cross-sectional shape of the nails were usually square or rectangular (fig. 63). No round cross-sectioned nails were found on the site at this time. Observation of nail cavities demonstrated that the nails retained a rectangular shape that narrowed at the tip and become pointed. Timber No. 466, for example, has the pointed tip of the nail just emerging from the degraded surface (fig. 64).

Fig. 63. A Typical Nail Cavity.

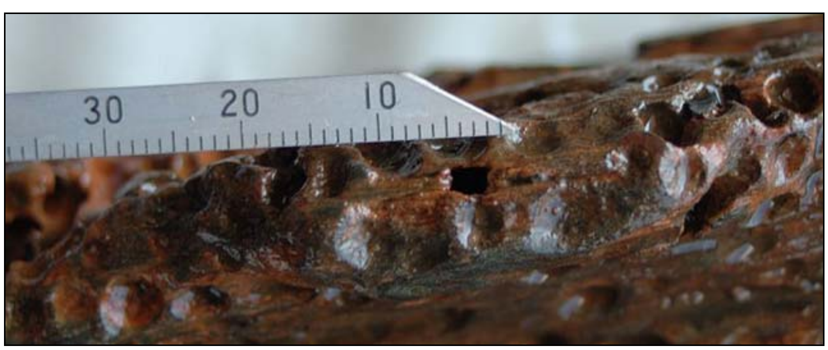

Fig. 64. A Close Up of a Nail Tip on Timber No. 466.

The most common nail type was a 0.8 to 1 cm square-sectioned nail. On large hull components including bulkheads and planks, larger 1 to 1.5 cm square nails, the next most common type, were used. A third type of much smaller nails, possibly tacking nails, was found on timbers from the deck planking category (fig. 65). These smaller nail holes were noted on Timber Nos. 141, 195, 286, and 356.[267] As seen in Timber No. 195, larger sized nails were also used on the same timber type. The possible wale, Timber No. 22 also had small nails on the surface. The difference in size does not indicate that the vessel was built in different areas; but rather that shipwrights had a selection of nail sizes and used them accordingly.

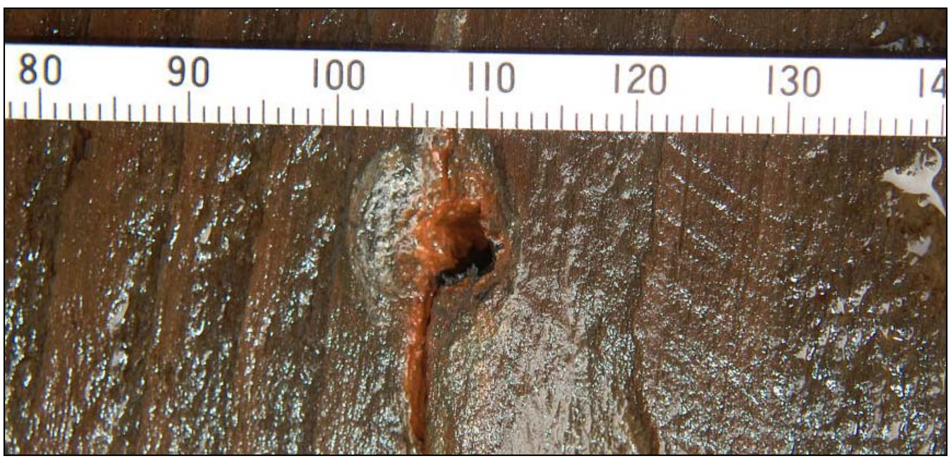

Fig. 65. The Hole from a Small Tacking Nail Found on Deck Planking.

The lengths of the nails were difficult to determine because most of the timbers were isolated single pieces having no matching component. One timber that has a component attached is Timber No. 465/466. Nails, with the size of 1 cm square in cross-section, were used along the seam of a diagonal scarf. The nails used for this purpose were approximately 25 cm long. Even

[267] Timber No. 141 (Original No. 988): No. 195 (No. 1120): No. 286 (No. 1341): No. 356 (No. 1638).

for the components that were being connected, it is still difficult to determine the exact length of the nail, because it may have held three or more components. Conclusive evidence is lacking, but with a 1 cm cross-section, the iron nails were not likely to be more than 30 or 40 cm long.

To determine the source of the iron ore used to make the nails, and whether they were cast or forged, a concretion attached to Timber No. 294 (Original No. 1357) was analyzed at the Fukuoka *Maizou Bunkazai* Center.[268] An examination of the micro-structure of the remaining iron inside the concretion and a trace element analysis using the Energy Dispersive X-ray Fluorescence System (EDX) was conducted.[269] The microscopic analysis of the remaining iron revealed the presence of columnar crystal and iron-casting de-carbonized steel. This suggests that the nails were most likely made from casting.[270] It was not possible to determine the origin of the ore because most of the iron had leached out during its 700 years of submersion, and some may have been replaced by sulfur and other minerals.[271] The result of this analysis is from just a small portion of corroded iron, and cannot be used as conclusive evidence.[272]

On large components, such as planks and bulkheads, a recess was cut into the timber where the nail was to be placed (fig. 66). Timber No. 322/323 show nails set in a pre-cut recess. Recesses that could be measured had openings about 5 cm wide. It is believed that all nails on

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[268] The Administration of Cultural Relics Management at Fukuoka City.

[269] For detail discussion of the methodology used for the analysis, refer to Takashima Board of Education 2005, 33-46.

[270] Takashima Board of Education 2005, 33-4.

[271] The trace elements yielded high percentage of sulfur, which is most likely from contamination.

[272] In addition, it is more likely that the shipwrights used forged nails considering that the cast iron nails be likely to shatter easily.

the surface of this bulkhead plank were set in a recess. Timber No. 161 is of special interest.[273] It is believed to be the bulkhead from a small boat. A small recess was made before placing the nail. After the nail was placed, a small wooden plug was inserted to fill the gap. The recess was only 1.5 cm wide, and it was difficult to find these plugs because they fit tightly into the timbers. Such practice can be seen even today in traditional East Asian river boat building, including dragon boats.[274]

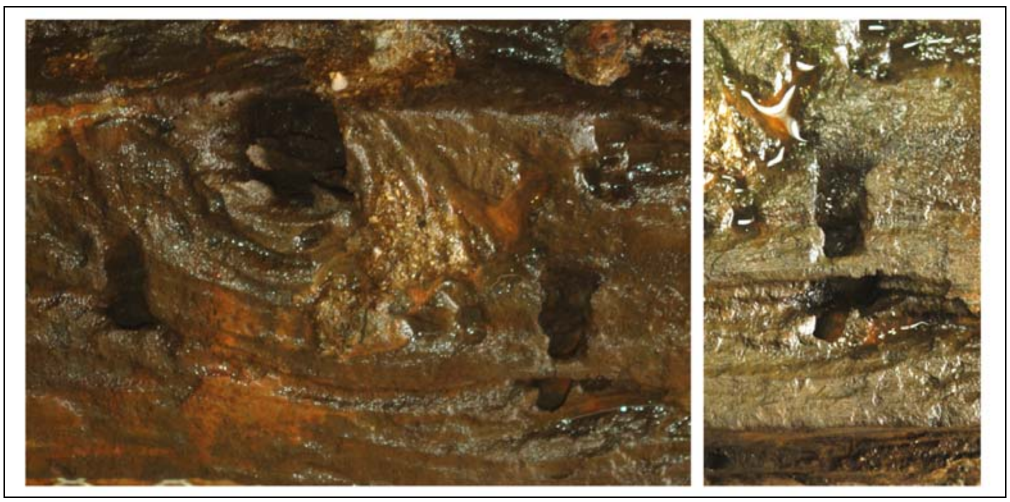

Fig. 66. Several Locations on Timber No. 322/323 Showing the Nail Recesses.

The results of the analysis of the nails found at Takashima were surprising. At site that appears to contain ships built in various areas, one would expect to see variation in nail types. The nails found at the site showed little variation in size and shape, indicating that only a small number of ships are represented at the site, or that most of the vessels found at the site were built

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[273] See fig. 33.

[274] Barker 1996, 31.

in relatively close locations. Another possibility is that the vessels were built in a government shipyard. The square nails found at Takashima were similar to some of the nails used for the construction of the Quanzhou and Shinan ships, both built in Fujian Province; the Quanzhou ship, however, showed diversity in the shape and length of nails.[275] In archaeological reports and ethnographic records, nails are often neglected or only briefly mentioned, and often the exact shape is not reported. For this reason, the shape and size of the nails from other shipwrecks have to be analyzed prior to considering the possibility of identifying a shipyard.

Wooden Joining Technologies

Fastening without a nail is another important aspect of East Asian shipbuilding technology. Many types of East Asian ships derive their strength from complex wooden joinery where shipwrights shaped the wood and fitted it to hold two components. From archaeological and ethnological accounts, it is known that Korean vessels were built using complex wooden joineries and did not rely on nails. Although it is naturally expected that many of the Takashima timbers with wooden joinery are from Korea, archaeological, historical, and ethnographical evidence suggests Chinese shipwrights also used wooden joinery. Recently, several vessels were excavated at Penglai, and this new research indicates extensive use of a mortise and tenon technique, as well as wooden plugs, for the vessels built along the Yangtze River.[276] Most of the discussions in this chapter will therefore address the general use of these joining methodologies and not the specifics of a timber. The timbers from Takashima were grouped into different fastening technologies, includes locks and locking elements, rabbets, scarfs, and recesses/notches.

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[275] Li 1986, 279.

[276] Cultural Relics Bureau of Penglai City 2006.

For each joinery type a description and examples from the site will first be given. Comparative finds from the region will be illustrated with a best guess of where the vessels from Takashima may have been built.

A total of 41 timbers were found having at least one complex wooden joint. This is 8.17% of the total recorded wooden artifacts, and it is much smaller in number compared to timbers with nails. Among the 41 timbers, 23 also have one or more nails and five timbers have two or more complex wooden joinery types. This implies that the Chinese shipwrights relied on various technologies to build a vessel including both nails and wooden joinery.

Locking and Locking Elements

In this study, a locking element refers to a cavity made to fit another component of a timber. This opening is enclosed within a plane; such as a mortise but not a recess or a notch. A locking element is the timber that is independent from two enjoined components, inserted to assist the hold between the timbers (this includes tenons, treenails, and dowels). A total of eighteen timbers were included in this group. Among them, the locking element group had eight timbers.

Timber No. 6 is the mast step described in the previous chapter, and the locking of the heels of the tabernacle is of importance here. The heels of the tabernacles were inserted into square sockets and secured by wooden pins, which did not survive. The inside surface of these square openings have mortises where the pins were inserted. On one of the socket found on the step from Takashima, a small indentation was found inside the wall of the heel openings across from the square hole where the pin had been inserted. The pin was inserted from the outside of

the mast step, going through the heel and stopping inside the wall of the mast step socket. On the other hand, another socket shows the square hole going through the step walls on both sides (fig. 67).

Fig. 67. The Locking Feature Found at the Mast Step.

Timber Nos. 14, 114 (Original No. 883), and 465 are from the plank category. These pieces have possible treenail holes going through the thickness, perhaps to join each to a frame. There is no conclusive evidence for treenail use in vessels built in East Asian; however, round holes on planks could be nail holes that became round over the years underwater. Timber Nos. 14 and 465 are similar in appearance, and both have diagonal nails of similar width and thickness. Timber No. 114 also has a round hole that may be a knot/pith of a branch that came loose (fig. 68). The examination of wood grain was not possible to determine if the hole was man-made or was natural. In light of the ambiguity surrounding the round holes through the timbers, determining the use of a locking mechanism for joining planks to the frame is not possible.

Fig. 68. A Photo of Timber No. 114, with its Round Cavity.

The base of the Timber No. 34, the previously described windlass support post, was attached to the deck by running the heel through a mortise cut through the deck planking. In addition, rectangular opening of the size of 6.5 x 3.5 cm was made at the shaft, below the level of the deck, going through the thickness of the post where a pin was inserted (fig. 69). By using these two methods, the windlass support post was securely fastened to the deck.

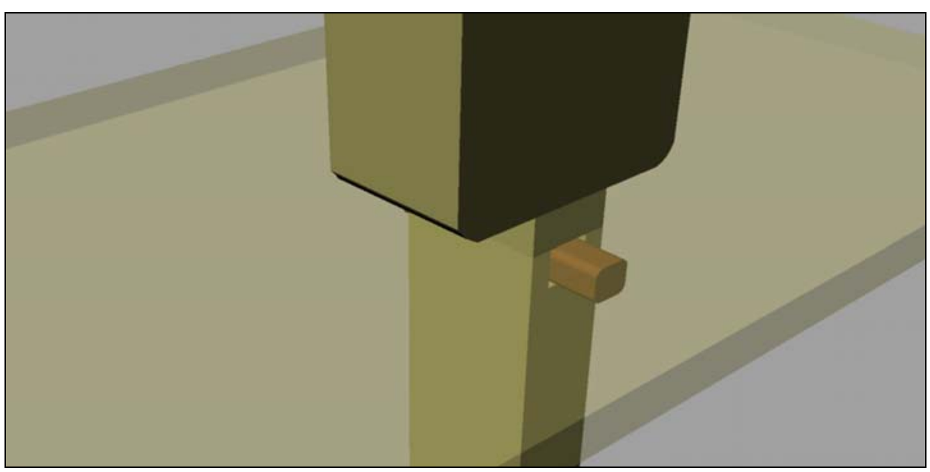

Fig. 69. Windlass and the Locking Pin Below the Deck.

Timber No. 325 (Original No. 1445) has both a notch and a locking element (fig. 70). It is 56 cm long, 8 cm wide, and 4 cm thick; the two-by-four appearance is typical of the railing category, but it has no nail holes and one end seems to taper. The notch is 2 cm deep and 5.7 cm wide. It runs through the thickness in the same direction as the locking hole. The rectangular hole is 3.8 cm long and 2.75 cm wide. The function of the notch and the lock are not known.

Fig. 70. A Photo of Timber No. 325.

The locking elements show a variety of shapes. Timber No. 69 as well as Timber No. 444 have a treenail-like appearance. These timbers could have been used as fillers for a circular hole to plug an opening made for temporary fasteners or plugging a knot. During the plank assembly for the traditional craft from Okinawa, known as *sabani*, a pith or a knot as well as a weak or rotten section of a wood is cut out and replaced with stronger timber.[277] Some of the round holes may correspond to the possible treenail holes found on Timber Nos. 14, 114, and

[277] Monden 2006. The word *sabani* may have derived from the word *sampan*, explaining the close relationship between the Chinese *sampan* and *Sabani.* Read Amino 1992 for further discussion on the relationship between Chinese and Japanese watercraft.

465. The possible treenail openings were much smaller than the possible treenails found at the site.

Timber No. 255, a possible treenail, has a slit. A nail or a wooden wedge may have been placed to expand the treenail for maximum holding power, but no records exist for this method of holding treenails in Chinese or Korean sources. Timber No. 158 has a circular cross-section with the appearance of a treenail, but has a square relief to make a close fit with a component with a rectangular recess. This may be a part of a small tool that required a round handle (fig. 71).

Fig. 71. Photos of (a) Timber No. 255 and (b) Timber No. 158.

Possible tenons, Timber Nos. 94 and 365, are similar in dimensions; both approximately 15 cm (fig. 72). Timber No. 94 has two holes, possibly for pegs, while Timber No. 365 only has one circular hole. Timber Nos. 318 and 366 were perhaps used to lock some components. The dimensions of the rectangular hole on the windlass support post, Timber No. 34, is 6.5 cm by 3.5 cm, and the dimension of Timber No. 318 is 6 cm by 3.5 cm. One can imagine similar pieces were used to lock the windlass support post and other similar components to the deck.

Fig. 72. Photos of (a) Timber No. 94 and (b) Timber No. 365.

The archaeological evidence of vessels from Fujian Province is surprisingly minimal regarding wooden joinery. The Shinan ship seems to have incorporated some mortise and tenon joinery, but the primary means of connecting planks and bulkheads were iron nails.[278] The mast step of the Shinan ship was built using locking pins.[279] Evidence from both the Quanzhou and Shinan ships reveals that iron nails were the primary joining methods with little use of other joining technologies.

On the other hand, the vessels from the Yangtze River were constructed using more locking mechanisms. The Ningbo ship used iron nails as a primary means to fasten the hull, but mortise and tenon joinery was also used. Numerous pieces of dowels were found on the floor of the shipyard.[280] The Penglai ship used mortise and tenon construction for bulkhead connections, as well as iron nails.[281] The ethnographic analysis provides good examples of the use of these locking systems. At the Yangtze estuary, many vessel types had deck beams locked into a hull

[278] Green and Kim 1989, 35.

[279] The Office of the Cultural Property Management 1984, Pl. 21.

[280] Lin et al. 1991, 302.

[281] McGrail 2004, 372.

by mortises and tenons or with wooden pins.[282] Shipwrights in the upper Yangtze River used locking systems more extensively, such as the use of wooden pins.[283] At Yunnan, mortise and tenon joinery was used to secure the planks, as well as pegs to secure the frames and planks together.[284] Dimensions and details of these joining methods were not recorded.

Korean shipwrights also extensively utilized wooden joinery. Many excavated vessels show large wooden pins going through the bottom planks, as well as tenons to hold the side planks in place (fig. 73).[285] Pegs were used on some of these vessels as well. Tenons are usually 5 cm wide and 10 to 20 cm long, and the peg is 2 to 2.5 cm in diameter.[286] The tenons, with one peg-hole, were nearly identical in shape and size to the examples from excavated Korean vessels.[287]

The locking elements have wide variety of uses, and are different in size and shape. The locking systems were used on major components of ship equipment, including the mast step and windlass, but not appear to have been used widely on the hulls. This may suggest that hulls were built by different craftsmen than those who built upper works and smaller components. Ibn Battuta mentions that a hull was built first and launched, and the upper works were built afterward.[288] The presence of the locking elements suggests that some of the vessels at Takashima were probably built using mortise and tenon, despite the fact that no planks were

[282] Worcester 1971, 173, 316.

[283] Donnelly 1936, 414.

[284] Fitzgerald 1943, 137.

[285] Yuan 2006, pl.9-11.

[286] Kim 1994, 76.

[287] See fig. 72, Timber No. 365.

[288] Defremaery, C., and B.R. Sanguinetti 1856, 172; Mackintosh-Smith 2002, 223-4; Needham et al. 1971, 468-70.

found with mortises. These types of vessels were built both on the Yangtze River area and in Korea.

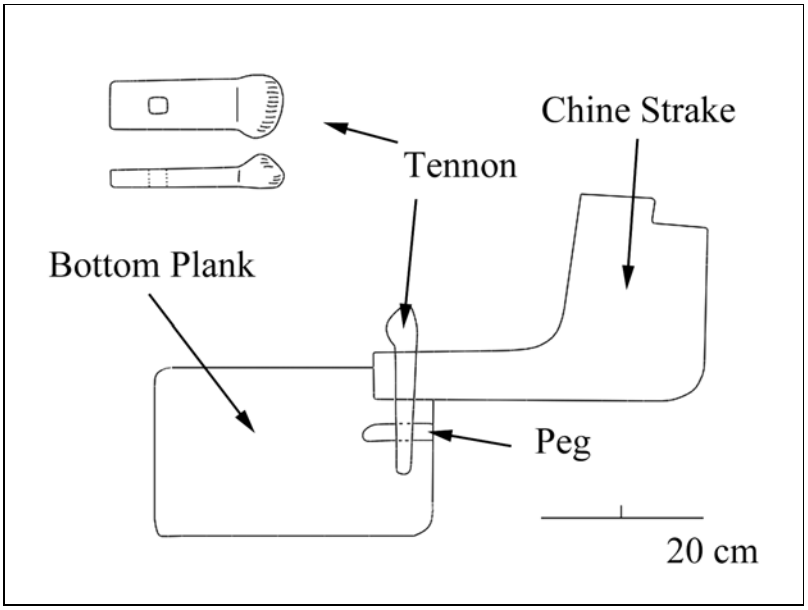

Fig. 73. A Schematic Section Drawing of the Wando Boat. (After Kim 1994, fig.44)

Some of the examples illustrating the use of locking joinery from Takashima demonstrate close parallels with other excavated vessels. Many of the timbers having both wooden joinery and iron nails seem to be from small to medium vessels built in the Yangtze Valley. Locking elements found at the site closely resemble ones found on Korean vessels, again suggesting that Korean built vessels may be present at Takashima, although historical documents note that many of the Korean vessels were saved from the typhoon. This suggests that the site should have only a small percentage of finds from Korea. Joinery that can be identified as coming from Korea is thus a rare and important discovery. Despite a wide range of locking element types, these comprise only a few examples from the total of 502 timbers.

Rabbets

A rabbet is a step-like cut made lengthwise at the joining surfaces of timbers. Only four timbers had rabbets.[289] Timber No. 18, a degraded timber which is probably a part of a bulkhead, has a rabbet on the upper surface edge. Timber No. 35 is degraded plank, and while much is lost, a small section of the rabbet survived. The next two bulkhead timbers have been extensively illustrated and because of their importance, they must be briefly mentioned here. Another timber, the bottom-most bulkhead, Timber No. 205 has a rabbet on its top side (fig. 74). The timber is 10 cm thick, and the rabbet is 5 cm thick with nails going through it. Timber No. 322/323, the 570 cm long bulkhead discussed before, also has a rabbet.

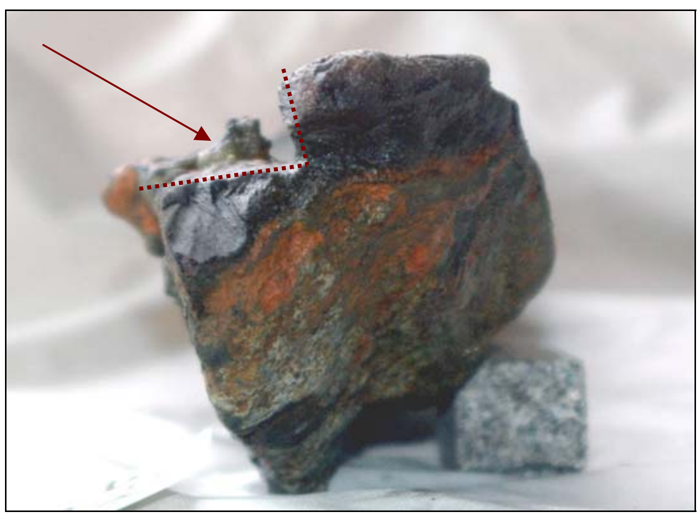

Fig. 74. A Side View of the Bulkhead Showing the Rabbet.

Rabbets were extensively used in all three regions: Fujian Province, the Yangtze River Valley, and Korea. The Quanzhou, Shinan, Wando, and other excavated vessels show rabbets on

[289] Timber Nos. 18 (Original No. 207), 35 (No. 315), 205, and 322/323.

planks as well as on bulkheads. The Quanzhou ship has what Green refers to as a "rabbetted clinker" assembly, a complex joining of planks in layers, testifying to the importance of rabbets for holding the shape of the hull.[290] Excavated evidence suggests the widespread use of rabbeted planks and bulkheads in East Asian ship construction and therefore they are not useful for determining the origin of a vessel.

Scarfs

A scarf is used to connect two components by increasing the adjoined surface area to increase the holding strength by friction. Nine timbers were found to fit this group. Two basic types of scarf were classified. One that connects railings or frame-like timbers was termed "railing scarfs," and another connecting a plank-like timber, "plank scarfs (fig. 75)."

Timber Nos. 108, 118, 305, 336, and 449 have railing scarfs used to connect rails lengthwise. [291] Timber Nos. 108 and 449 show a similar approach in joining two railings. Timber No. 108 also seems to have a diagonal cut at one side. Timber No. 118 has nails going through the timber only around the scarf, but not directly through the scarf itself. On the other hand, the diagonal scarfs or nib cuts at the end found on Timber Nos. 118 and 336 show nails going through the scarf, firmly holding the two parts together.

Evidence of planking scarfs was identified on Timber Nos. 121, 322/323, and 427 (Original No. 1317), and No. 465/466. On Timber No. 121, a step scarf can be found on one end, but the opposite end is rounded. No fasteners, such as iron nails, were found along the seam of

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[290] Green et al. 1998, 284-5.

[291] Timber No. 108 (Original No. 869): No. 118 (No. 887): No. 305 (No. 1378): No. 336 (No. 1477): No. 449 (No. 848-b).

the scarf. In addition, possible *chunam* was found adhering to the seam. Although it is highly degraded, Timber No. 427 was identified as having a diagonal scarf. Another good example of the diagonal scarf used on planks was found on Timber No. 465/466. The nails were placed from top to bottom on the scarf, acting as an internal metal frame inside the scarf join. The shipwright also drove iron nails diagonally along the seam of the scarf. Either an ample supply of iron nails was at hand, or the shipwright thought he needed extra support along the seam (fig. 75).[292]

Fig. 75. A Photo of the Scarf Found on Timber No. 465/466.

Use of scarfs in East Asian shipbuilding is well represented in the archaeological record. Both the Quanzhou and Shinan ships had various types of scarfs (fig 76).[293] The Ningbo ship also utilized a long scarf.[294] The bulkhead of the Penglai ship were joggled, or was not made straight.[295] For Korean vessels, planks were rabbeted, scarfed, and joined with pegs and

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[292] Timber No. 465/466 is discussed further in the next chapter.

[293] McGrail 2004, 363-71.

[294] Lin et al. 1991, 306.

[295] McGrail 2004, 372.

other fasteners.[296] Ethnographical studies of ships along the Yangtze River also show extensive use of scarfing to join timbers together.[297] Combined with the widespread use of sacrfs in East Asian shipbuilding tradition and the small number of such joins found at the Takashima underwater site, scarfs cannot be used as a diagnostic feature for determining the origin and type of a vessel.

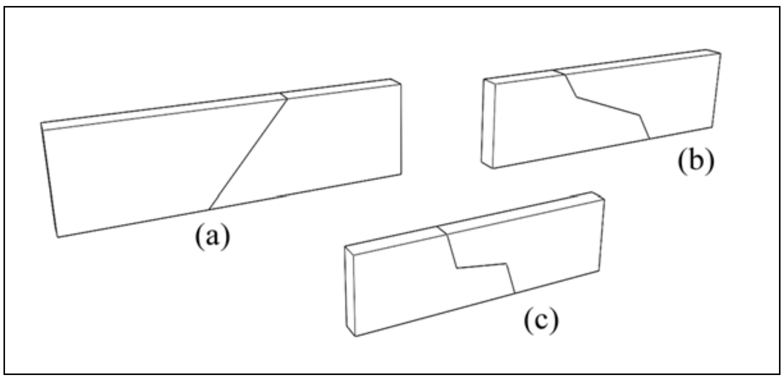

Fig. 76. Examples of Scarfs Found on the Quanzhou Ship.

(a) Simple Diagonal scarf (b)/(c) Variations on Z-scarf.

(After Li 1989, fig.4)

<u>Recesses and Notches</u>

A recess and notch is where timbers are joined by cutting a part of a timber to create a strong joint. The recess and notch have to be at the edge of the timber, and the opening should not be inside the timber creating an opening or a hole, but it should be located along a plane. A total of fifteen timbers are in the recess and notch group, making this type of fastening methods

[296] Kim 1994, pl. 27.

[297] Worcester 1971.

the largest joinery group. Timber No. 3 (Original No. 190) has an appearance of a naturally curved wood, with a small notch of 3.2 cm wide and 2 cm deep located on surface. Timber No. 4 (Original No. 191) also has the appearance of naturally curved wood. It is 98 cm long and has a small notch on surface (fig. 77). Timber No. 31, from the fashioned timber category, has a notch clearly seen on the upper surface of the carved area. Timber No. 51 is 300 cm long timber that has a large rectangular hole at one end which has been already described in Chapter IV.[298] The rectangular opening is 25 cm by 20 cm and one side is open. The function of this large notch is unknown.

Fig. 77. A Photo of Timber No. 4 with a Notch.

Timbers Nos. 53 (Original No. 610), 322/323, and 462 (Original No. 2003-8) should be discussed together because of their common characteristics. These timbers are likely to be bulkhead planks located just below the deck level, and having rectangular recess cut to fit carlings. The recess of Timber No. 53 survived for about 12 cm but the rest is broken. The plank

[298] See fig. 54.

is 10 cm thick. The recess in Timber No. 462 is cut 5 cm from the top and is more than 20 cm long, indicating a wider component was placed on top (fig. 78). Timber No. 323 is the large bulkhead that has been described on several occasions.[299] One of the recesses shows that a nail was used to fasten a possible longitudinal beam, or carling, to the bulkhead. If these timbers were all indeed bulkheads, the widespread use of such longitudinal beams may be suggested.[300]

Fig. 78. A Photo of Timber No. 462.

Two timbers from the beam category each also had notch and recess. Timber No. 126 has a 9 cm square section at one end which is abruptly reduced to 6 cm in width. Perhaps that was a through beam, or the notch rested on a bulkhead. Another timber from the beam Category, Timber No. 456 (Original No. 2003-1) is degraded, but shows a small notch at one end and a nail at the other end. The remaining six timbers, Nos. 287, 333, 363, 410, 437, and 446 are all poorly

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299 See fig. 28.

300 The use of carling is further discussed in the next chapter under the section Timber No. 322/323.

preserved.[301] These timbers show the presence of a notch or recess, but the original shape of the timber cannot be seen. Most show small grooves and small notches, less than 5 cm wide and 2 cm deep. A small hull component was inserted along these notches, and no strong connection was required. Having only one side of the joint and without the corresponding component that was attached, it is difficult to reach any conclusion. These notches were found on timbers with or without nails and various types of categories, including curved wood.

Removable floor and deck planks are known to have been used on East Asian ships. These, although not explicitly explained, must have used a notch or recess to keep the planks in place. Worcester records such practices in Ningbo and Shanghai.[302] The Hangzhou Bay Trader was also equipped with removable beams.[303] The use of notches and recesses was widely practiced in traditional Korean boat building.[304] All components having the recess or notch are for a large hull elements, and the author has not found an archaeological report that describes in detail the joinery of small components or ship's equipment. The finds from Takashima suggest that recesses or notches were extensively used, although most seem to be from small components.

Miscellaneous Joinery

The joinery using iron nails and complex wooden joinery has been discussed and in this last section, miscellaneous joinery features will be discussed. These are unique joints that

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[301] Timber No. 287 (Original No. 1342): No. 333 (No. 1466): No. 363 (No. 1650): No. 410 (No. 1856): No. 437 (No. 1428-b): No. 446 (No. 1827).

[302] Worcester 1971, 160, 222.

[303] Waters 1947, 31.

[304] Kim 1994, 57-82.

were not recorded as a group. Timbers with a large rectangular opening, triangular recessed joinery, dovetail joints, and *gua-ju* nails and stiffners will be discussed. The *chunam* was an important feature of vessels built in China, and will be examined here.

Unique Joinery

Timber No. 67 (Original No. 642) and Timber No. 319 (Original No. 1434) share the similar characteristic of having a large rectangular opening made. These timbers were probably made to lay horizontal, much like a mast step. The exact functions of these elements are not known. Timber No. 67 has an opening of 10 cm by 15 cm. Timber No. 319 has an opening size of 10 cm by 9 cm. Both are similar in dimension, and the hole is located close to one end. The only major difference is that Timber No. 67 has large nails, while Timber No. 319 has no nails (fig. 79). Without context, however, interpretation of such a detached piece is extremely difficult.

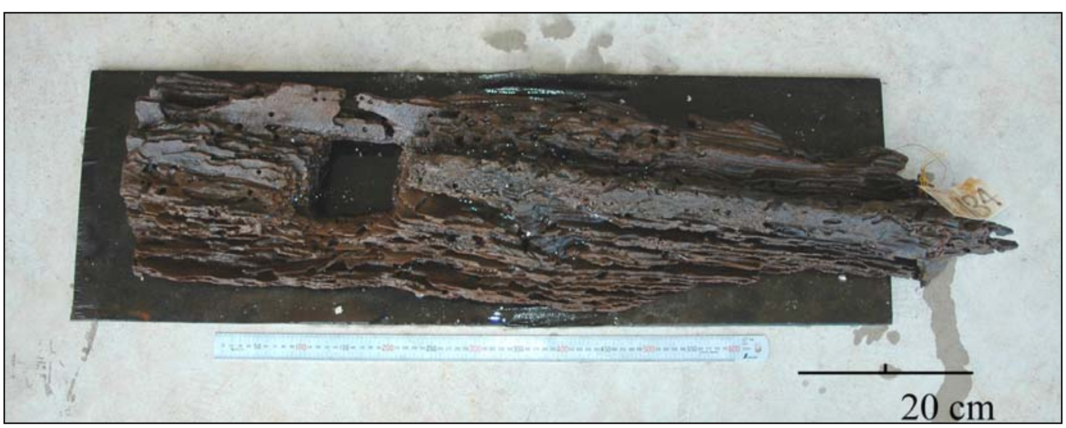

Fig. 79. A Photo of Timber No. 319.

Another unique joint, a possible lashing to join components, was found on Timber No. 417 (Original No. 1863). It is a possible bulkhead element or a plank measuring 187 cm long, 38 cm wide, and 13 cm thick. Triangular carvings can be seen near a seam (fig. 80). The lashing might have been put around to secure the planks together, or a large triangular wooden block might have been inserted. There is no known parallel in East Asian shipbuilding traditions and it may become an important artifact when new archaeological finds and undiscovered documents come to light.

Fig. 80. The Triangular Recess on Timber No. 417.

The large bulkhead, Timber No. 322/323, has possible dovetail joints (fig. 81).[305] Dovetail shapes are found on the lower bulkhead plank, but the corresponding bottom pair of the dovetail cuts are lost. These recesses are found at two locations close to the center. These are 4 cm and 7 cm wide. The actual dovetail joining elements were not found. The use of dovetails is

[305] See fig. 28 for more details.

known in traditional small crafts from Japan.[306] Compared to those found on traditional boats, the dovetails from Takashima seem to be too large and shallow to have had any significant joining strength. The Shinan ship had large dovetail cuts along the keel as well as on the bulkheads. This is believed to be the remnant of a temporary fastener.[307] The bulkheads were aligned, fasten by these dovetails, and nails driven to securely fasten the bulkhead pieces together.

Fig. 81. Possible Dovetail Joint Found on the Bulkhead from Takashima.

The Use of *Chunam*

Chunam is a putty-like substance widely used by southern Chinese shipbuilders. It is a mix of lime and *Tung* oil, extracted from the seeds of *Aleurites fordii*.[308] This sticky putty is

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[306] Monden 2006.

[307] A conservator at the National Maritime Museum of Korea at Mokpo mentioned that the dovetail on the keel as well as a bulkhead were used to aligne the planks before securing with iron nails; however, this theory is not rigorously discussed.

[308] Green et al. 1998, 294.

applied to seams and nails of a vessel as a means to securely fasten each component together, make the seam watertight, prevent the teredo worms from attacking the wood, as well as to prevent the nails from rusting. In some instances, straw is mixed with this substance to give different characteristics to the mix.[309] The putty is widely used on ships built in China, and it appears that almost all excavated vessels built in China had this substance applied, except for the vessels built for inland use, including Jinghai.[310] The use of *Chunam* is also mentioned by Polo, and this further attests to its wide use by the medieval period.[311] The Quanzhou ship was literally covered with *Chunam*, and it is said that "no nails were left behind" without the use of putty; every seam, including bulkhead and bulkhead connections, was sealed with an ample amount of *chunam*.[312]

Despite the extensive use of *chunam* on cargo vessels built in China*,* only a handful of timbers from Takashima had possible traces of this white, putty-like substance. Only Timber Nos. 6 and 122 (Original No. 918), had direct evidence for the use of *chunam*. Timber Nos. 123 and 327 may have had some as well, but this could not be confirmed. An additional twelve timbers had white or gray substances on their surfaces.[313]

Timber No. 6, the mast step previously discussed, has a cut groove at its base which for some unknown reason has a thick application of *chunam* (fig. 82). Timber No. 122, a part of Timber No. 121, has some thickly smeared only around a small section. It is not known why

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[309] Li 1986, 279-82.

[310] The Tianjin City Cultural Relics Administration 1983.

[311] Yamagata 2004, 55; Yule 1993, 250-1.

[312] Li (1986, 279) notes "no nails were left behind" without the use of putty.

[313] Timber Nos. 22, 25 (Original No. 221), 51 , 118, 123, 142 (No. 998), 165 (No. 1047), 217 (No. 1171), 242 (No. 1278), 327, 322/323, and 385 (No. 1743).

only a small portion was coated with *chunam*. This putty was still soft and could be rubbed off, but in each example it still adheres to the wood.

Fig. 82. Timber No. 6 with Possible *Chunam* Applied in the Groove at the Base.

The apparent lack of *chunam* is troubling when compared to the abundant use of *chunam* throughout the history of shipbuilding in China. Four reasons for the lack of *chunam* at the site can be suggested. First, the vessels found at Takashima were not built in southern China. The *Tung* oil was a major product of Fujian Province. The shipwrights along the Yangtze River may not have been aware of such an anti-corrosive putty. This corresponds well with other evidence from the site; many of the wood fragments appear to be from small vessels from the Yangtze River. Second, *chunam* may not have been applied to vessels newly and hastily constructed for the invasion. In order to build many vessels, a large quantity of *chunam* had to be mixed and applied, and when the construction of Kublai's fleet was ordered, the shipwrights may have decided not to use *chunam* to save time and/or expense. These naval vessels did not have to

endure long periods at sea and long years of service. The third explanation is that all the *chunam* may have washed away during the intervening 700 years. The chemical nature of the bay may also have had a detrimental effect on the preservation of the *chunam*. The fourth reason is that many of the timbers found at the site are a collection of upper-works and hence are parts that did not require the heavy use of *chunam*.

CHAPTER VI

THE PHILOSOPHY OF SHIPBUILDING

The Philosophy of Shipbuilding in East Asia

The "philosophy of shipbuilding" is a term describing how people perceived the vessel and how this is reflected in the pattern of construction. People's perception of shipbuilding changes through time and the way vessels are constructed changes according to various factors, including the vessel's purpose, technological expertise, availability of building materials, and geographical location. The study of the philosophy of shipbuilding is based on the theoretical background laid down by Steffy, and will continue to evolve as we understand the primary theories for the study of shipbuilding tradition.[314] Two primary paradigms for European shipbuilding pertain to the division between shell-based and skeleton-based construction. "Based" means that shell (plank) or skeleton (frame) provided the primary strength of the hull. According to these theories, vessels can be seen as an outerskin supported by frames or a waterproof skeleton. The construction sequence also reflects the shipwright's basic thinking. In the Mediterranean, the construction sequence changed from plank-first construction to frame first construction. In East Asia, detailed construction sequences and the philosophy of shipbuilding have not been fully developed or extensively debated. The primary concern in the archaeological reports on East Asian vessels focus on a general description of the hull and perhaps a detailed report on one or two particular features.[315] As bulkheads provide the primary

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[314] Steffy 1994; Hocker and Ward 2004.

[315] Herron 1994; Green 1998 et al.

strength for most Asian vessels, a different shipbuilding philosophy than those of Europe is suggested.

One of the first Asian water transports is said to have been created by the legendary Emperor Huang Ti around 2697 B.C.E.; the boats at the time were made by hollowing out logs. More than 30 dug-out boats have been excavated in China, mainly from the southern provinces. Many dug-out boats were found, mainly associated with burial sites where dug-outs were used as coffins.[316] The technology to hollow-out a log was well-known in the south, and assembled craft developed early. Although the detail lineage of the plank vessel is not known, it has been in use before the Han dynasty (207 B.C.E. – 220 C.E.).[317] The log boat seems to have declined in importance after the plank boat became widely used.[318]

A large gap exists in archaeological record between the ancient dug-out boats of pre-Han period and later fully developed planked vessels of the twelfth century and later. A series of new discoveries may shed a new light into this period, but because of the lack of evidence that shows a clear evolutionary lineage, the discussion for this thesis begins at twelfth century. A basis for understanding the process of construction is the understanding of how each component of a hull is connected, or not, to another component, and Table 3 summarizes some of the key features of the excavated vessels in China. Almost all excavated vessels in East Asia had planks nailed together, suggesting plank-base construction. If the planks are nailed to the frames, like a "true" skeleton-base construction, the plank to plank joinery is not necessary. Nonetheless, many different aspects, such as the presence of bulkheads, the shape of

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316 Wang 2000, 9-34.

317 McGrail 2004, 352-5.

318 Wang 2000, 98-100.

Table 3. The List of Relationships of Components of the Excavated Vessels.

	Quanzhou	**Shinan**	**Penglai**	**Ningbo**	**Shanghai**
	1277	1310	1376?	Before 1200?	Before 1200?
Bulkhead & Plank Connection	Iron Bracket	Stiffeners	Iron Nail and Bracket	Iron Nail	Iron Nail
Bulkhead & Frame Connection	Iron Nail	Iron Nail	Iron Nail?	Iron Nail	Iron Nail?
Bulkhead & Keel Connection	No Connection	Iron Nail	Iron Nail?	Mortise	Iron Nail?
Frame & Plank Connection	Iron Nail	Iron Nail?	Iron Nail?	Iron Nail	No Frame
Garboard & Keel Connection	Iron Nail	Iron Nail	Iron Nail	Iron Nail	Iron Nail?
Plank Scarf/Bulkhead Relationship	Under Bulkhead	Under Butt Plate	Under Bulkhead	Under Bulkhead	Random

the hull, and other evidence must also be considered in this analysis. Thus, a new paradigm may be developed for watercraft built in Asia. In this section concerning the philosophy of shipbuilding of the East Asian watercraft, a brief survey of different types of vessels found in Fujian province, along the Yangtze River and Northern China, and Korean peninsula will be described. For each region, several excavated shipwrecks will be described followed by a short discussion of how the archaeological evidence relates to the philosophy of the shipbuilding in East Asia. These descriptions of archaeological records will be useful in understanding the discussions of the findings from Takashima found in this chapter immediately following this section.

Vessels From Fujian Province

Among the several vessels excavated from East Asis, the Quanzhou ship of the thirteenth century is the primary example of the vessels built in Fujian Province (fig 83). The shape of the lower hull suggests that the garboard and keel make up the ship's base, like a log boat. The keel is 27 cm molded and 42 cm sided, and it is wider than tall and can be considered to be a mix of keel and bottom plank.[319] The garboard is larger than the other planks and was firmly attached to the keel.[320] The angle of the garboard was steep compared to the other planks, and thus, the keel and the garboards served as vestigial dug-out structures. The reconstruction shows that the second strake serves as a connection between the garboard and the series of three strakes as a unit (fig. 84).

[319] Green et al. 1998, 282.

[320] Green et al. 1998, 285.

In "true" frame-first construction, a plank to keel connection is not considered important because the planks can be attached directly to the frames. In shell first construction, the opposite holds true. The garboard to keel connection of the Quanzhou ship is strong; the nail spacing is regular, about 15 cm apart, compared with irregular 20 to 25 cm plank to plank connections.[321] On the other hand, the connection of the bulkhead and keel is weak in the Quanzhou ship; Green saw no indication that the bulkhead was attached to the keel.[322] On the other hand, a Chinese expert believes that the keel and the bulkheads were connected.[323] Half frames or floor timbers are attached to the lowest bulkhead timber, and no *gua-ju* nails were placed at the lowest bulkhead plank.

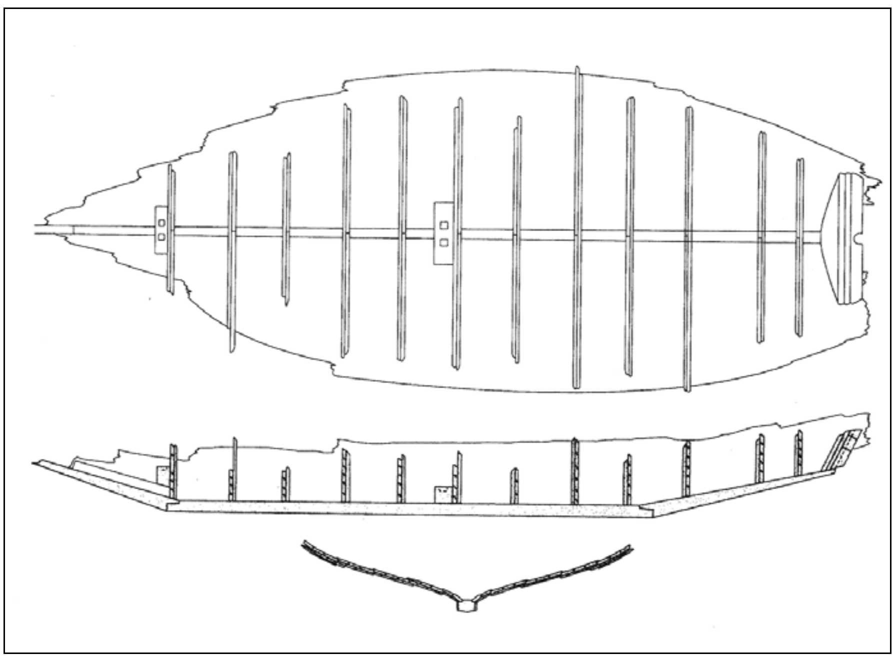

Fig. 83. A Plan of the Quanzhou Ship. (Green et al. 1998, fig. 5)

[321] Green et al. 1998, 287.

[322] Green et al. 1998, 293.

[323] Personnal communication with Xi, 2008.

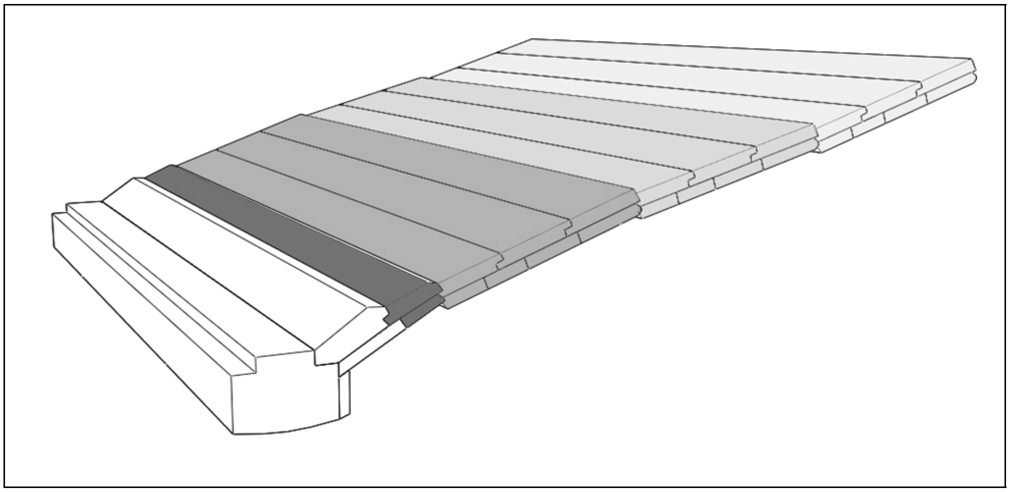

Fig. 84. A Schematic Reconstruction of the Bottom Structure of the Quanzhou Ship.

The longitudinal strength of the hull is derived from planking assembly and the strong connection between the strakes. At the same time the bulkheads provided substantial transversal strength to the hull. All the planks of the Quanzhou ship are nailed to the planks above and below. Well crafted scarfs and rabbets also provide strength to the hull and the multi-layering of planks gives additional longitudinal stiffening.[324] The use of *gua-ju* nails is also an important solution in distributing the stress on the planks to the bulkhead. The recess for the iron bracket is chiseled and clean-cut from inside, suggesting that the planks were assembled first, or it was chiseled beforehand.[325] There is no evidence of bending of planks, suggesting that the planks were erected prior to installing the bulkheads. Nevertheless, to be able to construct the Quanzhou ship, the shipwright had to know beforehand where all the bulkheads would be located as well as where the plank scarfs and the brackets were to be placed. All scarfs are aligned with the

[324] Green et al. 1998, 286.

[325] Green et al. 1998, 288.

bulkhead, and *gua-ju* nails placed above and below the scarf, suggesting extensive planning prior to building a plank assembly.[326]

The Shinan ship, discovered in Korea is another important archaeological record that must be discussed in detail.[327] This is a V-shaped cargo vessel dating to early fourteenth century and most likely built in Fujian province. The vessel also had a wide, but larger keel, 50 cm molded and 71 cm sided.[328] The garboards, thicker than other planks, were strongly attached to the keel as well.[329] One difference from the Quanzhou ship is that the lowest bulkhead timber of the Shinan ship is thicker than the other bulkhead timbers, acting as a frame.[330] The keel, garboards, and the lowest bulkhead timber formed the foundation of the vessel. The planks and bulkheads are firmly assembled with stiffeners, a wooden form of "iron bracket" seen in the Quanzhou ship. The bulkhead is cut following the shape of the hull, indicating that the planks were assembled first. The positions of the scarfs are symmetrical between the starboard and port sides, but are not aligned under the bulkheads.[331] Butt plates are used inside the hull and placed over the butt scarf to secure the seam: the position of the plank seam/scarf are not dependent on the bulkhead positions (fig. 85).[332]

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[326] Green et al. 1998, 288.

[327] The origin of the vessel is still being debated by some. Despite the V-shaped hull, the construction features are different from that of the Quanzhou ship in many respects.

[328] The Office of the Cultural Property Management 1984, 125-6.

[329] The Office of the Cultural Property Management 1984, 129.

[330] The Office of the Cultural Property Management 1984, 127-9.

[331] The Office of the Cultural Property Management 1984, pl. 8/1.

[332] Green and Kim (1989) describe butt plates as a wooden plate that is nailed to the seams of the planks for a support.

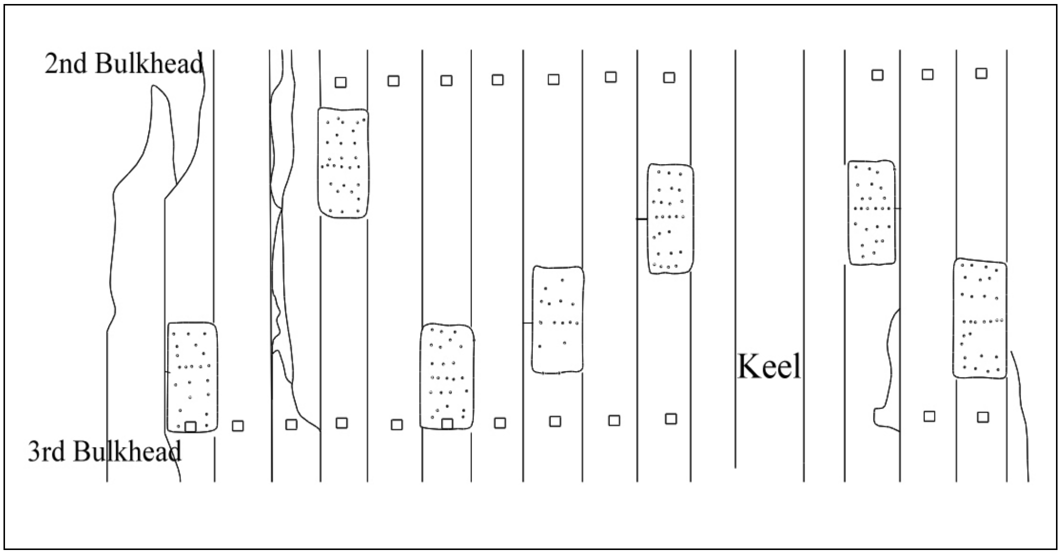

Fig. 85. A Planking Diagram of the Shinan Ship between Second and Third Bulkheads.

(Adopted from The Office of the Cultural Property Management 1984 fig. 8-1)

More research is needed on this area, and western shipbuilding concepts will not apply directly to vessels constructed in Fujian province including the Quanzhou and Shinan ships. The main contradiction seems to stem from the idea that the location of the bulkheads was known and this served as a basis for assembling the planking, but the planks appears to be assembled first. This can be resolved when the importance of the bottom-most section of the vessel is analyzed more closely. One hypothesis is that the keel and garboards were assembled first. Then only one or two bulkheads were placed and secured at some bulkhead stations. The bottom of the vessel was thus completed with several bulkhead planks in place to indicate the overall design of the vessel. The planks could be assembled from this base. This construction sequence seems to be the most logical conclusion reached from the available archaeological evidence for the vessels built in Fujian Province.

Vessels From the Yangtz River and Northern China

Vessels built on the Yangtze River have not been well studied from the archaeological viewpoint. The Penglai ship, a round-bottom vessel built at the Yangtze estuary during the Ming dynasty, has bulkheads with extensive scarfing, and mortise and tenon joinery.[333] The hull was constructed using iron brackets similar to those of the Quanzhou ship. The difference is that one end of the bracket is imbedded inside a cut slot within the plank and does not go through the entire plank thickness (fig. 86).[334] This shows clearly that the position of the bulkhead had to be known prior to building the strakes. The connection between garboards and keel connection is strong, while the connection between bulkhead and keel appears weak; but the description in the archaeological report is vague and cannot be determined for certain.[335]

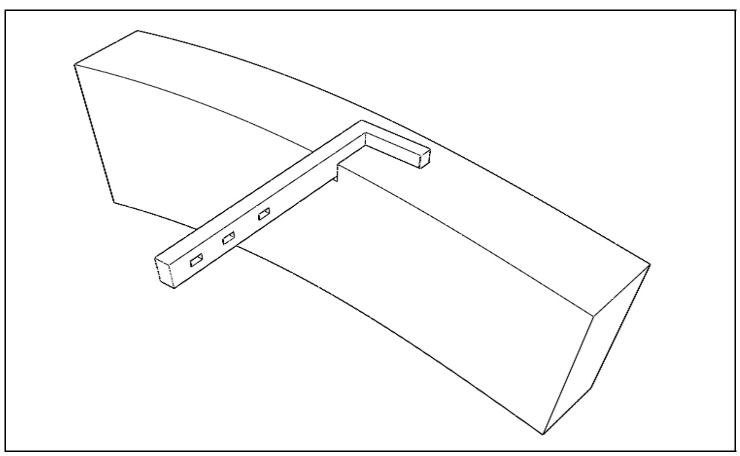

Fig. 86. Iron Bracket Configuration Found on the Penglai Ship.

333 Wang 2000, 213-5.

334 McGrail 2004, 372.

335 McGrail 2004, 372; Wang 2000, 213-5.

Another important vessel, commonly referred as the Ningpo ship, provides some important information regarding the shipbuilding tradition of the Yangtze river despite only a brief report is available.[336] This vessel was found in a wharf and dates to the early Song Dyansty, perhaps no later than thirteenth century.[337] The scarfs were placed under bulkheads, and this seems to be the typical feature for many of the vessels built on the Yangtze. The lowest bulkhead of the Ningbo ship is actually a curved frame.[338] This suggests an emphasis on the lower section of a hull as a basic unit, and the bulkheads were laid on top of this base (fig. 87).

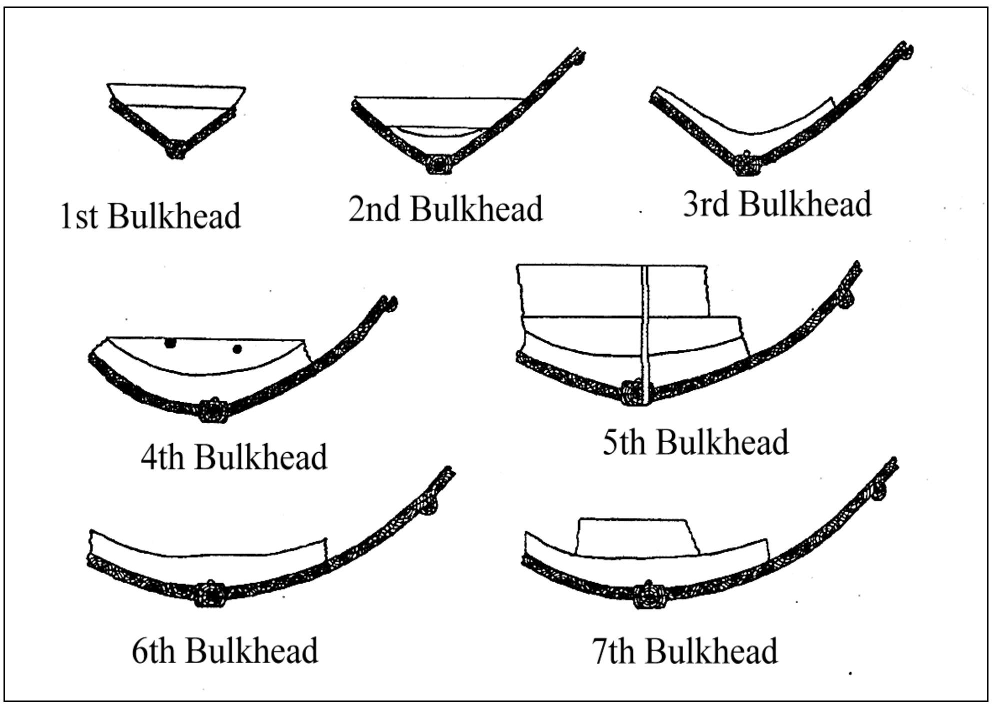

Fig. 87. Sections of the Ningbo Ship. (From Lin et al. 1991, fig. 12)

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336 Lin et al. 1991.

337 Lin et al. 1991.

338 Lin et al. 1991, 306-8.

Local watercraft like the Jinghai boat from northern China may shed some light on the shipbuilding tradition of the inland craft and should be briefly illustrated here. This vessel, built with a flat-bottom and multiple cross-beams, clearly suggests a different basic concept in shipbuilding: the overall appearance is similar to vessels built in Korea. All bottom planks were assembled first, followed by the building of side planks. The beams were inserted last.

While archaeological evidence provides some understanding of Asian watercraft construction features, historical and ethnographical sources also shed lights to the vessels used in the region. It is interesting to see that there is fair amount of archaeological evidence for the ships built in Fujian Province, while written records are lacking. On the other hand, there is not enough archaeological evidence for the Yangtze River vessels but there are many historical and ethnographical accounts.

The contemporary encyclopedia of medieval China, *Tien Hai kwang Wu,* has a section for shipbuilding.[339] It has been stated that when building a vessel, the bottom of a ship serves as a foundation, and is laid down first. Ibn Battuta, the Arab trader who visited China in the fourteenth century, also describes shipbuilding as practiced at the time. According to his account, the bottom was laid down first, and the two walls (side planking?) were installed next. After this, another series of walls (bulkheads?) were put across the hull.[340] Other historical accounts from the period describe vessels being built with planks first and bulkheads installed later.

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[339] *Tian Gong kai Wu（天工開物）* was originally compiled by *Song Yingxing (宋應星)*, born in 1587. Several publications of the original documents are available. See Yabuuchi 1955.

[340] Defremaery, C., and B.R. Sanguinetti 1856, 172; Mackintosh-Smith 2002, 223-4; Needham et al. 1971, 468-70**.**

The available evidence therefore suggests that some vessels were built using frame-first construction, while other vessels were built plank-first.[341] This indicates that the tradition of plank-first construction persisted while some change in the tradition also took place. Worcester illustrates traditional shipbuilding as it existed in the early twentieth century. The bottom was laid first, then the sides were built up. Then, the bulkheads were assembled often outside the hull, and fitted into place prior to adding the sides.[342] Although plank-first construction was obviously practiced in the past, no research indicates how this developed, or how in many areas it was replaced by frame-first, or bulkhead-first construction.

Vessels From Korea

Vessels built in Korea show a much different tradition. Korean shipwrights developed a flat-bottom vessel with hollowed out logs as chine strakes, added with extended strakes, as seen from the Wando boat.[343] The vessels built in Korea show a distinctive philosophy of shipbuilding. Korean shipwrights built the bottom planks first, connecting the planks by using long and heavy tenons that go through several planks (fig. 88). The planks have rabbets and use mortises and no nails. After the planks had been laid, beams were put throughout the hull. Korean ethnographical records are well known, and there is little doubt that the shipbuilding tradition showed a continuous tradition from the medieval period.[344]

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[341] See Lovegrove 1932; Waters 1946; Worcester 1971.

[342] Worcester 1971, 31.

[343] Kim 1994, 41-82.

[344] Kim 1994.

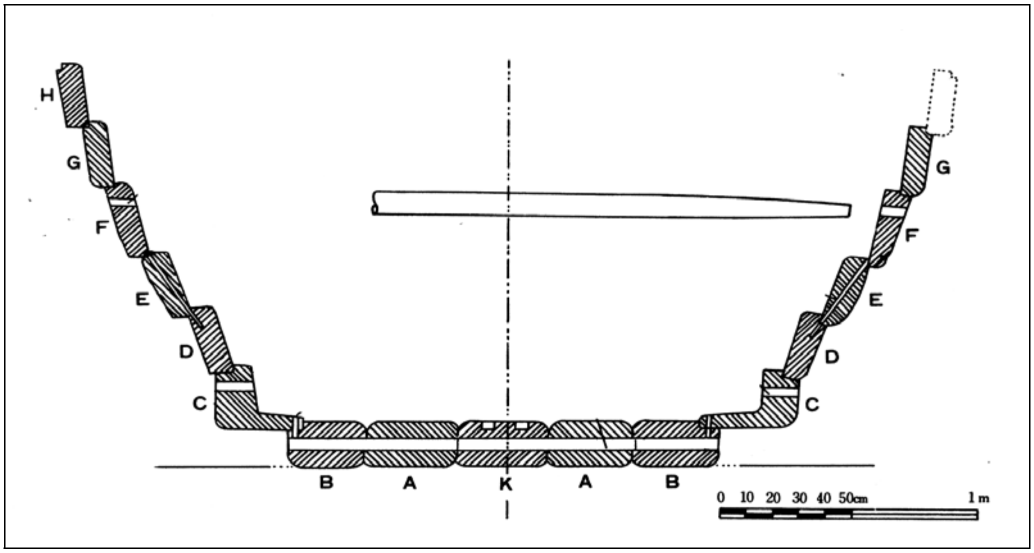

Fig. 88. A Section of the Wando Boat. (From Kim 1994, fig. 26)

Evidence from the Takashima Underwater Site

The timbers gathered from the Takashima underwater site were compared with the existing data to find if any of them yield clues to a shipbuilding philosophy. Several individual timbers were analyzed to accomplish this task. Timber Nos. 322/323, 205, 465/466, and 496 (Original No. 2004-26) were selected to assess the philosophy of shipbuilding. These timbers were chosen because they illustrate the building sequence well. Timber No. 322/323 is believed to be the upper section of a bulkhead of a V-shaped vessel. Timber No. 205 is the bottom bulkhead timber that connects to the keel. Timber No. 465/466 is scarfed planks. Timber No. 496 is a frame of a flat-bottom boat that shows evidence of an internal keel. All of these timbers show different building methodologies, indicating the existence of both bulkhead first and plank-first construction. The philosophy of Korean shipbuilding is not discussed here based on the findings from Takashima. This is because no timber found at the site showed conclusive

evidence of it belonging to a Korean vessel. The philosophy of shipbuilding in Korea is well documented and understood. The findings from Takashima underwater site can contribute more to the study of shipbuilding technology in China.

Timber No. 322/323

Timber No. 322/323 is most likely part of a bulkhead of a V-shaped hull, characteristic of vessels built in Fujian Province (fig. 89). Several characteristics show that the vessel was built using construction features prominent in later periods, suggesting a possible bulkhead first construction. The nail intervals connecting bulkheads of Timber No. 322/323 are placed very close, approximately 12 cm apart. The Quanzhou ship had the largest interval, while the Shinan ship was smaller. Timber No. 322/323 has the closest intervals of the three. This suggests an emphasis on bulkhead plank connections. If the bulkheads are placed after the planks are assembled, it does not require a strong bulkhead connection. Therefore, this seems to suggest that this vessel may have been built bulkhead-first.

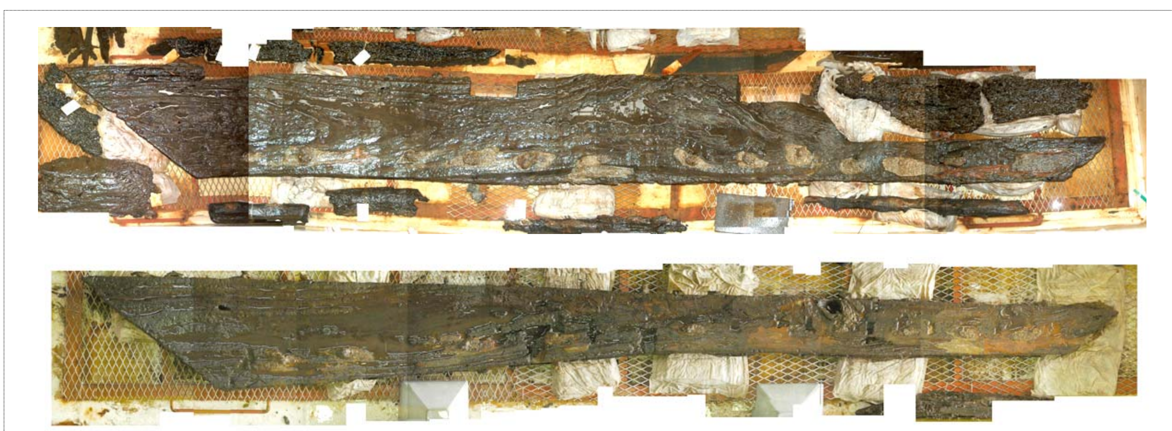

Fig. 89. Photo Mosaics of Timber No. 322/323.

One important aspect of this bulkhead is the recesses for fore-and-aft beams or carlings. Traditional shipbuilding shows multiple examples of this construction feature. The use of carlings was widespread, particularly in the north. The Kiangsu and Hangzhou Bay traders both had such feature.[345] Vessels built in Canton also had carlings.[346] Flat-bottom boats lack longitudinal strength due to not having a keel. To accommodate the weakness, wales and perhaps carlings were used. It is interesting to note that the bulkhead from a possible V-shaped vessel, Timber No. 322/323, had carlings. This bulkhead may not be from a vessel built in Fujian Province after all. Perhaps, it may have been from a lengthy ship where longitudinal stiffness was required of the hull; a lengthy warship may have required greater longitudinal strengthening, even if it has a V-shaped hull.

Another important feature of Timber No. 322/323 is the lack of iron brackets or stiffeners, instead, the side of the bulkhead has holes and concretions where large iron nails were used to connect planks to the bulkheads. The use of bracket and stiffeners seems decline after the fifteenth century because available historic and ethnographic data do not suggest a use of such joinery. There is also no reliable archaeological data of a hull from a later date in China. Shipwrecks found in Southeast Asia dating to the Ming dynasty may be used for a comparative study. These vessels were most likely built by Chinese immigrants and suggest a continuation of tradition, with some assimilation of Southeast Asian traditions occurred. These later wrecks from Southeast Asia uses stiffeners less frequently and using direct connection between the bulkhead and plank while having much closer intervals of nails to connect bulkhead planks together: Similar features are observed on Timber No. 322/323. The Pattaya wreck dating possibly to

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[345] Worcester 1971, 173; Waters 1947, 30.

[346] Lovegrove 1932, 249.

sixteenth or seventeenth century, found in Thailand, has close nail intervals of 16 to 18 cm.[347] Several vessels, including the Phu Quoc and Bakau ships have stiffeners, but these were used sporadically and smaller in size than the stiffeners found on the Shinan ship, suggesting that they were repairs inserted later.[348] The closer the interval of the nails to hold the bulkheads together, the less reliance on a brackets or stifiners may be observed, but more research is clearly needed to indicate a direct correlation.

The key features found on the large bulkhead from Takashima (Timber No. 322/323), the lack of bracket or stiffeners, the use of nails at the side to connect to the hull, and emphasis on bulkhead plank connection, are all characteristics of the later vessels made in Southeast Asia. Furthermore, it may suggest that the bulkhead was constructed first and the planks were applied later. If the possible dovetail recess described in the previous chapter was indeed used for a temporary fastener, it provides a favorable argument towards bulkhead first construction. There is little need of temporary fasteners when one can directly nail the bulkheads to the planks that have been erected first. It is, however, difficult to confirm this hypothesis with the available evidence from Takashima.

Timber No. 205

This timber is one of the most significant artifacts found at Takashima, for it is the bottom-most bulkhead plank of a vessel, placed where the bulkhead connects to the keel (fig. 90). An upper section was also found attached to this timber, but its state of preservation did not allow for a detailed study. Fortunately, this lower section is in good condition, and detailed

[347] Green and Intakosai 1983.

[348] Blake and Flecker 1994; Flecker 2001. See footnotes 107 and 108 on page 28 for more details.

analysis was possible. The width of this bulkhead is 47 cm at the top and 25 cm at the bottom. This gives the sided dimension of the keel as 25 cm, which is smaller than excavated examples. The sided dimension of the keel of the Quanzhou ship is 47 cm and the Penglai ship is 30 cm.[349] The bottom Timber No. 205 has a slight bevel in the fore-and-aft direction, suggesting that the bulkhead may have been located close to the bow or stern. The angle of the deadrise at the bottom is approximately 30 degrees, suggesting a steep V-shaped hull.

Fig. 90. A Photo of Timber No. 205.

The plank and bulkhead connection is difficult to assess because no planks were found attached and no nail holes survived because of the detrimental environment at the bottom of the bay. The surface of the bulkhead shows nails, indicating where the frame or bracket/stiffener had been placed. As seen on the Quanzhou Ship, frames are usually placed at the bottom instead of

[349] For the Quanzhou Ship, consult Green et al. 1998, 282; for the Penglai ship, see Yamagata 2004, fig. 3/10; Xi 1999, 213-5.

brackets and stiffeners.[350] Thus, as with other excavated vessels, the frame was probably nailed to the planks to secure the planks and bulkhead together.

This timber shows an interesting nailing pattern (fig. 91). Two nails are driven from outside most likely connected the garboard, the lowest bulkhead, and the bulkhead above.[351] These nails were placed from the extreme lower corner and driven upward. The next set of nails are placed from the below going through the lower bulkhead and stopping inside the upper bulkhead timber.[352] These two nails may not have been driven in from the keel below. If the nail is driven from the keel, the length of the nail must exceed 30 cm, which would not seem to be a very strong nail considering the 1 cm square cross-section. The nails must have be driven from the lower bulkhead to the upper bulkhead, suggesting that the bulkhead was pre-assembled then fitted inside the hull.

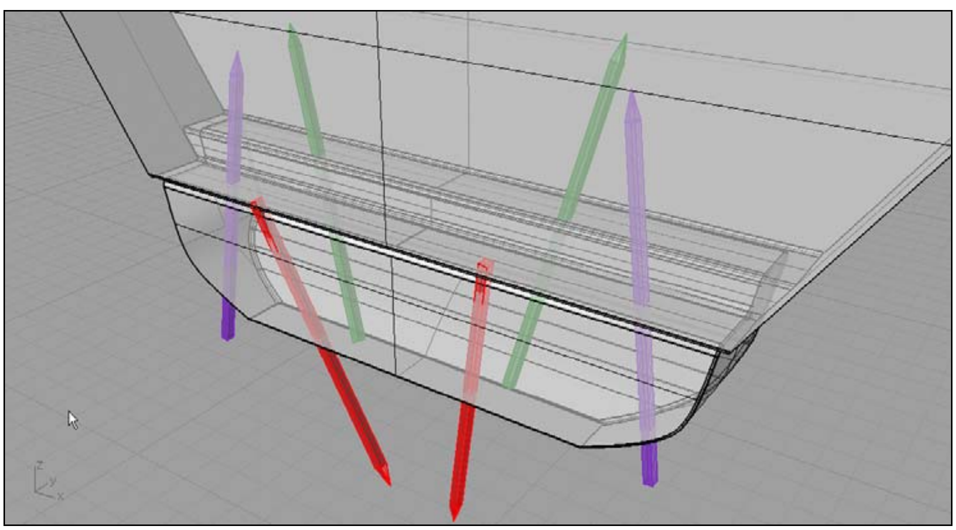

Fig. 91. A Model of Timber No. 205 with Nails.

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[350] Green et al. 1998, 292; The Office of the Cultural Property Management 1984, 129.

[351] These two nails are shown in purple in fig. 91.

[352] These nails are shown as green in fig. 91.

Another two nails were driven from the edge of the lower bulkhead surface down to connect the bulkhead and the keel.[353] When connecting the bulkhead and the keel, the most logical method is to place a bolt or a large nail from directly above the bulkhead down to the keel. Timber No. 205 shows nails driven diagonally from the outer surface of the bulkhead timber. This connection appears to be very weak, or seems to have been done as an afterthought; the two nails that connecting the bulkhead to the keel were evidently added after the bulkhead was connected to the hull. The bulkhead and keel were thus separated at the initial construction stage when the bulkhead was being assembled.

The nailing pattern, although confusing at first, follows a logical construction pattern. Bulkheads were assembled first. Two nails were used to temporarily hold the bulkhead timbers together. Next, a keel and garboard were constructed, although no evidence for these has survived. The pre-assembled bulkheads were placed over the keel and nails were driven from the garboards to connect to the bulkheads. After this, two more nails were driven from inside the hull to the keel.

Many peculiar features are also found on Timber No. 205. First, it does not show a thicker bottom-most bulkhead, but is instead less robust. The bottom-most bulkheads usually are made of larger timbers and securely fastened to the keel and the garboards, as seen on the Ningbo and Shinan ships.[354] The Shinan ship has the strongest connection at the bottom of the hull, suggesting this was an important section of a hull when building a vessel.[355] A frame was most likely placed at the bottom to support this weak bulkhead portion.

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[353] These nails are shown as red in fig. 91.

[354] Lin et al. 1991, 306-8; Office of the Cultural Property Management 1984, 127-8.

[355] Office of the Cultural Property Management 1984, 127-8.

Some discrepancies cannot be ignored, but overall, Timber No. 205 provides excellent information that can be used when considering shipbuilding practices. It was a part of a smaller vessel, but appears to be part of a V-shaped vessel built in Fujian Province. The keel and garboards were connected first to form the bottom element. After this, the bulkheads were assembled and installed to the garboards. At this point, the height of the bulkhead may have exceeded that of the planking. Planks were most likely laid down following this step.

Timber No. 465/466

The timber No. 465/466, discussed previously, is a plank-like timber with a diagonal scarf that had iron nails acting as an internal frame inside the join.[356] The construction features of these planks must be described briefly. The main concern in analyzing the scarf is where it was placed in relation to the bulkhead. The Quanzhou ship has long scarfs and hooked scarfs, while the Shinan ship use flat scarfs with butt plates added inside the hull.[357] These scarfs are usually located under bulkhead stations, except for the Shinan ship, but all vessels show careful planning in determining the position of the scarf. This evidence suggests that the location of the bulkheads was known prior to the plank assembly.

Timber No. 465/466 has a very steep angle of scarf with multiple nails that securely close the seam. Furthermore, the slight triangular shape suggests a more complex planking pattern. Much emphasis was placed on fastening the seam (fig. 92). Three internal nails were used along with the diagonal nails that were placed along the seam. These internal nails did not differ in size from the other nails. The nails were driven in from directly above. This indicates

[356] See fig. 75.

[357] Green et al. 1998, fig. 15; The office of the Cultural Property Management 1984, 129-31.

that this scarf was not made as a repair because the plank above could only be added after the nails were installed. After the scarf was fastened by the internal nails, the seams were made tight by using nails along the seam of the scarf. This use of nails appears excessive, and seems illogical to a person who does not understand the underlying philosophy that governs the building of this vessel. The exaggerated and somewhat obsessive fastening along the seam of the scarf may be the evidence of plank-first, plank-based construction. The structure of the plank gives its strength to the hull. The weakest spot in the planking is at the seam, and the shipwright decided to take extra steps in securing this.

No fasteners for connecting this scarf to a bulkhead or frame were found along the scarf. Instead, larger nails were found going through the thickness of the timber at another location. These nails were probably used to connect the plank to the bulkhead or to a frame. Thus, the scarf was not placed at the bulkhead station, indicating that the bulkhead had been placed afterward, and the shipwright did not know where the bulkhead would be.

Fig. 92. Timber No. 465/466 Showing the Scarf and the Nails.

Timber No. 496

This 170 cm wide frame was placed at the bottom of the hull with a little deadrise. There is little question that the piece was a floor timber (fig. 93). The presence of a limber hole, the symmetrical shape, and the size strongly confirm the evidence. Therefore, it can be considered a reliable source for determining the origin and type of the vessel.

All nails in Timber No. 496 were driven from below the hull, and it was not attached to other components such as the side or top of a bulkhead. Thus, this was an independent component that held the planks in place. Futtocks might have been placed to the sides, but this was not confirmed. The shape of the floor timber suggests a narrow, slightly rounded (almost flat-bottom) vessel. The apparent absence of a bulkhead suggests a purpose-built landing craft. To carry a large number of troops for a short distance in a small vessel the bulkheads may not have been necessary, or even an impediment.

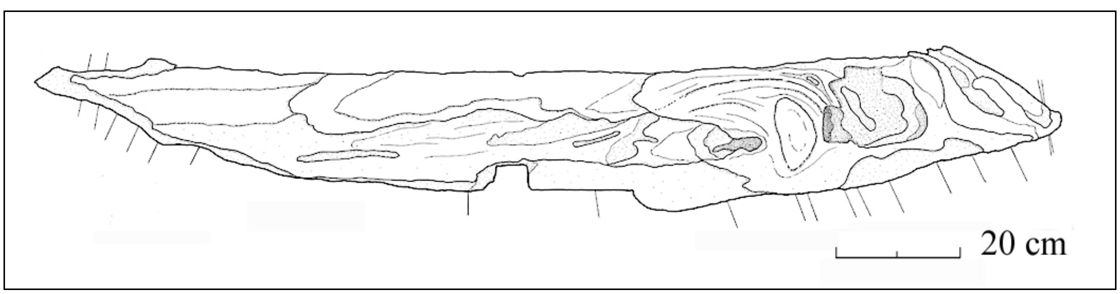

Fig. 93. A Drawing of Timber No. 496.

A close analysis of this timber revealed that some sort of internal keel was used. Although one side is broken, it can be assumed that an indentation was present at the center for the bottom timber to be fitted. The width of the keel may be estimated at approximately 30 cm.

Nails were driven straight from the bottom, indicating that they must have gone through and into the frame. If a developed keel was in place instead of a keel plank, the length of the nail would have exceeded 40 cm. This is highly unlikely. A keel plank less than 20 cm molded was most likely used. The nails could be safely driven from below without loosing any holding strength.

Timber No. 496 seems to be a good example of a frame from a flat-bottomed boat built within the bottom based tradition. Because it utilizes nails, the vessel was not built in Korea. The possible origin may be narrowed down to the Yangtze River valley.

CHAPTER VII

CONCLUSIONS

The Second Mongol invasion of Japan in the thirteenth century C.E. played an important role in shaping the maritime history of East Asia. The remains of the ill fated fleet discovered at Takashima Island have provided significant information regarding how the invasion was organized. They not only reveal details of the events, they also shed light on the shipbuilding technology of East Asia. This study represents a first step towards answering some of the topics not previously addressed because of a lack of available evidence. One of these topics pertains to the origins and types of vessels involved in the invasion using the physical remains of these vessels.

An analysis of the historical documents clearly suggests that the two fleets that Kublai Khan dispatched to Japan were entrusted with different functions. The Eastern Army used flat-bottom vessels built in Korea as landing craft to attack the Japanese forces and gain initial control of a small piece of territory in mainland Japan. The Southern Army's fleet was comprised mainly V-shaped cargo ships built in Fujian Province, and rounded and flat-bottom vessels made along the Yangtze River valley. Its task was to support the troops and to establish and maintain a base for the invasion.

The aim of this research was to study the timbers recovered from the Takashima underwater site in order to determine if these different types of vessels were represented at the site. Almost all the timbers analyzed were in poor condition and this made the analysis difficult. Three models were created to facilitate the interpretations. A timber category database divided

the timbers into categories to be analyzed component by component. The study of the joinery allowed the author to single out elements for comparative study. The focus on the philosophy of shipbuilding, and a detailed analysis of a small number of timbers, also provided useful insight into shipbuilding technology of Asian vessels.

The timber database produced some good results. Its analysis suggested that many of the timbers belonged to small vessels, most likely from the Yangtze River region. Most of the timbers were beams, railings, and supporting timbers. Although not a significant portion of the remains, at least one large V-shaped vessel built in Fujian province was also present. No timber found could be definitely identified as originating in Korea, but many timbers matched characteristics similar to vessels from Korea. Although this research is not conclusive, the archaeological evidence gathered from the Takashima underwater site seems to correspond with the information provided by historical documents. Many timbers showed features that revealed interesting functions. By isolating the few timbers that shared similar characteristics, it was possible to focus on specific aspects of shipbuilding technologies.

The study of joinery was not very successful in determining the origin of the vessels, but provided many questions to be asked in future research. From the number of the timbers with nail marks, it is apparent that the use of nails was the preferred method of joinery used on the vessels found at Takashima. Nails showed little variation in size and shape, indicating that perhaps only a small number of ships are represented at the site, or that most of the vessels found at the site were built in a relatively small geographic area, perhaps in government operated shipyards. Despite this, a few varieties found may suggest the use of captured pirate ships and conscripted merchant vessels as well. The nails used for the construction of the Quanzhou and

Shinan ships, both built in Fujian Province, were similar to nails found at the site. Moreover, for a large component of a hull such as a bulkhead, a recess was cut to receive a nail, which was a common practice in Fujian Province. Despite the similarity, the excavated vessels from elsewhere showed a wide variety of nail types in the same hull; the lack of variation in iron fasteners found at Takashima needs to be explained. The study of nails cannot determine the origin of the vessels because evidence from other areas is lacking for comparative purposes. In archaeological reports and ethnographic records, nails are often neglected or only briefly mentioned.

Although represented only in a small number of finds, complex wooden joinery was found at the site as well. A notch, a recess, locking systems, tenons, treenails, and other techniques were found. Several previously unrecorded joineries were also noted. Koreans are known to have utilized these complex wooden joineries, but only a handful of artifacts showed a possible Korean origin. From the study of the joinery, it is suggested that the remains of Korean vessels are present. Nails and complex wooden joineries were often used side by side. Several of these joinery types were represented in the Yangtze River vessels. The most prominent joinery type was the notch or recess, and most of them were found on smaller artifacts. Rabbets and scarfs did not make up the majority of the joinery found at the site. These techniques were mainly employed on fastening hull planking together. Many of the joineries found at the site seem to originate from the smaller components of ship's gear, or from small boats. Furthermore, *chunam*, used on the hull of the majority of the excavated vessels built in Fujian Province, was found only on a small number of timbers. To summarize the results of the study of joinery, many

of the timbers discovered at Takashima may not be hull components, but smaller structural remains, perhaps from vessels built along the Yangtze River.

Together with the study of hull components and joinery, a third approach, the study of the philosophy of shipbuilding, provides new information regarding East Asian shipbuilding practices. Considering the size of China and its diverse environment, various shipbuilding traditions have existed. Shipbuilding in medieval China shows reliance on the hull bottom elements to form the basic shape of the vessel and the reliance on bulkheads to support the hull. The ocean going craft built in Fujian Province and the inland craft built in the Yangtze River area differed in the bottom structure. In Fujian Province, the bottom consists of the wide keel, heavy garboards, and bottom-most bulkhead timbers. In the Yangtze River area the bottom planks served as the basis for both the flat-bottom and rounded hull boats.

The data from the Takashima underwater site demonstrates several complex building sequences and methods of construction. It is difficult to determine how a vessel was constructed from just one piece of a timber. It was possible, however, to relate some of the timbers to an identified vessel type. At least one large cargo vessel was built using bulkhead-first construction, while another vessel showed that bulkhead might have been inserted later. A frame from a landing craft suggests a bottom based construction. Shipbuilding tradition was continuously developing and ideas had been shared from region to region. As with the study of joinery, extensive analysis of existing data must be conducted.

In conclusion, the archaeological evidence from the Takashima underwater site demonstrates the presence of various types of vessels, namely a large V-shaped cargo vessel built in Fujian Province, medium to small rounded hull vessels and flat-bottom boats, and

strongly built Korean vessels. This study also indicates that the majority of the wooden fragments were most likely from small and medium ships built along the Yangtze River. It is interesting to note that these flat-bottom boats and rounded hull vessels were not constructed for long overseas voyages. The areas where Kublai ordered vessels to be built were places where shipwrights had little idea about the open seas. It is difficult, but tempting, to say a majority of the vessels lost at Takashima were inland watercraft, and the vessels that survived were the seagoing craft built in Fujian Province. It is known that the Eastern Army suffered less, and this claim can be substantiated by the archaeological evidence gathered at Takashima. The purpose of this research was to identify the origins and types of vessels used for the second invasion and not why the invasion failed. Kublai organized the fleet with care, considering the purpose of the invasion and the plan of the attack. Further study is required.

The prominent dilemma that the Takashima underwater site faces is the lack of usable data to confirm almost any hypothesis that tries to determine the origins and types of ships that were brought for the second Mongol invasion. For this study, three methodologies were employed to answer the model proposed by the study of historical documents. The relatively small sample size, the heavily disturbed nature of the site, as well as the lack of research that has been conducted in East Asia regarding the shipbuilding traditions made it difficult to reach more the tentative conclusions of this thesis. The complete nature of the invasion and its failure is still vague. Despite this, the study has proposed new areas of research that may be expanded in the future. Many small finds reveal interesting features of the East Asian shipbuilding technologies. Continued background research in East Asian shipbuilding history may lead to significant discoveries.

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APPENDIX A

CHINESE SHIPWRECKS SCANTLINGS LIST

The Quanzhou Ship

General Information

Hull Shape	V-Shaped
Purpose	Overseas Merchants Ship
Date	Song dynasty (1277 C.E.?)
Origin	Fujian Province
Dimensions	24 x 9 m (survived): 28 x 10 m (estimate): 200 tons

Planking

Length	13 m
Width	35 cm
Thickness	2.5 (out), 5 (middle), 8 (in) cm
Scarf	Half Step and Diagonal
Joinery	Diagonal Nails set in recess, 1-1.5 cm square, 20 cm Intervals: Complex rabbet clinker and lap joinery

Bulkheads

Width	20-5 cm
Thickness	8 cm
Joinery	Diagonal nails from both sides, set in recess, 10-40 cm Intervals: Use of *Gua-Ju* Bracket, 6 x 0.7 cm and 40-55 cm long.

Keel

Molded	27 cm
Sided	42 cm

Frames

Dimensions	20 x 20 cm
Type	Floor timbers connected to Bulkhead and Planks

Masts

Main Mast Size	260 x 55 x 48 cm
Tabernacle Size	20 x 20 cm: Spacing 60 cm
Foremast Size	180 x 45 x 32 cm
Tabernacle Size	18 x 18 cm: Spacing 37.5 cm
Type	Fit to Hull

Miscellaneous

Limber Hole, 25 cm high, 9 cm wide: Use of fairing Strips

Green, J., N. Burningham., and Museum of Overseas Communication History. 1998. "The Ship from Quanzhou, Fujian Province, People's Republic of China." *The International Journal of Nautical Archaeology* 27(4):277-301.

The Shinan Ship

General Information

Hull Shape	V-Shaped
Purpose	Overseas Merchants Ship
Date	Yuan Dynasty (1310 C.E.?)
Origin	Fujian Province
Dimensions	24 x 7.5 m (survived): 28 x 9 m (estimate?): 250 tons

Planking

Length	NA
Width	40 cm
Thickness	12 cm
Scarf	Flat-butt Plates under the seam
Joinery	Diagonal Nails set in recess, 1-1.5 cm square, lap joint

Bulkheads

Width	40 cm
Thickness	10 cm
Joinery	Diagonal nails from both sides, set in recess, large dovetail Use of stifners of 10 cm.

Keel

Molded	50 cm
Sided	71 cm

Frames

Dimensions	40 x 20 cm
Type	Bottom Bulkhead act as a frame

Masts

Main Mast Size	145 x 60 x 65 cm
Tabernacle Size	25 x 25 cm: Spacing 45 cm
Foremast Size	NA
Tabernacle Size	NA
Type	Composite with a locking pin

Miscellaneous

Use of butt plates to cover the seams of the planks at butt-scarfs.

Office of the Cultural Property Management 文化財管理局. 1984. *Shinan Haejeo Yumul Jaryo Pyeon II 新安海底遺物資料編 (Shinan Underwater Site Artifacts Report).* Seoul: Ministry of Culture and Publicity 文化広報部.

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The Penglai Ship (The Penglai I)

General Information

Hull Shape	Rounded Hull /Flat-Bottom
Purpose	Patrol Boat for inland use
Date	Yuan Dynasty (1271-1368 C.E.)
Origin	Yangtze River (?)
Dimensions	28.6 x 5.6 m (survived): 32-8 x 6 m (estimate)

Planking

Length	3-18m
Width	20-44 cm
Thickness	12-28 cm
Scarf	L-hook Scarf
Joinery	Dowels and nails

Bulkheads

Width	20-5 cm
Thickness	16 cm
Joinery	Mortise and tenon: Use of integral *gua-ju* iron breacket

Keel

Molded	30 cm
Sided	40 cm

Frames

Dimensions	25 x 10 cm
Type	Frames placed at the turn of the bilge

Masts

Main Mast Size	388 x 54 x 26 cm
Tabernacle Size	26 x 26 cm: Spacing 30? cm
Foremast Size	160 x 46 x 20 cm
Tabernacle Size	20 x 20 cm: Spacing 20? cm
Type	Fit to the hull

Miscellaneous

Internal Keel notched to bulkhead.

Garboard and bottom planks are close to rectangular in shape

Cultural Relics Bureau of Penglai City 蓬莱市文物局. 2006. *Penglai Gu Chuan 蓬莱古船 (Ancient Ships from Penglai).* Penglai: Cultural Relics Publishing House 文物出版社出版发行.

The Ningbo Ship

General Information

Hull Shape	Round Hull
Purpose	Overseas/Estuary Trade
Date	Song Dynasty (No Later than 1279?)
Origin	Lower Yangtze
Dimensions	9.3 x 4.3 m (survived)

Planking

Length	3-8 m
Width	21-42 cm
Thickness	6-8 cm
Scarf	Diagonal
Joinery	Iron Nails and Mortise and Tenon

Bulkheads

Width	16-30 cm
Thickness	7-10 cm
Joinery	Nails?

Keel

Molded	18 cm
Sided	26 cm

Frames

Dimensions	16-25 x 7-10 cm
Type	Bottom Bulkhead act as a frame

Masts

Main Mast Size	105 x 25 x 18 cm
Tabernacle Size	15 x 8 cm: Spacing 15 cm
Foremast Size	84 x 21 x 14 cm
Tabernacle Size	14 x 7 cm: Spacing 13 cm
Type	Fit to the Hull

Miscellaneous

Internal Keel, Use of Wales of 14 x 9 cm

Lin, S., D. Genqi., and J. Green 1991. "Waterfront Excavations at Dongmenkou, Ningbo, Zhe Jiang Province, PRC." *The International Journal of Nautical Archaeology* 20(4):299-311.

The Jinghai Boat

General Information

Hull Shape	Flat-bottom
Purpose	Local River Transport
Date	Song dynasty (960-1279)
Origin	Northern China
Dimensions	14.62 x 4.05 m (Complete)

Planking

Length	NA
Width	30 cm
Thickness	13 cm
Scarf	NA
Joinery	Iron Nails

Bulkheads

No Bulkhead. Beams were used instead

Keel

Molded	8 cm
Sided	40 cm

Frames

Dimensions	10-20 cm, grown timber (Beam)
Type	Stanchions, Knees, and Beams

Mast

No Mast?

Miscellaneous

Box Like Shaped Vessel with thicker keel Plank.

Use of Chine Strakes.

Knees, Stanchions, frames, and Beams were made of Grown Timber

Tianjin City Cultural Relics Administration 天津市文物管理处. 1983. "Tianjin Jinghai Yuan Menkou Song Chuan de Fajue 天津静海元蒙口宋船的发掘 (The Excavation of a Song Vessel at Jinghai near Tianjin)." *Wen Wu* 文物 7:54-8, 67.

The Shanghai Ship

General Information

Hull Shape	Flat-bottom
Purpose	Inland Water Transport?
Date	Song dynasty (960-1279)
Origin	Lower Yangtze? or Northern China?
Dimensions	6.23 x 1.4 m (survived)

Planking

Length	NA
Width	10-20 cm
Thickness	NA
Scarf	Joggled
Joinery	Iron Nails

Bulkheads

Width	18 cm
Thickness	10 cm
Joinery	Iron Nail

Keel

NA

Frames

NA

Mast

Main Mast Size	100 x 20 x 10 cm
Tabernacle Size	10 x 5 cm: Spacing NA

Miscellaneous

Scafs not positioned under the bulkheads

Ni, W 倪 文俊. 1979. "Jiading Fenbing Song Chuan Fajue Jianbao 嘉定封浜宋船发掘简报 (Excavation Report on the Song Dynasty Vessel from Jiading Fenbing)." *Wen Wu 文物* 12:32-6.

APPENDIX B

TIMBER DATABASE

BEAMS

Timber No.	Original No.	Rank	Length	Width	Thickness
2	189	2	167.5	16	9.5
7	195	2	63.5	7.5	7.5
116	885	3	97	11	10
126	959	1	82	9	9
269	1315	3	95	9	6
270	1316	4	65	11	4
307	1394	2	68	8	5
321	1436	4	50	3	NA
349	1627	5	50	NA	NA
452	885-b	3	50	7	4
456	2003-1	2	60	9	5
470	2003-21	3	56	7	3
495	2004-25	3	64	10	6

* All Measurements are in (cm).

Brief Descriptions

Timber No.	
2	Possible square cross-section, no nail
7	Long, somewhat rectangular cross-section, no nail
116	Square cross-section, no nail, seems to have a notch at one end
126	Possible throughbeam with a different thickness at one end
269	Rectangular cross-section, no nail
270	Degraded but rectangular cross-section, no nail
307	Rectangular cross-section, no nail
321	Degraded, possible rectangular cross-section, may be included in fashioned timbers
349	Degraded, possible rectangular cross-section, no nail
452	Slightly warped timber with square cross-section, no nail
456	Rectangular cross-section, one nail, original width preserved, has a notch
470	Rectangular cross-section, no nail
495	Rectangular cross-section, no nail

BULKHEADS

Timber No.	Original No.	Rank	Length	Width	Thickness
18	207	4	18	15	7.5
25	221	2	155	19	4.5
121	909	2	325	45	12
122	918	2	NA	NA	NA
123	949	2	320	45	16
161	1035	2	97	21	4
205	1142	1	47	9.5	9
315	1428	3	60	21	8.6
322	1439	1	465	49	16.5
323	1440	1	570	59	17
346	1609	5	47	NA	NA
414	1860	4	75.3	16	5
420	1866	2	140	26	10
437	1428-b	3	50	13	NA
462	2003-8	2	150	20	8

Brief Descriptions

Timber No.	
18	Possible small portion of an edge of a larger bulkhead
25	Possible bulkhead of a small boat? But the angle on both sides are different
121	Possible bulkhead or plank
122	Part of Timber No. 121, with possible *Chunam*
123	Most likely a bulkhead. Seems to have corrosion on surface that appears to be stiffeners
161	Very thin bulkhead or bulkhead support, with small wooden plugs to fill nail cavities
205	This is the bottom most bulkhead, perhaps near the stern?
315	Degraded possible bulkhead, diagonal nails placed from both sides, from top and to bottom
322	Lower section of the 6 m long bulkhead plank, with possible dovetail joints?
323	6 m long bulkhead, with two notches, found connected to Timber No. 322
346	Highly degraded but possible bottom most bulkhead with nails coming in from sides.
414	Highly degraded timber, but seems to have diagonal nails placed from both sides
420	Possible bulkhead of a smaller vessel, or could be a plank
437	Highly degraded, and curved, has a flat original surface
462	Possible bulkhead, has a rectangular notch for carling at top

DECK PLANKING

Timber No.	Original No.	Rank	Length	Width	Thickness
27	236	2	NA	11	2.5
56	614	2	33	10	1.5
98	844	3	42.2	7	1.5
114	883	2	44	14	2.5
141	998	2	115	20	2.5
171	1060	2	69	17	4
195	1120	1	50.5	20.5	3.5
208	1146	4	19	10	2
239	1271	4	NA	NA	0.5
286	1341	4	35	11	3
356	1638	2	72.2	13.2	2.22
359	1644	4	38	5.5	2
411	1857	4	33	5	2
413	1859	1	51	24.3	4.01

Brief Descriptions

Timber No.	
27	Possible deck planking
56	Charred thin plank with no nail, may be a sheathing
98	Thin plank, no nail
114	A thin plank with a round hole going through the thickness
141	Possible deck planking with two small nails
171	Possible deck planking
195	Possible deck planking, but has short width
208	Degraded possible deck planking with several nails
239	Thin piece of timber, may be deck planking or sheathing
286	Typical deck planking
356	Typical deck planking
359	Degraded possible deck planking
411	Small fragment of thin plank, may be a deck planking?
413	Thin plank, close to original shape, with several nails

PLANKS

Timber No.	Original No.	Rank	Length	Width	Thickness
13	201	4	55	25.5	12
14	202	2	64	12	5.5
35	315	4	150+	19	13
36	316	4	105	17	8.5
111	875	3	60.5	17.5	10.5
120	889	4	52	8	3.5
297	1364	2	64	11.5	5.5
330	1456	2	41	42	11.5
406	1852	2	92	14	4
408	1854	4	80	17	NA
427	1317	4	NA	NA	6
433	1047-a	4	98	28	NA
448	838-b	5	46	15	3.5
465	2003-16	2	88	22	8
466	2003-17	2	40	8	5

Brief Descriptions

Timber No.	
13	Degraded large timber with diagonal nails, possible plank
14	Possible plank but may be a bulkhead, similar to Timber No. 465/466
35	Highly degraded plank, with diagonal nails, similar to Timber No. 448
36	Highly degrade possible plank
111	Degraded, flat timber with nail holes and concretion, a round hole going through the thickness
120	Highly degraded plank with possible diagonal nails
297	Possible broken plank, nails set next to each other for possible repair?
330	Close to original shape, a part of a large plank, or possible bulkhead
406	Thin and long plank or bulkhead with several nails in random pattern
408	Degraded wood with concretions, appears to be a plank
427	Highly degraded and in fragmented, but it may be a remain of possible plank scarf
433	Large degraded timber with two concretions. It appears to be part of a larger plank
448	Highly degraded possible plank with diagonal nails, similar to Timber No. 35
465	Upper section of Plank with diagonal nail and a scarf, connects to Timber No. 466
466	Lower section of Plank with diagonal nail and a scarf, connects to Timber No. 465

RAILING

Timber No.	Original No.	Rank	Length	Width	Thickness
10	198	3	28.5	6.5	7
66	639	2	82.5	6	6
95	836	2	67	6	4
108	869	4	38	6.6	7.8
130	972	3	NA	9	2
138	993	3	44	4.2	1.5
149	1008	2	87	5	4
182	1092	2	44.5	6.7	4.2
202	1132	3	40	7	4
217	1171	4	52	NA	NA
225	1220	4	23.5	10.5	5
288	1344	3	66	6	NA
293	1356	4	20	7	5.5
324	1443	3	63	4.3	4.3
328	1448	3	21.7	8.8	4.5
336	1477	3	27	8	7
354	1636	2	55	6	3
364	1672	2	30	5	3

369	1684	2	45	8	6
370	1686	2	25	7	4.4
372	1694	2	51	8	4
373	1696	2	50	8	4
374	1697	2	35	4	3
376	1703	2	32	7	6
380	1725	3	27	6.5	4
388	1748	2	62	6	3
402	1830	3	34	2.5	NA
418	1864	4	86	6	5
425	1880	3	81.5	7.3	4.34
445	1827	4	18	7	3.2
449	848-b	2	40	8	7
479	2003-40	3	45	13	5
484	2003-45	4	26.5	4	3

Brief Descriptions

Timber No.	
10	Degraded timber with multiple nails in random orders
66	Neatly cut long and rectangular timber with equal spacing of nail, a possible stiffener?
95	Possible railing with one round hole
108	Most likely a railing type that has a scarf/diagonal cut?
130	Degraded timber with several nails
138	Thin, but nails placed in line
149	Thin, well preserved, but broken, nails in line
182	Railing like timber with two round holes
202	Highly degraded possible railing with two nails
217	Highly degraded timber, with three sets of two nails in close intervals
225	Highly degraded, but preserving the original width
288	Appears to be a driftwood, but shows a modified edge and a possible nail hole
293	Small timber fragment that appears to be of railing, with nails placed in close proximity
324	Thin possible railing type, with four nails in line
328	A possible railing, original width is preserved
336	Possible railing with a diagonal hooked scarf with nails going through
354	Long, thin, and slightly warped railing with a nail
364	Original surface preserved on one face, with multiple small nails
369	Degraded possible rail, with a possible scarf and no nail
370	Rail like shape, but with nails driven diagonally from sideway

372	Degraded possible railing, with nails
373	Broken possible railing, with nails
374	Possible railing with almost square cross section, with a nail
376	Degraded possible railing, with many nails placed in order and in line
380	Degraded possible railing, one surface well preserved
388	Degraded, but typical 2x4 railing with many nails in line
402	Degraded fragments with a nail
418	Three fragments that goes together. Could be railing, but show complex nailing pattern
425	Possible thin railing, many nails in various directions from repair/reuse
445	Degraded and broken timber, but may be railing type
449	Well preserved possible railing, with a scarf and rectangular cut
479	Degraded possible railing, with several nails
484	Degraded but rectangular cross-section, with several nails

FASHIONED TIMBERS

Timber No.	Original No.	Rank	Length	Width	Thickness
1	90	4	57.5	24	21
3	190	3	93	15	15
4	191	2	98	6	6
11	199	4	63	10	10
29	255	4	51	5	5
31	304	4	73	31	13
46	355	2	55	9	6
53	610	3	72	32	10
96	842	5	50+	NA	NA
110	874	3	50+	NA	NA
112	876	4	75	14	14
146	1005	5	50+	20+	NA
150	1011	3	NA	NA	NA
152	1013	5	50+	20+	NA
160	1032	4	50+	NA	NA
181	1081	4	50+	20+	NA
204	1140	4	50+	NA	NA
308	1396	3	62	20	NA

313	1401	3	66	20	3.5
326	1446	4	66	6	NA
341	1501	5	100+	NA	NA
342	1502	5	50+	20+	NA
405	1851	4	100+	50+	NA
407	1853	5	100+	20+	NA
409	1855	4	50+	20+	NA
421	1867	5	50+	NA	NA
438	1451,2,3,4	5	100+	50+	NA
464	2003-14	4	50+	10	4
474	2003-29	4	55	5	NA

Brief Descriptions

Timber No.	
1	Degraded, featurless, teredo infested shaped timber?
3	Round large timber with a rectangular cut or a notch
4	Well shaped rod with a notch, function unknown
11	Degraded large timber
29	Degraded and broken timber
31	Highly degraded naturally shaped wood with a shaped notch
46	Split-log without a nail
53	A part of a large timber, having a large notch, it may be a bulkhead and a notch for a carling
96	Large block of possible driftwood
110	Degraded timber, with cross-section is rectangular, appears to be a plank type but with no nail
112	Large naturally curved timber, no nail
146	Large degraded fragment of a plank or bulkhead, but found no nail, a part of larger component?
150	Several fragments of degraded timber, one of them may have a rectangular/square scarf?
152	Large fragment of a plank or bulkhead, but no nail
160	Teredo infested possible thick naturally curved wood
181	Possible fragment of a plank or bulkhead, but no nail
204	Highly fragmented timber in multiple fragments, no nail
308	Degraded wood without a feature
313	Degraded large block of wood, no nail

326	Degraded, thin and long timber
341	Degraded fragments of a larger timber
342	Degraded wood, perhaps a plank, but no feature
405	Degraded, large flat timber with no feature
407	Large plank like timber with no nail
409	Large plank like timber with no nail, might have a straight cut at the side? (butt joined) plank?
421	Degraded wood, no feature
438	Large fragments of plank or bulkhead, with no nail
464	Degraded fragments of larger timber
474	Degraded, long, naturally curved timber

WALES

Timber No.	Original No.	Rank	Length	Width	Thickness
22	214	1	166	14.5	6
37	317	3	116	25	11
45	354	2	51	8.5	4
50	362	2	50	10	7
101	856	2	56.5	13.5	6.5

Brief Descriptions

Timber No.	
22	A typical wale with nails in several directions in line
37	Cross-section may be split-log, like a wale, with bark still attached, an with several nails
45	Rounded cross-section, five nails set in various directions
50	Possible railing with multiple nails, rounded cross-section
101	Poor quality degraded half log with a nail, perhaps a filler piece

FASTENERS

Timber No.	Original No.	Rank	Length	Width	Thickness
69	645	1	15	8	8
94	828	2	17	7	1
158	1028	2	17	5	4
255	1297	2	11	3	3
318	1433	1	20	5.8	3.5
365	1677	2	16	7	3
366	1678	2	12.5	6	1.8
444	1811-c	2	5.5	3	3

Brief Descriptions

Timber No.	
69	Peg? Wood joinery from Korea? Cut marks
94	Complex Wood Joinery
158	Wooden plug?
255	Peg? Wood joinery from Korea?
318	Complex Wood Joinery with small nails
365	Peg hole, complex wood joinery
366	Complex Wood Joinery with small nail
444	Peg? Treenail?

UNKNOWN/OTHER

Timber

No.	**Original No.**	**Rank**	**Length**	**Width**	**Thickness**
6	193	2	130	31	16
21	213	2	26	10	8
23	215	4	25	3.5	NA
24	216	4	21	4.5	NA
34	307	2	176	18	8
51	601	2	300	48	16
61	627	2	23	10	5.5
67	642	2	101	26	13
75	669	2	40	24	9
77	672	1	27	9	3
81	679	2	60	25	10
88	742	5	43	18	6
91	749	4	44	13	NA
92	750	4	49	9	NA
97	843	3	62	23	10
99	851	1	28.2	17.5	6.8
118	887	3	38	8.5	12
125	951	2	12.5	10	4

132	980	2	NA	NA	NA
148	1007	3	32	13	7
168	1056	2	89	13.5	9
169	1057	5	23.5	10	6
179	1078	2	89	4	NA
196	1121	1	NA	NA	NA
219	1184	2	46	10	3.5
227	1236	1	46	15	12
274	1325	4	14	5	4.5
287	1342	3	35	NA	NA
289	1347	1	84	4	4
290	1349	4	33	5.5	3.5
305	1378	3	76	13	19
319	1434	3	100	22	22
325	1445	2	56	8	4
327	1447	2	125	8	8
334	1469	2	115	16	9
335	1476	1	262	37	15
343	1505	3	18	9	8
345	1607	1	87	16	2
347	1614	2	108	31	25
361	1648	1	30	5.2	4

363	1650	4	55	NA	NA
378	1718	2	49	3.5	2
390	1762	2	28	8.5	5.5
415	1861	2	225	16	16
417	1863	1	187	38	13
422	1871	2	31	9	7
423	1875	4	26	9	7
428	1346	3	26	13	5
429	1355	2	95	7.5	5
430	1030-b	1	39	5.5	4.5
458	2003-3	3	33	6	5
496	2004-26	2	170	40	10
498	2004-30	4	OT	NA	4

Brief Descriptions

Timber No.	
6	Degraded, poorly constructed mast step
21	Possible filling piece made for a specific purposes, small timber with several nails
23	Small fragment of bamboo
24	Small fragment of bamboo
34	Well preserved, but charred, windlass stand
51	3 m long timber, with a large rectangular opening and several concretions attached
61	Charred, rectangular shaped block of wood
67	Block of shaped timber with a rectangular opening, with large nails or bolts
75	Block of cut wood, neatly shaped in rectangular shape, without a nail
77	Charred curved wood, a possible decorated feature of a ship?
81	Large wood with only a small nails, a part of a large component
88	Highly degraded timber with several nails
91	Highly degraded blocky wood without any feature
92	Heavily degraded, but might have a carved joinery and might be a curved timber
97	Broken segment of a larger timber, with two large nails attached
99	Block of wood in original shape, neatly shaped with concave cross section, charred
118	Appears to be a scarf (triangular shape from side), with two nails
125	Degraded timber with many nails, originally one piece with Timber No. 390
132	Possible rigging element?
148	Appears to be a filling piece hold down by several nails

168	Possible floor timber or part of bulkhead?
169	Highly degraded possible filling piece, multiple nails
179	Long branch like timber, but has several small nails
196	Rounded flat shaped timber, possible plug for a container
219	Possible small equipment, perhaps a rigging element?
227	Possible frame or futtock, perhaps a large filling piece like deadwood
274	Possible filling piece with a trapazoidal cross-section
287	Degraded timber but seems to show a craved joinery at one end
289	Long rounded and well preserved timber, a spear or a rod
290	Highly degraded, but could have been a frame or bottom most bulkhead
305	Small section of a scarf or step of plank or bulkhead
319	Highly degraded timber, a possible mast step? a rectangular hole similar to Timber No. 67
325	A slender timber with rectangular hole and a rectangular notch, possible a part of an euipment
327	Long thin timber with numerous nails, used as a weapon or defense for a vessel
334	Possible frame, or naturally curved timber
335	Large frame, a bulkhead support timber, or a futtock
343	Possible section of a larger timber? Or filling piece
345	Flat plank with corrosions at the outer edges, perhaps a bulkhead support
347	Appears to be a split tree trunk, function unknown
361	Timber in original shape, two nails, function unknown
363	Highly degraded broken timber with a trace of carved joinery
378	Thin and slender wood, almost appears to be a firewood, but has a nail

390	Function is unknown, found a broken half (Timber No. 125)
415	Possible rudder stem, with two rectangular openings, charred
417	Thick plank like timber, nails, triangular recess, and other unique joinery found
422	Small timber with a rectangular opening (not going through)
423	A possible filler piece with many nails
428	Railing like timber with unknown function, similar to Timbers No. 125 and 390
429	Possible frame below deck planking, multiple nails as evidence of repair?
430	Small curved timber, well shaped, with nails, function unknown
458	Timber with multiple nails, function unknown, but appears to be of a small object
496	Most likely a floor timber of a round/flat bottom vessel
498	Degraded timber, having possible nails

LOGS

Timber No.	Original No.	Rank	Length	Width	Thickness
32	305	3	37	5	NA
33	306	3	28	7	NA
49	361	2	118	8	8
63	632	3	77	6.5	6.5
65	636	5	44.5	8	NA
79	678	3	166	8	NA
100	854	2	69	7	7.5
106	865	1	55.5	8	7
113	880	5	50+	NA	NA
115	884	3	77	12	9.3
136	990	3	91	10	10
144	1002	4	NA	NA	NA
145	1004	5	21	NA	NA
157	1024	3	NA	NA	NA
163	1045	4	29	6	NA
164	1046	5	NA	NA	NA
180	1079	1	53	2	NA
183	1095	4	33	10	NA

184	1099	4	22	7	NA
186	1106	5	50+	NA	NA
191	1116	4	37.2	4.5	NA
198	1127	4	NA	9	NA
214	1161	4	40	4	NA
256	1299	5	NA	NA	NA
268	1314	4	103	6.5	6.5
283	1337	4	30	3	3
299	1366	4	40	3.5	NA
301	1368	5	50+	NA	NA
309	1397	4	49	15	6
310	1398	4	22	5	NA
314	1402	4	NA	NA	NA
337	1479	5	NA	4	NA
350	1629	5	50+	NA	NA
353	1634	1	130	10	10
382	1734	1	55	5	4
439	1497-a	4	50+	NA	NA
440	1497-b	4	NA	NA	NA
451	865 fragment	5	NA	NA	NA
457	2003-2	2	174	7	5
486	2003-49	4	16	4	3

CUT LOGS

Timber No.	Original No.	Rank	Length	Width	Thickness
83	681	1	70.5	7.5	7.5
68	644	1	115	7	NA
86	685	2	40.2	4	4
87	686	4	NA	NA	NA
124	950	3	45	8	NA
127	964	2	49	13	5
143	999	2	55	5.5	5
151	1012	4	50+	NA	NA
170	1059	2	48.5	5	5
175	1069	1	221	8	8
176	1070	1	165	7	7
193	1118	1	51	5.5	5.5
211	1156	2	47	4	NA
230	1252	4	52	5	NA
246	1283	3	50+	3.5	3
258	1303	1	73	5.5	5.5
265	1311	3	40.5	4	4
296	1363	4	34	4.5	NA

306	1392	2	41	8	6
317	1432	3	70	9	8
332	1458	5	NA	NA	NA
357	1641	2	54	11	11
360	1645	3	28	5	5
362	1649	4	37	8.5	NA
368	1683	2	52	4	4
371	1691	1	52.5	3.5	3.5
392	1769	4	30	5	4.5
395	1772	2	47	10	NA
396	1776	3	73	5.6	NA
398	1805	2	100	4	4
399	1812	2	200+	5.5	5.5
401	1821	2	29	5.5	5.5
412	1858	4	78.5	9	9
416	1862	1	53	7.5	7.5
424	1879	1	57	3.8	NA
426	1900	3	64	4	4
442	1625-b	2	60	6	6
450	864-b	2	52	7.5	8
454	887 CL	2	40	8	8
491	2004-13b	4	27	6	3

UNIDENTIFIABLE

Timber No.	Original No.	Rank	Length	Width	Thickness
5	192	3	34	6.5	4
8	196	4	NA	NA	NA
26	222	3	20.5	5	1.5
38	345	3	34	9	5
40	347	4	18.5	4.8	5.5
41	348	4	28	4.5	NA
44	352	4	12	6	2
52	609	5	NA	NA	NA
54	611	5	NA	NA	NA
58	617	3	28	3.5	2
60	619	5	29	7.5	5
64	635	3	54	10	10
70	653	5	19	12	6.5
71	658	5	NA	NA	NA
74	668	5	NA	NA	NA
82	680	5	NA	NA	NA
84	683	5	NA	11	NA
85	684	3	NA	8	NA

93	795	4	NA	NA	NA
102	859	5	NA	NA	NA
103	860	5	50+	NA	NA
104	861	5	50+	NA	NA
105	862	5	NA	NA	NA
107	866	4	NA	NA	NA
117	886	5	NA	NA	NA
119	888	5	50+	NA	NA
135	990	5	NA	NA	NA
137	991	5	50+	NA	NA
139	996	4	NA	NA	NA
140	997	5	NA	NA	NA
142	998	4	82	8	5
154	1017	5	NA	NA	NA
155	1021	5	19	6	3.5
159	1029	4	37	13	NA
165	1047	5	NA	NA	NA
166	1048	5	NA	NA	NA
167	1055	5	NA	NA	NA
172	1062	3	NA	NA	7
174	1067	4	NA	3	1
188	1108	4	22	8	4

189	1111	3	19	8	NA
190	1112	3	35	4	3
194	1119	4	26	6	NA
200	1129	4	36	4.5	NA
201	1131	4	27	5	2
206	1143	3	NA	6.5	3
209	1152	4	NA	NA	3
212	1159	5	NA	NA	NA
213	1160	5	NA	NA	NA
216	1165	5	NA	NA	NA
218	1174	5	NA	NA	NA
220	1202	5	NA	NA	NA
221	1216	5	NA	NA	NA
222	1217	5	70	4	NA
223	1218	5	NA	NA	NA
224	1219	3	NA	NA	NA
228	1237	5	NA	NA	NA
229	1239	5	NA	NA	NA
234	1260	3	18	4	2
235	1265	4	NA	NA	NA
237	1269	5	NA	NA	NA
238	1270	5	NA	NA	NA

241	1276	4	NA	5	1.5
242	1278	4	24	NA	NA
243	1280	4	NA	NA	NA
247	1284	3	23	7	4
248	1289	5	14	3	NA
252	1294	3	NA	NA	NA
253	1295	3	20	10	NA
264	1310	4	NA	NA	NA
266	1312	4	21	6	NA
267	1313	4	NA	NA	NA
273	1322	5	NA	NA	NA
280	1333	4	29	5.5	NA
281	1334	5	NA	NA	NA
284	1338	5	NA	NA	NA
285	1339	5	NA	NA	NA
294	1357	4	12	7.5	4.5
295	1359	4	40	9	NA
302	1371	4	33	5.3	3
303	1372	5	NA	NA	NA
311	1399	5	NA	NA	NA
316	1429	5	NA	NA	NA
331	1457	4	17	10	NA

333	1466	3	40	7	NA
338	1491	4	33	9	6
344	1606	4	NA	NA	NA
348	1620	3	48	28	NA
355	1637	4	NA	NA	3
358	1643	4	48	8	5
375	1700	4	17	5	2
377	1707	5	50+	NA	NA
383	1739	5	NA	NA	NA
384	1741	4	NA	NA	NA
385	1743	4	NA	NA	2.5
386	1744	5	NA	NA	NA
389	1752	5	NA	NA	NA
391	1768	5	NA	NA	NA
394	1771	5	NA	NA	NA
397	1784	5	NA	NA	NA
400	1813	3	27	9	2
404	1845	3	NA	NA	3
410	1856	3	37	10	NA
431	1035-c	5	NA	NA	NA
432	1035-d	5	NA	NA	NA
434	1047-b	5	NA	NA	NA

435	1047-c	5	NA	NA	NA
436	1142 a, d	5	NA	NA	NA
443	1811-b	5	NA	NA	NA
446	1827	4	30	8.5	4
459	2003-4	4	28	8	5
460	2003-6	4	61	8	4
469	2003-20	4	50	4	4
471	2003-22	5	24	5	4
480	2003-41	4	40	7	NA
481	2003-42	4	18	5	3
482	2003-43	5	71	6	2
485	2003-47	4	22	6	NA
489	2004-10b	3	21	10	6
492	2004-19	4	39	8	7
494	2004-24	4	17	9	2
497	2004-27	5	NA	NA	NA
499	2004-34	5	25	2	2
500	2004-38	5	NA	NA	NA

FEATURELESS TIMBERS

Timber No.	Original No.	Rank	Length	Width	Thickness
9	197	5	16	1.5	1
12	200	3	15	4	4
15	203	4	23	6	6
16	204	5	17	5	4
17	205	5	30	6	9
19	208	5	25	4	1
20	209	5	18	5	3
28	250	3	32	5	3
30	303	4	40	11	11
39	346	4	NA	NA	NA
42	349	4	46	7	4
43	350	5	9	5	3
47	357	4	21	4	2
48	358	5	30	4	NA
55	612	5	NA	NA	NA
57	616	4	NA	NA	NA
59	618	5	NA	NA	NA
62	629	4	30	6	2

72	666	5	NA	NA	NA
73	667	5	NA	NA	NA
76	670	5	NA	NA	NA
78	677	5	NA	NA	NA
80	679	5	NA	NA	NA
89	747	5	NA	NA	NA
90	748	4	50+	20+	NA
109	872	5	NA	NA	NA
128	969	5	NA	NA	NA
129	971	5	NA	NA	NA
131	973	4	NA	NA	NA
133	985	5	NA	NA	NA
134	986	4	NA	NA	NA
147	1006	4	NA	NA	NA
153	1016	5	NA	NA	NA
156	1023	5	NA	NA	NA
162	1040	5	NA	NA	NA
173	1063	4	36	8	NA
177	1071	5	NA	NA	NA
178	1073	5	NA	NA	NA
185	1101	4	NA	NA	NA
187	1106	5	NA	NA	NA

192	1117	4	20	8	2
197	1122	5	NA	NA	NA
199	1128	5	NA	NA	NA
203	1134	5	NA	NA	NA
207	1144	4	NA	NA	NA
210	1154	5	NA	NA	NA
215	1164	3	17	2	2
226	1235	5	NA	NA	NA
231	1256	5	NA	NA	NA
232	1257	5	NA	NA	NA
233	1258	5	NA	NA	NA
236	1268	4	NA	NA	NA
240	1273	5	NA	NA	NA
244	1281	5	NA	NA	NA
245	1282	5	NA	NA	NA
249	1290	4	40	NA	NA
250	1292	5	NA	NA	NA
251	1293	4	NA	NA	NA
254	1296	4	NA	NA	NA
257	1301	4	NA	NA	NA
259	1304	5	NA	NA	NA
260	1305	4	NA	NA	NA

261	1307	5	NA	NA	NA
262	1308	5	NA	NA	NA
263	1309	3	NA	NA	NA
271	1317	5	NA	NA	NA
272	1318	5	NA	NA	NA
275	1326	5	NA	NA	NA
276	1327	5	NA	NA	NA
277	1328	4	NA	NA	NA
278	1329	5	NA	NA	NA
279	1330	4	NA	NA	NA
282	1336	5	NA	NA	NA
291	1350	5	NA	NA	NA
292	1351	5	NA	NA	NA
298	1365	5	NA	NA	NA
300	1367	5	NA	NA	NA
304	1376	5	NA	NA	NA
312	1400	5	NA	NA	NA
320	1435	4	NA	NA	NA
329	1455	5	NA	NA	NA
339	1498	5	NA	NA	NA
340	1499	5	NA	NA	NA
351	1630	5	NA	NA	NA

352	1631	5	NA	NA	NA
367	1682	3	28	NA	NA
379	1719	5	NA	NA	NA
381	1726	5	NA	NA	NA
387	1745	5	NA	NA	NA
393	1770	5	NA	NA	NA
403	1843	5	NA	NA	NA
419	1865	4	NA	NA	NA
441	1502-b	5	NA	NA	NA
447	679 fragment	5	NA	NA	NA
453	885-c	5	NA	NA	NA
455	990 Fragment	5	NA	NA	NA
461	2003-7	5	NA	NA	NA
463	2003-12	4	24	6	NA
467	2003-18	5	NA	NA	NA
468	2003-19	5	NA	NA	NA
472	2003-23	5	NA	NA	NA
473	2003-27	5	NA	NA	NA
475	2003-30	5	19	12	2.5
476	2003-35	4	48	NA	NA
477	2003-38	5	NA	NA	NA
478	2003-39	5	12	8	1.5

483	2003-44	5	16	3.8	0.5
488	2004-06	3	36	6	3
490	2004-13a	4	31	7	4
493	2004-22	5	NA	NA	NA
501	2004-40	5	NA	NA	NA
502	2004-41	5	NA	NA	NA

APPENDIX C

TIME-LINE OF EVENTS

	China/Mongol	Korea/Japan
960	Song dynasty Established	
1019		Jurchen Attacked Japan
1115	Jurchen Established Chin	
1127	Southern Song Establish	
1162	Gingis Khan was born	
1192		Kamakura Bakufu Established
1215	Kublai Kahn was born	
1223		First Record of Wako
1227	Death of Gingis Khan	
1231		Ogedai Khan invaded Korea
1267		Mongol Emissary reached Japan
1271	Yuan dynasty Established	
1273		Revolt of Sambyolcho ended
1274		The First Invasion
1276	Fall of Linan	
1279	Fall of Song dynasty	
1281		The Second Invasion
1292		Japanese Merchants in China

1333		Fall of Kamakura Bakufu
1368	Ming dynasty Established	
1377		Korea demanded to stop Wako
1392		Fall of Goryeo Dynasty in Korea
1405	Cheng-He’s Expeditions	
1433	Oversea Expedition Halted	

The Chinese Dynasties

Xia Dynasty	2100-1600 B.C.E.
Shang Dynasty	1600-1046
Zhou Dynasty	1122-256
Qin Dynasty	221-206
Han Dynasty	206 B.C.E. – 220 C.E.
Three Kingdoms	220-280
Jin Dynasty	265-420
16 Kingdoms	304-439
Southern and Northern Dynasties	420-589
Sui Dynasty	581-618
Tang Dynasty	618-907
5 Dynasties/10 Kingdoms	907-960
Liao	907-1125
Jin	1115-1234
Northern Song Dynasty	960-1127
Southern Song Dynasty	1127-1279
Yuan Dynasty	1271-1368
Ming Dynasty	1368-1644
Qing Dynasty	1644-1911

APPENDIX D

FOREIGN WORD LIST

Japanese Words

Asian Research Institute of Underwater Archaeology アジア水中考古学研究所

Bakufu 幕府

Board of Education 教育委員会

Fukuoka Maizou Bunkazai Center 福岡埋蔵文化財センター

Hakata 博多

Hirado 平戸

Iki 壱岐

Imari Bay 伊万里湾

Kamakura 鎌倉

Kamikaze 神風

Kenzo Hayashida 林田 憲三

Kōzaki 神崎

Kyūshū 九州

Kyūshū Okinawa Society for Underwater Archaeology 九州沖縄水中考古学協会

Sabani サバニ

Samurai 侍

Shōgun 将軍

Sijiko 四耳壺

Takashima 鷹島

Tetsuhau てつはう

Tokonami 床波

Tsushima 対馬

Wako 倭寇

Korean Words

Anapuchi Pond 안압지 雁鴨池

Cheju Island 제주대 済州島(耽羅)

Goryeo-sa 고려사 高麗史

Sambyolcho 삼별초 三別抄

Shinan 신안 新安

Sibidongpado 십이동파도 十二東波島

Talido 다리도 達理島

Wando 완도 莞島

Chinese Words

Antung 安東

Baator Fighting vessel 拔都魯輕疾舟

Cheng He 鄭和

Chunam 朱南

Combat Junk 戦艦

Covered Swooper 蒙衝

Dali 大理

Eastern Army 東路軍

Fukien Province 福建省

Flying Barque 走舸

Gua-Ju (Nail) 掛鋦

Grand Canal 大運河

Han dynasty 漢朝

Hangzhou 杭州

Huang Ti 黃帝

Hunan 湖南

Jinghai 静海

Kanzhou 贛州

Kiangsu 江蘇

Jiangnan Army (Southern Army) 江南軍

Jurchens 女真族

Ming Dynasty 明朝

Linana 臨安

Mingzhou 明州

Ningbo 寧波

Nanking 南京

One-Thousand-Liao vessel 千料船

Patrol Boat 遊艇

Penglai 蓬莱

Poyang Lake 鄱阳湖

Quanzhou 泉州

Sampan 三板

Sea-Hawk Ship 海鶻

Shangdong Province 山東省

Shanghai 上海

Song Dynasty 宋朝

Taizhou 泰州

Tang Dynasty 唐朝

Tianjin 天津

Tower Ship 楼船

Water Transport Boat 汲水小舟

Wenzhou 温州

Yangtze River 揚子江

Yangzhou 揚州

Yuan Dynasty 元朝

Yuan Shi 元史

Yunnan 雲南

VITA

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Selected Publications:

2005 "The Legend of Kamikaze: Nautical Archaeology in Japan." *The INA Quarterly* 32(1):3-8.

2006 "Where the Vessels were Built: Reconstructing the Mongol Invasions of Japan." *The INA Quarterly* 33(3):16-22.

Selected Formal Presentations:

2005 "The Nautical Archaeology of Kamikaze." at Annual Meeting of American Institute of Archaeology, 6-9 January, Boston.

2005 "Resurrecting of Shipwrecks" Invited Lecture: Kyūshū National Museum, 22 December, Fukuoka.

2006 "The Legends Beyond Kamikaze." at World Archaeology Congress, Inter-Congress, 12-15 January, Osaka.

2007 "The Origin of the Lost Fleet of the Mongol Empire." at Annual Conference of Society for Historical Archaeology, 9-12 January, Albuquerque.