

Historical development of shipbuilding technologies in East Asia

Jun Kimura

Abstract

Since 2008, the Maritime Archaeology Program at Flinders University has been collecting data on ship remains in East Asia in support of the Shipwreck ASIA project. This paper presents a summary of the collected data. Ship remains identified in Korea, China and the broader region are identified and discussed. Underwater archaeology conducted in Korea in the past two decades sheds new light into the discussion of possible historical interaction of the Korean and Japanese shipbuilding technology. The overall regional development of shipbuilding technologies is also discussed.

要約

2008年よりフリントース大学海事考古学ではShipwreck ASIAプロジェクトを発足させ東アジアでこれまで発掘された船舶のデータ収集に取り組んできた。本稿では収集されたデータの概略を提示する。過去20年韓国では在来船の考古学的発見が相次いでいる。これは特に韓国と日本の造船技術に交流があった可能性があることを議論するうえで重要な意味を持つ。中国でこれまで発掘された船舶の概略を提示する。本稿は特に幅広い視野での地域的な造船技術の発展を外観することに焦点を当てている。

Introduction

This is a summary report of excavated ships in East Asia. This study also examines principles (philosophy) of shipbuilding technology that could have existed in the region. The examination derives from the implementation of inclusive data collection on excavated ships and ship remains in this region. The data collection is supported by the “Shipwreck Asia” project funded by the Toyota Foundation Research Grant Program “Cultural Creation in Maritime East Asia” 2008 through 2010. The data obtained is used to understand ships, as ships have been a means of facilitating cultural interaction throughout history. To support this idea, shipbuilding technologies behind activities of the ships will be discussed. The discussion focuses on hull components used in Korean, Japanese, and Chinese ships. The collective data of ship remains in China will also be presented in this report. The hull component study on excavated ships provides

an insight into the historical development of East Asian shipbuilding technologies in relation to Southeast Asia. Maritime arteries of East and Southeast Asia have been evolving throughout centuries, and this could lead to technological hybridization of shipbuilding technologies between the two regions. A regional development theory of ship structure and construction methods will be demonstrated in this report.

Korea and Japan

Korean researchers made inroads into identifying shipwrecks since the late 1970s. Identified shipwrecks and ship remains in Korea include one overseas trader and a few indigenous ships dating to the Goryeo Dynasty (Table 1).

Country		Korea									
Site	Discovered Location	Dating	Origin	Status of Hull remains	Preservation Status	Year Discovered	Salvaged	Surveyed	Excavated	Purpose	
Wando ship	Offshore of Wando inland in Jeolla Province	Late 11th century	Goryeo Dynasty	High	Chemical Conservation	1983	No	Yes	Yes	Coastal trader	
Sibidongpado ship	Offshore of Sibidongpado, Okdo-myeon, Gunsan, Jellabuk Province	12th century	Goryeo Dynasty	Medium	Chemical Conservation	2003	No	Yes	Yes	Coastal trader	
Biando (Biungdo) underwater site	Biando Island, Gunsan, Jellabuk Province	12th century	Goryeo Dynasty	N/A (No hull remains)	N/A	2002–2003	No	Yes	Yes	Coastal trader?	
Yamido underwater site	Yami Island, Okdo-myeon, Gunsan, Jellabuk Province	12th century	Goryeo Dynasty	N/A (No hull remains)	N/A	2006	No	Yes	Yes	Coastal trader?	
Taeon ship (Goryeo Celadon Treasure ship)	Offshore of Daeseom Island in the Taeon Peninsula	12th century	Goryeo Dynasty	Low	Chemical Conservation	2007	No	Yes	Yes	Coastal trader	
Daebudo ship	Intertidal zone of Daebu Island, Ansan City in Gyeonggi Province	Late 12-early 13th century	Goryeo Dynasty	Low	Chemical Conservation	2008	No	Yes	Yes	Coastal trader	
Wonsando underwater site	Wonsan Island, Boryeong city, Chungnam	Early 13th century	Goryeo Dynasty	N/A (No hull remains)	N/A	2004–2005	No	Yes	Yes	Coastal trader?	
Shinan ship	4 kilometres offshore from Imjado Island, Shinan-gun, Jeollanam Province archipelago	Early 14th century	Yuan Dynasty	High	Chemical Conservation	1975	No	Yes	Yes	Oceangoing trader	
Anjwa ship	Agumsan-ri, Anjwa-myeon, Sinan-Gun, Jellanamdo 24 km SW of Mokpo	14th century	Goryeo Dynasty	High	Chemical Conservation	2005	No	Yes	Yes	Coastal trader	
Doripo underwater site	Intertidal part of the shore of Talido (or Dalido) island in Mokpo	Late 14th century	Goryeo Dynasty	N/A (No hull remains)	N/A	1995–1996	No	Yes	Yes	Coastal trader	
Talido (Daliso) ship		14th century	Goryeo Dynasty	Low	Chemical Conservation	1995	No	Yes	Yes	Coastal trader	

Table 1.

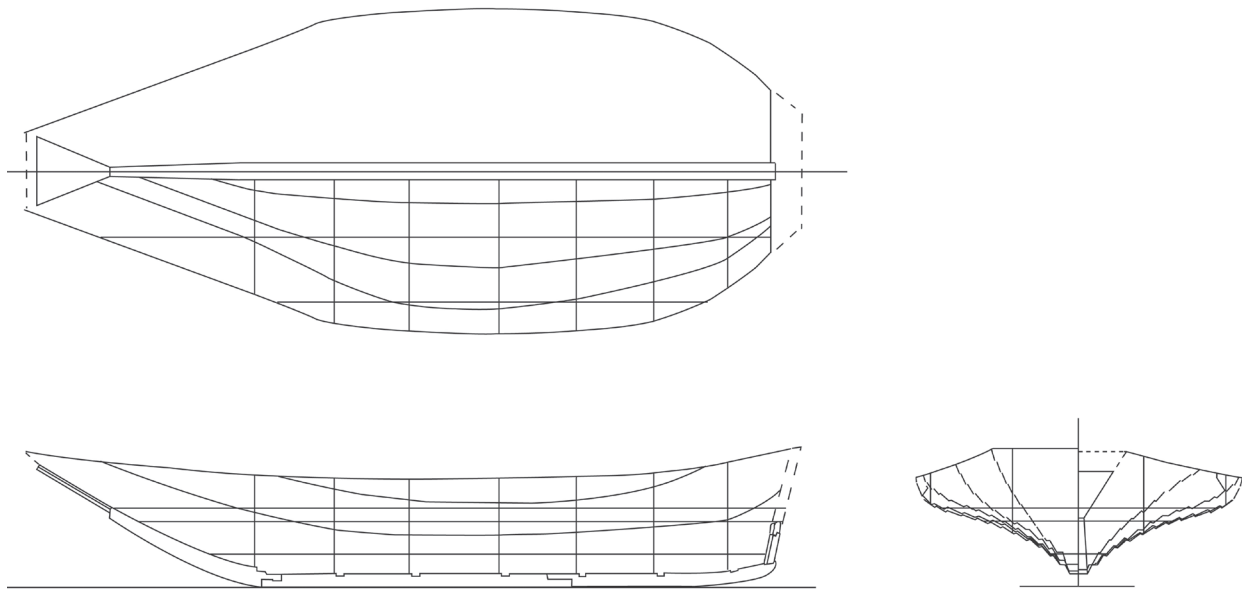


Figure 1.1 Ship line plan of the late 14th trader Shinan shipwreck. (Drawn by Jun Kimura)

Shinan shipwreck (新安沈没船)

The Shinan shipwreck is a ship that originated in China and had sunk in Korean waters. It was discovered in the waters of the archipelago in the Shinan-gun, Jeollanam Province. The ship is dated to the first quarter of the 14th century of the Yuan Dynasty period based on artefacts analysis. The Shinan ship was a private trader involved in overseas trading during the Yuan Dynasty. It was not a ship employed by governmental delegates that had been involved in the seaborne tribute trading during the previous periods. The historical study suggests that the ship can be classified as an East China Sea trader of the category entitled, “Temple-shrine chartered ship” (寺社造営料船). The ship carried commodities ordered from China by a temple in Kyoto and appeared to have departed from Ningbo.

The hull has been reviewed in a few English resources.¹ According to an archaeological report, 479 structural hull timbers were recovered. After PEG conservation, the hull was reconstructed in the gallery of the National Research Institute of Marine Cultural Heritage (National Maritime Museum) in Mokpo city. The remains of the hull measure 28.4 m in length and 6.6 m in breadth. It has a keel consisting of three timbers. The keel has been hogged.² A ship line plan indicates that the hog of the keel is not deliberate (Figure 1.1). The hull planking had originally been double layered by sheathing planks, but sheathing planks have not been restored into the reconstructed hull. The hull planking is fastened by iron nails in a rabbeted clinker

construction. The planking in the bow, forward of the first bulkhead, however, shows gradual changes from clinker to carvel. The keel consists of three parts. The transverse structure consists of bulkheads fixed by wooden brackets and frames. This shipwreck is one of the most important resources for examining the structure of medieval ocean-going ships.

Goryeo Dynasty’s shipwrecks and their feasible impact on Japanese shipbuilding technologies

Details of the Goryeo Dynasty’s shipwrecks discovered in the Korean waters are examined in the other report (See Sasaki and Lee’s article in this report). From the identified ship remains that have been dated to the periods during the end of the eleventh to the end of the fourteenth centuries, it is known that Korean traditional construction methods show coherent consistencies.

These are: flat hull bottom constructed by baulks (keel-less structure), hull planking that uses wooden nails, and beams for transverse structure. Embryonic periods of the development of the Korean shipbuilding tradition might date back to before the 10th century when Silla merchants around unified Silla (668–935) reigned the southern portion of the Korean peninsula. While details of the ships that they used have not been clarified, their prominent maritime activities are known throughout East Asian maritime history. The 11th century Goryeo Dynasty’s Wando ship, which is a shipwreck dating to the earliest period in East Asia, shows completion on the basis of the Korean shipbuilding technology. The construction methods used in the Wando ship are coherently identified

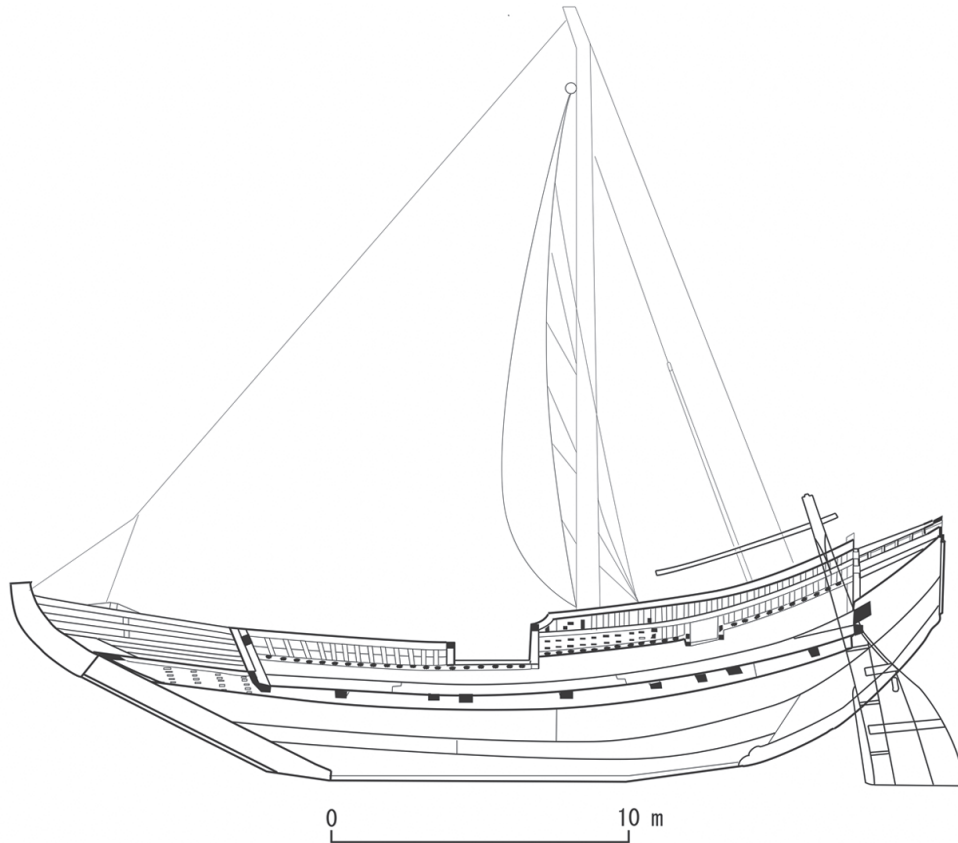


Figure 1.2 An image of the early 19th century Bezaisen. (Drawn by Jun Kimura)

in the excavated ships during the Goryeo Dynasty and even some features beyond this period (Figure 1.2).

The historical development of Japanese ships has not been archaeologically evidenced. The development has been understood only according to a linear development theory, based on many discovered dugout canoes with their evolution to planked-up dugout canoes. Further development of the planked-up dugout canoes linked to the advent of the Japanese native watercraft has been coherently presented.³ In relation to this idea little consideration and examination have been given to the influence from outside of Japan. Due to the lack of direct evidence, technological interactions between Korean and Japanese shipbuilding traditions are hardly induced. Perhaps, the sixteenth's historical Chinese text, "*Chou Hai Tu Bian*" (Illustrated Seaboard Strategy 籌海圖編), may provide an insight into what the Japanese ship's structure was around the period. It says:

*"Japanese ships differ from Chinese ships. They consists of large baulks tightened together, by not using iron nails but iron clamps (strips), and their seams are caulked neither by hemp, by fibre, or by tang oil but by short water-weed, which requires much hard labour and many resources. ...the bottoms of the Japanese ships are flat, which do not sufficiently cut into the wave."*⁴

A few queries arise from the above descriptions as to whether the flat bottom hull consisting of baulks had any similarity with the structure of the Goryeo Dynasty's Korean ships. Discussion of the feasible interactions only relying on insufficient evidence is speculative. The text mentions the use of iron to fasten the hull planks in Japanese ships. However, iron has not been used as fastening material in the Korean shipbuilding industries. As such, in order to further understand the mutual influence and historical development of shipbuilding between Japan and Korea, more evidence will be required.

The advent of Japanese construction methods of wooden ships at some stage in its naval history has been partly based on speculation. As such, the development of Japanese shipbuilding has not been fully understood. However, configuration of the Japanese coastal traders that appeared during the 17th and 18th centuries show a distinctive hull structure from the other coastal traders in East Asia. A Japanese coastal trader known as the Bezaisen is regarded as a representative of the traditional type of Japanese ships. They were used throughout the Edo Period (1600–1868) and brought heyday of domestic maritime transportation during the period. The ships are no longer seen along the Japanese coasts, and their configuration and structure can be appreciated mostly by referring to iconographic resources, such as drawings on wooden plaques called Ema, small scale models placed in local shrines by

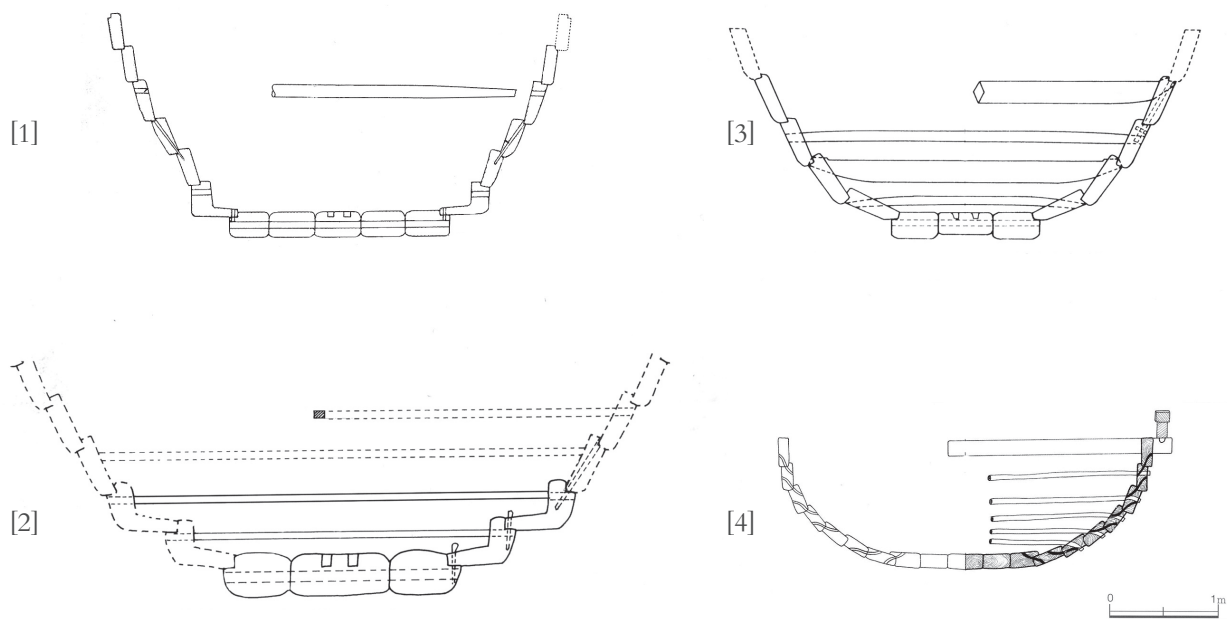


Figure 1.3 [1] Cross-sections of the Wando ship (the late 11th century), [2] Sibidongbado ship (the end 11th – the early 12th century), and [3] Talido ship (13–14th century). [4] Korean fishing boat (20th century). (Reproduced from the National Maritime Museum of Korea. (2005). Gunsan Sibidongpado Haejeo Yujeok (The Underwater Excavation of the sea off Sibidongpado, Gunsan 群山十二東波島海底遺蹟). National Maritime Museum, Mokpo.)

shipwrights for dedication, and historical documents including plans, specifications, and texts (Figure 1.3). However, how the structure and constructional methods had developed has not received thorough examination. Only limited data on archaeological ship remains has been collected in Japan and this includes a rudder post remain from the Bezaisen (Table 2).

China

A dataset of excavated ships in China is presented based on published resources. Of the data, 25 ship remains and wreck sites are introduced chronologically following their Dynastical periods from the Tang Dynasty to the Qing Dynasty (Table 3).

Tang Dynasty (618–907)

1. Rugao ship (如皋舟)

According to Chinese resources,⁵ the Rugao ship was discovered at Puxi in Ruguo city, Jiangsu Province during reclamation in 1973. The well-preserved hull measures 17.32 m in length and 2.58 m in width. The remaining part consists of bottom planks, bulkheads, and some strakes from the sides of the hull (Figure 1.4). The bottom forms a flat shape suitable for river transportation. Its bluff bow and aft parts are slightly narrower than the midship. The Chinese researchers' reports indicate that the basic joinery of the bottom timbers appears to be of a mortise and tenon type, yet

the details are unclear. The mortise and tenon joint is also indicative of having been used for the joint of the bulkheads and hull planking. The drawing shows ten bulkheads dividing the vessel into eleven holds. The fifth, sixth and seventh bulkheads are very close together and create two very small holds. The length of the bulkheads around the midship's beam of the vessel is approximately 2.80 m athwartship and measures approximately 0.95 m athwartship in the bow and stern parts. Chinese researchers have mentioned that there are doorways through the sixth to the eighth holds, yet these bulkheads produce watertight compartments. The Chinese researchers' reports imply that these holds could have been used as a living space in the absence of decks. Yet it could have been roofed by a bamboo sheet. The hull planking is clinker-built. The thickness of the planks is 40–70 mm and its bottom planks are 80–120 mm thick. The length of iron nails is 165 mm, and the section of the nail head measures 15 mm. Iron nails are used to fasten the hull planking and the driven pattern shows a 60 mm interval. The seams are caulked and sealed by putty. To determine the date of the Rugao ship, recovered ceramics which compose of mostly discovered artefacts from the Yue kiln are used and they are dated to the Tang Dynasty. Associated other artefacts also allow the Rugao ship to be dated to the Tang Dynasty. Chinese researchers conclude that the ship used was around the period of the reign of Gaozong (649–683) who was the third Emperor of the Dynasty.

Country	Japan										
	Site	Discovered Location	Dating	Origin	Status of Hull remains	Preservation Status	Year Discovered	Salvaged	Surveyed	Excavated	Purpose
	Kurakizaki Underwater Site	Uken-son, Oshima-gun, Kagoshima Prefecture	12–13th century	Southern Song Dynasty?	N/A (No hull remains)	N/A	1994	No	Yes	Yes	Oceangoing trader?
	Takahima Underwater Site	Takahima-town, Matsuura-city, Nagasaki Prefecture. 200 m off the coast. Approximately 20–30 m deep underwater	13th century	Southern part of Korean Peninsula and East China Sea. Yuan Dynasty	Low	Chemical Conservation	1981	No	Yes	Yes	Oceangoing military services
	Nishihama tpwn's Keel	Nishihama tpwn, Nagasaki city	Late 15-early 16th century	China?	Low	Non-treatment	1966	No	Yes	No	Oceangoing trader?

Table 2.

Country	China										
	Site	Discovered Location	Dating	Origin	Status of Hull remains	Preservation Status	Year Discovered	Salvaged	Surveyed	Excavated	Purpose
	Rugao ship	Puxixiang, Rugao district, Nantong city, Jiangsu	618–907	Tang Dynasty	High	Non-treatment	1973	No	Yes	Yes	River transportation
	Shiqiao ship	Shiqiao, Yangzhou city, Shiqiao	618–907	Tang Dynasty	High	Non-treatment	1960	No	Yes	Yes	River transportation
	Hebao Island wreck site		618–907	Tang Dynasty?		Non-treatment	1985	No	Yes	Yes	River transportation
	Liuzi ship No.1	Liuzi, Suixi district, Huabei city, Anhui	618–907	Tang Dynasty	High	N/A	1999	No	Yes	Yes	River transportation
	Liuzi ship No.4		618–907	Tang Dynasty	High	N/A	1999	No	Yes	Yes	River transportation
	Dazhi ship	Dazhi city, Nanhui, Shanghai city	960–1279	Song Dynasty	Medium	N/A	1978	No	Yes	Yes	River transportation
	Yuannmengkou ship	Duannmengkou-cun, Dongrantou-xiang, Jinghai district, Tianjing Province	960–1279	Song Dynasty	High	N/A	1978	No	Yes	Yes	River/Coastal transportation
	Fengbinyang Bay shipwreck	Fengbinyang Bay shipwreck, Jiading, Shanghai city	960–1279	Song Dynasty	High	N/A	1978	No	Yes	Yes	River/Coastal transportation
	Ningbo Ship	Ningbo city, Zhejiang	N/A	Song (or Yuan Dynasty)	High	Non-treatment	1978	No	Yes	Yes	Coastal trader
	Nanghai No.1	Guandong, Yangjian city	960–1279	Song Dynasty	High	Others	1989	No	Yes	Yes	Oceangoing trader

Table 3.

1 Historical development of shipbuilding technologies in East Asia

Site	Discovered Location	Dating	Origin	Status of Hull remains	Preservation Status	Year Discovered	Salvaged	Surveyed	Excavated	Purpose
Yilu Ship	Heyilu, Ningbo city, Zhejiang	960–1127	Northern Song	High		2003	No	Yes	Yes	River Transportation
Quanzhou ship	Hozhu, Quanzhou city, Fujiang	1270–80	Song Dynasty	High	Chemical Conservation	1973	No	Yes	Yes	Coastal trader
Fashi Ship	Fashi, Quanzhou city, Fujiang	960–1279	Song Dynasty	High	In situ preservation	1982	No	Yes	Yes	Coastal trader
Bai Jiao 1 wreck site	Bai Jiao, Dinghai Bay, Fujiang	12–14th century	Southern Song (or Yuan Dynasty)	Low	N/A	1989	No	Yes	Yes	Coastal trader?
Bai Jiao 2 wreck site	Bai Jiao, Dinghai Bay, Fujiang	N/A	Southern Song (or Yuan Dynasty)?	N/A (No hull remains)	N/A	1990	No	Yes	Yes	Coastal trader?
Yamen battle shipwreck	Yamen, Xinhui, Guangdong Province	13th century?	Song (or Yuan Dynasty)	Low	N/A	1991	No			Battle ship?
Huangang Reef No.1 shipwreck	Parcel Islands	N/A	Song Dynasty	Medium	Chemical Conservation	1996	No	Yes	Yes	Oceangoing trader
Sandaogang wreck site	Suizhong, Huidao city, Liaoning Province	13–14th century?	Yuan Dynasty	N/A (No hull remains)		1991	No	Yes		Oceangoing trader?
Liaoshan Ming Dynasty battle ship	Songjin River, Heihunmao, Liangshan, Shandong Province	14th century	Ming Qing Dynasty	High	N/A	1958	No	Yes	Yes	Riverine ship
Xiangshan ship	Qibu, Xiangshan district, Ningbo city	14th century	Ming Dynasty	High		1994	No	Yes	Yes	Trader or a battle ship
Penglai ship No.1	Penglai city, Shangdon	14th century	Yuan Dynasty	High	Chemical Conservation	1984	No	Yes	Yes	Patrol ship?
Penglai ship No.2	Penglai city, Shangdon	15–16th century?	Ming Dynasty	High	Chemical Conservation	2005	No	Yes	Yes	Patrol ship?
Penglai ship No.3	Penglai city, Shangdon	15–16th century?	Ming Dynasty	High	Chemical Conservation	2005	No	Yes	Yes	Patrol ship?
Penglai ship No.4	Penglai city, Shangdon	15–16th century?	Ming Dynasty	High	Chemical Conservation	2005	No	Yes	Yes	Patrol ship?
Baolian Harbour shipwreck	Baoling Harbour, Wenchang, Hainan Province	N/A	Qing Dynasty	N/A (No hull remains)		1987	No	Yes	Yes	Trader?
Donggu Ming zheng wreck site	offshore of Dongshan, Fujian Province	N/A	Ming Dynasty or the early Qing Dynasty	N/A (No hull remains)	N/A	2000	No	Yes	Yes	Trader?
Jijing Shenhu Bay wreck site	Shenfu Bay, Fujian Province	N/A	Ming and Qing Dynasty	N/A (No hull remains)	N/A	N/A	No	Yes	Yes	Trader?
Wanjiao No.1 wreck site	Wuzhou reefs offshore of Yutou, Pingnan, Fujian Province	17–18th century	Qing Dynasty	N/A (No hull remains)	N/A	2005	No	Yes	Yes	Trader?

Table 3 (continued).

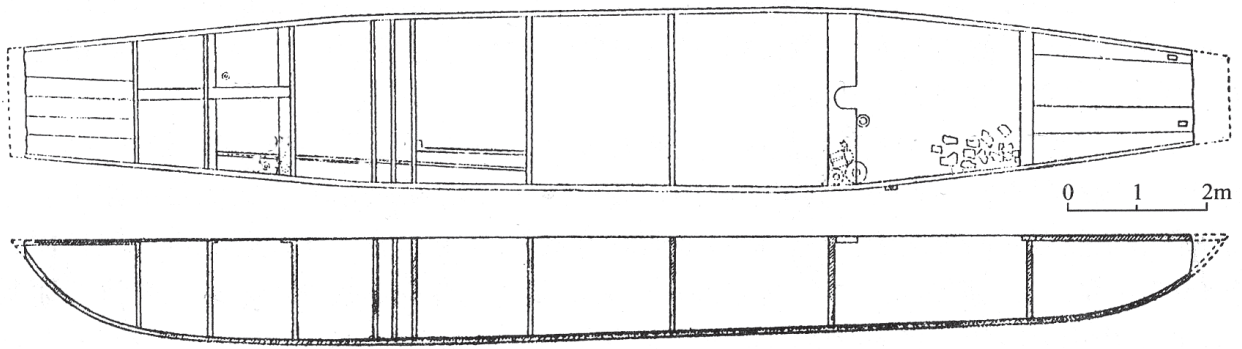


Figure 1.4 Rugao ship. (Wang 2000)

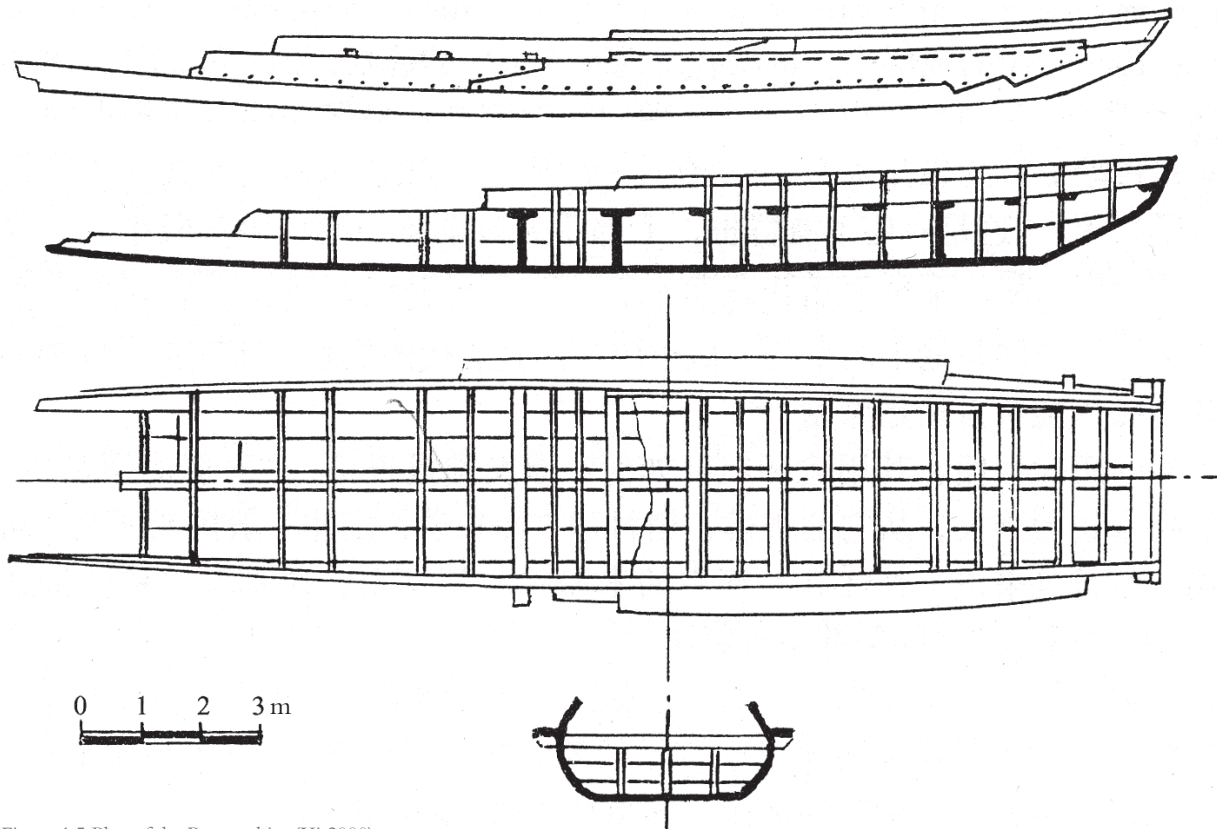


Figure 1.5 Plan of the Rugao ship. (Xi 2000)

2. Shiqiao ship (施桥舟)

During the river development at Shiqiao in Yangchan, Jiangsu Province in 1960, one wooden ship was found with a few dugout canoes. According to Xi Longfei,⁶ its stern part was missing, and the remaining part of the hull measures 18.4 m in length, 2.4 m in width, and 1.3 m in depth (Figure 1.5). The transverse structure consists of the combination of beams and bulkheads (the exact number of holds divided by the bulkheads

is unclear). Mortise and tenon joints and iron nails appear to have been used for hull planking. The dimension of the nails used is 170 mm in length, and its head is 20 mm. These nails are driven into the hull planks with an interval of approximately 250 mm. The nails are used for the construction of the bottom and sides. The exact date of the ship is disputable. Initially, the date was attributed to the Song Dynasty

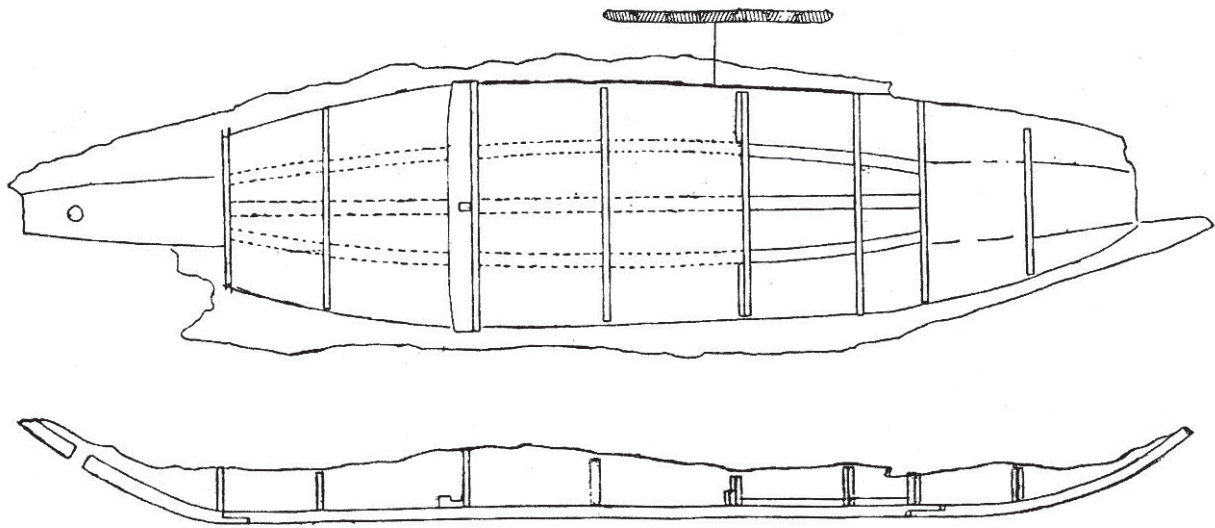


Figure 1.6 Plan of the Dazhi boat. (Ji 1987)

based on artefact analysis, but later researchers agreed that it dates back to the Tang Dynasty. The depth of the ship is not high and the structure indicates that the ship was originally used for river transportation.

Song Dynasty (960–1279)

3. Dazhi boat (大治舟)

According to a short archaeological report, seven ship remains were discovered in 1978 during the dredging of the Dazhi River, Nanhui district in Shanghai city. The Cultural Properties Administration Board in Shanghai city conducted the excavation and has reported the discovery of one Song Dynasty's ship (Figure 1.6). Although the upper part of the hull is missing, the bottom was well preserved when discovered. The remaining part measures 16.2 m in length and 3.86 m in width. The cross section of the hull bottom is flat. It seems that the bottom consists of seven strakes. The strakes appear to comprise three planks longitudinally, each joined by lap joints. Three internal runs of planks double the bottom planking, though they only partly remain. Eight bulkheads divide the hull into nine holds. The spacing of the bulkheads varies: 2.90 m, 1.26 m, 1.90 m, 1.70 m, 1.84 m, 1.42 m, 0.78 m, 1.30 m, and 1.61 m. There is no report of limber holes. Iron nails were used to fasten the hull planking to the bulkheads and putty made from lime and oil was used to seal the iron nail heads. A notable feature is a hole with a diameter of 0.2 m through the median plank in the bow (if the bow is correctly identified on the basis of the position of a mast step). It is said that this is what is called "Mao chayan" (Hole to drive anchor through 锚插眼).⁸ This would be a type of anchor that has been reported as

"stick-in-the-mud" anchor in Worcester's study.

It is a pole used by Chinese river boats as an anchor, driven through the bottom of the hull into the bed of the river.⁹ There is one mast step attached to the third bulkhead having one recess to hold a mast. From the first hold, 24 copper coins with the inscription of Taibin Tongbao (太平通寶), which represents the reign of the second emperor of the Northern Song Dynasty (960–1127), were discovered. In the hold, a silver hairpin was also discovered. Based on the discovered coins and one ceramic glazed bowl, the ship is dated to have originated during the Song Dynasty. It is said that the use of this ship probably was for short distance coastal transportation and, for some reason, it had been abandoned.¹⁰

4. Yuanmengkou ship (元蒙口船)

According to Xi Longfei, there are ship remains from the Song Dynasty that were discovered at Yuanmengkou, at Dongtantou of Jinghai district in Tianjing Province in 1978.¹¹ The remains of the ship are 14.62 m in length, 4.05 m in width, and 1.23 m in depth. Except for the upper part of its port side, the hull is relatively well preserved. The displacement of the original ship has been estimated to be approximately 38 tonnes.¹² The shipwreck shows a flat bottom and a rectangular section shape throughout its length (Figure 1.7). It is effectively a box with a scow-bow. The structure of the bottom has not been clearly reported, but it seems that a large piece of flat timber was longitudinally placed in the centre of the hull, and there were large chine planks as well. Between these large planks, planks were longitudinally placed. The cross section drawing indicates a flush edge joint in

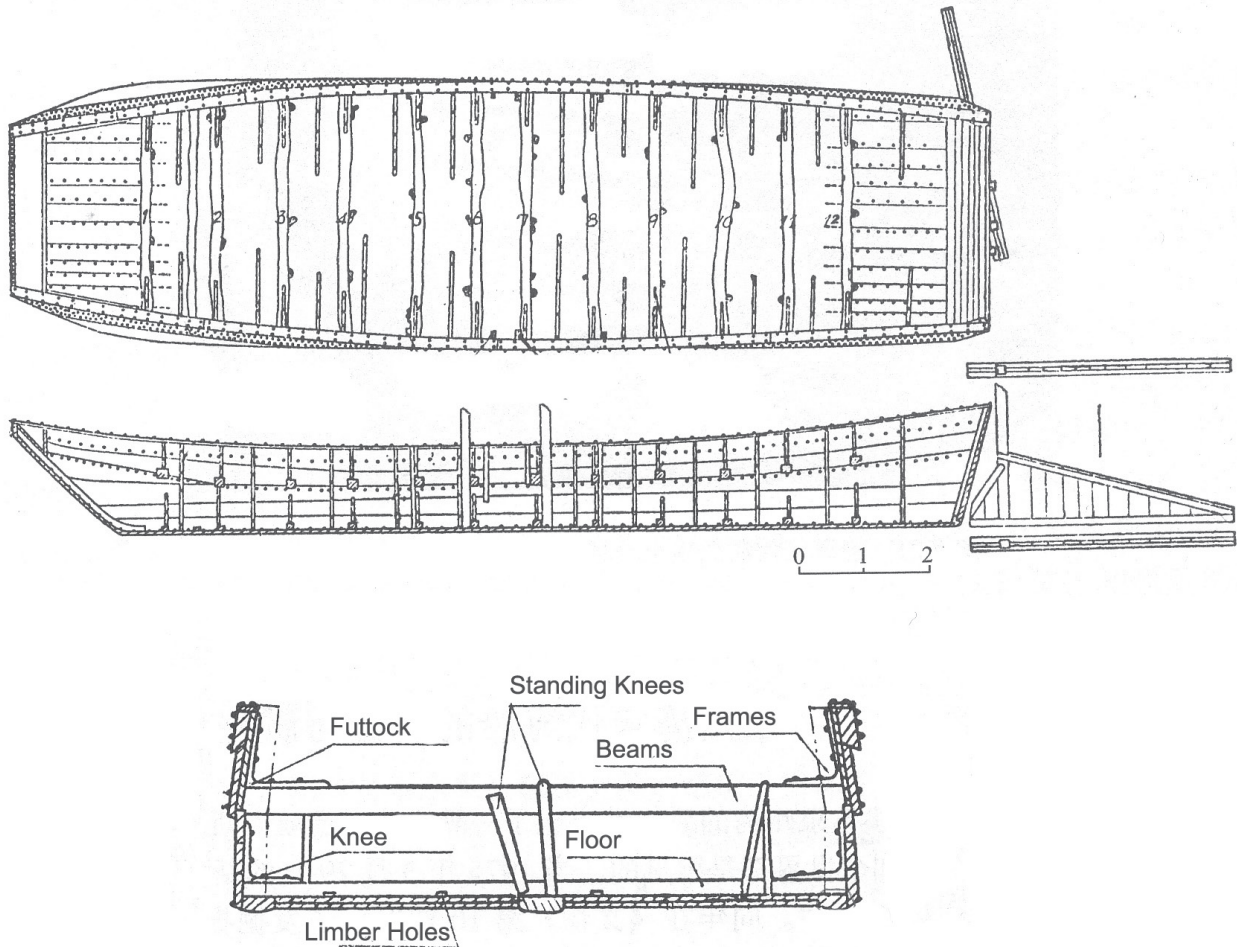


Figure 1.7 Yuanmengkou ship. (Reproduced from Xi 2000)

both the bottom and topside planking. However, the topside planking shows a double layer. The drawing shows floors (bottom frames), futtocks or knees at the chines, beams, and standing knees supporting the plank above the beams. In addition, there are twenty half frames between the beams. There are limber holes in the floors or bottom frames. The strength of the hull is further enhanced by top timbers on the fifth beam to the eighth beam around the midship. Chinese researches have pointed out that the most significant discovery is a wooden rudder regarded as the oldest example of a balanced rudder.¹³ The rudder blade forms a scalene triangle measuring 3.9 m along the bottom. The height of the rudder post is 2.19 m. The ship could be dated to the Northern Song Dynasty. The date has been initially determined by identifying a copper coin Zhenghe Tongbo (政和通寶) recovered from the ship which gives an idea of an absolute date of 1111, and sedimentation analysis suggests that the ship may have been abandoned before the flood prevention works were conducted in 1117. With regard to the date, however,

the uniqueness of the structure using half frames with an absence of bulkheads makes the hull appear more modern than the 12th century.

5. Fengbinyang Bay ship (封浜杨湾沉船)

In 1978, a local commune of Fengbinyang discovered ship remains among the sediments of Fengbinyang Bay adjacent to Jiading district in Shanghai city. The remaining part of the hull measures 6.23 m in length. Although the forward part of the ship is mostly missing, it is in relatively good condition (Figure 1.8). The hull is slightly tapered from the midship toward the bow in the plan, yet it forms a square transom bow that has a platform at the deck level. There are seven bulkheads comprising eight compartments, and a mast step is placed on the forward side of the fourth bulkhead. Iron brackets, known as Guaju (挂铜), are used to fasten hull planking to the bulkheads.¹⁴ Some butts of hull planks show a half-lap joint. The cross-section shape shows a flat bottom made of two strakes, double chines, and some tumblehome of the topsides above the second chine. One of the notable

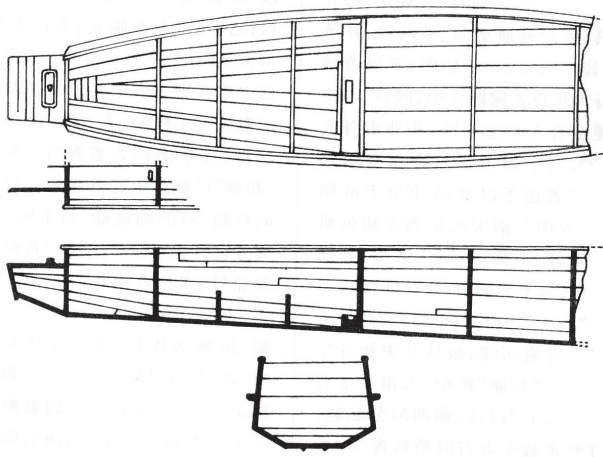


Figure 1.8 Fengbinyang Bay ship. (Wang 2000)

features of the ship is two longitudinals beneath the bottom planks. The two longitudinals have a semicircle section and they run along the hull as small bilge keels or bilge runners. It has been pointed out that these are more likely to provide further longitudinal strength to the hull, and they appear to be small runners to protect the bottom planking during launching and beaching.¹⁵ From the inside of the hull, bricks and yellow glazed ceramics, which are probably from the Jizhou kiln in the Jiangxi region, were discovered. These artefacts have been used to determine the date of the ship to the late 13th century. Furthermore, the discovery of an iron pan and sword has also indicated its link to this period.

6. Fashi ship (法石船)

A shipwreck was found at Fashi vicinity of Quanzhou Bay in 1982. A portion of the hull was located under a building, so only a partial excavation was implemented.¹⁶ An exposed part of the hull was reburied for *in situ* preservation. A portion around midship toward the stern was revealed during the excavation. The hull has a keel, and three bulkheads have been identified. The exposed keel consists of a part of the main (midship's) keel and the aft keel. Bilge water could run along the bilge through limbers in the bulkheads. The Fashi ship evidences the use of wooden brackets (or pegs) to fasten bulkheads to hull planking. The length of one wooden bracket measures 720 mm and its cross-section is 60 x 60 mm at the hull planking and tapers to 20 x 30 mm at the inboard end. They are driven from outer surfaces of some of the hull planks and attached onto the forward sides of the bulkheads. This is a similar fastening method to that noted above in the Fengbinyang Bay ship, also observed on the Quanzhou ship, and it is more or less identical to the use of wooden brackets in the Shinan

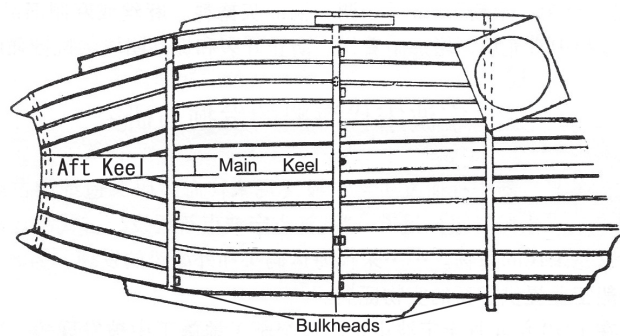


Figure 1.9 Fashi ship. (Reproduced from Xi, Yang, *et al.* 2004)

shipwreck. Iron nails are used to fasten the bulkheads' planks. A portion of the recovered hull including a bulkhead plank is under chemical treatment in the Quanzhou Ancient Ship Gallery of the Museum of Overseas Communications History) (Figure 1.9).

7. Heyilu ship (和义路船)

During a rescue excavation in 2003 conducted by the Cultural Relic Preservation Administration Center of Ningbo and Archaeological Research Institute of Ningbo at the south side of the site of HeyimenWengcheng (Turret of Heyi gate), the remains of a watercraft were found.¹⁷ Although the stern of the hull is missing, the remaining part is relatively well-preserved and measures 9.2 m in length and 2.8 m in width (Figure 1.10). The bow of the ship is fairly sharp and the cross-section of the lower hull is a fairly sharp V-shape. The forward keel and main keel remain, and the cross section of the main keel around midship is rectangular and measures 0.3 x 0.1 m, yet toward the bow it changes to a triangular shape to fit to the forward keel. Nine bulkheads remain and sturdy frames are attached to them. The bulkheads appear to be irregularly distributed. Each bulkhead remain consists of three to four planks fastened by iron clamps. There are limber holes in the bottom planks of the bulkheads. Seven strakes remain at the portside and starboard side in the mid part of the hull. Hull planks measuring 0.4–0.6 m are edge-joined by skewed iron nails. A mast step has not been found, and according to a figure of the reconstructed ship in the report, its propulsion appears to have relied on a yuhlo.¹⁸ Based on ceramics recovered from the inside of the hull, the ship has been dated to the Southern Song Dynasty and it could have been used for short distance transportation in the harbour or coastal areas.

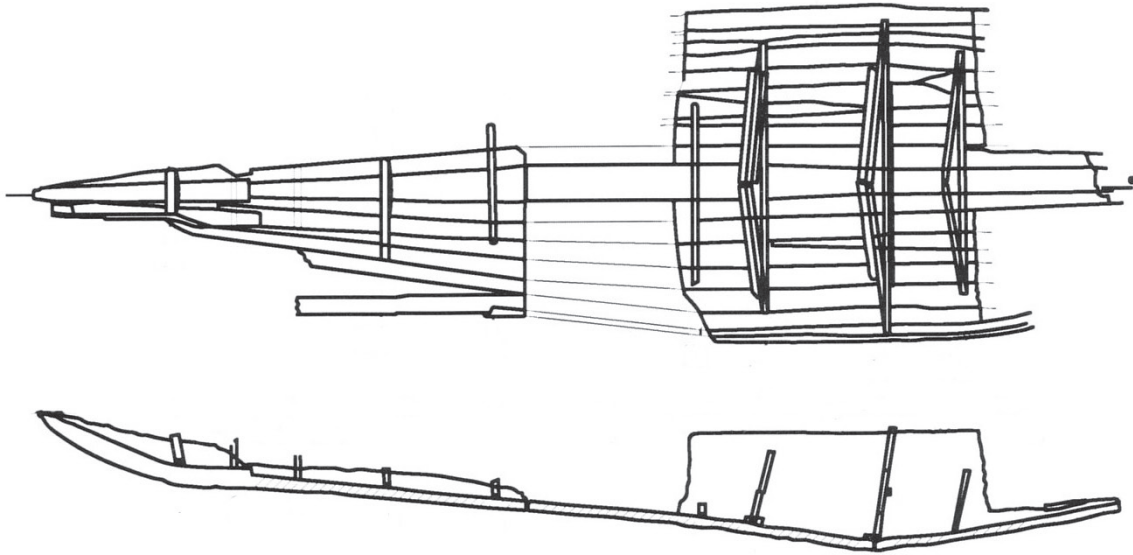


Figure 1.10 Heyilu ship. (Reproduced from Gong, C., Ding, Y., *et al.* 2008)

8. Quanzhou ship (泉州船)

The remains of the hull known as the “Quanzhou ship” or “Quanzhou ancient ship” (Quanzhou Guchuan 泉州古船) has been studied over three decades as one of the most important archaeological remains of oceangoing ships ever discovered in East Asia. A comprehensive report, the collaboration of many Chinese researchers, was published by the Museum of Overseas Communications History which is the custodian of the ship remains.¹⁹ The Quanzhou ship has been reviewed and assessed in a few English resources.²⁰ The ship is currently displayed at the Quanzhou Ancient Ship Gallery in Kaiyuanshi (開元寺) at Quanzhou city in Fujian province. The overall length of the hull remains is 24.2 m and the breadth is 9.15 m.²¹ The main structure of the hull is composed of a keel, bulkheads, and sturdy planking. The keel of the Quanzhou ship is composed of three parts. Twelve bulkheads produce thirteen holds on the hull. Upper planks of most bulkheads are missing. The bulkheads are fastened to the hull planking by metal bracket and large frames. The hull planking forms clinker-like steps and consists of multiple layers, double changing to triple layers around the turn of the bilge. Those outer layers function as sheathing to protect the main planking from teredo. The outer layers also contribute to the strength of the plank-shell. The date of the ship has been estimated by discovered copper coins that range from the Tang Dynasty to the Song Dynasty. The era 1265–1274 of the minting of the coins was determined as the latest date after which the ship sunk or was abandoned.

9. Ningbo ship (寧波船)

The Ningbo ship’s archaeological remains were discovered at the vicinity of the Fenghua River (奉化江) at Dongmenkou in Ningbo city.²² After revealing the hull, deterioration occurred quickly and, unfortunately, the hull was not properly preserved. The remains of the hull measure 9.3 m in length and 4.4 m in width, and they consist of the forward section of the hull bottom including the forward keel, the main keel, bulkheads, and hull planking (Figure 1.11). The length of the remaining main keel is 7.34 m long, 0.26 m wide and 0.18 m deep. The middle member of the main keel shows the greatest length measuring 5.10 m and both ends are stepped for the scarfs. On its aft scarf, a piece of the timber regarded as a part of the aft member of the main keel or an aft keel remains. Since this is hardly determined, the number of the original members that consists of the main keel is not ascertained. The forward member of the main keel is approximately 2 m long and its forward end is scarfed to join the forward keel. The forward keel angles upwards at 35 degrees. The remaining part of the forward keel measures 1.55 m long and has a triangular cross section with the widest part measuring 0.18 m with a depth of 0.20 m. It has been mentioned that there are twelve coins and associated small holes in the scarf joint between the main keel and the forward keel, associated to the shipwrights’ tradition.²³ Seven bulkheads remain on the main keel. The thickness of the bulkhead planks is 70–100 mm on average. The bulkheads are nailed to the frames that are, in turn, nailed to the hull.²⁴ A supporting timber or stiffener is vertically installed against the aft side of the fifth

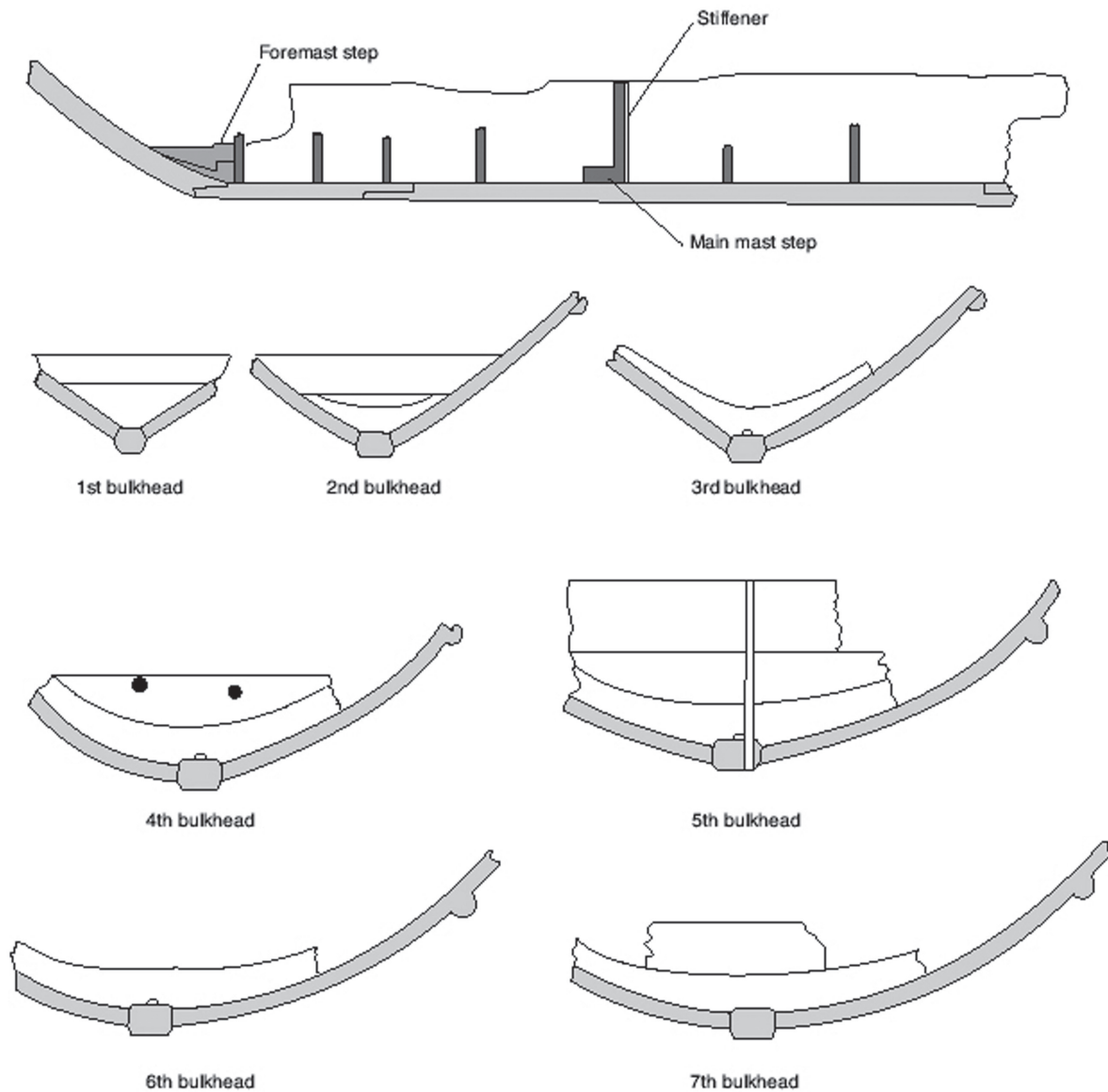


Figure 1.11 Ningbo ship. (Green 1997)

bulkhead, and this timber is fixed into a recess on the keel. As this arrangement only appears to be on the fifth bulkhead which is the position of a mast step, the timber is presumably for reinforcing the bulkhead against the loads imposed by the mast. The spacing of the bulkheads varies, and the smallest hold is the second hold measuring 0.62 m, and this is compared to the space of the fifth hold measuring 2.05 m, which is the largest space. A forward mast step is placed on the forward side of the first bulkhead and it measures 0.84 m athwartship, 0.21 m wide and 0.14 m thick. A main mast step is placed in the forward side of the fifth bulkhead and measures 1.04 m athwartships, 0.25 m wide and 0.18 m thick. Both mast steps have recesses to receive tabernacle cheeks. The cross section drawings show a gentle turn to the bilge starting at the

garboards with a moderate dead rise. In the bow the cross-section shows sharp V-shape. The hull planking is carvel-built, and according to the drawing, it is single layered. The length of the remaining plank measures 3–8 m with a width of 210–420 mm and a thickness of 60–80 mm. Iron nails having a rectangular section with a side of 10–15 mm are used for the hull planking and these nails have been skew driven with an interval of 0.10–0.25 m. The seams of the strakes are filled with putty. On the outer surface around the seventh and eighth strakes in the starboard side, a longitudinal timber having a semi-circular profile is fixed by iron nails. It is 7.10 m long and runs along the hull. This has been explained to function as a bilge strake to contribute to stability and strength.²⁵ It seems that a part of the rudder stock remains.

10. Bai Jiao shipwreck No.1 wreck site (定海1号沉船)

The site is known as the Dinghai wreck site or the Bai Jiao 1 wreck site.²⁶ The site is located at 3.5 km northeast of Dinghai village on the south of Huangqi Peninsula and north of the Min and Ao rivers' mouths in Fujian Province. It was well known by the locals that from the waters around the Dinghai, a large number of various types of ceramics including bowls, jars, pots, and dishes had been recovered. These ceramics have been dated to different periods ranging from the Tang to Qing Dynasties, and the artefacts probably originate from different sources such as river sedimentation, abandoned cargos, and wreck events. The wreck site was specifically found during shell dredging operations and was inspected in 1989 to assess whether potentially it was suitable as a training site for the China–Australian cooperative programme. In 1990, provisional surveys and test excavations were conducted on the concentration of the ceramics in the site. The majority of the recovered ceramics are black glazed bowls, so-called ten moku or tainmu tea bowls. In 1995, the full excavation was implemented in the extended area adjacent to the 1990 excavation area. During the 1995 excavation, two large metal concretions regarded as originally comprised of iron billets or bars, the concentration of bowls, and some large timbers were identified. The timber lies beneath the concretions and its exposed part measures 1.4 m with a section of 0.28 x 0.30 m, and iron nails and metal concretions were observed on its surface. This timber baulk was not removed during the excavation. However, a small sample of the timber with a tree nail and nail hole was recovered, and some bamboo ropes as well. Due to the evidence of the use of iron nails and tree nails, the sample is regarded as part of the hull of the shipwreck. The species has been identified to pitch pine or yew by Australian researchers. The use of the treenails and wood used for the hull raises suspicions as to whether the ship originated from China. The date of the ship is estimated by a number of black glazed bowls that could have comprised the main cargo of the ship.

11. Nanhai No.1 shipwreck (南海1号沉船)

The Nanhai (South China Sea) No.1 shipwreck is the most known shipwreck attracting people's interest, not only because of its historical significance but also because of its state of preservation of the hull and cargo. The details of this shipwreck, however, are barely available and only in limited resources.²⁷ The shipwreck was accidentally discovered in 1987 by the Guangzhou Salvage Bureau under the Ministry of Communications and a British salvage company, while they were searching for Dutch East India Company's shipwrecks offshore near the Shangchuan

and Xiachuan islands. The significance of the site was recognized after some precious artefacts were recovered, and immediately after that the site was protected. In 1989, the shipwreck site was initially inspected by an international team consisting of the National Museum of Chinese History and an avocational organisation for underwater archaeological survey from Japan. Since 2001, a Chinese team from the Underwater Archaeology Research Center of the National Museum commenced a series of surveys and partial excavations. As a result of the exploration that continued until 2004, a challenging approach was adopted in a way that would raise the ship remains with surrounding sediment for the sake of presenting underwater archaeological excavation work on the shipwreck within a caisson inside a museum. In 2007, a large caisson was placed onto the Nanhai No.1 shipwreck and was recovered containing the shipwreck and its physical seabed context. It was moved to the newly built museum in Hailing Island in Yangjiang city, Guangdong. Almost two decades after the discovery, the entire shipwreck still remaining in the sediments was placed on land. Chinese researchers continue to remove the sediment and expose the hull in the following years in the museum. According to the result of the partial excavation and remote sensing survey that was previously conducted, the estimated size of the burial shipwreck in the caisson measures 30 m long, 7 m wide and 4 m in depth. At this stage, further information about the shipwreck's hull is not available. A number of recovered ceramics originating from Jingdezhen, Jiangxi, Longquan, Zhejiang, Dehua, and Cizao, indicates that the ship was a trader. Many copper coins were also recovered and mainly dated to the Northern Song Dynasty (960–1127). Among them, two coins inscribed as Jianyan Tongbao (建炎通寶) and Shaoxing Yuanbao (紹興元寶) date the wreck to the Southern Song Dynasty (1127–1279). Relevant academic reports have not yet been published, and only partial information about the recovered artefacts is available at this stage.²⁸

12. Huaguang Reef No.1 shipwreck (華光礁1号沉船)

A Chinese underwater archaeology team has conducted underwater archaeological surveys and excavations in the Paracel Islands (Xisha Islands) through the late 1990s. During the seasonal work, thirteen sites dating from the Five Dynasties (907–960) up to the 20th century were identified. They include one well-preserved shipwreck site. The remaining part of the hull was found at the southern-central reef known as a Discovery Reef or Huaguang Reef among the Islands. The shipwreck is named the Huaguang Reef shipwreck No.1. The date of the discovery was 1996, and immediately after locating the hull, the site was disturbed by looters. Through 1998 and 1999, the Chinese team conducted surveys and test excavations. During the operation a total of over 850 pieces of ceramics, ship timbers, and other artefacts was recovered. In 2007, a full excavation commenced, and

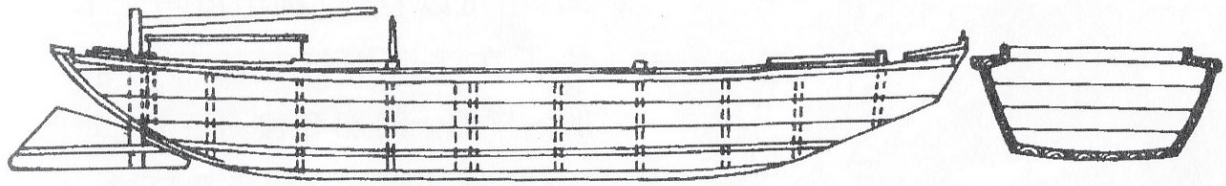


Figure 1.12 Nankai River ship. (Wang 2000)

the preservation status of the hull and the area of the site was assessed. The number of artefacts recovered from this operation is more than 6,000 items, which were more mostly ceramics, including some intact artefacts. During the second season's excavation of the year, a total of 511 ship timbers were recovered. The recovered ship timbers were brought into a museum in the Hainan Island in Guangdong Province for preservation and analysis. Although the detailed information about this shipwreck is not available for researchers outside of the country at this stage, the brief explanation of the site was provided in the international conferences in 2009 by a Chinese government officer.²⁹ According to Yang Zelin from the Institute of Cultural Relics and Archaeology of Fujiang Museum, the remaining hull measures approximately 17 m in length and 7.54 m in width. The preservation state of the hull is very good. Three members of the keel remain. Hull planking shows five layers in some parts. The first and second inner planks were thicker than the other outer planks. Iron nails were used for the hull planking, while the details have not been reported yet. There are ten bulkheads. The seams of the bulkheads' planks show rabbeted joints. There were limber holes in the bulkheads. It has been pointed out that the manner of joining the bulkheads to the hull planks was similar to that of the Shinan shipwreck in the use of the wooden brackets and frames.³⁰ The shipwreck was dated to the Song Dynasty. Some blue and white porcelain pieces were found in the hull, and some ceramics were discovered beneath the shipwreck. A large metal concretion was in the middle of the hull. This shipwreck is as significant as the Quanzhou ship and the Nanhai No.1 shipwreck in terms of comparative analyses of the hull. The official site report is expected to be available in the near future.

Yuan Dynasty (1271–1368)

13. Nankai River ship (南开河船)

In 1975, six river boats were discovered at the ancient channel of the Zhang River vicinity of Nankai village in Ci district, Hebei Province. It has been reported that of the six remains, the No.5 ship shows the most well-preserved state, measuring 16.6 m in length and about 3 m in width (Figure 1.12).³¹ The hull is nearly flat-bottomed with a slight curve in the cross-section of the bottom, hard chine, flared topsides, and has eleven bulkheads. The hull planking is edged-joined, and

the cross section of the hull has side decks and a low coaming. It is said that iron nails are the main fastening method. An axial balanced rudder was found on the hull. The date of the ship was determined to the Yuan Dynasty period based on an inscription on the stern of the No.4 ship remain implying the reign period of the Toghun Temur of the Yuan Dynasty (1320–70). The inscription includes the term *Liang chuan* (粮船), indicative of its use as a cargo ship, and for riverine transportation from the structure. The date of the ship is arguable since the hull remains look modern.

14. Sandaogang Yuan Dynasty wreck site (三道岗元代沉船)

A shipwreck was found by a local fisherman in the place called Shandaogang in the Bohai Sea, southwest of Suizhong district in Liaoning Province. From 1991 to 1997, members of the Underwater Archaeological Research Centre of the National Museum conducted remote sensing surveys and underwater archaeological excavation. Although a ship's cargo has been identified, little information is available about the hull of the shipwreck. According to an official site report, there are no remains of the wooden hulls because of the action of marine borers.³² The area of the distributed artefacts suggests that the dimension of the original ship could be 20–22 m long and 8.5–9 m wide. Despite the loss of the hull, it seems that radiocarbon dating was conducted on a sample of the ship's timber. Its result shows 740 ± 80 BP.³³ The report focuses on the ship's cargo including a large number of porcelain remains, mostly from the Cizhou kiln. They are white and black glazed porcelains with various motifs and their types vary, such as jars, basins, bowls, dishes, lids, and vases.

15. Penglai ship No.1 (蓬莱古船 I 号)

Penglai ship No.1 is the earliest discovered ship of the four ship remains known as Penglai ancient ships. They were found outside of the Penglai Castle at Yantai city in Shandong Province. In 1984, during dredging at Dengzhou harbour, one ship remain was discovered. The shipwreck has been documented in various resources (See Cai, Li, and Xi's article in this report).³⁴ The remaining part of the hull measures 28.6 m long and 5.6 m wide. There is a narrow flat bottom and then a gentle turn to the bilge. It appears that

the cross-section shape above that turn of the bilge is very flared. The well-preserved lower hull includes a keel and thirteen bulkheads. The keel consists of three members that are joined by hooked scarf joints. The lengths of the keel members are: 3.6 m (forward keel), 17.06 m (main keel), 5.58 m (the aft keel). The main keel shows slight hogging. There are recesses for placing mirrors or coins in the keel joints. The keel scarfs are reinforced by hog pieces fitted on the top of the keel. The most well-preserved bulkheads No.3 and No.5 consist of four planks and are 0.16 m thick on the average. A part of the upper surface of the three lower planks is rabbeted to form a tongue and groove joint, and the upper most bulkhead planks have four holes that could be used to place longitudinal timbers through the hull. Each bulkhead plank is joined by four sets of mortises and tenons, and iron clamps appear to fasten the lower and upper bulkhead planks. There are two limber holes in each bulkhead, about half a metre from the keel on either side. The bulkheads located forward show that half-frames are attached to their aft side and iron brackets are used for their fixing; bulkheads hull planking is also attached to their forward side. The reverse arrangement is practised on the bulkheads located aft of midship: they have half-frames on the forward side and iron brackets on the aft side. Ten strakes remain on the port side and eleven strakes remain in the starboard side. The dimension of the hull planks is from 3.7 to 18.5 m in length, 0.20 to 0.44 m in width, and 0.12 to 0.28 m in thickness. Starboard strakes show the greatest thickness; indeed they are baulks rather than planks. The hull planking is edge-joined by two different types of square iron nails including large edge driven nails and bent skewed nails. The hull planks are joined to make up strakes with hooked scarf joints having mortise and tenon ends. Propulsion of the ship is evidenced by two mast steps remaining on the hull. A forward mast step having two recesses with a size of 0.20 x 0.20 m to receive tabernacle cheeks is located on the forward side of Bulkhead No.2, measuring 1.6 m long athwartships. A main mast step having two recesses with a size of 0.26 x 0.26 m is located on the forward side of Bulkhead No.7, measuring 2.88 m thwartships. A transom consisting of three timbers has a rudder stock hole (rudder trunk) with a diameter of 0.30 m. Discovered artefacts from the ship include five iron grapnels, a wooden anchor, three stone anchors, ropes, 489 Chinese ceramics, a few Korean ceramics, and Japanese coins. From the discovered ceramics and the study of sedimentation where the hull was discovered, it has been concluded that the ship was built around the end of the Yuan Dynasty and was used into the early Ming Dynasty.³⁵ Considering the historical background of the Penglai Castle and a few weaponry artefacts discovered inside the hull, Chinese researchers speculate that the ship could have been used as a

battle ship, referring to a ship mentioned as “Daoyu Zhanzhao” (Sword-fish battle ship 刀鱼战棹), and in the Qing Dynasty’s historical text, “Penglai Xianzhi” (History of Penglai).

Ming Dynasty

16. Liangshan Ming Dynasty ship (梁山明代船)

In 1958, a well-preserved ship was discovered near a channel of Songjin River at Heihumiao district in Liangshan, Shandong Province. The ship has been reviewed in a few resources.³⁶ The ship remains are said to be of the most intact condition among ship remains ever discovered in China.³⁷ The intact condition allowed scholars to reconstruct the original configuration of the hull. It is 21.9 m long, 3.49 m wide at deck level, 1.24 m deep with a draught of 0.75 m, and with a displacement of 31.96 tonnages. The hull has a flat bottom and bulkheads. Nine planks compose the bottom of the hull. Three planks at the centre have a thickness of 165 mm while the other planks have a thickness of 80 mm. Twelve bulkheads divide the hull. Bulkhead No.8 is the largest and consists of five planks. The bulkheads have two limber holes each located next to either side of the three centre bottom planks. The use of half frames has been indicated, yet they have not been confirmed in the original position.³⁸ Hull planking is comprised of eight strakes and an extra wale (or fender) is attached. The planking up to the deck level is flush constructed. There are side decks surmounted by a coaming which is supported by the bulkheads — the bulkheads are built right up the height of the top of the coaming. Butts of the hull planks appear to be of a hooked scarf joined: the same technique as the Penglai ship. Iron skewed nails are used for hull planking and the joints of bulkhead planks. A forward mast step is located at the front of the Bulkhead No.3 and a main step is located at the front of the Bulkhead No.7. When the ship was discovered, a number of artefacts were also recovered, including weapons, harnesses, metal wares, ceramics and an iron grapnel. The time period of this ship was determined from some artefacts, such as copper coins and the date inscribed on the bronze gun and the anchor associated with the reign of Hongwu (1368–1398). It has been pointed out that the appearance of armed river crafts occurred in the early Ming Dynasty.³⁹ The overall configuration and structure of this ship bear remarkable similarities with watercrafts for riverine use during the 20th century in China.

17. Xiangshan Ming Dynasty shipwreck (象山明代沉船)

In 1994, the remains of a Ming Dynasty ship were found in the silt area of an ancient harbour around Qibu village in Xiangshan, Zhejiang Province. From 1995, the Archaeological Research Institute of Ningbo conducted an excavation of the ship (Figure 1.13).

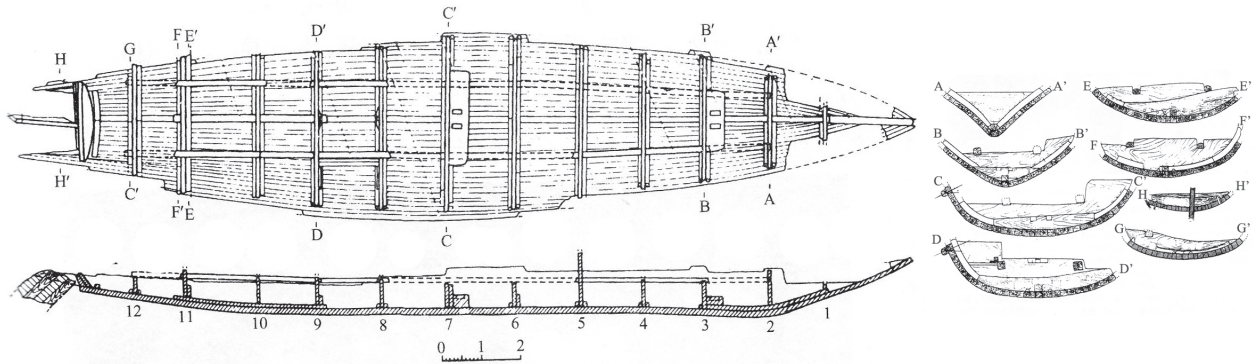


Figure 1.13 Plan of Xiangshan Ming Dynasty shipwreck. (Reproduced from Xi, Yang, *et al.* 2004)

The remaining part of the hull measures 23.7 m in length and 4.9 m in width and includes a keel and bulkheads.⁴⁰ The cross section shows a rounded bottom with sharper sections in the bow. The details of the keel have not been reported, yet it seems that the keel consists of three timbers. On each posited joint in the keel, there is a hog piece like those observed on the Penglai ship. Twelve bulkheads divide the hull and two or three broad bulkhead planks remain in each bulkhead. Some of the second bulkhead planks have two square holes with a size of 0.18–0.20 m x 0.14–0.20 m to place two timbers longitudinally running through the hull. The bulkhead planks in the bottom have two limber holes. There are frames attached to the bulkheads. The distribution of the frames has not been clearly explained but it seems from the drawings that most bulkheads have frames on both the forward side and the aft side. The frames attached to the bulkheads seem to have been fastened to the hull planking by iron nails. A large number of hull planks remain, counting a total of 17 strakes per side through the mid-body of the hull. The dimension of the planks is 140–160 mm in thickness and 80–200 mm in width. They are baulks rather than planks. The hull planking is edge-joined and fastened by iron nails, though the details of iron nails and the pattern of fastening are unclear. The seams of the hull planking were caulked with hemp and are secured by a putty of tang oil and lime. The hull planking extends beyond the aft transom where a part of the rudder remains. A forward mast step remains on the forward side of Bulkhead No.2 and a main mast step remains on the forward side of Bulkhead No.7. From the bottom of the hull, besides bricks and roofing and ridge tiles, a few ballast stones were found. The date of the ship was determined from discovered ceramics including a porcelain bottle with a small mouth dating to the Yuan Dynasty period and a few celadon from the Longquan kiln dating to the early Ming Dynasty. The purpose of the use of the ship has not been identified. It was either a local cargo ship used by private merchants or a battle ship employed by the government. It is said that the ship is in most respects similar to Penglai ship No.1.⁴¹

18. Penglai ship No.2 (蓬莱古船II号)

The remaining part of the hull of the Penglai ship No.2 measures 21.5 m (or 22.5 m) long and 5.2 m wide. Although the stern is missing, the bottom of the hull is relatively well-preserved and the remaining part includes a keel, some bulkheads and eleven strakes in each side (Figure 1.14). Details of the hull including the dimensions of the remaining planks are available in the archaeological report with other detailed information about the hull.⁴² The cross section of the bottom hull shows some hollow around the bow, and these changes to a rounded shape through the mid-body. The keel shows slight hogging. The keel is comprised of three members: 4.78 m (forward keel), 16.20 m (main keel). These are joined by hooked scarf joints with mortise and tenon. In the joints, there seems to be a hole for the placement of a mirror or coins evidencing the practice of the shipwright's belief. Iron straps and iron nails are used to fasten the forward and main keel. A hog piece is fitted on top of each joint and large iron nails are driven from them down through the keel. The sides of the main keel are rabbeted and thick planks (garboard planks) are fitted using a mortise and tenon joint. Although the ship originally has had thirteen bulkheads, only six bulkheads remain. There are limber holes from the Bulkhead No.3 to No.7, yet Bulkhead No.2 and No.8 do not have limber holes due to mast steps located at their forward faces. The lower and upper part of each bulkhead plank is fashioned for a tongued and groove joint and they are joined with mortises and tenons (loose tenons). Skewed iron nails are also driven into the seams of the bulkhead planks. Frames are used to fix the bulkheads and hull planking together, fastened by iron nails. Using iron brackets to fasten the hull planking to bulkheads is evidenced on the Bulkheads No.2, No.3 and No.7, although these brackets are mostly degraded. Only corroded iron remains in the recesses of the surface of the bulkhead planks into which the brackets have been slotted. The joint pattern of the hull planking shows the same method with the Penglai ship No.1 and uses

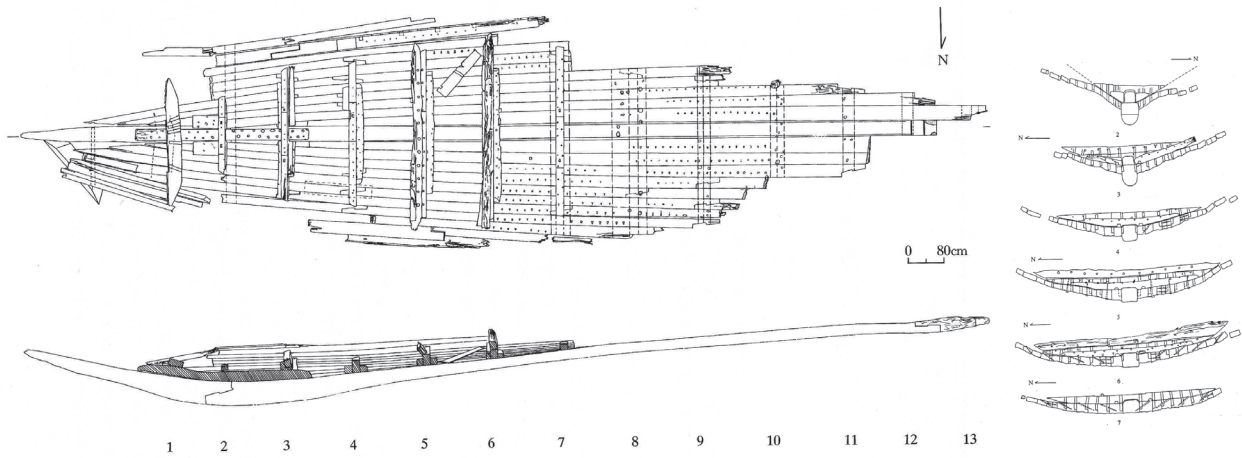


Figure 1.14 Plan of Penglai ship No.2. (Cultural Relics and Archaeological Institute of Shangdong Province, Yantai Municipal Museum., et al. 2006)

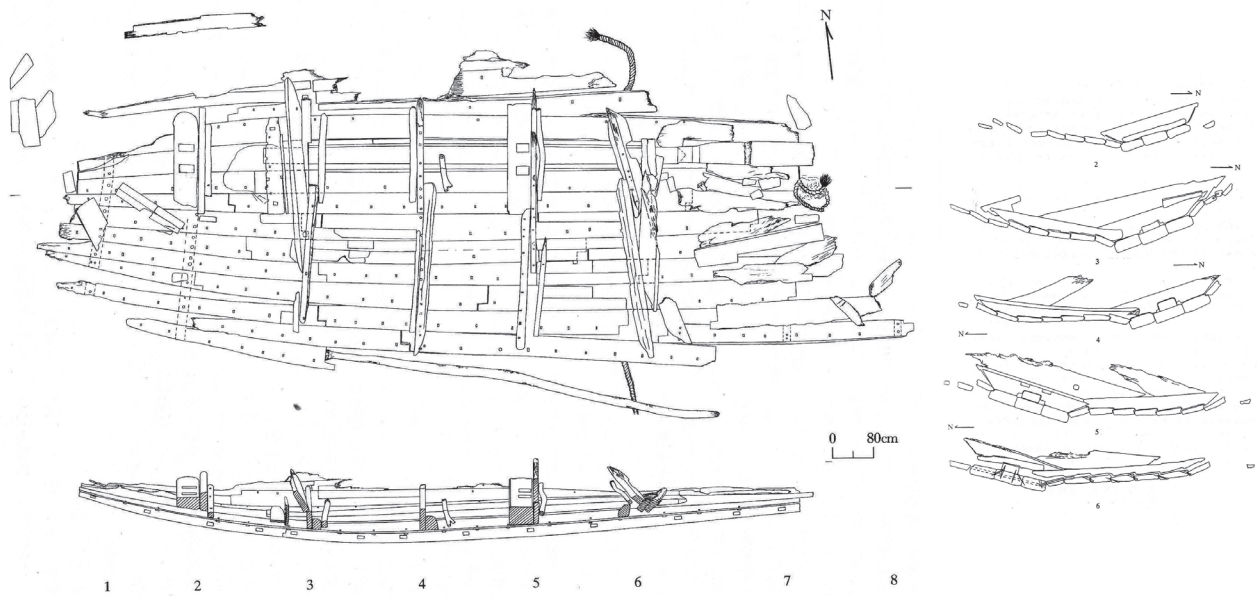


Figure 1.15 Plan of Penglai ship No.3. (Cultural Relics and Archaeological Institute of Shangdong Province, Yantai Municipal Museum., et al. 2006)

large edge driven nails and bent skewed nails. The mast steps are fixed to the hull planking by iron nails. The length athwartships of the forward mast step is 1.9 m with two square recesses measuring 160 x 225 mm. The main mast step is missing. The Penglai ships No.1 and No.2 have been evaluated as the same type of ships.

19. Penglai ship No.3 (蓬莱古船III号)

Ship remains were identified just next to the Penglai ship No.2. However, the two ships are distinguishable in their structure. The remaining part of the hull measures 17.1 m long and 6.2 m wide and includes bottom planks, bulkheads, and hull planks, though the stern is missing (Figure 1.15). Details of the hull including dimensions of the remaining planks are

available in the archaeological report with other detailed information about the hull.⁴³ The structure of the bottom hull and hull planking shows remarkable similarities with Korean shipwrecks discovered in Korean waters (see the section below). The hull has a flat bottom consisting of three strakes. The planks of the strakes are joined together by transverse wooden bars or dowels. Thirteen bars are used in the extant portion of the ship's bottom. Wooden nails seem to be driven from the centre bottom planks to the sided planks in a few places. The structure of the bottom planks and their fastening methods are similar to those observed on the Korean origin shipwrecks. However, an extra plank placed on top of the centre bottom plank and its fastening method using edge driven iron nails have not been found on the Goryeo Period's Korean ships. Three strakes remain in the portside

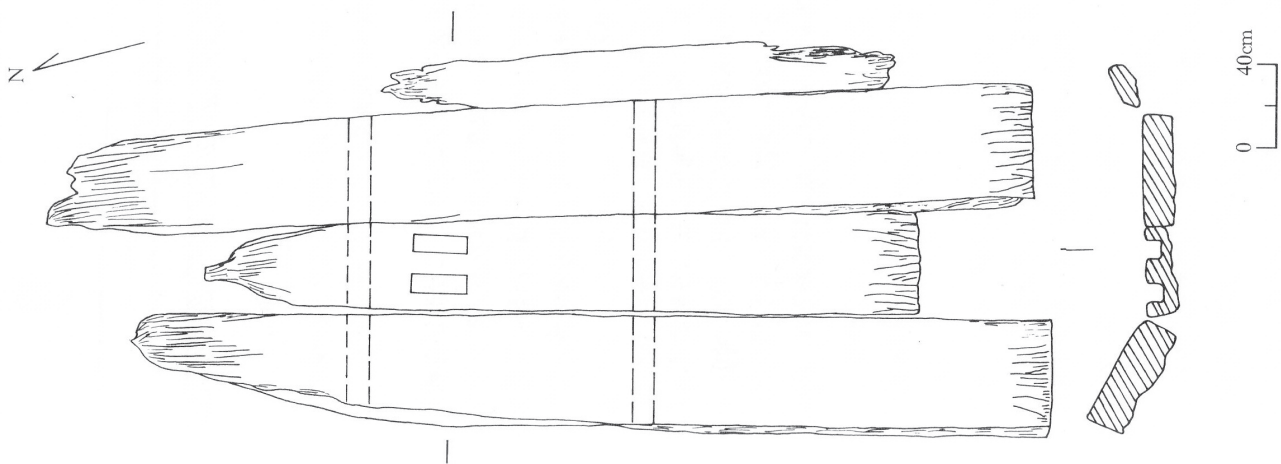


Figure 1.16 Plan of Penglai ship No.4. (Cultural Relics and Archaeological Institute of Shandong Province, Yantai Municipal Museum., *et al.* 2006)

and nine strakes remain in the starboard side. The first strakes are fitted into rabbets on the upper edge of the side bottom planks and appear to be fastened with mortises and tenons (or dowels). The hull planking is a form of clinker-built with rabbeted seams. Skewed wooden nails are driven from the outer surface of the upper planks into the lower plank through the rabbeted seams. Butts of the hull planking are held together by lap-joints. Also, iron nails are used to fasten the hull planking. Bulkheads, which are not used in the Korean shipbuilding tradition, are the main structures for the transversal strength of this ship. Five bulkheads remain and they are regarded as the second to sixth bulkheads. One to five remain. More than eight bulkheads have been originally used. The bulkheads' bottom planks have a recess in their bottom that fits to the extra plank onto the centre bottom plank and also creates limbers. Bent skewed iron nails are used to fasten bulkhead planks as well as to fix the hull planking and bulkheads together. Frames are attached onto some of the bulkheads and the bent skewed iron nails are used to fasten the hull planking to the frames. Intensive use of iron nails is unusual in the traditional Korean shipbuilding. The use of different types of the wooden bars, mortises and tenons, nails and iron nails is emphasized in a comparable study on the Penglai Ship No.2 and No.3.⁴⁴ The forward and main mast steps that have two recesses are identified at the second and fifth bulkheads. The ship was discovered in almost the same elevation as the Penglai Ship No.2, indicative of the contemporary use of the two ships.

20. Penglai ship No.4 (蓬莱古船IV号)

A few ship timbers were discovered about twelve metres away from the No.2 and No.3 ships. Only four timbers remain, yet they clearly show identical features with the Penglai ship No.3 (Figure 1.16). According

to an archaeological report, of the four timbers, three are the bottom planks forming a flat bottom.⁴⁵ The dimension of the remains of the centre bottom plank is 3.46 m long, 0.20–0.44 m wide, and 0.16–0.20 m thick. It has two recesses that could receive tabernacle heels directly, instead of using a mast step. This arrangement is well-evidenced on the discovered shipwrecks of the traditional Korean coastal ships as discussed below. Two bottom planks are positioned, one on each side of the centre bottom plank. The dimension of the remaining part of the two planks measures 4.8 m in length, 0.26–0.52 m in width, and 0.10–0.22 m in thickness. The upper edges of their outer parts appear to be recessed to place strakes. The three bottom planks are fixed by two wooden bars. One timber regarded as a part of the hull planking was found and another large timber measuring 9.24 m long was found away from the four timbers and also regarded as a hull plank. It is disputable if the Penglai ship No.4 had hybrid features like the No.3's bulkhead structure, and the use of both iron and wooden fastenings. Besides many distinctive structural features between the ship remains adopting Chinese traditions (Penglai ship No.1 and No.2) and the ship remains adopting Korean traditions (Penglai ships No.3 and No.4), the assemblage of woods used for each tradition shows differences. The Penglai ship No.1 and No.2 use more different types of wood in the hull structure. In contrast, the kinds of wood used for the main structure of the Penglai ships No.3 show less diversity, and most parts of the hull use pine.

Qing Dynasty

21. Baolian Harbour shipwreck (or known as Hainan Wenchang shipwreck) (宝陵港沉船)

The Agency for Cultural Affairs in Hainan Province discovered one old shipwreck in the waters of Baoling Harbour in Wenchang in 1987. While an Underwater Archaeology Team from

the National Museum was conducting a survey on the shipwreck in 1990, it identified a remain of the shipwreck that has been substantially covered by sediment. Large concretions were found on the sites and contained some metal remains consisting of iron pans and copper drums. Also, miscellaneous artefacts, such as some ceramics, a copper candle stick, silver ingots, and copper coins were found inside the concretions. It is said that remnants of hull planking were identified under the concretions, yet the details have not been made available.

22. Shantou Guangao shipwreck (or known as Nangao No.1 shipwreck) (汕头广澳沉船)

In 1995, members of the National Museum of Chinese History conducted an underwater survey in Guangao Harbour in Shantou city, Guangdong Province and found one shipwreck. On the seabed, its keel and frames were exposed, yet most parts of the hull have still been covered by sediments. During the inspection, copper alloy seals were found and their inscriptions indicate that the ship probably dates back to the 17th century.

23. DongguMingzheng wreck site (冬古明郑沉船)

The site was identified by a local museum in Dongshan district in Fujian Province in 2000. As result of underwater survey, four bronze guns, two iron muskets, a set of bullets and gun powders, and ten pieces of ceramics and some ship timbers were recovered. The discovered ceramics are blue and white porcelains from the Zhangzhou kiln, likely to be dated to the end of Ming Dynasty or the early Qing Dynasty

24. JinjingShenhu Bay wreck site (晋江深沪湾沉船)

A municipal museum in Jinjiang in Fujian Province inspected the shallow waters of Shenfu Bay and found the wreck site. Discovered artefacts include a large bronze cannon that has been cast in Wenzhou, an iron gun, fragments of copper alloy drums, and a few other metal objects, such as a spoon, a sword handle, and ingots. From the inscription on the discovered white porcelain, the date of the site was determined to have been at the end of the Ming Dynasty or the Qing Dynasty.

25. Wanjiao No.1 wreck site (碗礁1号沉船)

The site was discovered at the Wanjiao reef which is a part of Wuzhou reefs offshore of Yutou at Pingtan district in Fuzhou city in 2005. Immediately after the discovery the site was looted, such that an underwater archaeological excavation was conducted and directed by the Underwater Archaeology Research Center of the National Museum

cooperative with regional government agencies. As a result of the excavation, 17,000 ceramics, which mostly consist of the blue and white porcelains from the Jingdezhen kiln dating to the mid-period of the reign of Kangxi Emperor (1661–1722), were recovered and also an ink stone and copper coins were found. Despite the discovery of this great number of artefacts, the site has been substantially destroyed by looters since it was shallowly buried in the seabed in a depth of 13–15 m. Many artefacts as well as the hull went missing. An archaeological report lists the major types of ceramics from the site, yet no information about the hull is available.⁴⁶

Bulkhead structure in the excavated ships in Southeast Asia

The use of bulkheads has been recognized as a lasting characteristic of the Chinese shipbuilding tradition. In developing the data of ship remains in China, bulkheads are identified as early as in the Tang Dynasty's riverine ships. During the Song Dynasty, it is presumed that Chinese merchants made inroads into trade with Southeast Asian regions on their own initiative. This suggests an idea of examining the possible influence of Chinese shipbuilding in Southeast Asia. It has been known from previous studies that some identified shipwrecks from Southeast Asia have some similarities in the hull structure and construction methods with Chinese ships.⁴⁷ Since the 1980s, underwater archaeological excavations have been implemented in some countries of Southeast Asia. Many of the discovered ships in the Philippines, Thailand, and Indonesia indicate an influence from the Chinese shipbuilding tradition, represented in the use of bulkheads. An inventory of those ship remains in several Southeast Asian countries is developed in the Shipwreck ASIA project through cooperating with local experts (Table 4, 5 & 6). In the Philippines, some underwater sites are dated to the Song Dynasty period, yet the hull remains are not identified. In Indonesia, a site known as the Pulau Buaya wreck is identified to the Song Dynasty. While various artefacts recovered from the site assembled cargo dating to the Song Dynasty's ships, whether they have originated from Chinese built ships has not been clarified. It is well known that Chinese commodities have been distributed by seaborne trading since the Tang Dynasty. A question remains as to the time period that Chinese merchants started to use their own built ships.

Conclusion

Data presented in this paper resulted from a database approach implemented in the "Shipwreck Asia" project. In general, a database is understood as a useful instrument

Country		Philippines										
Site	Discovered Location	Dating	Origin	Status of Hull remains	Preservation Status	Year Discovered	Salvaged	Surveyed	Excavated	Purpose		
Butuan (Balangays) No.1	Butuan, Agusan Valley, Mindanao	320?	Philippines	Low	Chemical Conservation	1976	No	No	Yes	Coastal transportation?		
Butuan No.2	Butuan, Agusan Valley, Mindanao	1250?	Philippines	Medium	Chemical Conservation	1986?	No	No	Yes	Coastal transportation?		
Butuan No.5	Butuan, Agusan Valley, Mindanao	1215?	Philippines	Low	Chemical Conservation	1986	No	No	Yes	Coastal transportation?		
Breaker Reef wreck	Breaker Reef, Palawan	N/A	Song Dynasty?	N/A (No hull remains)	N/A	1991	Yes	No	Yes	Trader?		
Investigator Shoal wreck	Investigator Shoal, Palawan	N/A	Yuang Dynasty	N/A (No hull remains)	N/A	1990	Yes	No	Yes	Trader?		
Lena Shoal wreck	Lena Shoal, Busuanga, Palawan	N/A	Ming Dynasty	High	Non-treatment	1997	Yes	No	Yes	Trader		
Marinduque wreck (junk)	Gaspar Island, Gasan, Marinduque	N/A	Ming Dynasty? or Siam origin?	Low	Non-treatment	1980	Yes	No	Yes	Trader		
Pandanan wreck	Pandanan Island, Palawan	15th century	South China Sea/Vietnamese?	N/A (No hull remains)	N/A	1993	Yes	Yes	Yes	Trader		
Puerto Galera wreck	Puerto Galera, Mindoro	N/A	South China Sea?	N/A (No hull remains)	N/A	1983	Yes	No	Yes	Trader		
Santa Cruz wreck	Sta, Cruz, Zambales	Late 15th century	South China Sea	High	Non-treatment	2001	Yes	No	Yes	Trader		
San Isidro wreck	San Isidro, Zambales	16th century	Southeast Asia?	Low	Non-treatment	1996	Yes	No	Yes	Trader		

Table 4.

Country	Thailand										
	Site	Discovered Location	Dating	Origin	Status of Hull remains	Preservation Status	Year Discovered	Salvaged	Surveyed	Excavated	Purpose
	Ko Rang Kwien Shipwreck	About 800 m north from Rang Kwien island, West of Bang Saree Bay	14-early 15th century	N/A	Low	Non-treatment	1978	N/A	Yes	Yes	Oceangoing Trade
	Bang sak shipwreck	1.6 km from Thabiatwan beach, Phang Nga	Radio carbon date of 760±220 B.P	N/A	Low	Non-treatment	2008	N/A	Yes	No	N/A
	Ko Si Chang 1	Ko Sichang, Chonburi	Late 16th century	N/A	Low	Non-treatment	1982	N/A	Yes	Yes	Oceangoing Trade
	Ko Si Chang 2	Ko Sichang, Chonburi	14-15th century	S.E.A	Low	Non-treatment	1982	N/A	Yes	Yes	Oceangoing Trade
	Ko Si Chang 3	Ko Sichang, Chonburi	Mid 16th century	Siamese?	Low	Non-treatment	1985	N/A	Yes	Yes	Coastal trade
	Ko Khram or Sattahip Shipwreck	Near Ko Kram Island which faces Sattahip Bay, Chonburi	1450-1475	N/A	Low	Non-treatment	1974	N/A	Yes	Yes	Oceangoing Trade
	Klang Aow 2	At the middle in the gulf of Thailand, 62 Miles from Sattahip Chonburi	16th century	N/A		Non-treatment	2004	N/A	Yes	No	N/A
	Hin Bush wreck site	N/A Rayong province?	16th century	N/A	Low	Non-treatment		N/A	Yes	Yes	Oceangoing Trade
	Ko Kra	14 km from Ko Kra, 94 km from Pak Panang	16th century	N/A		Non-treatment	2005	N/A	Yes	No	Oceangoing Trade
	Ko Tao	N/A	16th century	N/A	Low	Non-treatment	2009	N/A	Yes	No	
	Klang Aow 1 Shipwreck	At the middle in the gulf of Thailand, 55 miles from Sattahip Chonburi	1500-1530	N/A	Low	Non-treatment	1991	N/A	Yes	No	Oceangoing Trade
	Ko Kraat Shipwreck	1 km north of the northern end of the island in Trad	1522-1566	S.E.A	N/A (No hull remains)	Non-treatment	1977	N/A	Yes	Yes	Oceangoing Trade
	Ko Rin wreck site	N/A	1558-1757	N/A	N/A (No hull remains)	N/A	1988	N/A	Yes	No	N/A
	Ko Samae San Shipwreck	N/A	1658-1857	N/A	N/A	N/A	1985	N/A	Yes	No	Jettison
	Ko Samui Shipwreck	In the waters between Samui island and Tan island	1658-1857	N/A	Low	Non-treatment	1984	N/A	Yes	Yes	Oceangoing Trade
	Prachuap Khiri Khan wreck site	N/A	1558-1757	N/A	Low	N/A	1987	N/A	Yes	No	N/A
	Pattaya Shipwreck	In the waters between Pattaya beach and Lan island	1558-1657	N/A	Low	Non-treatment	1977	N/A	Yes	Yes	Oceangoing Trade
	Rayong wreck site	N/A	1657-1757	N/A	N/A	N/A	1977	N/A	Yes	No	N/A
	Nakhon si Tammarat	N/A	450 B.P/carbon 14	N/A	N/A	N/A	1978	N/A	Yes	No	N/A
	Bangkachai I	Bangkachai Bay	N/A	N/A	N/A (No hull remains)	Non-treatment	1989	N/A	Yes	No	N/A
	Bangkachai II	In the waters 2 km away from the seashore, Bangkachai Bay	Early 17th century	Siamese?	Low	Non-treatment	1992	N/A	Yes	Yes	Oceangoing Trade
	Samed Ngam	At the riverbank around the mouth of Hanthaburi river, Tambon Samedngam Aumper Muang, Chanthaburi province	18th-19th century	Fujian junk?	Low	Covered the ship by roof and soak it in fresh water at Local site museum.	1982	N/A	Yes	Yes	Oceangoing Trade

Table 5.

Country		Indonesia										
Site	Discovered Location	Dating	Origin	Status of Hull remains	Preservation Status	Year Discovered	Salvaged	Surveyed	Excavated	Purpose		
Cirebon Wreck	Nothern Java Sea	973	Five Dynasty Period, Arab or India origin?	Low	Non-treatment	2003	Yes	Yes	No	Cargo for Trade		
Belitung shipwreck	"Offshore Belitung Island"	9th century?	Arab or India origin?	High	Non-treatment	1998	Yes	Yes	No	Trader		
Intan Shipwreck	N/A	10th century?	Arab or India origin?	High	Non-treatment	1997?	Yes	Yes	No	Trader		
Java Sea Shipwreck	N/A	13th century?	Indonesian origin?	Low	Non-treatment		Yes	Yes	Yes	Indonesian trader		
Pulau Buaya Wreck	Pulau Buaya – Kepulauan Riau	1300s	Song Dynasty	N/A (No hull remains)	Others	1989	Yes	Yes	No	Cargo for Trade		
Belamakan Shipwreck	Belamakan waters, Subang, West Java	14th century	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
Bukit Jakes Shipwreck	Bintan Island	1400-1460	Ming Dynasty	High	In situ preservation	1981?	No	Yes	Yes	Trader		
Teluk Sumpat Wreck	Bintan Island	1700s	Yuan and Ming Dynasties	N/A (No hull remains)	Non-treatment	2005	Yes	Yes	Yes			

Table 6.

to store and share the information and contributes to the development of a regional cooperation in both archaeological research and underwater cultural heritage management. As represented by the states of Korea, China, and Thailand, some achievements in maritime and underwater archaeology in Asia occurred in the last two decades. Of maritime archaeological study, however, shipwreck and ship remains themselves have been lagging behind, compared to the international study regarding their cargo and trading commodities. Considering the past achievements in each state, it becomes more meaningful to analyse archaeological remains of Asian ships inclusively by taking a comparative approach. The collective data in the project is expected to be used as an inventory. Further details of each identified ship remains in the project are expected to be pursued by individuals with their own research themes.

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